



Appendix A-1

Methane Emission Reduction Technologies & Practices— Production Sector

The list below describes a variety of methane emission reduction technologies that Natural Gas STAR partners in the production sector have implemented and reported to Natural Gas STAR. Sunset dates (i.e., the length of time a technology or practice can continue to accrue emission reductions after implemented) are one year in duration unless otherwise noted in parentheses. An asterisk (*) indicates that a technical document related to the technology or practice is available online at epa.gov/gasstar/tools/recommended.html.

Compressors/Engines

- Automate systems operation to reduce venting*
- Automated air/fuel ratio controls (10 years)*
- Catalytic converter installation (10 years)
- Convert engine starting to nitrogen (10 years)*
- Convert to low pressure compressor starters (10 years)
- Eliminate unnecessary equipment and/or systems*
- Increase compression capacity to reduce venting/flaring
- Install electric compressors (10 years)*
- Install electric motors (10 years)
- Install lean burn compressor (10 years)
- Redesign blowdown systems and alter ESD practices*
- Reducing emissions when taking compressors off-line*
- Reducing methane emissions from compressor rod packing systems*
- Replace gas starters with air (10 years)*
- Replace ignition - reduce false starts*
- Turbine fuel use optimization

Dehydrators

- Install condensers on glycol dehydrators (10 years)
- Install flash tank separators on glycol dehydrators (10 years)
- Optimize glycol circulation and install of flash tank separators in dehydrators *
- Replacing gas-assisted glycol pumps with electric pumps (10 years)*
- Replacing glycol dehydrators with desiccant dehydrators (10 years)*
- Reroute glycol skimmer gas*
- Shutdown glycol dehydrator stripping gas in winter

Directed Inspection & Maintenance

- DI&M at compressor stations*
- DI&M: leak detection using lower emission threshold
- DI&M: survey and repair leaks

Pipelines

- Inject blowdown gas into low pressure mains*
- Pipeline replacement and repair
- Using pipeline pumpdown techniques to lower gas line pressure before maintenance *

Pneumatics/Controls

- Capture/use gas released from gas-operated pneumatic pumps
- Convert gas pneumatic controls to instrument air (10 years)*
- Convert gas-driven chemical pumps to instrument air (10 years)*
- Convert pneumatics to mechanical controls (10 years)*
- Identify and replace high-bleed pneumatic devices (7 years)
- Install controllers on gas-assisted methanol pump (10 years)
- Install electronic flare ignition devices (10 years)*
- Install no bleed controllers (10 years)
- Install non-venting dump controllers (10 years)
- Reduce gas pressure on pneumatic devices
- Use add-on controls to reduce emissions from pneumatics (10 years)

Tanks

- Consolidate crude oil production and water storage tanks (10 years)*
- Convert water tank blanket from natural gas to produced CO₂ gas (10 years)*
- Install evactors (10 years)
- Install flash gas compressors (10 years)
- Install hydrocarbon liquid stabilizer (10 years)
- Install pressurized storage of condensate (10 years)*
- Installing VRUs on crude oil storage tanks (10 years)*
- Protective tank coatings to reduce leaks (10 years)
- Recycle line recovers gas during condensate loading*
- Reduce excess blanket gas blow-by to the atmosphere



Methane Emission Reduction Technologies & Practices— Production Sector

Appendix A-1 (cont.)

Valves

- Install BASO valves (10 years)*
- Install plugs on valves and open ended lines (10 years)
- Test and repair pressure safety valves*

Wells

- Artificial lift: gas lift (10 years)
- Artificial lift: pressure swabbing
- Connect casing to vapor recovery unit *OR* Install compressors to capture casinghead gas (10 years)*
- Gas well "smart" automation system (10 years)*
- Gas well unloading time optimization*
- Perform reduced emissions completions/green completions*
- Install automated shut-in cycle units to reduce well venting (10 years)
- Install flash tank separator on water gathering system (10 years)
- Install pumpjacks on low water production gas wells (10 years)*
- Install pumps for separators (10 years)
- Install soap launcher/soap unit (10 years)
- Install velocity tubing strings (10 years)*
- Installing plunger lift systems at gas wells (10 years)*
- Lower heater-treater temperature*
- Use foaming agents*

Other

- Capture and use waste heat to reduce gas usage and emissions
- Convert natural gas fired generator to solar power (10 years)
- Flare reduction program
- Install flares (10 years)*
- Nitrogen rejection unit optimization*
- Recover gas from separators
- Re-inject gas for enhanced oil recovery
- Re-inject gas into crude
- Replace aged heaters with new efficient gas fired heaters (10 years)



Appendix A-2

Methane Emission Reduction Technologies & Practices— Gathering and Processing Sector

The list below describes a variety of methane emission reduction technologies that Natural Gas STAR partners in the gathering and processing sector have implemented and reported to Natural Gas STAR. You may use this list as a guide when completing your annual report. Sunset dates (i.e., the length of time a technology or practice can continue to accrue emission reductions after implemented) are one year in duration unless otherwise noted in parentheses. An asterisk (*) indicates that a technical document related to the technology or practice is available online at epa.gov/gasstar/tools/recommended.html.

Compressors/Engines

- Eliminate unnecessary equipment and/or systems*
- Install electric compressors (10 years)*
- Install electric starters (10 years)*
- Redesign blowdown systems and alter ESD practices*
- Reducing emissions when taking compressors off-line*
- Replace gas starters with air (10 years)*

Dehydrators

- Install condensers on glycol dehydrators (10 years)
- Install flash tank separators on glycol dehydrators (10 years)
- Optimize glycol circulation and install of flash tank separators in dehydrators*
- Replace glycol dehydration units with methanol injection (10 years)*
- Replacing gas-assisted glycol pumps with electric pumps (10 years)*
- Reroute glycol skimmer gas*

Directed Inspection and Maintenance

- DI&M at compressor stations*
- DI&M at gas plants and booster stations
- DI&M: aerial leak detection using laser and/or infrared technology
- DI&M: leak detection using IR camera/optical imaging
- Improve measurement systems to track gas loss
- Inspect and repair compressor station blowdown valves*

Pipelines

- Composite wrap for non-leaking pipeline defects*
- Pipeline replacement and repair
- Recover gas from pipeline pigging operations*
- Revise pigging schedule to reduce methane emissions
- Use inert gases and pigs to perform pipeline purges*
- Using hot taps for in-service pipeline connections*
- Using pipeline pumpdown techniques to lower gas line pressure before maintenance*

Pneumatics/Controls

- Convert gas pneumatics to instrument air systems (10 years)
- Install back-up power at booster sites to prevent venting (10 years)
- Install no bleed controllers (10 years)
- Use add-on controls to reduce emissions from pneumatics (10 years)

Tanks

- Install hydrocarbon liquid stabilizer (10 years)
- Install pressurized storage of condensate (10 years)*
- Installing VRUs on crude oil storage tanks (10 years)*
- Reduce excess blanket gas blow-by to the atmosphere
- Reduce vapors vented out of drip tanks
- Route inlet flash vapors to station suction (10 years)

Valves

- Convert gas operated valves to hydraulic operation (10 years)
- Heat tracing to prevent control valves from freezing open
- Rupture pin shutoff device to reduce venting (10 years)

Other

- Convert natural gas fired generator to solar power (10 years)
- Install flares (10 years)*
- Nitrogen rejection unit optimization*
- Process/re-route acid gas to reduce venting
- Replace aged heaters with new efficient gas fired heaters (10 years)



Appendix A-3

Methane Emission Reduction Technologies & Practices— Transmission Sector

The list below describes a variety of methane emission reduction technologies that Natural Gas STAR partners in the transmission sector have implemented and reported to Natural Gas STAR. You may use this list as a guide when completing your annual report. Sunset dates (i.e., the length of time a technology or practice can continue to accrue emission reductions after implemented) are one year in duration unless otherwise noted in parentheses. An asterisk (*) indicates that a technical document related to the technology or practice is available online at epa.gov/gasstar/tools/recommended.html.

Compressors/Engines

- Automate systems operation to reduce venting*
- Automated air/fuel ratio controls (10 years)*
- Eliminate unnecessary equipment and/or systems*
- Install electric compressors (10 years)*
- Install electric motors (10 years)
- Install electric starters (10 years)*
- Lower purge pressure for shutdown*
- Redesign blowdown systems and alter ESD practices*
- Reduce the frequency of engine starts with gas*
- Reducing emissions when taking compressors off-line*
- Reducing methane emissions from compressor rod packing systems*
- Replace compressor cylinder unloaders*
- Replace gas starters with air (10 years)*
- Replace ignition - reduce false starts*
- Replacing wet seals with dry seals in centrifugal compressors (10 years)*
- Use of turbines at compressor stations (20 years)

Dehydrators

- Install condensers on glycol dehydrators (10 years)
- Optimize glycol circulation and install of flash tank separators in dehydrators*
- Replace glycol dehydrator with separators & in-line heaters (10 years)*
- Replacing gas-assisted glycol pumps with electric pumps (10 years)*
- Reroute glycol skimmer gas*

Directed Inspection and Maintenance

- Conduct DI&M at remote sites*
- DI&M: aerial leak detection using laser and/or infrared technology
- Directed inspection and maintenance at compressor stations

- DI&M: leak detection using IR camera/optical imaging
- DI&M: survey and repair leaks
- Inspect and repair compressor station blowdown valves*
- Use ultrasound to identify leaks*

Pipelines

- Composite wrap for non-leaking pipeline defects*
- Inject blowdown gas into low pressure mains*
- Perform leak repair during pipeline replacement*
- Pipeline replacement and repair
- Recover gas from pipeline pigging operations*
- Reduced emissions through third-party damage prevention
- Use inert gases and pigs to perform pipeline purges*
- Using hot taps for in-service pipeline connections*
- Using pipeline pumpdown techniques to lower gas line pressure before maintenance*

Pneumatics/Controls

- Convert gas pneumatic controls to instrument air (10 years)*
- Convert gas-driven chemical pumps to instrument air (10 years)*
- Identify and replace high-bleed pneumatic devices (10 years)
- Reduce meter run blowdowns
- Replace bi-directional orifice metering with ultrasonic meters*
- Use add-on controls to reduce emissions from pneumatics (10 years)

Tanks

- Capture methane released from pipeline liquid storage tanks (10 years)*
- Install flash gas compressors (10 years)



Methane Emission Reduction Technologies & Practices— Transmission Sector *Appendix A-3 (cont.)*

Valves

- Close main and unit valves prior to blowdown*
- Design isolation valves to minimize gas blowdown volumes (10 years)*
- Move fire gates in to reduce venting at compressor stations (10 years)*
- Test and repair pressure safety valves*
- Use of YALE closures for ESD testing*

Wells

- Switch from underbalanced to overbalanced drilling in gas storage field

Other

- Convert natural gas fired generator to solar power (10 years)
- Improve system design/operation
- Install flares (10 years)*
- Require improvements in quality of gas received*
- Replace aged heaters with new efficient gas fired heaters (10 years)



Appendix A-4

Methane Emission Reduction Technologies & Practices— Distribution Sector

The list below describes a variety of methane emission reduction technologies that Natural Gas STAR partners in the distribution sector have implemented and reported to Natural Gas STAR. You may use this list as a guide when completing your annual report. Sunset dates (i.e., the length of time a technology or practice can continue to accrue emission reductions after implemented) are one year in duration unless otherwise noted in parentheses. An asterisk (*) indicates that a technical document related to the technology or practice is available online at epa.gov/gasstar/tools/recommended.html.

Compressors/Engines

- Eliminate unnecessary equipment and/or systems*
- Install electric starters (10 years)*
- Redesign blowdown systems and alter ESD practices*
- Reduce the frequency of engine starts with gas*
- Reducing methane emissions from compressor rod packing systems*
- Replace ignition - reduce false starts*

Directed Inspection and Maintenance

- DI&M at compressor stations* (non-mainline transmission)
- Directed inspection and maintenance at gate stations and surface facilities
- DI&M: survey and repair leaks
- Improve measurement systems to track gas loss
- Increase walking survey from a 5-to 3-year basis*

Pipelines

- Identify and rehabilitate leaky distribution pipes
- Inject blowdown gas into low pressure mains*
- Insert gas main flexible liners (10 years)*
- Reduce/downgrade system pressure
- Reduced emissions through third-party damage prevention
- Use no-blow insertion fittings
- Using hot taps for in-service pipeline connections*
- Using pipeline pumpdown techniques to lower gas line pressure before maintenance*

Pneumatics/Controls

- Convert gas pneumatic controls to instrument air (10 years)*
- Convert gas-driven chemical pumps to instrument air (10 years)*
- Use add-on controls to reduce emissions from pneumatics (10 years)

Valves

- Install excess flow valves (10 years)*
- Install overpressure protection system (10 years)
- Test and repair pressure safety valves*
- Test gate station pressure relief valves with nitrogen*

Other

- Convert natural gas fired generator to solar power (10 years)
- Improve system design/operation
- Install flares (10 years)*
- Re-inject CNG cylinder test gas
- Replace aged heaters with new efficient gas fired heaters (10 years)
- Retighten LNG pumps seals
- Use automated systems to reduce pressure



Appendix B

Conversion Factors

Please see below for a variety of conversion factors that might be useful when completing your annual report. Please contact Natural Gas STAR if you have questions about this information.

Gas Conversions

Please report emissions reductions to Natural Gas STAR International in thousand cubic feet (Mcf).

1 Cubic foot of methane	= 1,014.6 Btu
1 Btu	= 0.000986 Cubic feet of methane
1 Cubic foot	= 0.02832 Cubic meter
1 Cubic meter	= 35.312 Cubic feet
1 Mile	= 1.609 Kilometer
1 Kilometer	= 0.6214 Mile
1 Btu	= 251.996 Calories
1 Calorie	= 0.00397 Btu
1 Btu	= 1055.056 Joules
1 Joule	= 0.00095 Btu

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