[Company Name], [Date Submitted]

Rulemaking (R.) 15-01-008 to Adopt Rules and Procedures Governing Commission Regulated Natural Gas Pipelines and Facilities to Reduce Natural Gas Leaks Consistent with Senate Bill 1371, Leno.

In Response to Data Request, R15-01-008 2019 June Report

Appendix 9; Rev. 03/29/19

System Categories	Emission Source Categories	Emission Factor Sources	Description [in natural gas volume]	Explanatory Notes/Comments
Transmission Pipeline	Transmission Pipeline Leaks	Engineering Estimate	Emissions estimated from size of breach / pressure / duration calculation	For 2018, the INGAA Greenhouse Gas Emission Estimation Guidelines for Natural Gas Transmission and Storage - Volume 1 GHG Emission Estimation Methodologies and Procedures (September 28, 2005 - Revision 2) - Table 4-4 study provides the best available estimate of emissions for Transmission Pipeline, which includes emissions from Flanges and Valves. The emissions for the component leaks reported in "Component leaks" worksheet are accounted for by this mileage-based INGAA Emission Factor.
	All damages (as defined by PHMSA)	Engineering Estimate	Emissions estimated either from modelling or size of breach / pressure / duration	
	Transmission Pipeline Blowdowns	Engineering Estimate	Unique equipment volume (corrected for pressure and temperature)	For the Transmission Odor Intensity Test; Annual Emission = Number of Tests * Volume per Test
	Pneumatic Devices - Pneumatic/Hydraulic Valve Operators, and Turbine Valve Operators	MRR	Low Continuous Bleed = 0.0336 Mscf/day/dev Intermittent Bleed = 0.0576 Mscf/day/dev High Continuous Bleed = 0.4457 Mscf/day/dev Hydraulic Valve Operator = TBD Turbine Valve Operator = TBD	
	Pressure Relief Valves	MRR	Pressure relief valve = 0.9518 Mscf/day/dev	
	Odorizer (Odorizer and Gas Sampling Vents)	TCR	1.27 Mscf/yr/odorizer (if manufacturing specs are available, use the manufacting specs instead of the default emission factor)	The following equations adhere to manufacturing specifications: ● For Transmission (BTU) Gas Chromatographs (GCs); Annual Emission = (Number of GCs * Sample Flow + Number of GC Streams * Bypass Flow) * Unit conversion factor. ● For Transmission (Gas Quality) Gas Chromatographs (GCs); Annual Emission = (Number of GCs * Sample Flow + (Number of GCs + Number of Additional Streams) * Flow "Genie") * Unit conversion factor. ● For Odorizer; Annual Emission = Number of strokes * Emission per stroke, where Number of strokes = (Gas Volume * Injection Rate)/(Odorant Density * Pump Stroke Volume) * Unit conversion factor.
Transmission M&R	M&R Stations - Farm Taps & Direct Industrial Sales	MRR	# of leaks > 10,000 ppm x Subpart W EF (ref: Table W-3 of Subpart W of Part 98) Farm Tap / Direct Sale = 12.2 Mscf/yr/station **Non-compressor components** Valve = 0.1572 Mscf/day/dev Connector = 0.1399 Mscf/day/dev Open-ended line = 0.276 Mscf/day/dev Pressure relief valve = 0.0492 Mscf/day/dev Meter = 0.0728 Mscf/day/dev	
	M&R Stations - Transmission-to-Transmission Company Interconnect	MRR	# of leaks > 10,000 ppm x Subpart W EF (ref: Table W-3 of Subpart W of Part 98) Trans-to-trans = 1,554.8 Mscf/yr/station **Non-compressor components** Valve = 0.1572 Mscf/day/dev Connector = 0.1399 Mscf/day/dev Open-ended line = 0.276 Mscf/day/dev Pressure relief valve = 0.0492 Mscf/day/dev Meter = 0.0728 Mscf/day/dev	● The vented emissions for pneumatic devices reported in the "Component Vented Emissions" worksheet for Transmission M&R Stations are accounted for as part of the station's emission factor, which is 1,554.8 Mscf/yr/station. ● The fugitive emissions for the component leaks reported in "Component Leaks" worksheet for Transmission M&R Stations are accounted for as part of the station's emission factor, which is 1,554.8 Mscf/yr/station.
	Transmission M&R Leaks	MRR	# of leaks > 10,000 ppm x Subpart W EF (ref: Table W-3 of Subpart W of Part 98) **Non-compressor components** Valve = 0.1572 Mscf/day/dev Connector = 0.1399 Mscf/day/dev Open-ended line = 0.276 Mscf/day/dev Pressure relief valve = 0.0492 Mscf/day/dev Meter = 0.0728 Mscf/day/dev	
	Transmission M&R blowdown	Engineering Estimate	Unique equipment volume (corrected for pressure and temperature)	See Appendix 2 Explanatory Notes / Comments
Transmission Compressor Stations	Compressor station - Equipment leaks from valves, connectors, open ended lines, pressure relief valves, and meters (using leak detection)	MRR	**<u>Leaker EFs-Compressor Station</u>** **<u>(Component Leaks identified per survey use the following EFs)</u>** # of leaks > 10,000 ppm x Subpart W EF (ref: Table W-3 of Subpart W of Part 98) **<u>Compressor Components</u>** Valve = 0.3562Mscf/day/dev Connector = 0.1342 Mscf/day/dev Open-Ended Line = 0.4145 Mscf/day/dev Pressure Relief Valve = 0.9518 Mscf/day/dev Meter = 0.4639 Mscf/day/dev Other = 0.0984 Mscf/day/dev **<u>Non-compressor components</u>** Valve = 0.1541 Mscf/day/dev Connector = 0.1370 Mscf/day/dev Open-ended line = 0.2705 Mscf/day/dev Pressure relief valve = 0.0482 Mscf/day/dev Meter = 0.0703 Mscf/day/dev Other = 0.0984 Mscf/day/dev	# of leaks > 10,000 ppm x Subpart W EF (ref: Table W-3 of Subpart W of Part 98) **Compressor components** Valve = 0.35616 Mscf/day/dev Connector = 0.13416 Mscf/day/dev Open-ended line = 0.41448 Mscf/day/dev Pressure relief valve = 0.95184 Mscf/day/dev Meter = 0.46392 Mscf/day/dev
	Compressor Station - Transmission storage tanks	MRR	Direct measurement of tank vapor vent stack + operating hours (pg 218-219 of Regulation for MRR)	For Transmission Storage Tanks such as Condensate Tanks, Aboveground Waste Condensate Vessels, and Scrubbers, engineering estimation was performed to estimate the annual emissions. Annual Emissions [Mscf/year] = TS x VC x VNG ● TS = Throughput of System [MMscf of dry gas/year] ● VC = Condensate volume per unit volume of dry Natural Gas [gal of liquid/MMscf of dry gas] ● VNG = Volume of Natural Gas vaporized from condensate liquids [Mscf/gal of liquid]
	Compressors (Centrifugal) - Transmission--data collection will require time spent in modes (active, pressurized idle, de-pressurized idle), compressor venting	MRR	Direct measurement x operating hours (operating mode)	
	Compressors (Reciprocating) - Transmission--data collection will require time spent in modes (active, pressurized idle, de-pressurized idle)compressor rod packing venting	MRR	Direct measurement x operating hours (operating mode)	
	Compressor station - Equipment and pipeline blowdowns	MRR	Eq. W - 14A # of blowdowns * piping volume	
	Compressor Station - Natual gas pneumatic device venting	MRR	Low Continuous Bleed = 0.0336 Mscf/day/dev Intermittent Bleed = 0.0576 Mscf/day/dev High Continuous Bleed = 0.4457 Mscf/day/dev	
Distribution Mains and Services Pipelines	Distribution Mains (Below-Ground Leaks)	GRI (1996)	Unprotected Steel Main = 0.1548 Mscf/day/leak Protected Steel Main = 0.0612 Mscf/day/leak Plastic Main = 0.2988 Mscf/day/leak	
	Distribution Mains (Above Ground Leaks) - Not MSA	GRI (1996)	Unprotected Steel Main = 0.1548 Mscf/day/leak Protected Steel Main = 0.0612 Mscf/day/leak Plastic Main = 0.2988 Mscf/day/leak	
	Distribution Service (Below-Ground Leaks)	GRI (1996)	Copper = 0.0226 Mscf/day/leak Unprotected Steel Service = 0.0600 Mscf/day/leak Protected Steel Servce = 0.0276 Mscf/day/leak Plastic Service = 0.0089 Msc/day/leak	
	Distribution Service (Above-Ground Leaks) - Not MSA	GRI (1996)	Copper = 0.0226 Mscf/day/leak Unprotected Steel Service = 0.0600 Mscf/day/leak Protected Steel Servce = 0.0276 Mscf/day/leak Plastic Service = 0.0089 Msc/day/leak	
	Distribution Main, Pressure Relief Valves	MRR	Pressure relief valve = 0.00696 Mscf/day/dev	
	Distribution Mains and Services blowdown	MRR	Equation W-14A , Eq. W-35 , Eq. W-36	● For an Abandoned High/Medium Pressure Pipe and Service; Annual Emission = pi * ((Pipe Diameter)^2)/4 * Blowdown Footage * Pressure conversion factor/Natural Gas Compressibility Factor. Note that for shut-in pressures less than 100 psig, the Natural Gas Compressibility Factor is 1. ● For the Distribution Odor Intensity Test; Annual Emission = Number of Tests * Volume per Test

	All damages (as defined by PHMSA)	MRR	Equation W-14A , Eq. W-35 , Eq. W-36	● For AG Non-hazardous and MSA damages, emissions were estimated based on a company emission factor for the maximum leak rate of AG Non-hazardous based on soap test criteria for above ground facilities: number of days leaking * 4 cfh * 24/1000 = Mcf/damage. ● For AG Hazardous and Below Ground Code 1 damages, emissions were estimated based on engineering calculations using pipe size, damage opening size, and duration. Where an estimate was not made at the time of the event, the emissions were estimated from a population of similar events with respect to pipe material and size. ● For Code 2 and Code 3 damages, the emission factor for Distribution pipeline leaks was used (line 24 and 26).
	Pneumatic Devices - Pneumatic/Hydraulic Valve Operators, and Turbine Valve Operators	Engineering Estimate	Manufacturer Supplied Information (e.g., Bristol, Becker, Moore, etc)	
Distribution M&R Stations	Distribution Above grade M&R Station Leaks (> 300 psi)	GRI (1996)	1,684.5 Mscf/yr/station	The fugitive emissions for the component leaks reported in the "Component Leaks" worksheet for Distribution M&R Stations are
	Distribution Above grade M&R Station Leaks (100 - 300 psi)	GRI (1996)	896.5 Mscf/yr/station	The fugitive emissions for the component leaks reported in the "Component Leaks" worksheet for Distribution M&R Stations are
	Distribution Above grade M&R Station Leaks (< 100 psi)	GRI (1996)	40.6 Mscf/yr/station	The fugitive emissions for the component leaks reported in the "Component Leaks" worksheet for Distribution M&R Stations are
	Distribution Below grade M&R Station Leaks (> 300 psi)	GRI (1996)	12.176 Mscf/yr/station	The fugitive emissions for the component leaks reported in the "Component Leaks" worksheet for Distribution M&R Stations are
	Distribution Below grade M&R Station Leaks (100 - 300 psi)	GRI (1996)	1.840 Mscf/yr/station	The fugitive emissions for the component leaks reported in the "Component Leaks" worksheet for Distribution M&R Stations are
	Distribution Below grade M&R Station Leaks (< 100 psi)	GRI (1996)	0.964 Mscf/yr/station	The fugitive emissions for the component leaks reported in the "Component Leaks" worksheet for Distribution M&R Stations are
	Distribution M&R Station Blowdowns	Engineering Estimate	Average Pressure x Average Volume x # of inspections & Maintenance Activities	● For Abandoned Piping in Medium Pressure M&R Stations; Annual Emission = pi * ((Pipe Diameter)^2)/4 * Blowdown Footage * Pressure conversion factor/Natural Gas Compressibility Factor. Note that for shut-in pressures less than 100 psig, the Natural Gas Compressibility Factor is 1.
	Distribution M&R Station Pneumatics	Engineering Estimate	Manufacturer Supplied Information (e.g., Bristol, Bettis Actuators, etc)	● The vented emissions for pneumatic devices reported in the "Component Vented Emissions" worksheet for Distribution M&R Stations are accounted for as part of the Above Grade station emission factors.
Commercial, Industrial and Residential Meters	Residential Meters	GRI (1996)	0.148 Mscf/yr/meter	
	Commercial and Industrial Meters	GRI (1996)	0.051 Mscf/yr/meter	
	All Damage (as defined by PHMSA)			● For AG Non-hazardous MSA damages, emissions were estimated based on a company emission factor for the maximum leak rate of AG Non-hazardous leaks based on soap test criteria for above ground facilities: number of days leaking * 4 cfh * 24/1000 = Mcf/damage. ● For AG Hazardous MSA damages, emission was estimated based on engineering calculation using pipe size, damage opening size, and duration. Where an estimate was not made at the time of the event, the emissions were estimated from a population of similar events with respect to pipe material and pipe size.
	Vented Emission from MSA	Engineering Estimate	Estimated volume release by MSA and activity type	See Appendix 6 Explanatory Notes / Comments
Underground Storage	Dehydrator Vents - Storage	GRI (1996)	One of the following three cases per dehydrator facility 1. Glycol dehydrator with VRU and thermal oxidizer = 0 Mscf 2. Glycol dehydrator with no control device = Engineering Estimate 3. Desiccant dehydrator = 2.23E-03 mt CH4/MMscf (Alternative: Eq. 5 in MRR)	
	Storage - piping leakage	MRR	**Leaker EFs-Storage Station, Gas Service** **(Component Leaks identified per survey use the following EFs)** Connector = 0.1342 Mscf/day/dev Valve = 0.3562 Mscf/day/dev Pressure Relief Valve = 0.9518 Mscf/day/dev Open-Ended Line = 0.4145 Mscf/day/dev Meter = 0.4639 Mscf/day/dev Other = 0.0984 Mscf/day/dev **Population EFs-Storage Wellheads, Gas Service** **(For all un-surveyed components use the following EFs)** Connector = 0.0002 Mscf/day/dev Valve = 0.0024 Mscf/day/dev Pressure Relief Valve = 0.0041 Mscf/day/dev Open Ended Line = 0.0007 Mscf/day/dev	
	Storage - surface casing leakage	Engineering Estimate	TBD	
	Storage - Wellhead leakage	MRR	**Leaker EFs-Storage Wellheads, Gas Service** **(Component Leaks identified per survey use the following EFs)** Connector (other than flanges) = 0.0288 Mscf/day/dev Valve = 0.1080 Mscf/day/dev Pressure Relief Valve = 0.0984 Mscf/day/dev Open-Ended Line = 0.0600 Mscf/day/dev Flange = 0.0912 Mscf/day/dev Other = 0.0984 Mscf/day/dev **Population EFs-Storage Wellheads, Gas Service** **(For all un-Surveyed components, use the following EFs)** Connector = 0.0002 Mscf/day/dev Valve = 0.0024 Mscf/day/dev Pressure Relief Valve = 0.0041 Mscf/day/dev Open-Ended Line = 0.0007 Mscf/day/dev	
	Storage - Compressor & blowdowns	Engineering Estimate	Eq. 13 of MRR (piping volume x # of blowdowns)	
	Storage - Wellhead Rework blowdown and bring-in	Engineering Estimate	Eq. 9,10,11,12 of MRR	
	Pressure Relief Valves	MRR	Pressure relief vallve = 0.9518 Mscf/day/dev.	
	Pneumatic Devices - Pneumatic/Hydraulic Valve Operators, and Turbine Valve Operators	MRR	Low Continuous Bleed = 0.0336 Mscf/day/dev Intermittent Bleed = 0.0576 Mscf/day/dev High Continuous Bleed = 0.4457 Mscf/day/dev Hydraulic Valve Operator = TBD Turbine Valve Operator = TBD	