Processing in 2015 GHGI

- 22.7 MMT CO$_2$e
- 14% of natural gas systems methane emissions

2013 Processing Emissions

- Equipment Leaks: 46%
- Gas Engines: 20%
- Recip. Compressors (seals): 13%
- Centrifugal Compressors (seals): 6%
- Blowdowns/Venting: 5%
- Other: 10%
- 5%
• Activity Data
  – Activity factors are based on 1996 EPA/GRI factors
    • e.g., number of acid gas removal units or compressor hp-hr per unit throughput
  – Throughput and plant counts obtained from annual EIA and O&GJ data.

• Emission Factors
  – All EFs except centrifugal compressor seals are based on EPA/GRI (1996).
  – Centrifugal compressor seals EF based on a World Gas Conference paper (wet seals), and data from Gas STAR partners (dry seals)
New data on Processing

• GHGRP
  – Data from 2011-2014
  – See next slide

• Marchese et al.
  – Measured methane plumes from 16 sites
  – Year 2013/2014 data
  – Scaled to national level using EIA and O&GJ databases
## Available GHGRP Data-Processing

<table>
<thead>
<tr>
<th>Emission Source</th>
<th>Reported Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reciprocating compressor venting</td>
<td>Activity (compressor size, hours of operation by mode, emission controls) and EFs (by operating mode)</td>
</tr>
<tr>
<td>Centrifugal compressor venting</td>
<td>Activity (compressor size, hours of operation by mode, emission controls, seal type) and EFs (by operating mode)</td>
</tr>
<tr>
<td>Blowdown vent stacks</td>
<td>No activity or EF; annual total emissions by equipment type and event type</td>
</tr>
<tr>
<td>Dehydrator vents</td>
<td>Activity (including throughput, controls, etc. for large units) EFs for large units; small units use rule-provided EF</td>
</tr>
<tr>
<td>Acid gas removal vents</td>
<td>Activity (throughput by unit and portion of CO$_2$ recovered for other uses) and EF per unit</td>
</tr>
<tr>
<td>Flare stack emissions</td>
<td>Activity (including throughput, etc.) and EF per flare</td>
</tr>
<tr>
<td>Equipment leaks</td>
<td>Activity (component type, # leaking comps, time leaking) Annual emissions by component type based on rule-provided EFs</td>
</tr>
</tbody>
</table>
Marchese et al. compared findings to year 2012 estimates in the 2015 GHGI:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Marchese et al.</th>
<th>2015 GHGI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operations</td>
<td>506 Gg</td>
<td>851 Gg</td>
</tr>
<tr>
<td>Routine maintenance</td>
<td>-</td>
<td>40 Gg</td>
</tr>
<tr>
<td>Reciprocating compressors per site</td>
<td>6.4</td>
<td>9.3</td>
</tr>
<tr>
<td>Reciprocating-to-centrifugal compressor activity ratio</td>
<td>2.6</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Gathering & Boosting Emissions in the GHGI

- Gathering is integrated with well pad activities into production segment of Natural Gas Systems in GHGI
- Production emissions are calculated for 6 NEMS regions
- GHGI sources that are predominantly in gathering:
  - Large reciprocating compressors
  - Large reciprocating stations
  - Pipeline leaks
  - Pipeline blowdowns
  - Pipeline mishaps
- These predominantly gathering sources = 9% of net production emissions
Gathering & Boosting Emissions in the GHGI (cont.)

• Gathering sources that cannot be straightforwardly disaggregated from well-pad activities in GHGI:
  o Fugitive equipment leaks (heaters, separators, dehydrators, meter runs)
  o Pneumatics (valves and pumps)
  o Condensate tanks
  o Vessel blowdowns and releases.

• Mixed sources = over half of net production & gathering total methane

• Large reciprocating compressors and stations are most comparable to the Marchese et al. study of gathering facilities
Gathering: Large Reciprocating Compressors and Stations, Current Inventory Method

• Activity Data
  – EPA/GRI (1996) survey of 13 production companies to estimate stations per mile of gathering lines and gathering pipeline miles per gas well.
  – EPA/GRI activity factor used in conjunction with number of gas wells in a given year from Drilling Info data.

• Emission Factors
  – Same EFs for all 6 NEMS regions
  – Adapted from EPA/GRI emission tests on transmission compressor stations
  – Includes: valves, connections, relief valves, station and compressor blowdowns, compressor starts, seal leaks.
New data on Gathering and Boosting

• GHGRP
  – Gathering data will begin collecting gathering and boosting data in 2016 (to be reported to EPA in 2017)

• Marchese et al.
  – Measured methane plumes from 114 sites
  – Year 2013/2014 data
  – Scaled to national level using state permit databases
Requests for Stakeholder Feedback

• Are other new data sources available for processing or gathering and boosting?
• Please comment on approaches for incorporating new processing data (e.g. GHGRP, Marchese)
• There are several potential approaches to address gathering and boosting in the GHGI. Please comment on these approaches.
  – Maintain current inventory structure with aggregate estimates for production and gathering
  – Separate gathering from production, and continue to estimate emissions on a source-by-source basis
  – Separate gathering from production, and use station-level factors (e.g., those from Marchese)