Natural Gas Processing Unit Modules Definitions

Alberta Climate Change Office

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Natural Gas Processing

Unit Modules Definitions

The purpose of this document is to provide descriptions of Natural Gas Processing unit modules, including the definitions, the technology that qualifies, module boundaries and the throughput metric.

Information contained would primarily be used by facilities for the purpose of annual emissions reporting under Carbon Competitiveness Incentive Regulation (CCIR) and as part of third party verification to confirm modules reported satisfy the definitions.

Natural gas processing is a complex process that consists of operations involving separation of impurities and various non-methane hydrocarbons and fluids from the raw natural gas to produce a pipeline quality dry natural gas. The process is also used to recover natural gas liquids (condensate, natural gasoline and liquefied petroleum gas) or other substances such as sulfur.

A **"gas processing module"** is one or more grouped operations in the gas processing facility that can be defined and separated from others.

Glossary of Terms[1]

Ethane (C2) is a mixture mainly of ethane, which ordinarily may contain some methane and propane.

Propane (C3) is a mixture mainly of propane, which ordinarily may contain some ethane and butanes.

Butanes (C4) is a mixture mainly of butanes, which ordinarily may contain some propane or pentanes plus. Includes ISO and normal butane.

Natural Gas Liquid (NGL) is a mixture of ethane, propane, butanes, or pentanes plus, or a combination of them, removed (condensed) as a liquid from the processing of natural gas or condensate.

Pentanes plus (C5+) is a mixture of mostly pentanes plus heavier hydrocarbons such as C6-C9 in smaller amounts, extracted directly from natural gas. Natural gasoline is the largest component of Pentanes plus. The Pentanes plus (C5+) compound is highly volatile and aliphatic in nature.

[1] Based on "Petrinex" Oil and Gas reporting system.

Condensate is a mixture mainly of pentanes and heavier hydrocarbon that may be contaminated with sulphur compounds, that is gaseous in its virgin reservoir state but is liquid when recovered at atmospheric pressure and ambient temperatures at inlet separators or scrubbers in natural gas processing plants. Condensate removed from the raw gas at this stage is reported as PROC C5-SP in Petrinex.

Sulphur is an element produced as a by-product from the sour gas processing. It can be extracted and/or stored in a prill, slate, block, or molten form.

Spec Product (SP) means ethane, propane, butanes or pentanes plus that have been processed (fractionated) to a condition where they meet purchaser specifications for product quality. For condensate (reported in Petrinex as PROC C5-SP), also includes condensate production that is not further processed at the gas plant.

Unit Modules Description

Inlet Gas Compression

Inlet gas compression is a process that involves pressurizing/compressing inlet natural gas when gas processing at the facility requires pressure higher than the pressure in the delivering pipeline.

The inlet gas throughput (E3m3) includes only the volume of the facility inlet gas that requires compression before the gas enters the first processing module which operates at the facility's working pressure. Module throughputs include inlet gas volumes through both gas-fired and electric-drive compressors.

Dehydration

Dehydration of natural gas is a process that involves extraction of water vapor from the gas to a specified maximum limit for residual water content. The most common dehydration processes include, but not limited to, absorption with glycol and adsorption with dry desiccant. Glycol dehydrating agents include diethylene glycol (DEG) and triethylene glycol (TEG). The most common desiccants include activated alumina or a granular silica gel material.

The gas throughput volume (E3m3) reflects the total natural gas requiring dehydration. This includes the volume of natural gas through a stand-alone glycol dehydration process and/or the volume of natural gas processed through a molecular sieve dehydrator.

Gas Sweetening

Gas sweetening is a process involving removal of the CO2 and H2S from the raw gas to meet the CO2 and H2S sales gas specifications. Gas sweetening agents may include, but are not limited to primary, secondary, and tertiary amines and/or chemical compounds such as Selexol,

Fluor, Purisol, and Sulfinol. A “Merox” process may also be used to remove CO2 and H2S from the raw gas stream.

The amine/gas sweetening throughput includes the total inlet gas volume in E3m3 through the process.

Total Refrigeration

Refrigeration in natural gas treating is a process and/or series of processes that involve separation of natural gas liquids (NGL) from the raw natural gas. Typical individual processes include refrigeration, shallow cut, deep cut and lean oil systems. Refrigeration is also used to meet the hydrocarbon dew point, as well as the water dew point specification for residue or sales gas.

The refrigeration process primarily incorporates the two major methods: absorption and cryogenic expander processes. An absorbing lean oil with high affinity for NGLs is used in the absorption method. The turbo-expander and the Joule-Thomson expansion processes are used in the cryogenic expander method.

The total gas throughput volume (E3m3) in the refrigeration module is determined based on the configuration of refrigeration processes within a facility and is based on three scenarios, as follows:

1. When only one refrigeration process exists within a facility, the total gas throughput volume (E3m3) through this individual refrigeration processing module should be used.
2. When multiple refrigeration processes are run in series, the maximum throughput gas volume (E3m3) through any individual refrigeration processing module should be used.
3. When the refrigeration processes are run in parallel, the total throughput gas volume (E3m3) must be calculated based on the sum of throughput for each individual refrigeration processing module operating in parallel.

Fractionation

Fractionation is a process that involves further separation of the NGLs removed from the natural gas and/or NGLs brought onsite from a Third-Party contractor(s) for further processing/fractionation. Fractionation is based on the different boiling points of different hydrocarbons in the NGL stream. The fractionation process is broken down into steps in the following processing order:

1. Deethanizer - removal of spec product ethane (C2-SP);
2. Depropanizer – removal of spec product propane (C3-SP); and
3. Debutanizer – removal of spec product butanes (normal- and iso- C4-SP), leaving the pentanes and heavier hydrocarbons in the spec product pentane (C5-SP) and/or NGL streams.

Deethanizer, Depropanizer and Debutanizer are referred as the “Fractionation processing module”.

The production from the fractionation module includes the total production of specification (SP) ethane, propane, butane, and pentane products reported in Petrinex in m3 and converted to cubic metres of oil equivalent (m3OE).

Only the portion of C5 plus that goes through the fractionation module, reported as FRAC in Petrinex, should be included here.

When pipeline specification ethane is produced in a Deep Cut Refrigeration process or in the Ethane Extraction processing module at a straddle plant, it should not be included in the fractionation production.

The total fractionation production should include specification products from both: Gas Processing (reported as PROC in Petrinex excluding PROC Pentane-SP) and Fractionation Processing (reported as FRAC in Petrinex).

Stabilization

Condensate stabilization is a process that involves a separation of the very light hydrocarbon gases, e.g. methane and ethane, from the heavier hydrocarbon components so that a vapor phase is not produced upon flashing the liquid into atmospheric storage tanks. Stabilization of the condensate/pentanes+ is usually accomplished through flash vaporization.

The production from the stabilization module includes the total production of Pentane-SP reported in Petrinex as PROC Pentane-SP in m3 and converted to cubic metres of oil equivalent (m3OE). This should not include C5-SP produced in the fractionation module that is reported in Petrinex as FRAC C5-SP.

Sales Compression

Sales gas compression involves pressurizing/compressing pipeline specification sales natural gas to a pressure required for the natural gas transmission and distribution system.

The sales gas throughput (E3m3) includes only the volume of the sales gas leaving the facility where the processing module operating pressure requires further compression prior to delivery to the natural gas transmission and distribution system.

Any re-compression that exists within a processing unit is not included in this module.

Module throughputs include sales gas volume delivered to a natural gas transmission line through both gas-fired and electric-drive compressors.

Sulphur Plant

Sulphur recovery is a process of recovering elemental sulfur from acid gas streams containing hydrogen sulfide.

Hydrogen sulfide is a by-product of the sour natural gas processing. The “Claus Process” in the most common method used is the recovery of elemental sulfur. The “Claus” technology consists of a thermal stage (combustion chamber, waste heat boiler) and two or three catalytic reaction stages (reheater, reactor and condenser). The sulfur produced in the thermal stage is condensed in the waste heat boiler or the condenser. The remaining un-combusted hydrogen sulfide undergoes the “Claus” catalytic reaction to form elemental sulfur. Alumina or titanium dioxide are the most commonly used catalysts.

The sulphur plant production includes the sulphur production reported in Petrinex in tonnes of sulphur.

Ethane Extraction

Ethane extraction is a process of removing ethane (including natural gas liquids) from marketable natural gas. Facilities that utilize this process are also referred as straddle plants.

The most common ethane extraction process is a cryogenic process. The cryogenic process consists of lowering the temperature of the gas stream, often with the use of a turbo expander process. The natural gas stream is cooled by using external refrigerants, followed by an expansion turbine, which rapidly expands the chilled gases. This causes the natural gas temperature to drop significantly and rapidly, thus condensing ethane and other hydrocarbons. Methane will remain in a gaseous form.

For straddle plants, the greenhouse gas emissions associated with dehydration, amine sweetening and refrigeration processing are embedded within the ethane extraction plant so a single ethane extraction processing module includes all three processes.

The ethane production includes the volume of ethane production (C2-SP) in E3m3 reported in Petrinex and converted to cubic metres of oil equivalent (m3OE).

Acid Gas Injection

Acid gas injection is a process of injecting or disposing of the acid gas stream into a deep geological formation. The two following steps are associated with the acid gas injection process, after sulfur and carbon dioxide compounds are removed from the acid gas through an amine gas treatment process:

1. The gas is transported through pipelines to a suitable place where it can be injected; and
2. The gas is forced into an injection well.

The acid gas injection throughput includes the total injected volume of acid gas (E3m3) reported in Petrinex or measured at the facility.

Cavern Storage

Cavern storage is the storage of liquid hydrocarbon products in depleted salt caverns. This does not include the storage of processed natural gas. The process of “displacement” is used to

move the product in and out of the cavern. Displacement uses brine to force product out of the cavern. Since the brine is heavier than the hydrocarbons and sits below the product in the cavern, brine can be pumped into the cavern through a pipe close to the bottom of the cavern to force the product out through a pipe at the top of the cavern. As product is injected into the cavern, the brine is removed from the bottom of the cavern. To make the displacement system work, most of storage facilities maintain a large brine pond on the surface to move product in and out of the cavern. The volume of the brine pond usually equals that of the volume of the cavern.

The cavern storage production includes the total volume of all liquefied gas product(s), i.e. ethane, propane, butane and associated mixtures reported in m3 injected into the cavern(s), converted to cubic metres of oil equivalent (m3OE)[2].

Note: At this time, due to the small sample size, cavern storage allocations will be assigned on a per facility basis.

CO2 Plant

The CO2 plant refers to a process involving the removal of CO2 from the gas stream, including CO2 purification and/or liquefaction. The cryogenic technology is the most common and efficient technology used in this process.

The CO2 plant processing module throughput includes the total CO2 gas volume (E3m3) produced through the CO2 removal process as measured by facility meters or scales.

Flaring, Venting, Fugitives, Other

The “Flaring, Venting, Fugitives, Other” module includes all GHG emissions sources that are not used for the purpose of gas or liquids processing at a regulated facility.
This module includes, but is not limited to, flare and Incinerator stacks, venting, facility fugitive emissions, residue gas for straddle plants, diesel emergency generators, fire water pumps and other minor (<100 tonnes CO2e) emission sources.

The “Flaring, Venting, Fugitives, Other” is equivalent to the total annual facility production reported in Petrinex, converted to m3OE.

To further illustrate the concept of the natural gas processing modules the Appendix contains overview of the modules followed by some typical natural gas plants configurations.

Average module intensities represented by weighting factors for Alberta Gas Processing Index are also provided in the Appendix.

[2] The use of m3OE unit for Cavern Storage allocation will be revisited in 2019.

APPENDIX A

A.1 – Overview of Natural Gas Processing Modules

A.2 – Simplified Flow Diagram of a Typical Natural Gas processing Plant

A.3 – Simplified Flow Diagram of a Typical Natural Gas processing Plant (Dehydration within Refrigeration)

A.4 – Simplified Flow Diagram of a Typical Natural Gas Straddle Plant

A.5 – Simplified Flow Diagram of a Typical Natural Gas Straddle Plant (without Fractionation)

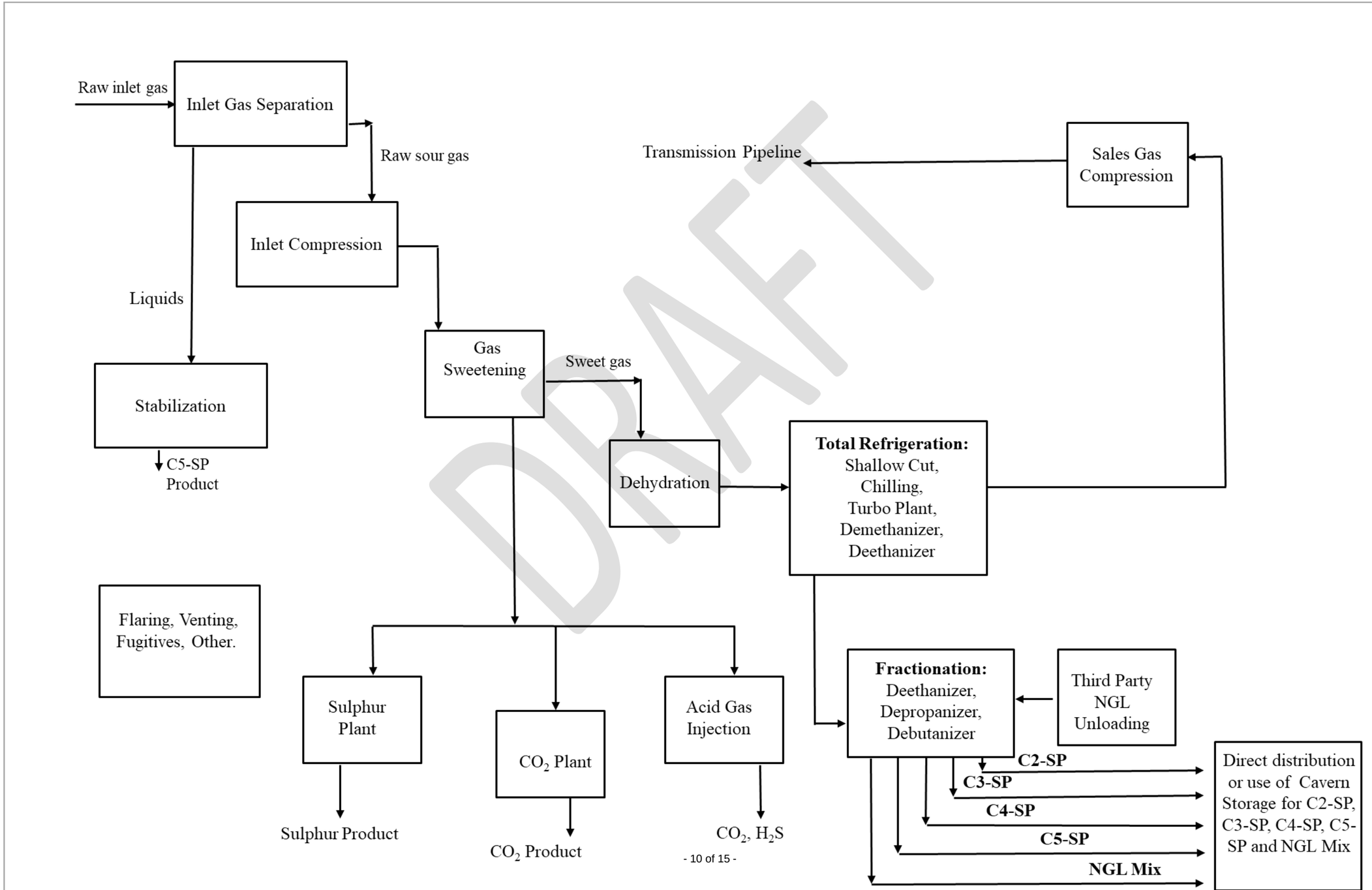
A.6 – Alberta Gas Processing Index Weighting Factors

A.1 - Overview of Natural Gas Processing Modules

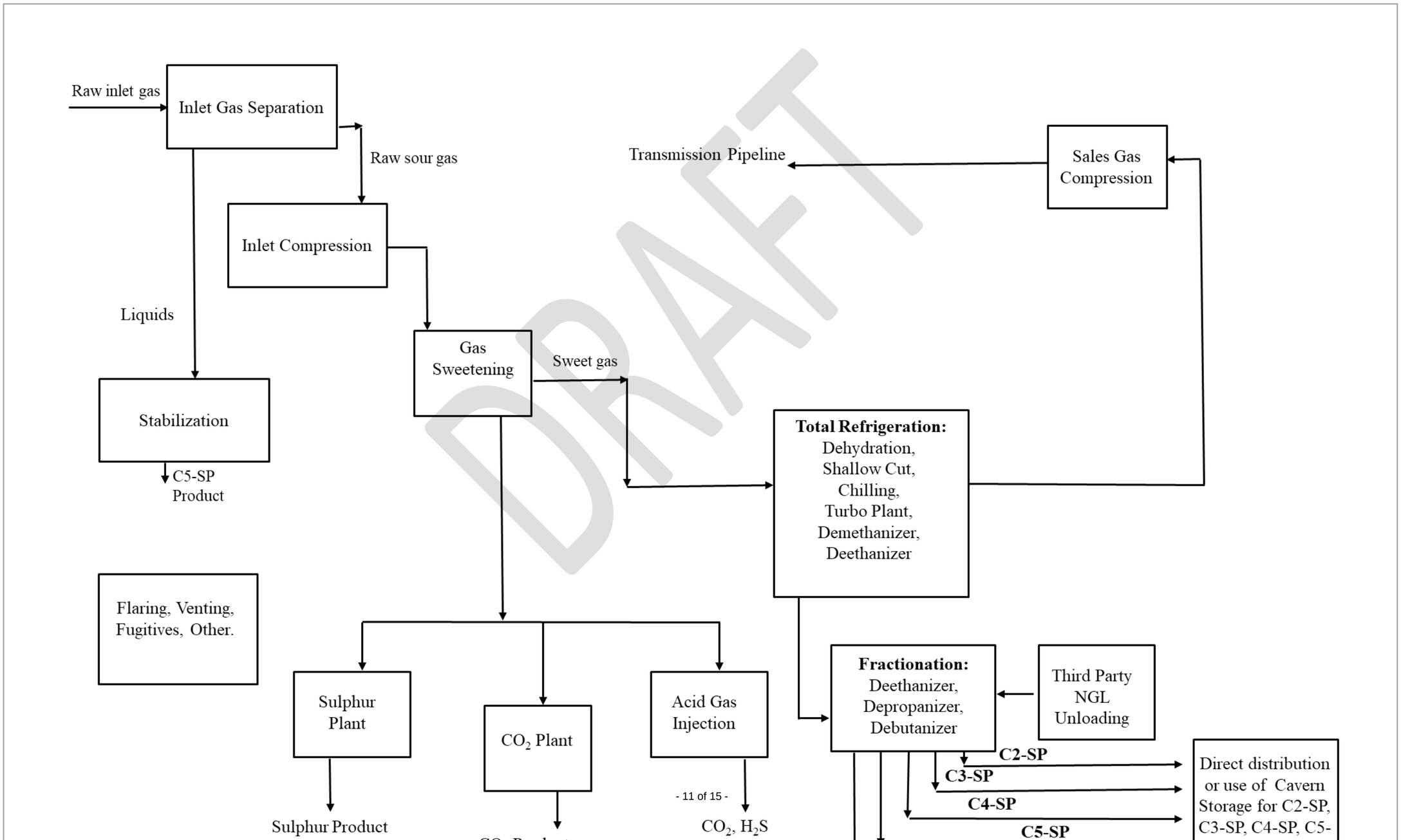
Process Unit (Module)	Inlet	Outlet	Typical Equipment	Stream Measured	Unit of Measure [1]
Inlet Compression	Inlet Gas to compression	Compressed Inlet Gas to Processes	Reciprocating engines, centrifugal compressors.	Only volume of the inlet gas requiring compression at the facility's point of entry.	E^3m^3
Dehydration	Gas to the dehydrator(s)	Dry gas from the dehydrator(s)	Heaters, boilers, heat exchangers, molecular sieves	All inlet gas volume requiring dehydration.	E^3m^3
Gas/Amine Sweetening	Sour/Sweet Gas to Gas/Amine Sweetening	Sweet Gas from Gas/Amine Sweetening with a separate acid gas stream	Heaters, boilers, amine sweetening unit(s), heat exchangers.	Total inlet gas volume through the gas/amine sweetening process.	E^3m^3
Total Refrigeration	Sweet gas to Refrigeration	Sales Gas, Natural Gas Liquids ("NGLs") and specification ethane depending in refrigeration process	Heaters, Lean Oil System, Turbo-Expander, Cryogenic Expander.	The total gas in the refrigeration module is determined based on the configuration of refrigeration processes within a facility and is based on three (3) scenarios, as follows: 1. When only one refrigeration process exists within a facility, the total gas volume through this individual refrigeration processing module should be used. 2. When multiple refrigeration processes are run in series, the maximum gas volume through any individual refrigeration processing module should be used. 3. When the refrigeration processes are run in parallel, the total gas volume must be calculated based on the sum of each parallel individual refrigeration processing module.	E^3m^3
Fractionation	Natural Gas Liquids ("NGLs")	Specification Ethane, Propane, Butane, and Pentane Products, and/or NGLs	Heaters, Reboilers, Deethanizer, Depropanizer, Debutanizer, heat exchangers.	The production from the fractionation module includes the total production of specification (SP) ethane, propane, butane, and pentane products reported in Petrinex in m^3 and converted to cubic metres of oil equivalent (m^3OE). Only portion of C5 plus that goes through the fractionation module, reported as FRAC in Petrinex, should be included here. When pipeline specification ethane is produced in a Deep Cut Refrigeration process or in the Ethane Extraction processing module at a straddle plant, it should not be included in the fractionation production. The total fractionation production should include specification products from both: Gas Processing (reported as PROC in Petrinex excluding PROC Pentane-SP) and Fractionation Processing (reported as FRAC in Petrinex).	m^3OE
Stabilization	Inlet Gas	C5-SP Product	Heaters, boilers.	Total production of C5-SP reported in Petrinex as PROC C5-SP. This should not include C5-SP produced in the fractionation module that is reported in Petrinex as FRAC C5-SP.	m^3OE
Sales Compression	Sales Gas to Compression	Sales Gas to Transmission System	Reciprocating engines, centrifugal compressors.	Only volume of the sales gas requiring compression at the Facility's exit point.	E^3m^3
Sulphur Plant	Sour Gas	Sulphur Product	Boilers, heaters, heat exchangers.	Sulphur production reported in Petrinex.	tonnes sulphur
Acid Gas Injection	Acid Gas to Underground Injection	Acid Gas Injected Underground	Reciprocating engines, centrifugal compressors.	Volume of acid gas injected underground, either reported in Petrinex, or obtained directly from the facility.	E^3m^3
Ethane Extraction	Marketable Gas	Sales Gas, Specification Ethane and NGLs	Heaters, boilers, Turbo-Expander, Cryogenic Expander	Ethane production reported in Petrinex.	m^3OE
Cavern Storage	Liquefied Gas products, i.e. Ethane, Propane, Butane and asso-ciated mixtures	Liquefied Gas products, i.e. Ethane, Propane, Butane and associated mixtures stored in Cavern	Reciprocating engines, centrifugal compressors.	Total volume of the liquefied gas product(s) injected into the cavern(s).	m^3OE
CO_2 Plant	Acid Gas from Amine Sweetening to the CO_2 Plant	Gaseous or Liquid CO_2 Product	Cryogenic technology equipment involving the removal of CO_2 from the gas stream, including CO_2 purification and/or liquefaction.	Total CO_2 gas volume from the amine sweetening through the CO_2 removal and purification process.	E^3m^3
Flaring, Venting, Fugitives, Other	Various Natural Gas Streams throughout Process Units/Modules	Various Natural Gas Streams throughout Process Units/Modules	Flare and Incinerator stacks, venting, facility fugitive, residue gas for straddle plants, diesel emergency generators, fire water pumps and some other emission sources.	Total annual facility production reported in Petrinex.	m^3OE

[1] All volumetric units should match standard conditions as defined in Petrinex. Standard conditions for calculating and reporting gas and liquid volumes are 101.325 kPa (absolute) and 15°C. Monthly gas volumes are reported in units of 10^3 m^3 and rounded to one decimal place. Liquid volume measurements must be determined to a minimum of two decimal places and rounded to one decimal place for monthly reporting in cubic metres (m^3). m3OE units for Cavern Storage will be subject of a further review.

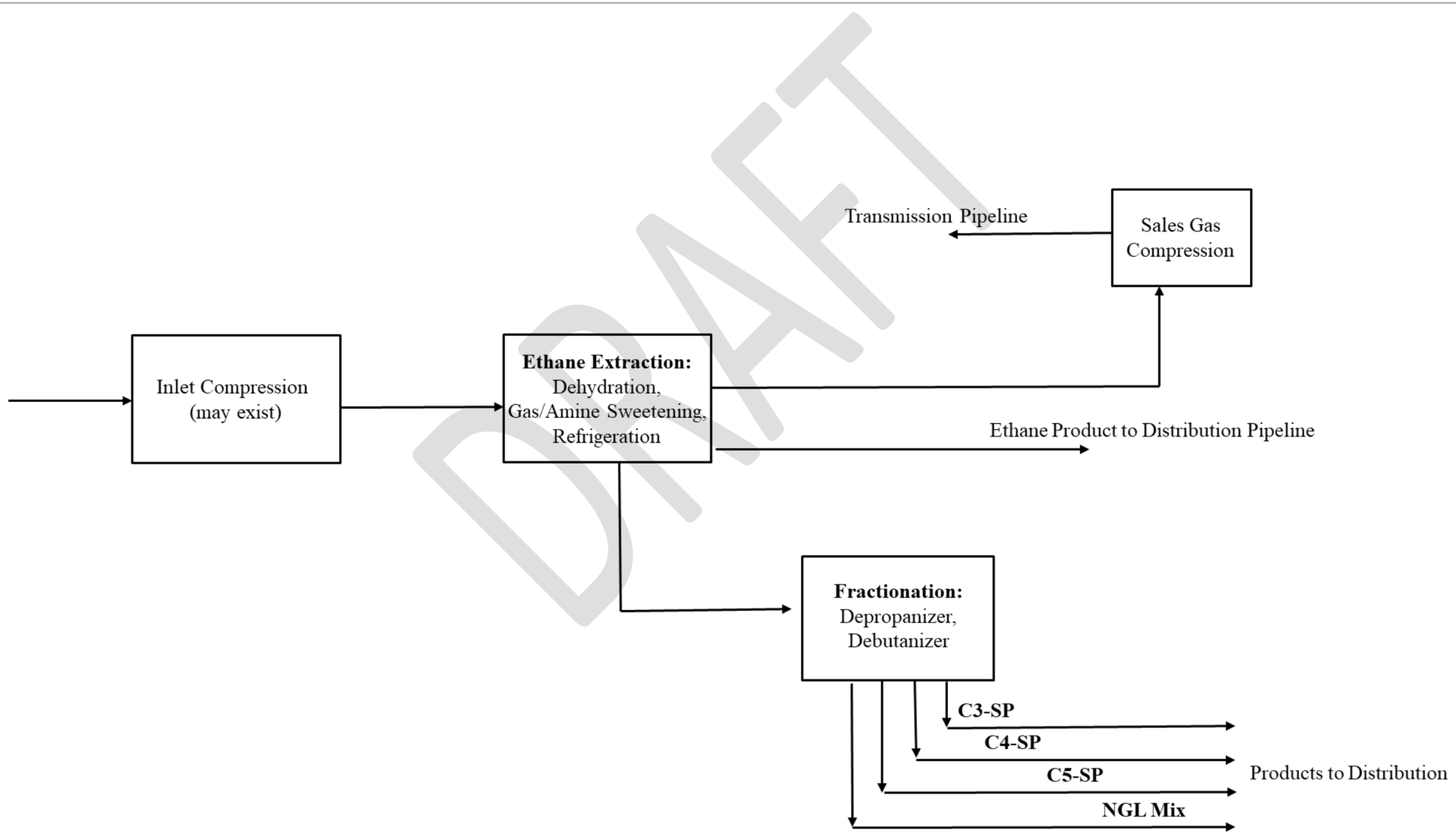
A.2 – Simplified Flow Diagram of a Typical Natural Gas processing Plant



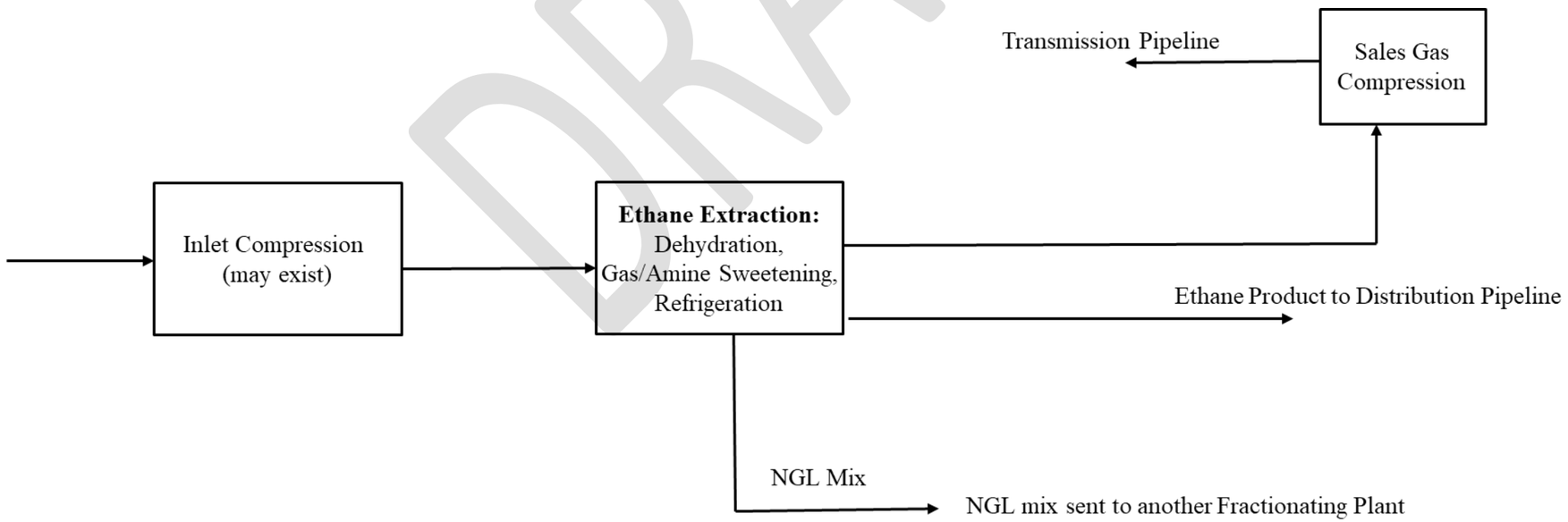
A.3 – Simplified Flow Diagram of a Typical Natural Gas processing Plant (Dehydration within Refrigeration)



A.4 – Simplified Flow Diagram of a Typical Natural Gas Straddle Plant



A.5 – Simplified Flow Diagram of a Typical Natural Gas Straddle Plant (without Fractionation)



A.6 – Alberta Gas Processing Index Weighting Factors

Module		Stream		Weighting Factor	
		Type	Unit	Value	Unit
1	Inlet Compression	throughput	e^3m^3	0.03304	t_{CO2e} / e^3m^3
2	Dehydration	throughput	e^3m^3	0.00247	t_{CO2e} / e^3m^3
3	Gas Sweetening	throughput	e^3m^3	0.03040	t_{CO2e} / e^3m^3
4	Total Refrigeration	throughput	e^3m^3	0.01835	t_{CO2e} / e^3m^3
5	Fractionation	production	m^3_{OE}	0.04141	t_{CO2e} / m^3_{OE}
6	Stabilization	production	m^3_{OE}	0.05537	t_{CO2e} / m^3_{OE}
7	Sales Compression	throughput	e^3m^3	0.02135	t_{CO2e} / e^3m^3
8	Sulphur Plant	production	$t_{Sulphur}$	0.4249	$t_{CO2e} / t_{Sulphur}$
9	Acid Gas Injection	throughput	$e^3m^3_{Acid\ Gas}$	0.3960	$t_{CO2e} / e^3m^3_{Acid\ Gas}$
10	Ethane Extraction	production	m^3_{OE}	0.1251	t_{CO2e} / m^3_{OE}
12	CO_2 Plant	throughput	$e^3m^3_{CO2}$	0.1881	$t_{CO2e} / e^3m^3_{CO2}$
13	Flaring, Venting, Fugitives	production	m^3_{OE}	0.004452	t_{CO2e} / m^3_{OE}