Environmental Protection Agency (EPA) Methane White Paper

Oil and Natural Gas Sector Compressors

INGAA Comments

1. Introduction

The Interstate Natural Gas Association of America (INGAA), a trade association of the interstate natural gas pipeline industry, submits these comments on the EPA's technical white paper, "Oil and Natural Gas Sector Compressors" (Compressor Paper). On April 15, 2014, the EPA released five technical white papers discussing potentially significant sources of emissions in the oil and natural gas sector. Specifically, the white papers focus on potential emissions and mitigation techniques for methane and volatile organic compounds (VOCs). INGAA is submitting separate comments on the three papers (Compressors, Leaks and Pneumatics) that address sources applicable to the interstate natural gas transmission and storage (T&S) sector. These comments address the Compressor Paper.

In the Compressor Paper, EPA summarized its current understanding of vented VOC and methane emissions from this source category, and its understanding of available mitigation techniques and the cost, effectiveness and application of these techniques in the oil and natural gas sector. EPA has requested comment on 12 questions related to the contents and conclusions of the Compressor Paper.

INGAA and its member companies have a long history of working collaboratively with a variety of stakeholders on numerous greenhouse gas (GHG) related issues, including methane quantification and mitigation. As such, INGAA welcomes the opportunity to contribute its knowledge of emissions and available control technologies. INGAA commends EPA for involving stakeholders and inviting comment on the methane white papers.

Executive Summary

INGAA has three general points in response to EPA's white papers. First, there are significant differences in the methane emission estimates produced by EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (the National Inventory) and the Subpart W portion of its Greenhouse Gas Reporting Program (GHGRP).[1] There also are significant gaps in the information available. EPA needs to develop a systematic program to reconcile these differences and fill the gaps in order to support further discussion on methane reductions. Second, INGAA recommends additional discussion and analysis of the implications, including costs, of potential mitigation methods. Finally, EPA should recognize that new information will be available soon to supplement this discussion.

[1] *See* http://www.epa.gov/ghgreporting/ and http://www.epa.gov/ghgreporting/reporters/subpart/w.html (Starting with the 2011 calendar year for Subpart W, the GHGRP requires pipeline companies to submit annual reports of GHG emissions for subject facilities. Pipelines must submit 2014 emission information for the fourth annual report by March 31, 2015).

In response to the Compressor Paper specifically, INGAA offers the following comments:

1. EPA should review the data for centrifugal compressors. There is a significant disparity in reported emissions between the National Inventory and Subpart W for centrifugal compressors. EPA should resolve this issue before contemplating mitigation methods.
2. EPA should consider additional mitigation approaches for rod packing. Specifically, INGAA recommends condition-based maintenance for rod packing as an alternative to maintaining or replacing rod packing on a prescribed schedule.
3. Finally, EPA should acknowledge that almost all new compressor units use dry seals and therefore wet seals as a source of emissions should no longer be a focal point of the discussion.

INGAA welcomes the opportunity to contribute to this discussion.

Overview of INGAA Responses

INGAA has attempted to answer each question to the best of its ability. Due to time and other limitations, however, INGAA has not answered all questions fully. For some questions, INGAA could not respond completely because this would require a significant long-term effort (e.g., a research program) that includes all stakeholders. For example, questions regarding technology prevalence, cost implications and technical feasibility impacts would entail an integrated research effort to provide a quality, validated and vetted answer. In most cases, however, INGAA has provided a thorough response with the information available while noting the gaps in existing data. Whenever possible, INGAA offers specific examples of field conditions and industry experience. Appendix A provides a quick reference to EPA's questions on compressors and INGAA's response.

2. Establish an Open Process that Involves All Stakeholders to Further Examine Methane Reduction Issues

Other than the Natural Gas STAR program, EPA has focused its oil and gas industry GHG efforts primarily on quantifying or estimating methane emissions. EPA must consider a number of issues, including economic, operations and environmental issues as it moves toward a broader methane strategy.

INGAA envisions a process that is transparent and inclusive of industry and other stakeholders to examine issues and potential strategies. This has proven effective at other federal agencies and for other EPA regulations. For example, EPA could host technical conferences similar to those convened by the Federal Energy Regulatory Commission (FERC) to examine critical issues prior to initiating a rulemaking.[2]

[2] FERC typically holds public technical conferences to gather information on important policy issues and to hear potentially competing positions in advance of issuing significant rulemakings. For example, in 2012-2013, FERC held a series of technical conferences to explore issues surrounding the increased use of natural gas for electric power generation and issues that may impede coordination between the gas and electric industries. After considering discussions raised by interested stakeholders at the 2012-2013 technical conferences, and subsequent public comments, the FERC initiated two rulemakings that propose to address concerns raised by participants at the technical conferences. Technical conferences provide the benefit of educating the regulator and other stakeholders on a particular issue and facilitating a structured dialogue where stakeholders can debate the effectiveness or need

This process would provide an efficient and effective means to advance the current understanding of methane emissions and how to design effective programs. As an example, the EPA GHGRP is intended to develop improved GHG inventories and to inform policy decisions.[3] Subpart W of the GHGRP addresses T&S segment emissions from vents and equipment leaks and companies have submitted three years of data to date. Data is publicly available for the 2011 and 2012 reporting years,[4] and indicate significant differences between Subpart W reporting and the National Inventory[5] for T&S sources. These differences are due in part to differences in scope but also other reasons. It is very important that these differences are understood and that a single, accurate inventory is in place before EPA or industry can develop and implement effective and efficient mitigation strategies. These proposed technical conferences or workshops can provide EPA and industry the platform to discuss these important issues so that EPA's future methane reduction policies reflect all relevant analysis.

3. Sources of Information on Emissions and Reduction Opportunities[6]

EPA has requested comment on whether the Compressor Paper appropriately characterizes the different studies and data sources. INGAA agrees that it is important to understand the sources of methane emissions, how those emissions are measured and reported, what reduction opportunities exist (and what is the cost associated with these opportunities). While the Compressor Paper provides a summary of several sources of information, the paper does not reflect the full breadth of valuable information available to EPA on the topic. Further, while the studies have been summarized, they are neither compared nor contrasted with each other or with other sources of similar information. It would have been valuable for EPA to provide a tabular summary that presents the primary results from each study in common engineering units in order to identify data gaps and inconsistencies. While it may not have been the intent of the Compressor Paper to compare or contrast information, such an exercise is necessary to determine if a particular study appropriately characterizes the data available. Further, a comparison of the studies would help identify conflicts and data gaps in the information.

Due to the limited comment period, INGAA did not have time to develop a definitive analysis of the various studies listed or a list of key studies that were not included. However, more detailed discussion below provides examples of data gaps or differences in the primary tools that are being used to inform the process (e.g., differences between Subpart W reporting and the National Inventory).

In general, INGAA views the Compressor Paper as a summary of *some* information, but not the full range of studies and data sources currently available. EPA's characterization that the studies

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for prospective action prior to the issuance in a proposed rulemaking. Often technical conferences can reveal stakeholder support for certain initiatives, identify potential flaws in certain proposals, and identify alternative ways to address the regulator's or stakeholders' concerns.

[3] *See* 40 C.F.R. Part 98 (2014).

[4] EPA publishes GHGRP reporting results through its data publication tool, Facility Level Information on GreenHouse gases Tool (FLIGHT); see http://ghgdata.epa.gov/ghgp/main.do

[5] *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*, EPA 430-R-14-003 (April 2014). This report presents the U.S. national GHG inventory from 1990-2012 for anthropogenic sources (i.e., associated with human activity) and is referred to as the "National Inventory" in these comments. The report is updated annually.

[6] This section generally responds to Compressor Paper questions 1 and 2.

presented in the paper are pivotal suggests that EPA considers them key to understanding these issues. INGAA would caution EPA against placing excessive weight on this limited information since other studies, not referenced in the Compressor Paper, may be based on the same or similar data sets but reach different conclusions.

INGAA also urges EPA to elaborate on how it arrived at its cost analysis for mitigation measures. Cost estimates are sensitive to assumptions and inherent data inconsistencies. Costs vary over time and with location and chosen technology. As presented by EPA, the 2014 study by ICF, *Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries*, (ICF paper),[7] appears to be the primary source of information on evaluating cost-effective emissions reduction opportunities. However, the ICF paper has several limitations such as only including emissions mitigation options for a subset of emission sources, only addressing one mitigation technology or work practice for these select sources (i.e., alternatives are not addressed), and generally not addressing uncertainties or presenting ranges associated with emission mitigation costs and performance. Further, several other sources of similar information have not been referenced. In fact, cost-effectiveness has been examined by a number of organizations such as the International Petroleum Industry Environmental Conservation Association (IPIECA)[8] and the Intergovernmental Panel on Climate Change (IPCC).[9] Cost effectiveness has also been a topic during the United Nations Framework Convention on Climate Change (UNFCCC) events. Given the significance of understanding the costs associated with various methane reduction technologies in crafting a comprehensive cost-effective reduction strategy, the Compressor Paper should expand the discussion to describe more fully the body of available information, including key parameters and assumptions that impact cost analyses.

Other issues associated with the listed studies have not been fully vetted in the available time for comment. For example, the ICF paper makes assumptions to refine existing emission factors and update activity data counts and uses very coarse data (e.g., miles of pipe) to change activity data for compressor counts. Such unverified "guesstimates" introduce uncertainty across emissions, mitigation and cost discussions is differences between Subpart W data and the National Inventory for T&S sources. This is important because differences in the inventory affect potential achievable reductions and have implications for economic analysis. The Subpart W and National Inventory differences are discussed further below.

New sources of information soon will become available that will significantly add to the understanding of methane emissions and reduction opportunities in the T&S sector. Specifically, the Pipeline Research Council International (PRCI)[10] is completing a report summarizing GHG emission reduction technologies and work practices applicable to natural gas pipeline compressor stations. The PRCI work will identify existing and commercially available GHG emission reduction technologies and work practices for pipeline compressor stations, as well as

[7] *Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries*, ICF International, 2014.
[8] Oil and Natural Gas Industry Guidelines for Greenhouse Gas Reduction Projects, March 2007.
[9] Climate Change 2007, the Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change (IPCC).
[10] The Pipeline Research Council International (PRCI) is the global collaborative research development organization of, by, and for the energy pipeline industry.

identify technologies in development. The report will evaluate technical and economic viability of existing and developmental GHG emission reduction technologies and work practices. While this report has yet to be released, PRCI has permitted INGAA to acknowledge the draft document for the purposes of our comments. More detail on compressor emissions reduction technologies and costs is provided in comments below.

4. National Estimates of Methane Emissions and Methane Emission Factors, Activity Data, and Calculation Methodologies[11]

EPA has asked for comment on the national estimates of methane emissions and methane emission factors, activity data, and calculation methodologies. While there are several sources of information on methane emissions from the natural gas system, the two primary sources of GHG emission data are the National Inventory and the EPA GHGRP. The EPA compiles both a top-down estimate of GHG emissions (i.e., National Inventory activity data uses data such as facility count and miles of pipe to estimate emissions) and detailed bottom-up reporting (GHGRP). Using other common vernacular, the National Inventory is commensurate with a Tier 1 or Tier 2 estimate (i.e., using activity data at the facility or large unit level), while Subpart W of the GHGRP uses Tier 3 (more granular source or component level activity data) or Tier 4 (detailed source level data or direct measurement) estimates. These two reports use different methods for estimating methane releases and do not include all of the same sources of releases. Accordingly, there currently is no single compilation that comprehensively and accurately addresses all sources of methane released by the T&S sector.

While the National Inventory and the GHGRP produce consistent estimated emissions from some sources (e.g., the natural gas production segment), there are significant differences for the other segments of the natural gas system. There likely are multiple reasons for the disparity, including differences in the methodologies used in the two programs, and the specific sources being measured and included for reporting. For example, EPA updated key National Inventory estimates for the production segment based on more recent data, including Subpart W data. In contrast, EPA has not yet updated its key estimates for the T&S segment, and it does not appear that EPA has compiled or analyzed results based on thousands of measurements for T&S sources completed in response the GHGRP reporting requirements. INGAA suggests that the approach used for production can also be used to improve the estimates for the T&S sector and to serve as a more accurate basis for determining costs and mitigation opportunities. Work to reconcile these estimates remains an area of needed analysis before drawing any definitive conclusions about the total level of methane emissions from natural gas transmission or definitively addressing related questions about mitigation and costs.

The need for more current data and analysis on methane emission levels is highlighted by the fact that most T&S emission factors used for estimating methane emissions are based on a limited set of data that is approximately two decades old. The emission factors that are used to calculate methane emissions for both the National Inventory Report and for some Subpart W sources have typically been in place since the 1990s and need to be updated. For T&S, the National Inventory (and other published papers and studies) primarily rely on emission factors

[11] This section generally responds to Compressor Paper questions 1, 2, 4 (on mitigation technologies, reductions and costs), and 12 (ongoing or planned related studies).

derived from an EPA – Gas Research Institute (GRI) study[12] that was conducted in the early 1990s and published in 1996. These factors may not accurately reflect natural gas transmission methane emissions because operating practices, as well as the efficiency of operating equipment, have improved over the past 20 years. INGAA urges EPA to initiate a program to use the T&S data from 2011, 2012 and 2013 GHGRP reporting to support development of improved emission factors, and improved emission estimates for the T&S segments.

The GHGRP also has some limitations, including reliance on dated emission factors and exclusion of smaller facilities and smaller sources at subject facilities. Subpart W also does not require reporting of known sources, such as rod packing emissions in "not operating-pressurized" (i.e., standby) mode, and centrifugal compressor emissions from dry seals. However, analysis of the reported data should significantly improve the understanding of methane emissions from the T&S sector, especially where measurement is required. Future improvements in estimates of aggregated methane emissions, along with use of Subpart W direct measurements to update emission factors, can lead to more accurate estimates overall. INGAA asks that EPA work with the industry to develop emission factors for the sources with new measurement data available.

Compressor Emission Factors, Activity Data and Emission Estimates

As noted above, while the emission studies listed in the Compressor Paper provide a sampling of available information, other valuable sources are available. For example, a number of papers from the late 1990s and early 2000s followed the publication of the EPA/GRI Report. As another example, in 2005 and 2006, INGAA (along with the American Petroleum Institute and American Gas Association) worked with EPA to prioritize data gaps and methane emission factors that required additional research. That effort developed a plan for a methane "emission factor reconciliation" project[13] and initiated an effort to secure funding for field tests. The project would have implemented emissions testing projects to address data gaps that remain to this day, based on a prioritized list of emission sources collaboratively developed by EPA and the industry stakeholders. However, this project was not executed due in large part to EPA's new responsibility to develop the GHGRP.

A more comprehensive list of reports and emissions-related documents could be compiled, but a higher-priority endeavor might involve a better characterization of the strengths and weaknesses of available documents, identifying data or information gaps and defining a programmatic approach for resolving differences. INGAA cannot now provide a comprehensive response because of the limited time provided to respond to the white papers. INGAA believes there is a general need to develop a systematic approach to reconcile differences in available information because definitive data is not available or has not yet been analyzed (e.g., Subpart W data).

[12] *Methane Emissions from the Natural Gas Industry*, EPA/GRI report (June 1996) at: http://www.epa.gov/gasstar/tools/related.html; This 15-volume compendium of reports is from an EPA/GRI study published in 1996 that remains a seminal reference on methane releases from natural gas systems. These reports and related data are referred to as the "EPA-GRI Study" in this paper.

[13] *INGAA/API/AGA Natural Gas Systems GHG Emission Factor Comparison, Gap Assessment, & Improvement Collaborative Project*, Executive Summary (May 17, 2006).

These comments will illustrate differences in the level of methane emissions by comparing the National Inventory with data from the first two years of Subpart W reporting – i.e., 2011 and 2012 annual Subpart W reporting. Although, INGAA has not completed a thorough analysis of Subpart W data, a subset of this information has been reviewed. This review indicates that INGAA members have completed over 10,000 direct measurements of compressor emissions in the first two years of Subpart W reporting. Yet, it does not appear that EPA has completed an analysis of Subpart W measurement data. INGAA is working with PRCI on compilation and review of Subpart W data along with supplemental data on equipment, operations, and methods used for Subpart W measurements. Initial review indicates that emissions for compressors as reported pursuant to Subpart W are *significantly* lower than the National Inventory estimate of such emissions. EPA should analyze these more recent data. Additional information likely will be available as further analysis is completed, and INGAA will coordinate with PRCI to share that information with EPA.

When comparing the data, it is important to understand the different nomenclature used to categorize emissions. For the white papers, INGAA supports the Compressor Paper approach that focuses on vented emissions – e.g., rod packing venting from reciprocating compressors. For Subpart W (and emission factors used in the National Inventory), "compressor" emissions include equipment leaks from unit isolation valves (when units are not operating and de-pressurized) and blowdown valves (e.g., when units are operating). EPA addresses those emissions in the Leaks White Paper, and that appears to be a reasonable approach. However, it is important to understand how emissions are reported and how various vented or leaking emissions are reflected in estimates. Since time was limited to comment, INGAA cannot provide concise analysis on this issue, but there certainly are inconsistencies. For example, in the National Inventory and Subpart W estimates discussed here, leaks along with compressor vented emissions are grouped and compared. However, when assessing *mitigation* it is inappropriate to use the same estimate because the emission rate may include rod pack venting (which is covered by the Compressor Paper and would be reduced by rod packing maintenance) and leaks (e.g., isolation valve leakage when the unit is shutdown, which should be covered in the Leaks paper and would not be affected by rod packing maintenance).

Additional time would be required to segregate National Inventory emissions and Subpart W reported emissions into subsets based on emission source (e.g., rod packing, valve leak) and compressor operating mode. Both inventories present "rolled up" compressor emission estimates that aggregate some leak sources addressed in the Leaks Paper with vents addressed in the Compressor Paper, but the reported data from both programs is similar because certain leaks (e.g., isolation valve) and vented emissions are captured within the estimate for compressors. Since compressor emissions are reported on a similar basis, comparison is appropriate. Other than the emissions data used for the estimate (i.e., 1990s emissions factors versus recent Subpart W measurements), the primary difference is that only larger facilities that exceed the GHGRP threshold of 25,000 metric tons CO_2 equivalent (CO_2e) report for the GHGRP. For compressors in the transmission segment, comparisons indicate that:

- Reciprocating compressor emissions are *over seven times higher* in the National Inventory than Subpart W; and
- Centrifugal compressor emissions are *over 30 times higher* in the National Inventory than Subpart W.

These differences are due in part to the fact that many facilities were not required to submit a GHGRP report because only 30 percent or less of the transmission compressor stations exceeded the reporting threshold for the GHGRP. In contrast, the National Inventory uses "coarse" activity data (e.g., facility count for many sources, compressor count for compressor emissions). This can be reconciled by normalizing compressor emissions from Subpart W based on total emissions and total compressors (or facilities) for reporting facilities and then scaling using National Inventory activity data. Using data collected from INGAA members for 2011 GHGRP reporting, INGAA completed an initial analysis to normalize GHGRP data then scale the emissions based on the National Inventory activity data (i.e., compressor counts for the entire sector). This initial analysis to scale emissions shows that there remain significant differences for transmission compressors, including:

- Reciprocating compressor emissions are *over 50 percent higher* in the National Inventory than based on Subpart W data; and
- Centrifugal compressor emissions remain very disparate – *20 times higher* in the National Inventory than based on Subpart W data.

This is based on an initial analysis and provided as an example to demonstrate the significant uncertainty regarding compressor emission estimates. More detailed analysis should be completed by industry stakeholders at a later date, and INGAA comments on Subpart W have inquired about EPA plans to review Subpart W data, especially measurement data from T&S facilities. In addition, INGAA and others that are required to complete compressor vent measurements for Subpart W have asked EPA to use that data to develop emission factors for compressors (e.g., in recent comments on proposed Subpart W amendments). INGAA welcomes the opportunity to continue to explore how to best resolve these data inconsistencies and arrive at a reasonably accurate inventory that balances the considerable expense and burden incurred by INGAA members to implement Subpart W measurement and reporting requirements with the need for more consistent and accurate data.

These comparisons clearly show large uncertainties regarding compressor emissions – especially for centrifugal compressors. There are significant and important data gaps.

While some may presume that compressors are a primary source of emissions and mitigation measures are available, educated decisions about the need for, effectiveness of, and cost of mitigation cannot be made until the emission differences are resolved and there is a technically based understanding of compressor-related emissions. The contribution of various sources *must be clearly understood* before effective policies can be developed. Since GHGRP (and Subpart W) information is intended to inform policy decisions, it is imperative that program data be used to advance the current understanding of emissions and thus the potential for reductions. If Subpart W data shows significantly lower emissions from a particular source, then it would be appropriate to focus efforts on other sources. For example, focusing on emissions from centrifugal compressor emission sources, such as wet seal degassing vents, may be unproductive because these sources may account for lower emissions than indicated by the National Inventory and because new units will use dry seals rather than wet seals.

To summarize:

- Two key available resources – GHGRP Subpart W reporting and that National Inventory – show very different emissions from compressors.
- It is imperative that emissions and the associated sources (e.g., vents, leaks) be clearly defined, including understanding how differences in scope and approach affect the results from different programs. Significant data gaps may still remain.
- If Subpart W is not meeting its intended objective, improvements in survey and reporting protocols should be considered, because the emissions data from this program is intended to inform policy decisions, such as methane reduction opportunities within the T&S sector.
- "Compressor-related" emissions can include sources that are intended to vent (e.g., reciprocating compressor rod packing) and equipment leaks (e.g., unit isolation valve when the compressor is shut down and depressurized.) Data is not consistently "rolled up" for various reports listed by EPA, and consistent roll-up is needed to understand the actual emissions. The white papers intend for leak-related emissions (e.g., leaking valve) to be addressed by the Leaks Paper rather than the Compressor Paper.
- Reported emissions from different studies may be based on emission factors that represent a different subset of emission sources – e.g., reciprocating compressor emissions factors include rod packing venting, and may also include leak sources (e.g., isolation valve leakage). Inconsistencies in different studies can introduce problems when comparing emissions or assessing mitigation effectiveness. For example, "average" times in different operating modes and both vented and leak sources are integrated into "composite" compressor emission factors in the original EPA-GRI study. Significant review of each study and emissions roll-up is needed to understand the data and implications better. This can influence emission reduction calculations – e.g., control effectiveness for rod packing maintenance should not be applied to an emission factor that includes other emission sources (compressor-related leaks). This is discussed further in the next section.
- A systematic program needs to be developed and implemented to understand the data that is available through Subpart W, the National Inventory, and other sources to ensure that it is representative and consistent over the primary platforms being used by EPA to inform GHG policy. Leveraging Subpart W data and ongoing GHGRP requirements should be integral to that process.
- Additional work is being completed. Still, a comprehensive, systematic approach is needed to understand fully the data generated by Subpart W, as well as how the accuracy and completeness of this data collection effort can be improved. Industry projects include an ongoing PRCI project to compile and analyze Subpart W data and related supplemental data provided by PRCI and INGAA members. In addition, several natural gas transmission companies are participating in a study with the Environmental Defense Fund that includes measurements at a number of T&S facilities, including on-site measurements and mobile monitoring using tracers. Results from that study should be available later this year.

5. Compressor Mitigation Techniques and Costs[14]

The Compressor Paper discusses available emission mitigation techniques and focuses on reducing vented emissions from reciprocating compressor rod packing and centrifugal compressor wet seal degassing. As noted in the emissions discussion above, INGAA's understanding is that leak-related emissions (e.g., from a leaking isolation valve) are addressed in the Leaks Paper. As noted in earlier comments, the mitigation information presented is only a sampling of available technologies and work practices. A PRCI report is being completed that should be available this summer; that report is intended to provide a thorough list of technologies and work practices, and the associated performance and cost of such technologies and work practices. It includes both existing mitigation methods and developmental or conceptual approaches. The report includes all but one of the T&S mitigation techniques in the ICF paper and also includes many additional prospective mitigation technologies and work practices and their technical feasibility. While the PRCI report includes mitigation techniques that are currently in development or less common techniques, detailed appendices address the primary mitigation techniques. INGAA expects it will be able to share information from this report with EPA soon.

INGAA is concerned with EPA's estimates of potential reductions. As noted in Section 4, there is significant uncertainty about emissions, yet an assumed baseline emissions level is used to estimate potential reductions. Clearly, emissions data gaps need to be addressed before potential reductions can be understood. Section 4 also discusses the potential for errors in reduction calculations based on an unclear understanding of emission factors. For example, a reduction target for "compressors" applies a mitigation technique to reciprocating compressor rod packing. However, emission factors, such as EPA/GRI study emission factors used in the National Inventory, may represent emissions from several compressor-related sources, including leaks. These "typical" emission factors are a composite of different emission sources (e.g., rod packing venting, isolation valve leakage) and typical time in different compressor modes (e.g., operating, shutdown and depressurized). For a technology or practice that reduces rod packing venting, it is not appropriate to calculate the reduction using an emission factor that includes both rod packing and leak emissions. To understand the specific implications, significant additional review of the Compressor Paper material would be required (e.g., decouple the emissions factors and only apply rod packing reduction to the portion of the emission factor that applies to rod packing emissions). That was not possible within the comments schedule and may not be productive. Rather than delving into such nuance, EPA should consider identifying the differences in available data (e.g., comparing the National Inventory to Subpart W) and design and implement a systematic approach to resolve these differences and address data gaps.

The Compressor Paper does not discuss cost sensitivities and factors that contribute to cost differences from facility to facility. The draft PRCI report, discussed above, will include several approaches for reviewing economic implications, and present cost ranges. Site-specific operating conditions and requirements can result in a wide range of mitigation costs. INGAA asks EPA to consider the additional information provided, when available, in the PRCI report.

[14] This section generally responds to Compressor Paper questions 3, 4, 5, and 6 (on mitigation technologies, reductions and costs), 10 (on prevalence) and 12 (ongoing or planned related studies).

As with other issues, INGAA welcomes that opportunity to continue to engage with EPA on understanding mitigation performance and costs. As noted throughout these comments, a clearer understanding of emissions should be attained to reduce uncertainties in assessing mitigation performance and costs.

Condition-Based Maintenance for Rod Packing

The Compressor Paper fails to, and should, include condition-based maintenance for rod packing. This is used by some companies as an alternative to maintaining / replacing rod packing at a prescribed interval. Reliability studies have shown that many different mechanisms can affect the need for maintenance or contribute to the failure of a component (e.g., packing wear that increases emissions). Prescribed maintenance intervals are a relatively antiquated approach that is being replaced in many cases with predictive or condition-based maintenance, where operating conditions are monitored and maintenance decisions are based on performance (or defined "conditions") rather than assuming a specific time basis (e.g., every 3 years) for maintenance. INGAA strongly recommends including condition-based maintenance for rod packing as a viable alternative to mitigate methane emissions.

Condition-based maintenance practices may extend the operation of functional rod packing and preclude premature and wasteful rod packing maintenance/replacement. In other cases, it will identity rod packing where premature wear warrants maintenance on a more frequent basis than the prescribed interval. It also encourages the development of innovative rod packing technologies. This option considers current practices being used by operators, improvements to rod packing design, and the evolving technology.

The EPA Natural Gas STAR program includes a lessons learned document "Reducing Methane Emissions from Compressor Rod Packing System,"[15] which provides an example for condition-based maintenance practices. Rod packing gas leaks are periodically monitored and the value of the incremental leaked gas (relative to post-maintenance/replacement leak rates) is compared with the discounted rod packing maintenance/replacement cost. When the incremental lost gas value exceeds the maintenance/replacement cost, the rod packing maintenance/replacement is cost-effective. This same general philosophy can be applied using a different basis for the repair decision, such as a defined leak rate or change in leak rate over time.

Changing compressor rod packing at a set interval is discussed in the Compressor Paper as a means of reducing methane emissions. We support this approach provided the operating company is allowed the flexibility to establish a packing replacement interval coordinated with regular scheduled maintenance. The desired outcome of a rod packing replacement protocol is to prevent methane emissions to the environment, but the frequency of replacement must consider the blowdown emissions that occur each time the packing is replaced.

Companies understand the value of rod packing monitoring and maintenance/replacement programs, and such programs have been instituted as part of safety and standard maintenance practices. EPA requests more details on mitigation techniques, including prevalence, but those answers are not known. For example, a survey would be required to understand the prevalence

[15] http://www.epa.gov/gasstar/documents/ll_rodpack.pdf

and common procedures for rod packing condition-based maintenance. In general, condition-based maintenance grounded on periodically measuring rod packing leak rate typically will show a relatively flat leak rate over time, followed by an increase in leak rate when rod packing begins to fail.

Low Emissions Rod Packing

Question 3 from the Compressor Paper asks about low emissions packing for reciprocating compressors. While this technology is available, INGAA questions whether its effectiveness has been proven. INGAA has not developed detailed information on this topic, but is aware that some operators currently are assessing its performance by comparing conventional rod packing to low emission packing on similar units and monitoring the vent rate and changes over time. Such evaluations indicate that low emissions packing may emit at similar or higher levels than conventional packing. Thus, it is not apparent that this technology can significantly reduce vented rod packing emissions. At best, this technology requires additional study and improvement before its mitigation viability can be confirmed.

6. Compressor Mitigation – Technology-Specific Questions[16]

The Compressor Paper includes several questions specific to control technology, especially related to centrifugal compressor wet seal emissions. This section provides some general responses. As noted in Section 4, there is a significant disparity in reported emissions from centrifugal compressors for Subpart W and the National Inventory. INGAA strongly recommends understanding and reconciling the differences and identifying, as appropriate, revisions to the National Inventory estimate or Subpart W methodologies. Mitigation-related questions cannot be addressed on an informed basis until that important data gap is addressed. It is possible that industry results from compilation and review of Subpart W data or the collaborative study with EDF will offer some insights, and those will be shared with EPA when available.

Regarding centrifugal compressors with wet seals:

- New turbine / centrifugal compressor installation are unlikely to include wet seals, as dry seals have been the norm for about two decades are longer.
- Solar Turbines, the primary supplier of industrial-scale units used for natural gas compression, has not sold wet seal units for a number of years. A Solar Turbines representative indicated that it may consider a special request for wet seals but it is not aware of any such request in recent years.
- According to a centrifugal compressor manufacturer, dry seal technology replaced wet seals to provide benefits that include increased safety, reliability and efficiency, and reduced operating, utility and maintenance costs.

[16] This section generally responds to Compressor Paper questions 7, 8, 9, 10, and 11(specific technology questions such as questions regarding centrifugal compressor wet seals).

- An informal query of INGAA members indicates that most companies last installed a unit with wet seals in the late 1980s or early 1990s. All subsequent installations included dry seals. However, one company provided an example of three units with wet seals being installed in the mid-2000s.
- Although there is an existing population of older units with wet seals, new units largely will be equipped with dry seals.
- For the existing units, Subpart W data indicates that EPA has over-estimated the population of compressors with wet seals. For the transmission segment, the National Inventory assumes that 91 percent of centrifugal compressors include wet seals. Based on a review of the vast majority of Subpart W reports for 2011 and 2012, about 36 percent of units in 2011 and 48 percent in 2012 indicated wet seals in the Subpart W report. At this time, it is unclear why there is such a difference between the two years, but in either case, the population is significantly lower than the National Inventory estimate.
- As noted in Section 4, there is a 20-fold difference in the National Inventory estimate and an estimate scaled up from Subpart W data that uses the same activity data (total compressor count) as the National Inventory. The population difference and associated contribution from wet seals is only a part of that difference. Clearly, the National Inventory emission factor differs from Subpart W results to date.

  Initial review of 2011 Subpart W data (from a vast majority but not all reporting facilities in transmission) indicates about 70 measurements of wet seal degassing vents. The average value for annual emissions was 0.56 MMSCF or about 260 metric tons CO_2e (287 short tons). The emission factor for wet seal compressors presented in Table 3-11 is 126 tons *methane* per compressor-year or 3,150 tons CO_2e. This difference, along with the population count difference noted above, are most likely the primary contributors to the discrepancy in Subpart W and National Inventory estimates. Insight into the reason for this difference is not available at this time, but additional review, investigation, and analysis are clearly needed.
- The Compressor Paper inquires about replacing wet seals with dry seals for existing wet seal units. INGAA's understanding is that this practice is possible but is not common. INGAA does not have data on how frequently wet seals are replaced with dry seals. The Compressor Paper presents in Section 4.3.3 the capital costs for replacement and O&M savings costs in Table 4-4 that are much more favorable for dry seal replacement than similar costs noted for the ICF paper. The discrepancy is not acknowledged or explained. Compressor specific factors, such as compressor size, operating pressure, type of wet and dry seals, etc. also impact the costs for replacing a wet seal with a dry seal. One INGAA member company reported capital costs of $865,000 for replacement of a wet seal on a Solar Centaur 40 T4702S centrifugal compressor, based on a May 2014 vendor proposal. This is more than double the cost in the ICF paper and more than an order of magnitude higher than the costs in Table 4-4. It also requires extensive compressor downtime of approximately 7 to 8 months to perform the replacement of wet seals with dry seals, which has economic implications that need to be considered. The upcoming PRCI report may also provide additional information on this issue for EPA's consideration.

- Regarding vapor-recovery units (VRUs), INGAA believes that there are safety and operational concerns not addressed in the Compressor Paper. The use of VRUs to capture emissions from rod packing vents has rarely (if ever) been used in practice across the T&S sector and will require a feasibility or pilot study to determine the viability of the technology. Thus, INGAA does not support this control technique for compressor stations.

  As discussed in INGAA's comments on the Leaks Paper, it supports the apparent consensus from the literature that a few sources/leaks contribute the vast majority of emissions (i.e., the 80/20 or 90/10 rule) from compressor stations. Thus, approaches such as "directed inspection and maintenance" would be preferred for finding and mitigating larger emitters. Application of vapor recovery is unlikely to be a reasonable alternative. In addition, transmission facilities rarely include flares so on site use of the recovered gas is required. However, using the recovered gas may also introduce safety issues (e.g., pressure of vent line and system pressures) or may not be compatible with fuel if considered for that purpose.

These bullets are intended to summarize information related to centrifugal compressor wet seal mitigation questions from the Compressor Paper. INGAA recommends that EPA reconcile the significant differences in estimated centrifugal compressor emissions between the National Inventory and Subpart W. Once emissions are better understood, it is possible that emissions from wet seals will be lower priority, especially since future centrifugal compressor installations will include dry seals.

7. Coordinate Methane Initiatives across Agencies and Establish a Primary Point of Contact

As part of the Obama administration's Climate Action Plan, the Administration has initiated several efforts that address methane reductions, including revisions to the EPA Natural Gas STAR Program, launch of the Quadrennial Energy Review, revision of EPA's GHGRP, the five methane white papers and plans to revise regulations to control VOC emissions and possibly methane emissions, from the oil and gas sector.[17] This level of simultaneous activity on a common issue challenges the industry and other stakeholders, and coordination between industry and policymakers and across agencies is crucial. Therefore, INGAA recommends the Administration establish a primary point of contact responsible for ensuring coordination across the multiple federal agencies and departments tasked with methane-related initiatives impacting the T&S sector. Ideally, this point of contact would provide guidance and assistance in the development, interpretation and implementation of methane policies. It can be difficult for the pipeline industry to manage the numerous and sometimes duplicative requests for information from multiple agencies and departments.

As questions arise about the overall climate change strategy, it would be extremely helpful to have this same primary point of contact within the Administration to discuss methane and other GHG reduction issues, opportunities and policies.

[17] For example, potential revisions to 40 C.F.R., Part 60, Subpart OOOO.

8. Conclusion

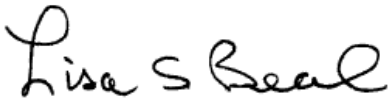
INGAA and its members are committed to reducing methane emissions in a prudent and environmentally responsible manner. INGAA and its members are undertaking initiatives to understand the sources of T&S sector methane emissions and to identify the most significant sources and the most cost-effective methane emission reduction strategies.

In summary:

1. There are significant differences in compressor emission estimates for the National Inventory and Subpart W of the GHGRP. This is due in part to a subset of sources reporting under the GHGRP, but the differences are not due solely to that fact.
2. These differences must be reconciled and emissions data gaps addressed before conclusions can be made regarding the efficacy of mitigation measures or associated costs.
3. A systematic program needs to be developed and implemented to address data gaps and reach consensus conclusions on compressor emissions.
4. INGAA is aware of additional information that will be available from ongoing studies to supplement this discussion. This information may inform the process and provide some insight, but it is not expected that it will address all of the emissions data gaps.
5. Once emissions are better understood, INGAA recommends additional discussion on the implications, including costs, of potential mitigation methods.
6. Compressor Paper mitigation discussions focus on reciprocating compressor rod packing venting and centrifugal compressor wet seals. For rod packing, condition-based maintenance should be included an alternative to maintaining or replacing rod packing on a prescribed schedule. Centrifugal compressor emissions reported for Subpart W are significantly lower than the National Inventory. In addition, new units are equipped with dry seals, which has been the standard for over a decade. Thus, it may be inappropriate to continue to focus on wet seal emissions.

INGAA appreciates the opportunity to comment on the Compressor Paper and will continue to provide EPA with additional information as it becomes available.

Sincerely,



Lisa S. Beal

Vice President, Environment and Construction Policy

Interstate Natural Gas Association of America

Appendix A
Compressor Charge Question and INGAA Response Quick Reference

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.

Responses are found in sections three and four of the INGAA comment document.

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

Responses are found in sections three and four of the INGAA comment document.

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.

Responses are found in section five of the INGAA comment document.

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

Responses are found in sections four and five of the INGAA comment document.

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?

Responses are found in sections five of the INGAA comment document.

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.

Responses are found in sections five of the INGAA comment document.

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

Responses are found in section six of the INGAA comment document.8. Are there technical reasons why an operator would use a wet seal centrifugal compressor without a gas recovery system?

Responses are found in section six of the INGAA comment document.

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

Responses are found in section six of the INGAA comment document.

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

Responses are found in sections five and six of the INGAA comment document.

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?

Responses are found in section six of the INGAA comment document.

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?

Responses are found in sections four and five of the INGAA comment document.