INGAA – OMB Meeting on NSPS OOOOa Leak Detection and Repair

May 22, 2018






Topics

- Leak Detection and Repair (LDAR): Documentation Related to Transmission and Storage Quarterly LDAR Surveys
  - Emissions – EPA estimates and current data
  - LDAR performance as a function of survey frequency
  - Leak emissions and implications (e.g., delay of repair)
- LDAR – Delay of Repair
  - March 2018 amendments
  - INGAA's recommended revisions
- Recommendations
  - LDAR survey frequency
  - Delay of Repair – good cause to delay repairs

Emissions Estimates:
Historical Data versus
GHG Reporting Program Results
and Recent CARB Study

Emissions Estimates from Leaks

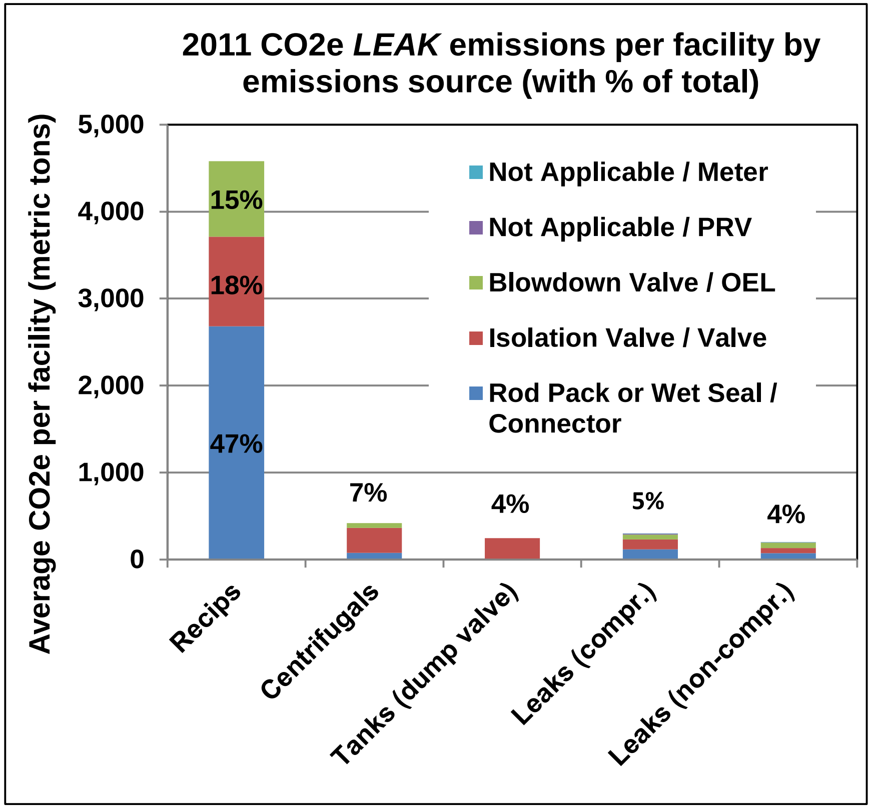
- NSPS OOOOa requires quarterly LDAR for Transmission and Storage (T&S facilities)
- INGAA developing White Paper on emissions and control efficiency
  - Prior INGAA comments discuss flaws in repair cost estimates
- EPA Technical Support Document (TSD) uses data from the EPA/GRI mid-1990s study to estimate emissions
  - Methane emissions from model facilities for T&S are ~1010 TPY CO_2e and 3560 TPY CO_2e, respectively
  - EPA estimates emissions and reductions from rod packing leakage (reciprocating compressors) and wet seal degassing (centrifugal compressors)
- EPA annual GHG inventory (GHGi) includes compressor blowdown valve and isolation valve leakage with compressor leaks
- Comparing GHGi emission estimates to current data from GHG Reporting Program (GHGRP) allows "apples to apples" comparison

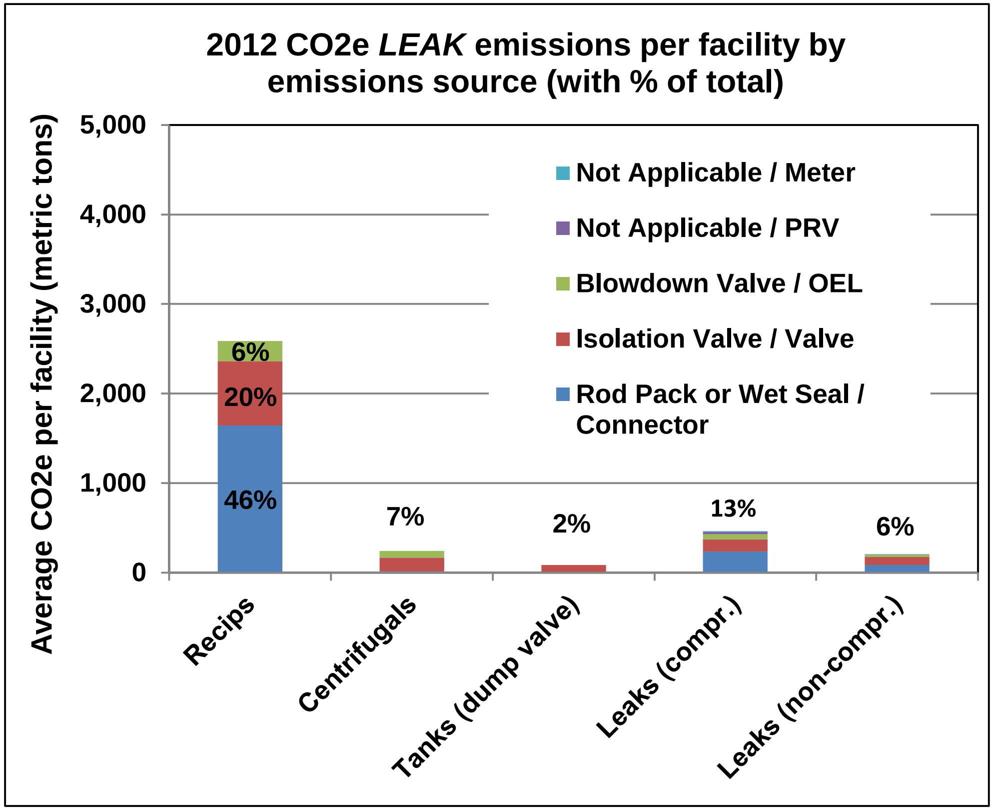
Emission Estimates – GHGRP Data

- During rule development, EPA noted that direct measurement is required because compressors are a significant emissions source, and *other options are not available* (i.e., limited data, emission factor uncertainty)
- Pipeline Research Council International (PRCI) report, "GHG Emission Factor Development for Natural Gas Compressors"
  - Compiled and analyzed 2011 – 2016 GHG Reporting Program (GHGRP) Subpart W data for transmission and storage: Over 14,000 measurements of compressor vents (leaking valves) and rod packing (reciprocating) or wet seal (centrifugal) leakage
  - Developed emission factors for reciprocating compressors and centrifugal compressors based on this data. Implications for:
    - National GHG inventory
    - Subpart W – Replace annual measurement with compressor emission factors (EFs); EFs common for GHGRP emission estimates
    - Leak mitigation opportunities – Emission rates for various leak sources and frequency of larger leaks
    - Compare "average T&S facility" methane leak emissions for: (1) historical EPA estimate, (2) recent EPA inventory update, (3) Subpart W emission factor estimates, and (4) Subpart W with largest leaks mitigated

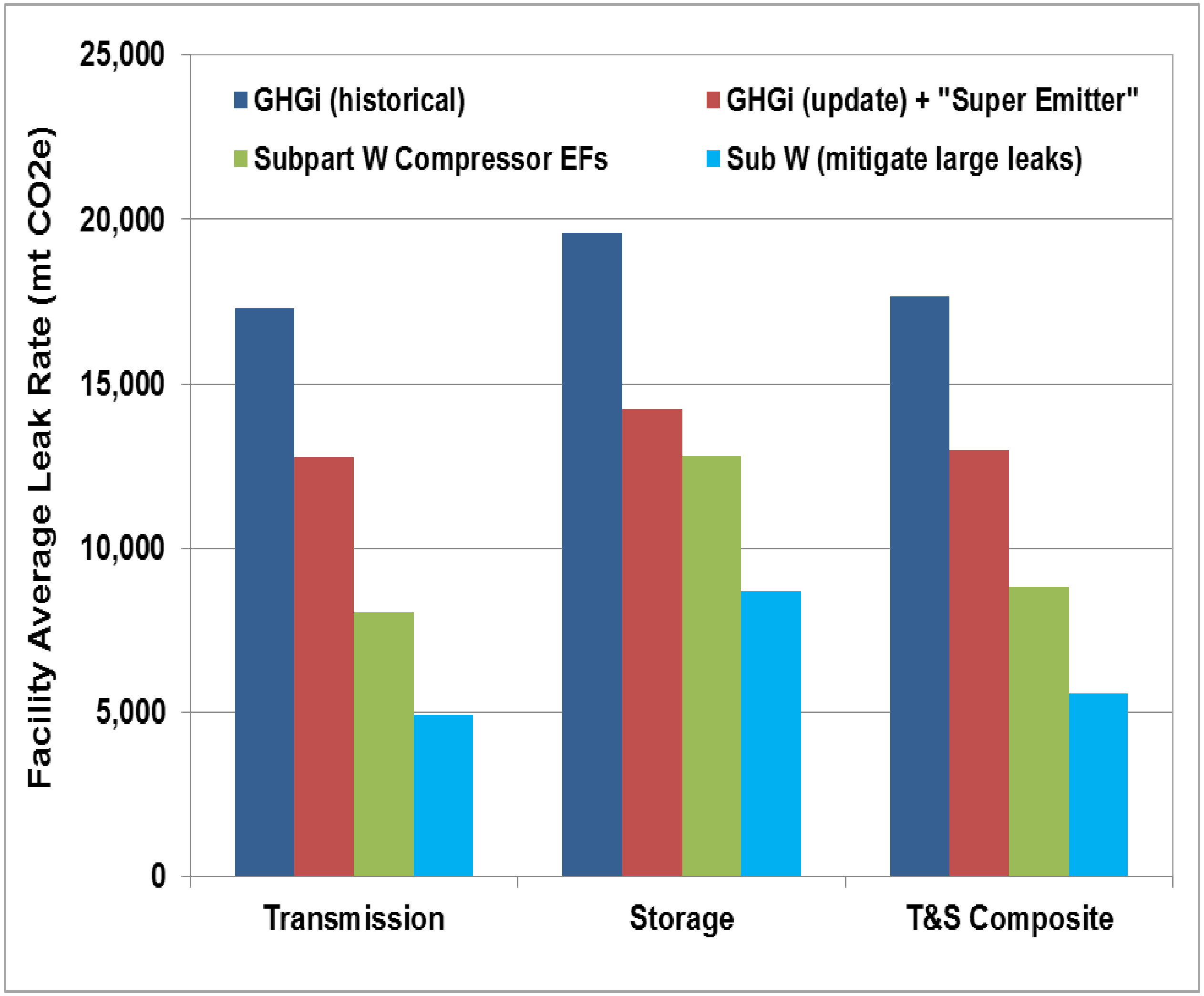
GHGRP – Average Facility Leak Emissions

- Leak estimates for 2011 and 2012 GHGRP data
  - Compressor estimates based on *measurement*
  - Reciprocating compressor rod packing and isolation valves are the two largest contributors; other leak emissions are relatively minor





Facility Level GHG Inventory Implications



- Emission factors can be used to assess the implications for **"average" facility leak emissions** based on EPA GHG Inventory EFs versus Subpart W-based Compressor EFs
  - Historical GHG Inventory
  - Recent GHG Inventory updates that consider industry-EDF study
  - Subpart W Compressor EFs
  - Subpart W Compressor EFs based on program that mitigates largest (<3% by count) compressor-related leaks

Leak Detection and Repair (LDAR) Performance – i.e., Control Effectiveness

NSPS OOOOa – LDAR Frequency for Compressor Stations

- A Canadian Association of Petroleum Producers (CAPP) 2014 document "Update of Fugitive Equipment Leak Emission Factors" estimates that upstream oil and gas equipment leak emissions have decreased about 75% since Directed Inspection & Maintenance (DI&M) best management practices (BMP) were implemented in ~ 2007
- Components generally deemed to be leaking if Method 21 (M21) screening value (SV) $\geq$ 10,000 ppm or emissions detected by OGI
- BMP guidance is annual surveys for most components
- **75% reduction** in leak emissions based on directly measured and estimated (e.g., from M21 SVs & associated EFs) leak emissions encompassing multiple years
- These data are the most reliable and best supported estimate of leak emissions reductions found in the literature

NSPS OOOOa – LDAR Frequency for Compressor Stations

- NSPS OOOOa requires quarterly leak surveys for compressor stations [40 C.F.R. §60.5367a(g)(2)]
  - <u>Measured</u> leak reductions documented by CAPP shows approximately equivalent emission reductions with *annual* surveys
- In proposed rule TSD, EPA assumed 40, 60, 80% LDAR control efficiencies (CEs) for annual, semi-annual, and quarterly surveys from Colorado (CDPHE) reference
  - Comments highlighted that the CDPHE reference was a hypothetical scenario analysis and not based on actual data
- For final TSD, new EPA analysis results in similar CEs
  - 500 ppmv and 10,000 ppmv Method 21 (M21) screening value (SV) repair threshold with CEs estimated using "**EPA Leak Protocol**" *model* – i.e., leak reductions <u>not</u> measured. Assumptions likely under-estimate CEs

Monitoring Frequency	Fugitive Percent Reduction (LDAR CE)		
	Method 21 Repair Threshold		OGI
	10,000 ppm	500 ppm	
Annual	42	68	40
Semiannual	55	75	60
Quarterly	67	83	80

NSPS OOOOa – LDAR Frequency for Compressor Stations

- EPA Leak Protocol: Flawed/unrepresentative leak data & assumptions
  - *40 year-old chemical industry* (SOCMI) plant data used to estimate leak rates
    - Not representative of current T&S equipment or maintenance practices
    - Very small data set (155 valves, 71 in gas service)
    - Leak protocol model very sensitive to assumptions, such as % leaking components
    - Leak data from GHGRP indicate lower leakage for T&S than measured historical data (based on 5 to 25 year old historical data)
  - Only **valve** leak data used to estimate new leak occurrence rate
    - Valves have moving parts/seals, thus develop more leaks than static components (i.e., valve leak occurrence rate > rate for all components)
  - For 14% of repairs, leaks assumed to immediately recur after repair
    - OOOOa requires all repairs be resurveyed and verified
  - High bias in leak occurrence rate and recurrence rate (post-repair) affect control efficiency (i.e., calculated CE is biased low)

LDAR – Delay of Repair

NSPS OOOOa – Delay of Repair (DOR)

- Final Rule published on June 3, 2016
- DOR amendments published on March 12, 2018, 40 C.F.R. §60.5397a(h)(2):

  "(2) If the repair or replacement is technically infeasible, would require a vent blowdown, a compressor station shutdown, a well shutdown or well shut-in, or would be unsafe to repair during operation of the unit, the repair or replacement must be completed during the next scheduled compressor station shutdown, well shutdown, well shut-in, after a~~n unscheduled~~, planned ~~or emergency~~ vent blowdown or within 2 years, whichever is earlier."

NSPS OOOOa – Delay of Repair Revisions

- Concerns remain – e.g., planned blowdown occurs, but part not available or demand change requires immediate re-start
  - DOR should address parts availability, good cause language, etc.
  - CARB data shows that typical component leak rates are small and minor actions (e.g., vehicle trip) may *increase* emissions
- INGAA's recommended amendments (submitted to EPA):

"(2) If the repair or replacement is technically infeasible, would require a vent blowdown, a compressor station shutdown, a well shutdown or well shut-in, or would be unsafe to repair during operation of the unit, the repair or replacement must be completed during the next scheduled compressor station shutdown <u>for maintenance</u>, well shutdown, well shut-in, ~~after an unscheduled, planned or emergency vent blowdown~~ or within 2 years, whichever is earlier.

NSPS OOOOa – Delay of Repair Revisions

Language submitted to EPA (continued)

Delay of repair will be allowed beyond the next scheduled compressor station shutdown for maintenance but within the 2 year period if (a) replacement parts cannot be acquired before the next scheduled shutdown for maintenance or (b) the delay is attributable to other good cause. The operator must document: the location and nature of the leak, the date the leak was added to the delay of repair list, the basis for delaying the repair, the date replacement parts were ordered, the vendor providing the parts, and the anticipated delivery date. Replacement parts must be promptly ordered after determining it is necessary to delay the repair and replacement parts are required to make the repair. The repair must be completed within 30 business days of receipt of the replacement parts, during the next scheduled maintenance shutdown after the parts are received (if the repair requires a shutdown), or within 30 business days after the cause of delay ceases to exist. The Administrator may approve further extensions on a case-by-case basis."

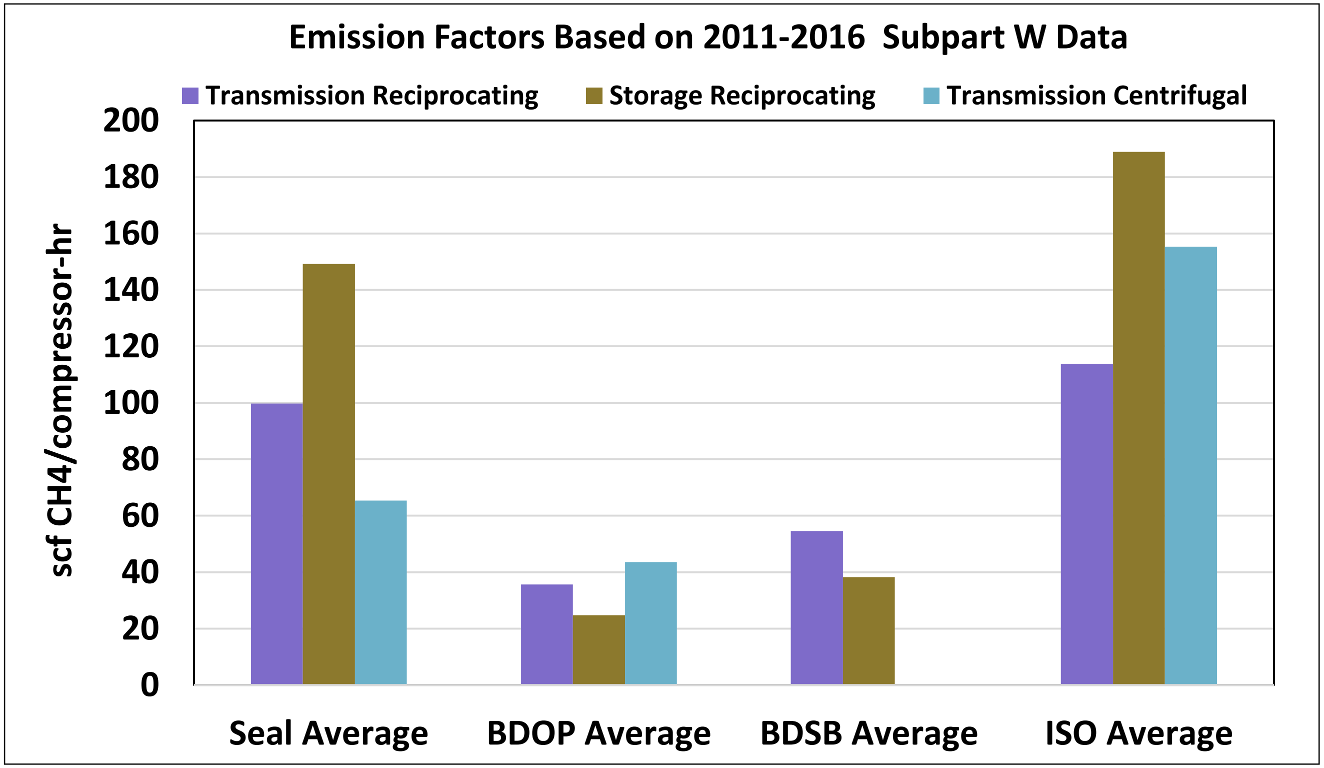
Conclusions and Recommendations

- T&S leak emission estimates
  - Unique situation – Thousands of new GHGRP measurements
  - Compressor emissions are lower than historical data
  - CARB study shows lower component leak rates than historical data
  - Baseline emissions are lower than current EPA estimates
  - Compressor rod packing & isolation valves are main emissions source
- LDAR performance
  - Proposed TSD used flawed citation – scenario analysis from Colorado not based on real data
  - Final TSD reaches similar conclusions: Uses protocol to *estimate* reductions from 40 year old data from chemical plants
  - **Annual Survey:** CAPP study, which includes measured data, indicates similar reduction (~75%) for T&S with annual surveys
- Delay of Repair: amendments for “good cause” still needed
  - Rare scenarios (e.g., parts) are not addressed by March amendments
  - Incremental emissions resulting from delay are typically very small

Appendix

GHGRP – Compressor Leak Measurements

- Seals (recip rod packing, centrifugal wet seal) and isolation (ISO) valves are larger emitters than blowdown (BD) valves
  - BD valve leakage in either operating (OP) mode or standby pressurized (SB) mode (limited hours in latter mode)
  - These leaks, on average, are much larger than other facility leaks – i.e., 80 – 90% of facility leak emissions from compressors

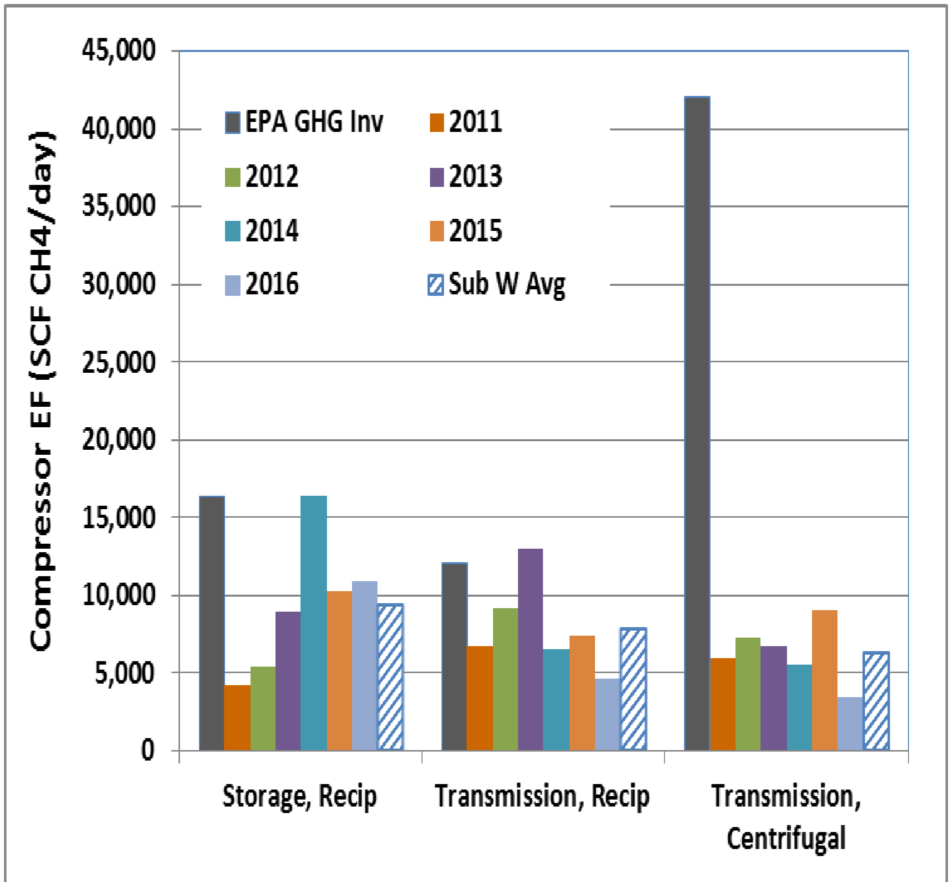


- NOTE - Example EPA over-estimate: centrifugal wet seal average leak rate from Subpart W (65 scf/hr) versus historical data / TSD estimate (2860 scf/hr)

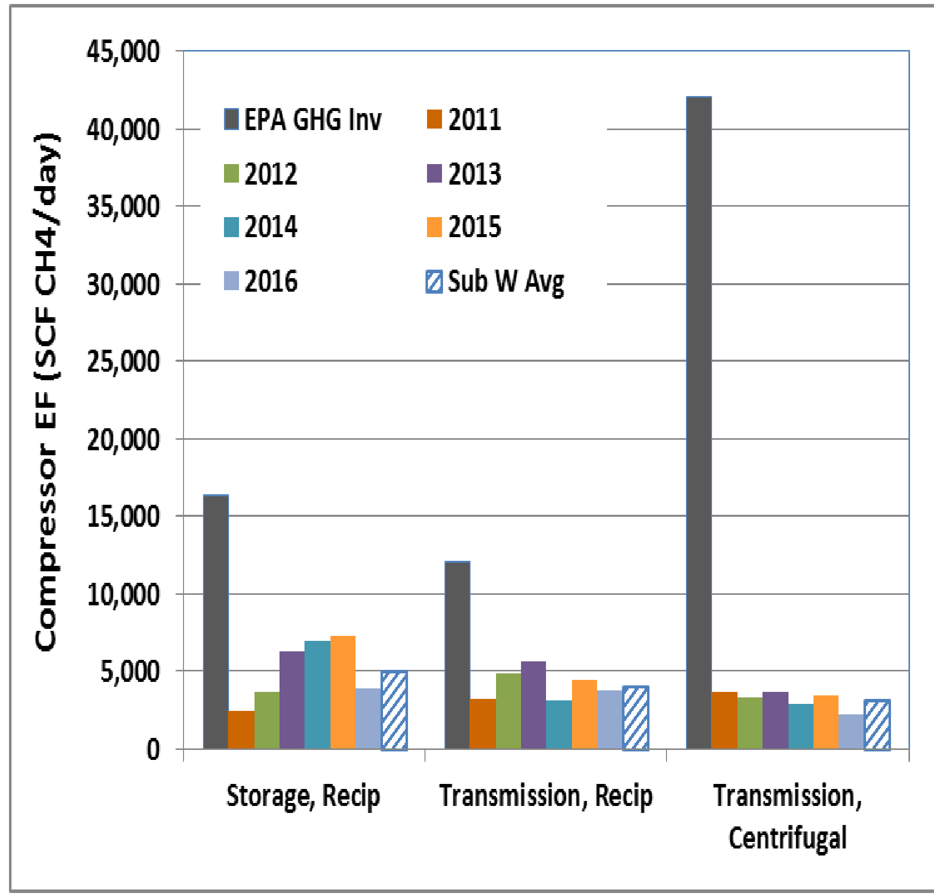
Emission Factor (EF) Comparison
(EPA EF vs Subpart W by Year and Average)

- GHGi EF compared to annual and composite Subpart W data
- Compressor-related leaks comprise >80% of facility leak emissions

All Data

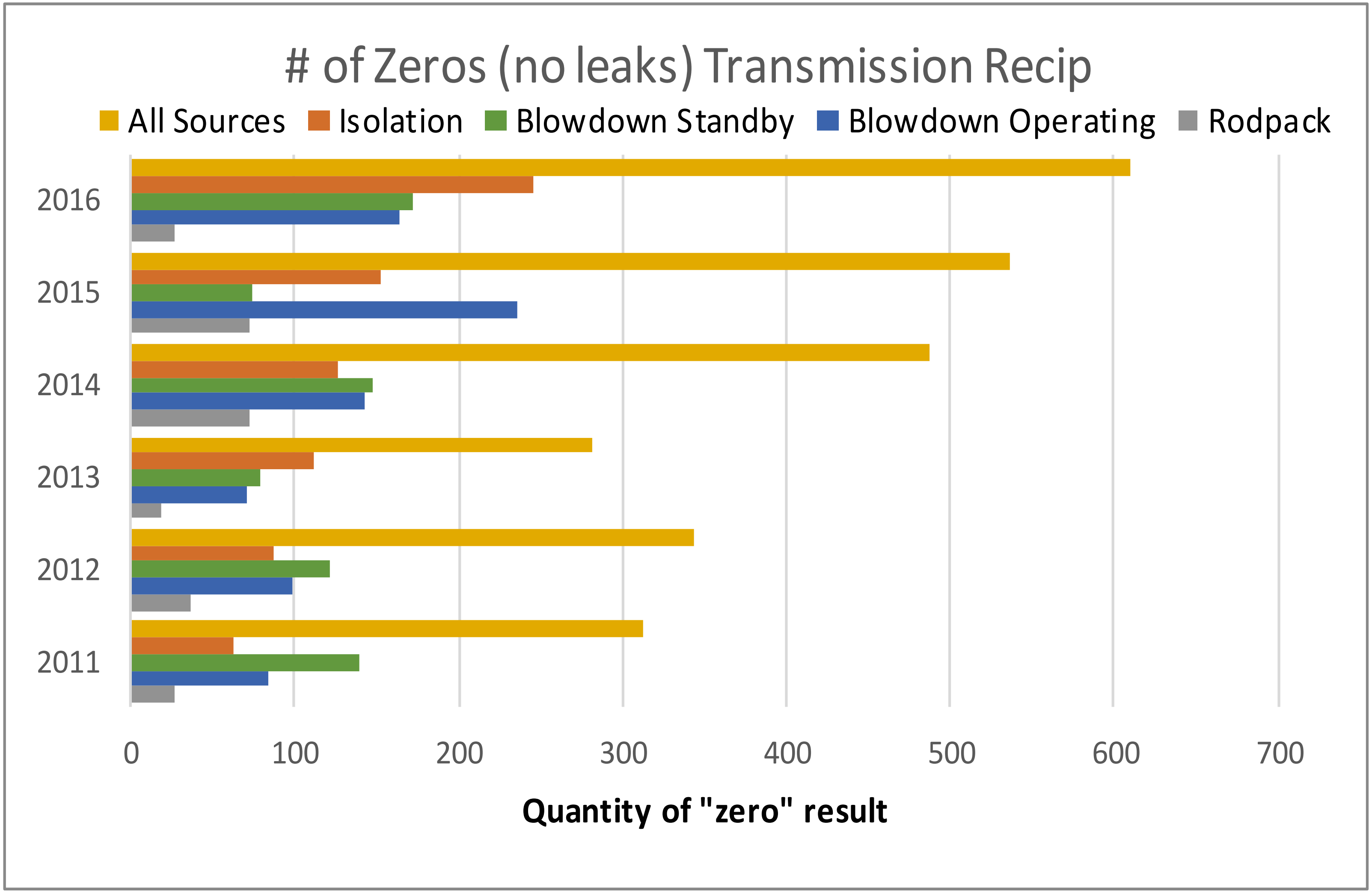


Omit Leaks >2000 SCF/hr (~280 of 10k measured)



Prevalence of Measured "Zero" Leak Rate – Count for Transmission Recip Measurements

- *Reporting* program shows increase in "zero" measurements



CARB / Sage Environmental Study Shows Low Leak Rates from Method 21 Correlations

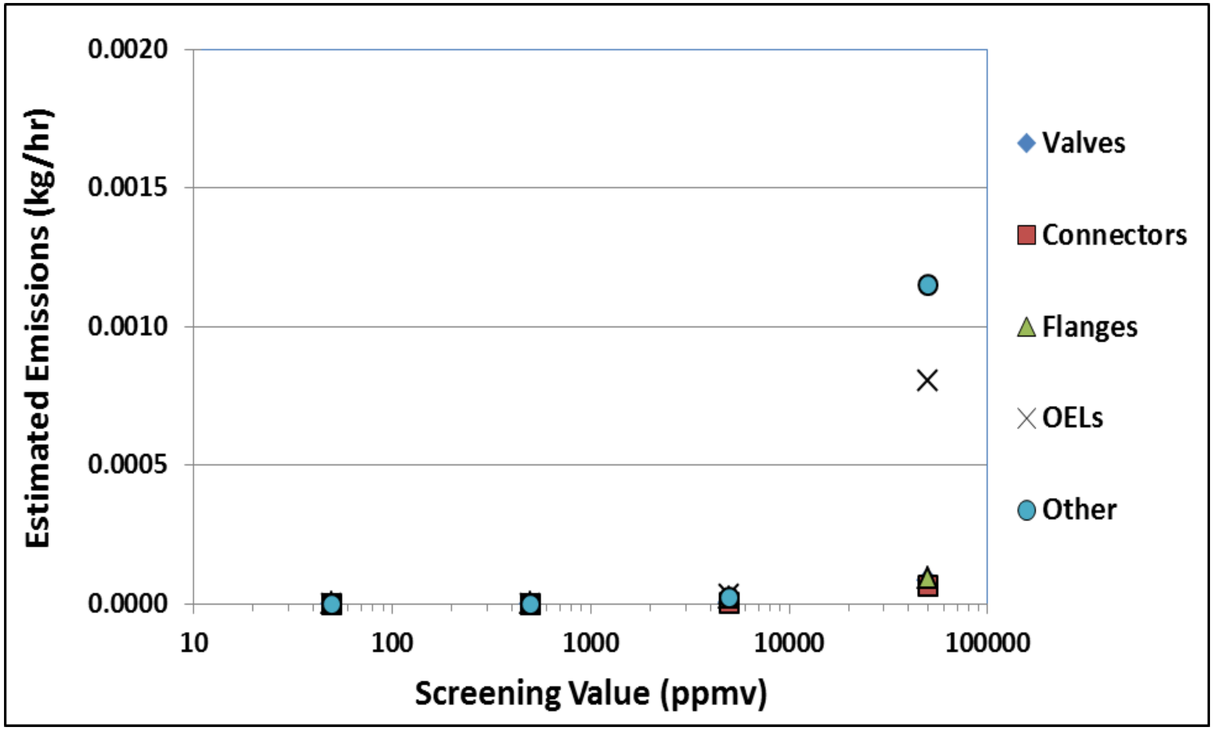
CA Air Resources Board (CARB) Report: "Enhanced Inspection and Maintenance for GHG's and VOCs at Upstream Facilities – Final," Sage Environmental, December 2016 (released 2/3/2017)

- Measured mass emission rates from leaking components. Correlated emission rates with EPA Method 21 screening values (SV)
- Components included valves, connections, flanges, OELs, and others
- Average leak rate from ARB study correlation equations in table below
- Subpart W leak rates (emission factors) range from **1 to 40 scf/hr**
- Subpart W leak survey *counts* show ~20 leaks per facility each year

M21 SV (ppmv)	Average Component Leak Rate (TOC as CH4)						
	kg/hr	g/day	lb/yr	mt CO2e/yr	scf/hr	scf/yr	$ NG/yr
1,000	1.4E-6	0.03	0.03	0.001	7.2E-5	0.6	$0.002
10,000	4.1E-5	0.99	0.79	0.026	2.1E-3	18.8	$0.06
50,000	5.1E-4	12.24	9.85	0.322	2.7E-2	233.0	$0.80
100,000	1.6E-3	37.31	30.03	0.981	8.1E-2	710.2	$2.44

CARB 2016 Study Leak Rate Equations

- Correlation equations estimate leak rate as a function of M21 screening value (SV) – typically plotted on log-log scale, but shown here with linear y-axis
  - "Typical" leaks are very small – e.g., SV of 500 ppmv for Subpart OOOOa
  - If immediate (or low cost) repair is not feasible, alternatives may be warranted (e.g., delay until planned maintenance shutdown)



“Typical” Leak Rate is Small: Mandatory Repair Schedule May Result in Excess GHG Emissions

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- “Special actions” (e.g., blowdown, travel to acquire parts or unique skillset) to meet repair schedule may have negative consequence
- Example calculation compares CO_2 from vehicle miles (e.g., “special trip” for repair) and methane emissions from CARB correlation eqns

Vehicle emissions (lbs CO_2e/mi)	Mileage assumed	Vehicle emissions (lbs CO_2e)	Leak Screening Value (ppmv)	Average Emissions [A] (lbs CO_2e / day)	Equivalent time (days)[B]
1.0	10	10.0	10,000	0.048	208
1.0	10	10.0	500	0.00071	14,085
1.0	10	10.0	10,000	0.010 [A]	1,000

[A] Average emissions based on CARB report emission rate as a function of Method 21 screening value. The first two rows use the weighted emission factor for all component types. The third example uses the emission factor for a leaking connector or flange, which is the most common leak source.

[B] **“Equivalent time” is the days required for the leaking component CO_2e mass emissions to be equivalent to the emissions from a 10-mile trip with a light duty truck.**