Opportunities for Methane Emissions Reductions in Natural Gas Processing: Brief Overview

Turkmenistan Symposium on Gas Systems Management: Methane Mitigation

April 26 – 29, 2010, Ashgabat, Turkmenistan

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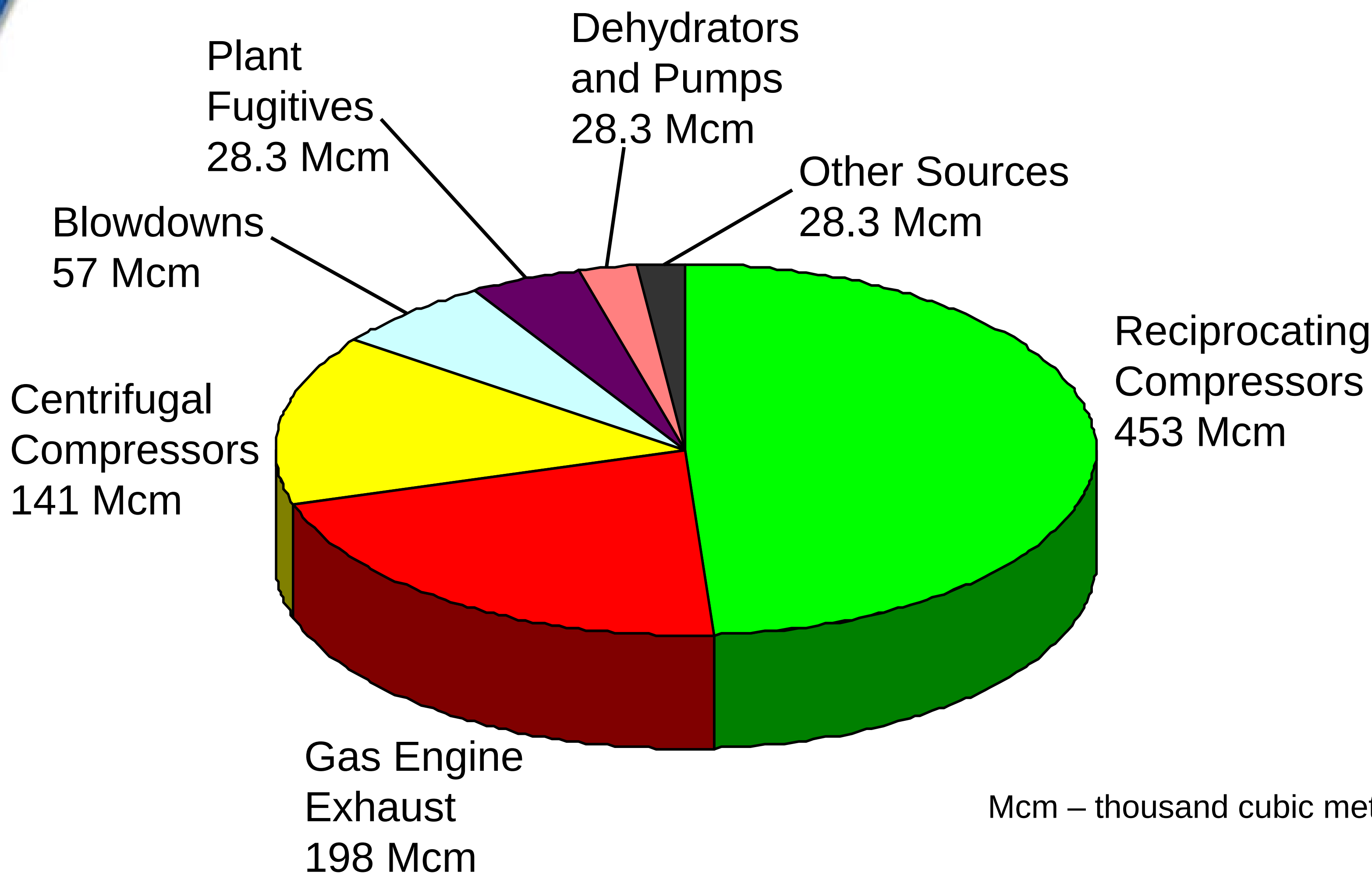
Agenda

- **U.S. Processing Sector Methane Emissions**
- Overview of Technologies and Practices
- Methane Saving Opportunities
  - Compressor seals
  - Leak detection, quantification and repair
  - Acid gas removal
- Contact Information and Further Information

Methane to Markets

2007 U.S. Processing Sector Methane Emissions (2007)

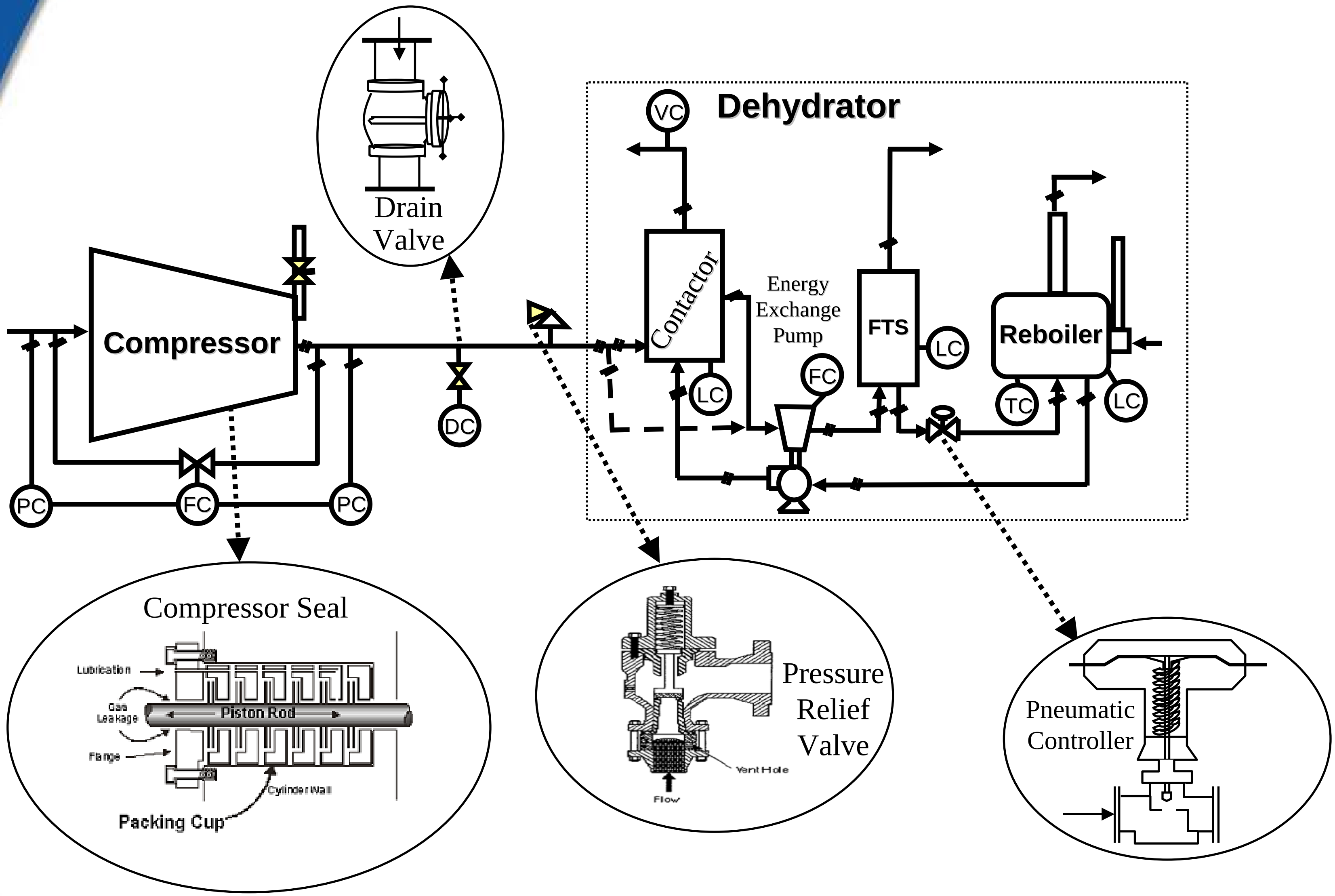


Mcm – thousand cubic meter

EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2007.* April, 2009. Available on the web at: epa.gov/climatechange/emissions/usinventoryreport.html

Note: Natural Gas STAR reductions from gathering and boosting operations are reflected in the production sector.

Emission Sources in Processing Plants



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Overview of Technologies and Practices

- 29 technologies and practices that apply to the processing sector
  - 17 focused on operating practices
  - 12 focused on technologies

- Relevant processing technologies and practices:

Operating practices

- Begin leak detection, quantification and repair at processing plants
- Eliminate unnecessary equipment and/or systems
- Rerouting glycol skimmer gas
- Pipe glycol dehydrator to vapor recovery unit
- Inspect and repair compressor station blowdown valves

Technologies

- Convert gas-driven pneumatic devices to instrument air
- Install flash tank separators in glycol dehydrators
- Use of composite wrap repair
- Install pressurized storage of condensate
- Use ultrasound to identify leaks

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Compressor Seals

- Rod packing in reciprocating compressors leak gas by design
  - Anywhere between 1.7 to 25.5 m^3/h depending on age of packing
  - Replace rod packing to minimize leaks
- Seal oil degassing, from centrifugal compressors, can vent 1.13 to 5.7 m^3/h to the atmosphere
  - Use dry seals to avoid the use of seal oil
- More information on emission reductions from compressor seals can be found in the presentation “Methane Reductions at Compressor Stations”

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Methane to Markets

Leak Detection, Quantification and Repair by Leak Imaging

- Majority of fugitive methane emissions are from a a relatively small number of leaking components
  - Valves (30%)
  - Connectors (24%)
  - Compressor seals (23%)
  - Open-ended lines, crankcase vents, pressure relief devices and pump seals (23%)

- Leak imaging
  - Real-time visual image of gas leaks
  - Quicker identification & repair of leaks
  - Screen hundreds of components an hour
  - Screen inaccessible areas simply by viewing them
- More information can be found in the presentation "Methane Leak Detection and Measurement"

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Methane to Markets

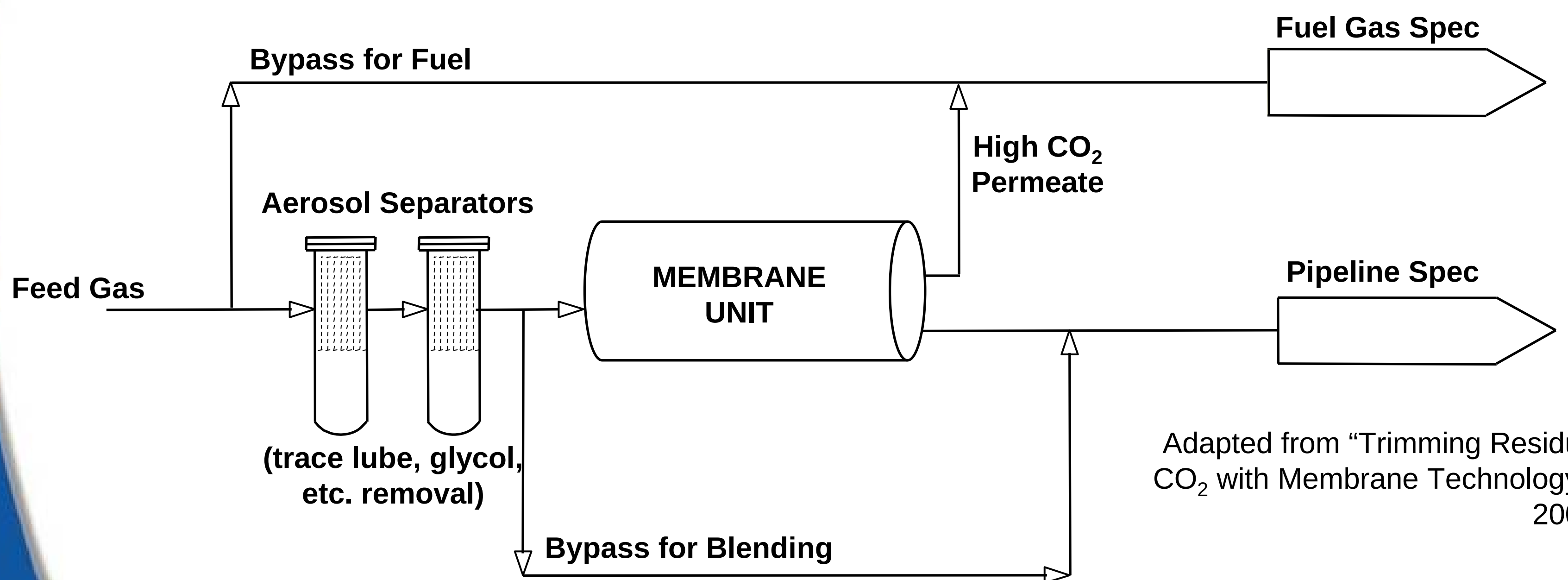
NaturalGas EPA POLLUTION PREVENTER

Acid Gas Removal (AGR) – What is the Problem?

- Wellhead natural gas may contain acid gases
  - Hydrogen sulfide (H_2S) and CO_2 are corrosive to gathering/boosting and transmission lines, compressors, pneumatic instruments, and distribution equipment
- Acid gas removal processes have traditionally used an aqueous amine solution to absorb acid gas
- Amine regeneration strips acid gas (and absorbed methane)
  - CO_2 (with methane) is typically vented to the atmosphere, flared, or recovered for enhanced oil recovery (EOR)
  - H_2S is typically flared in low concentrations or sent to sulfur recovery

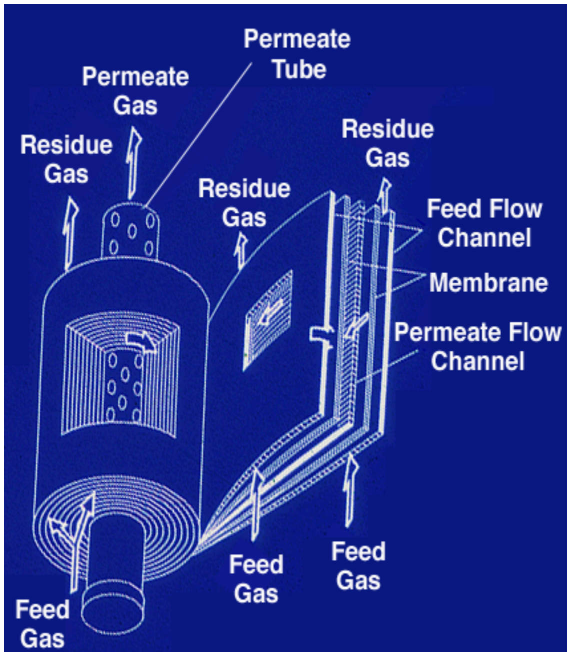
AGR - Kvaerner Membrane Process

- Membrane separation of CO_2 from feed gas
  - Cellulose acetate spiral wound membrane
- High CO_2 permeate (effluent or waste stream) exiting the membrane is vented or blended into fuel gas
- Low CO_2 product exiting the membrane exceeds pipeline spec and is blended with feed gas



Adapted from “Trimming Residue CO_2 with Membrane Technology”, 2005

AGR- Kvaerner Membrane Technology



DCP Midstream

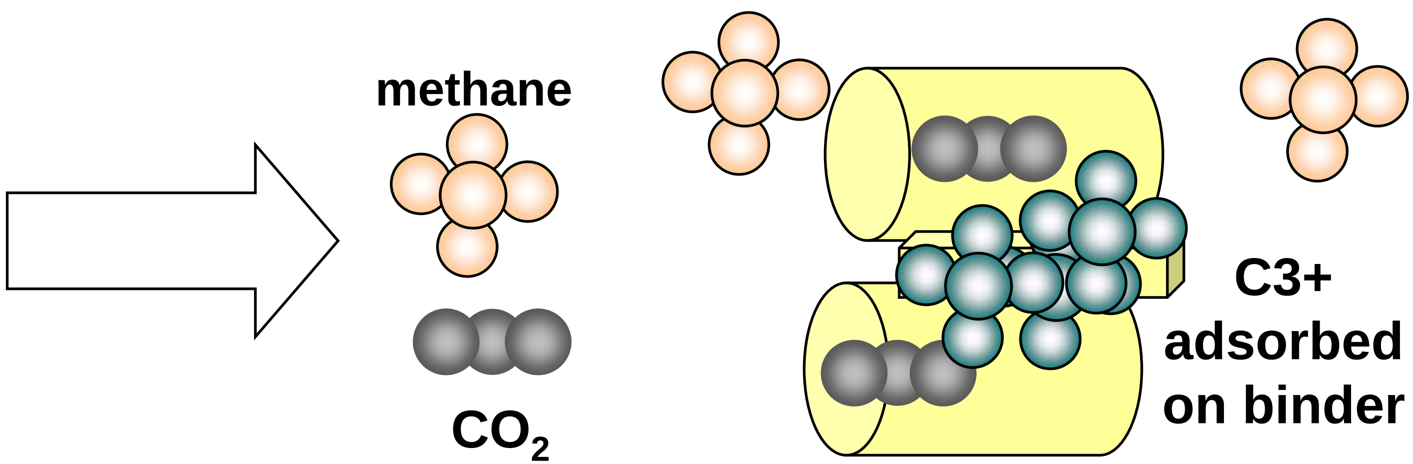
- CO_2 (and some methane) diffuse axially through the membrane
- High-CO_2 permeate exits from center of tube; enriched product exits from outer annular section
- One application for fuel gas permeate
  - Methane/CO_2 waste stream is added with fuel gas in a ratio to keep compressor emissions in compliance
- Design requirements
  - Upstream separators remove contaminants which may foul membrane
  - Line heater may be necessary

AGR- Is Recovery Profitable using Kvaerner Membrane?

- Costs
  - Conventional DEA AGR would cost TMT 12.8 to TMT 14.3 million capital, TMT 1.43 million operation and maintenance (O&M) per year
  - Kvaerner Membrane process cost TMT 4.28 to TMT 4.85 million capital, TMT 0.06 to TMT 0.14 million O&M per year
- Optimization of permeate stream
  - Permeate mixed with fuel gas, TMT 855/Mcm fuel credit
  - Only installed enough membranes to take feed from >3% to >2% CO_2, and have an economic supplemental fuel supply for compressors
- In addition, offshore Middle East is using NATCO membrane process on gas with 90% CO_2, achieving pipeline spec quality

AGR - Molecular Gate® CO_2 Removal

- Adsorbs acid gas (CO_2 and H_2S) in fixed bed
- Molecular sieve application selectively adsorbs acid gas molecules of smaller diameter than methane
- Bed regenerated by depressuring
  - ~10% of feed methane lost in “tail gas” depressuring
  - Route tail gas to fuel
- Applicable to lean gas sources



AGR - Is Recovery Profitable using Molecular Gate® CO_2 Removal?

- Molecular Gate® costs are 20% less than amine process
  - 0.0002 to 0.035 TMT/Mcm product depending on scale
- Fixed-bed tail gas vent can be used as supplemental fuel
  - Eliminates venting from acid gas removal
- Other Benefits
  - Allows wells with high acid gas content to produce (alternative is shut-in)
  - Can dehydrate and remove acid gas to pipeline specs in one step
  - Less operator attention

AGR - Morphysorb® Process

- Morphysorb® has a 30% to 40% operating cost advantage over DEA or Selexol™ [1]
  - 66% to 75% less methane absorbed than DEA or Selexol™
  - About 33% less total hydrocarbons (THC) absorbed[1]
  - Lower solvent circulation volumes
- Morphysorb® can process streams with high (>10%) acid gas composition
- At least 25% capital cost advantage from smaller contactor and recycles[1]
- Flashing of Morphysorb recycling recovers about 80% of methane that is absorbed[2]

1 – GTI
2 – Oil and Gas Journal, July 12, 2004, p 57, Fig. 7

Comparison of AGR Alternatives

	Amine (or Selexol™) Process	Morphysorb® Process	Kvaerner Membrane	Molecular Gate® CO_2
Absorbent or Adsorbent	Water & amine (Selexol™)	Morpholine derivatives	Cellulose acetate	Titanium silicate
Methane Savings Compared to Amine Process	--	66 to 75% less methane absorption	Methane in permeate gas combusted for fuel	Methane in tail gas combusted for fuel
Regeneration	Reduce pressure & heat	Reduce pressure	Replace membrane about 5 years	Reduce pressure to vacuum
Primary Operating Costs	Amine (Selexol™) & steam	Electricity	Nil	Electricity
Capital Cost	100%	75%	35%	<100%
Operating Cost	100%	60% to 70%	<10%	80%

Contact Information and Further Information

- More detail is available on these practices and over 80 others online at: epa.gov/gasstar/tools/recommended.html
- For further assistance, direct questions to:

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