November 30, 2017

Mr. William F. Durham
Director
WVDEP, Division of Air Quality
601 – 57th Street SE
Charleston, West Virginia 25304

**Re: Tug Hill Operating, LLC, Permit Determination Application – Wengerd Well Pad**

Dear Mr. Durham,

Tug Hill Operating, LLC (Tug Hill) and SLR International Corporation (SLR) have prepared the attached Permit Determination Application for the Wengerd Well Pad located in Marshall County, West Virginia. The site was purchased as a non-permitted pad below permitting thresholds and as a result, no DAQ ownership transfer forms are necessary and this should be the first determination submitted for the site. This determination reflects the addition of a Caterpillar G3508 TALE 4SLB compressor engine. The compressor engine is being proposed to lower the well's operating pressure and boost pressure before entering the sales pipeline. Therefore, all site emissions have been evaluated and are attached for your review within this determination.

If any additional information is needed, please feel free to contact me by telephone at (304) 545-8563 or by e-mail at jhanshaw@slrconsulting.com

Sincerely,
**SLR International Corporation**

Jesse Hanshaw

Jesse Hanshaw, P.E.
Principal Engineer

# Tug Hill Operating, LLC

# Wengerd Well Pad

# Proctor, West Virginia

# Permit Determination

SLR Ref: 116.01631.00017

November 2017

# Wengerd Well Pad Permit Determination

Prepared for:

**Tug Hill Operating, LLC**
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

This document has been prepared by SLR International Corporation. The material and data in this permit application were prepared under the supervision and direction of the undersigned.

Alex Asbury
Staff Engineer

Jesse Hanshaw, P.E.
Principal Engineer

# CONTENTS

**Section**

# SECTION 1.

# TECHNICAL SUPPORT DOCUMENT

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017

## 1.1 INTRODUCTION

The Wengerd Site previously owned and operated by Gastar Exploration Inc. has been purchased by Tug Hill Operating, LLC. The site was purchased as a non-permitted pad below permitting thresholds based on the operations of the following equipment: (7) Marcellus wells, (6) 1.0 MMBtu/hr GPU heaters and (2) 400 bbl produced fluid tanks. As a result, no DAQ ownership transfer forms are necessary and this should be the first determination submitted for the site. Tug Hill has prepared this permit determination in order to evaluate the existing equipment at the site, as well as the installation of a Caterpillar G3508 TALE 4SLB compressor engine.

The details of this evaluation are provided in section 2.0 with supporting calculations and ProMax Simulations conducted for worst case operating scenarios.

## 1.2 SITE HISTORY

The following is a brief summary of the history related to this site:

- The wells onsite were put into production in 2012.
    - The turn in line (TIL) date for the well was recorded as being in 2012.
- The tanks were installed in 2012 based on the TIL date and have not been replaced since the pad started production.

## 1.3 DESCRIPTION OF FACILITY

Tug Hill Operating, LLC is submitting a permit determination to evaluate the PTE from (2) 400 bbl produced water tanks, as well as the installation of a Caterpillar G3508 TALE 4SLB compressor engine.

**DESCRIPTION OF PROCESS**

Natural gas, condensate and produced water are generated from (7) wells located onsite producing from the Marcellus formation. Each well stream passes through the Gas Processing Unit (GPU), which consists of a 1.0 MMBtu/hr line heater and 3-phase separator.

In the separator, the multiphase stream is divided into sales gas and its associated liquids (produced water and condensate). The gas and condensate leave the separator and go directly into separate pipelines. The proposed G3508TALE compressor will be used to lower the well's operating pressure and boost pressure before entering the sales pipeline. The produced water will be routed to (2) 400 (bbl) tanks (T01-T02). The produced liquid is hauled from the site using 140 bbl tank trucks.

**Description of Emission Calculations**

The existing process water tanks (T01-T02) were evaluated and found to have a small amount of condensate present with the produced water. The historic water/brine throughput shows a maximum of 0.48 bbl/day condensate being carried over with 20 bbl/day of water. These tank emissions were estimated using ProMax. This estimate predicts approximately 9.26 tpy of VOCs originating from the tanks as flash gas emissions. Working, breathing and loading losses are all predicted by ProMax to be very small due to being 98% water. The produced water is hauled from the site using 140 bbl tank trucks.

The newly proposed compressor engine has been designed to utilize catalytic controls which are integral to the system. Therefore, in accordance with the PTE provisions of Rule 13 the emission estimates from this unit take into account control efficiencies.

## 1.4 FEDERAL AND STATE REQUIREMENT

### APPLICABLE REGULATIONS

This facility is subject to the following applicable rules and regulations:

**Federal and State:**

**45 CSR 2** – Particulate Matter Standards from Combustion of Fuel in Indirect Heat Exchangers

The indirect heat exchanger consisting of the line heater is subject to the visible emission standard of §45-2-3 as follows:

3.1. No person shall cause, suffer, allow or permit emission of smoke and/or particulate matter into the open air from any fuel burning unit which is greater than ten (10) percent opacity based on a six minute block average.

However, in accordance with the exemptions defined with §45-2-11 these sources have limited requirements as follows:

11.1. Any fuel burning unit(s) having a heat input less than ten (10) million B.T.U.'s per hour will be exempt from sections 4, 5, 6, 8 and 9. However, failure to attain acceptable air quality in parts of some urban areas may require the mandatory control of these sources at a later date.

**45 CSR 10** - Emission of Sulfur Oxides

The well pad facility evaluated within this determination application utilizes fuel burning units, but they are all less than the exemption threshold of 10 MMBtu/hr as stated in 45CSR§10-10.1 as follows:

10.1 Any fuel burning units having a design heat input less than ten (10) million BTU's per hour will be exempt from section 3 and sections 6 through 8. However, failure to attain acceptable air

quality in parts of some urban areas may require the mandatory control of these sources at a later date.

**40 CFR 61** - This facility is subject to the asbestos inspection and notification requirements. However, no asbestos is affected by the proposed construction activities.

**45 CSR 13 -** Permits for Construction, Modification, Relocation, and Operation of Stationary Source of Air Pollutants

The company is applying for a permit determination to assure all permitting thresholds are evaluated and the proper minor source permits are identified if applicable. The site was evaluated for aggregate emissions above 6 lb/hr of each criteria pollutant and 2 lb/hr or 5 tpy for aggregate HAPs. Additionally, the site was evaluated for Rule 27 pollutant thresholds such as 1000 lb/yr formaldehyde. All were found to be below permitting thresholds.

The site was also evaluated and found to be exempt from any federal regulations containing substantive requirements.

**WV Code § 22-5-4 (a) (14)**
The Secretary can request any pertinent information such as annual emission inventory reporting. This station is not required to submit an annual air emission inventory.

**45 CSR 17** - Fugitive Particulate Emissions

The site shall minimize fugitive PM so that emissions do not travel offsite.

**40 CFR 60, Subpart JJJJ –** Standards of Performance for Stationary Spark Ignition Internal Combustion Engines

The compressor engine (CE-1) at the station was manufactured on 10-31-2005, which predates the January 1, 2008 applicability date for engines greater than 500 hp. Therefore, the compressor engine is not subject to emissions limits according to 40 CFR§60.4230-(a)(4)(i). Additionally, the compressor will be installed as a booster at the Wengerd location in 2017 and therefore evaluated for applicability to §60.4236 related to requirements for installing previous model year engines. This engine was found to be exempt as a relocated unit according to §60.4236(e).

**40 CFR 63, Subpart ZZZZ –** National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines

The natural gas compressor engine (CE-1) is a 4SLB Cat 3508TALE engine manufactured on 10-31-2005; therefore this engine would be subject to the maintenance work practice standards of this Regulation. However, since these are not viewed as substantive requirements in accordance with 45CSR13 DAQ policy this requirement alone would not trigger the need for permitting.

**NON-APPLICABILITY DETERMINATIONS**

The following requirements have been determined “not applicable” due to the following:

**45 CSR 27 -** To Prevent and Control the Emissions of Toxic Air Pollutants

This rule is not applicable because natural gas is included as a petroleum product and contains less than 5% benzene by weight. 45CSR § 27-2.4 exempts equipment "used in the production and distribution of petroleum products providing that such equipment does not produce or contact materials containing more than 5% benzene by weight."

**45 CSR 30** – Requirements for Operating Permits – Title V of the Clean Air Act

This facility does not meet the emission thresholds to trigger a 45 CSR 30 Title V Operating Permit nor is it subject to any Federal Standards that require a Title V Permit.

**40 CFR 60 Subpart K, Ka, Kb** - Storage Vessel NSPS

The two 400 bbl [16,800 gal] produced liquid tanks T01-T02 are below the size capacity threshold of 75 meters cubed (m^3) [19,813 gallons] defined within the applicability section 60.110b(a) of this Federal standard.

**40 CFR 60 Subpart KKK -** Natural Gas Processing Plant NSPS

This subpart is not applicable because this site is not a processing plant engaged in extracting natural gas liquids by fractionation from natural gas.

> *Natural gas processing plant (gas plant) means any processing site engaged in the extraction of natural gas liquids from field gas, fractionation of mixed natural gas liquids to natural gas products, or both.*

**40 CFR 60 Subpart OOOO** - Storage Vessel NSPS Requirements

The existing storage vessels (T01-T02) were constructed after August 23, 2011 but before, September 18, 2015 and have been demonstrated to exhibit a PTE for VOCs < 6 tpy using ProMax equation of state estimation techniques with representative inputs. Therefore, the existing storage vessels are not considered an affected source under this regulation.

**40 CFR 60 Subpart OOOOa** - Storage Vessel NSPS Requirements

The existing storage vessels predate the applicability date of this regulation, September 18, 2015

**40 CFR 60 Subpart OOOOa** – Fugitive Component Leak Monitoring

The site is classified as a well pad facility, which will not be subject to the monitoring requirement of this section since the existing site predates the applicability date of September 18, 2015 as defined under this Federal regulation.

**40 CFR 60 Subpart OOOOa** – Compressor Packing Requirements
The site is classified as a well pad facility, which will not be subject to the monitoring requirement of this section since the compressor meets the exemption for units operated at well sites as defined under this federal regulation.

**40 CFR 63 Subpart HH** - National Emission Standards for Hazardous Air Pollutants from Oil and Natural Gas Production Facilities

There is no dehydration unit at this site.

**40 CFR 63 Subpart JJJJJJ** - Boilers Located at Area Sources of HAPs

This subpart is not applicable because the process heater at this facility is not classified as boiler under the area source GACT standard.

**40 CFR 82 Subpart F** - Ozone Depleting Substances

The purpose of this subpart is to reduce emissions of class I and class II refrigerants and their substitutes. The facility does not utilize class I and class II refrigerants nor any substitutes.

**Aggregation Discussion (Facility Determination)**

The Wengerd well site is operated solely by Tug Hill Operating, LLC. This well pad facility has the ability to transfer its products via pipeline to midstream compression companies, of which are located on non-contiguous sites over a mile away. Additionally, these sources are not under common control nor is there any support and/or dependency relationship between the midstream companies and Tug Hill.

No other facilities operated by Tug Hill are within a quarter-mile radius and as a result this pad should be considered a single facility as defined within this determination application.

# SECTION 2.

# APPLICATION FOR PERMIT

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017

WEST VIRGINIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF AIR QUALITY
601 57th Street, SE
Charleston, WV 25304
Phone: (304) 926-0475
www.dep.wv.gov/daq

# *PERMIT DETERMINATION FORM (PDF)*

**FOR AGENCY USE ONLY:** PLANT I.D. # _____

PDF # _____ PERMIT WRITER: _____

1. NAME OF APPLICANT (AS REGISTERED WITH THE WV SECRETARY OF STATE'S OFFICE):

Tug Hill Operating, LLC

2. NAME OF FACILITY (IF DIFFERENT FROM ABOVE):

Wengerd Well Pad

3. NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (**NAICS**) CODE:

211111

4A. MAILING ADDRESS:

380 Southpointe Blvd, Suite 200

Canonsburg, PA 15317

4B. PHYSICAL ADDRESS:

Yoho Rd.

Proctor, WV 26055

5A. DIRECTIONS TO FACILITY (PLEASE PROVIDE **MAP** AS **ATTACHMENT A**):

Traveling north on I-77 N take exit 179 for WV-2 N/WV-68S/Emerson Ave towards Vienna. Turn right onto WV-2N/Emerson Ave and travel 15.9 miles. Turn left onto WV-807 N and travel 0.4 miles. Continue onto OH-807 N. Turn left onto OH-7 N/ Ohio River Scenic Byway and travel 28 miles. Take a slight right onto WV-7 and travel 1 mile. Merge onto WV-2 N and travel 4.5 miles. Turn right onto Proctor Creek Rd. and travel 6 miles. Turn left onto Co Rd 1/7 and travel 1.7 miles. Continue onto Coffield Rd and travel 1.4 miles. Continue straight onto Rines Ridge, and travel 1.9 miles Turn right onto Yoho Rd. and travel 0.6 miles. At the fork go right, the well pad will be located straight ahead in approximately 0.7 miles.

5B. NEAREST ROAD: Yoho Rd.

5C. NEAREST CITY OR TOWN: Proctor

5D. COUNTY: Marshall

5E. UTM NORTHING (KM): 4,400.988

5F. UTM EASTING (KM): 522.632

5G. UTM ZONE: 17

6A. INDIVIDUAL TO CONTACT IF MORE INFORMATION IS REQUIRED:

Amy Miller

6B. TITLE: Environmental Coordinator

6C. TELEPHONE:

(724) 338-2030

6D. FAX:

6E. E-MAIL: amiller@tug-hillop.com

7A. DAQ PLANT I.D. NO. (FOR AN EXISTING FACILITY ONLY):

___ ___ ___ – ___ ___ ___ ___ ___

7B. PLEASE LIST ALL CURRENT 45CSR13, 45CSR14, 45CSR19 AND/OR TITLE V (45CSR30) PERMIT NUMBERS ASSOCIATED WITH **THIS** PROCESS (FOR AN EXISTING FACILITY ONLY):

**N/A**

7C. IS THIS PDF BEING SUBMITTED AS THE RESULT OF AN ENFORCEMENT ACTION? IF YES, PLEASE LIST: **No**

8A. TYPE OF EMISSION SOURCE (CHECK ONE):

☒ **NEW SOURCE** ☐ **ADMINISTRATIVE UPDATE**

☐ **MODIFICATION** ☐ **OTHER** (PLEASE EXPLAIN IN 11B)

8B. IF ADMINISTRATIVE UPDATE, DOES DAQ HAVE THE APPLICANT'S CONSENT TO UPDATE THE EXISTING PERMIT WITH THE INFORMATION CONTAINED HEREIN?

☒ **YES** ☐ **NO**

9. IS *DEMOLITION* OR PHYSICAL *RENOVATION* AT AN EXISTING FACILITY INVOLVED? ☐ **YES** ☒ **NO**

10A. DATE OF ANTICIPATED INSTALLATION OR CHANGE:

**12/15/2017**

10B. DATE OF ANTICIPATED START-UP:

December /15/2017 .

11A. PLEASE PROVIDE A **DETAILED PROCESS FLOW DIAGRAM** SHOWING EACH PROPOSED OR MODIFIED PROCESS EMISSION POINT AS **ATTACHMENT B**.

11B. PLEASE PROVIDE A **DETAILED PROCESS DESCRIPTION** AS **ATTACHMENT C**.

12. PLEASE PROVIDE **MATERIAL SAFETY DATA SHEETS (MSDS)** FOR ALL MATERIALS PROCESSED, USED OR PRODUCED AS **ATTACHMENT D**. FOR CHEMICAL PROCESSE, PLEASE PROVIDE A MSDS FOR EACH COMPOUND EMITTED TO AIR.

13A. **REGULATED AIR POLLUTANT EMISSIONS:**

⇒ **FOR A NEW FACILITY,** PLEASE PROVIDE PLANT WIDE EMISSIONS BASED ON THE POTENTIAL TO EMIT (PTE) FOR THE FOLLOWING AIR POLLUTANTS INCLUDING ALL PROCESSES.

⇒ **FOR AN EXISTING FACILITY,** PLEASE PROVIDE THE PROPOSED CHANGE IN EMISSIONS BASED ON THE PTE OF ALL PROCESS CHANGES FOR THE FOLLOWING AIR POLLUTANTS.

*PTE FOR A GIVEN POLLUTANT IS TYPICALLY BEFORE AIR POLLUTION CONTROL DEVICES AND IS COLLECTED BASED ON THE MAXIMUM DESIGN CAPACITY OF PROCESS EQUIPMENT.*

| **POLLUTANT** | **HOURLY PTE** (LB/HR) | **YEARLY PTE** (TON/YR) (HOURLY PTE MULTIPLIED BY 8760 HR/YR) DIVIDED BY 2000 LB/TON |
|---|---|---|
| **PM** | 0.10 | 0.44 |
| **$PM_{10}$** | 0.10 | 0.44 |
| **VOCs** | 2.70 | 11.80 |
| **CO** | 0.71 | 3.08 |
| **$NO_x$** | 3.37 | 14.75 |
| **$SO_2$** | 0.01 | 0.03 |
| **Pb** | <0.01 | <0.01 |
| **HAPs** (AGGREGATE AMOUNT) | 0.23 | 0.98 |
| **TAPs** (INDIVIDUALLY)* | | |
| Benzene | 0.01 | 0.02 |
| Formaldehyde | 0.10 | 0.43 |
| **OTHER** (INDIVIDUALLY)* | | |

* ATTACH ADDITIONAL PAGES AS NEEDED

13B. PLEASE PROVIDE ALL **SUPPORTING CALCULATIONS** AS **ATTACHMENT E**.

*CALCULATE AN HOURLY AND YEARLY PTE OF EACH PROCESS EMISSION POINT (SHOWN IN YOUR DETAILED PROCESS FLOW DIAGRAM) FOR ALL AIR POLLUTANTS LISTED ABOVE INCLUDING INDIVIDUAL HAP'S (LISTED IN SECTION 112[b] OF THE 1990 CAAA), TAP'S (LISTED IN 45CSR27), AND OTHER AIR POLLUTANTS (E.G. POLLUTANTS LISTED IN TABLE 45-13A OF 45CSR13, MINERAL ACIDS PER 45CSR7, ETC.).*

14. **CERTIFICATION OF DATA**

I, SEAN WILLIS (*TYPE NAME*) ATTEST THAT ALL THE REPRESENTATIONS CONTAINED IN THIS APPLICATION, OR APPENDED HERETO, ARE TRUE, ACCURATE, AND COMPLETE TO THE BEST OF MY KNOWLEDGE BASED ON INFORMATION AND BELIEF AFTER REASONABLE INQUIRY, AND THAT I AM A ***RESPONSIBLE OFFICIAL**** (*PRESIDENT, VICE PRESIDENT, SECRETARY OR TREASURER, GENERAL PARTNER OR SOLE PROPRIETOR*) OF THE APPLICANT.

SIGNATURE OF RESPONSIBLE OFFICIAL: S.K.W.

TITLE: VICE PRESIDENT – ENGINEERING & DEVELOPMENT MANAGER – APPALACHIA REGION DATE: 11/29/2017.

**NOTE:** P116.01631.00016LEASE CHECK ENCLOSED ATTACHMENTS:

☒ **ATTACHMENT A** ☒ **ATTACHMENT B** ☒ **ATTACHMENT C** ☒ **ATTACHMENT D** ☒ **ATTACHMENT E**

***RECORDS ON ALL CHANGES ARE REQUIRED TO BE KEPT AND MAINTAINED ON-SITE FOR TWO (2) YEARS.***

THE PERMIT DETERMINATION FORM WITH THE INSTRUCTIONS CAN BE FOUND ON DAQ'S PERMITTING SECTION WEB SITE:

***www.dep.wv.gov/daq***

# ATTACHMENT A

# AREA MAP

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017

# Attachment A - Area Map

Tug Hill Operating LLC - Wengerd Well Pad

GPS Coordinates of Site:
Lat: 39.75851, Lon: -80.73579

# ATTACHMENT B

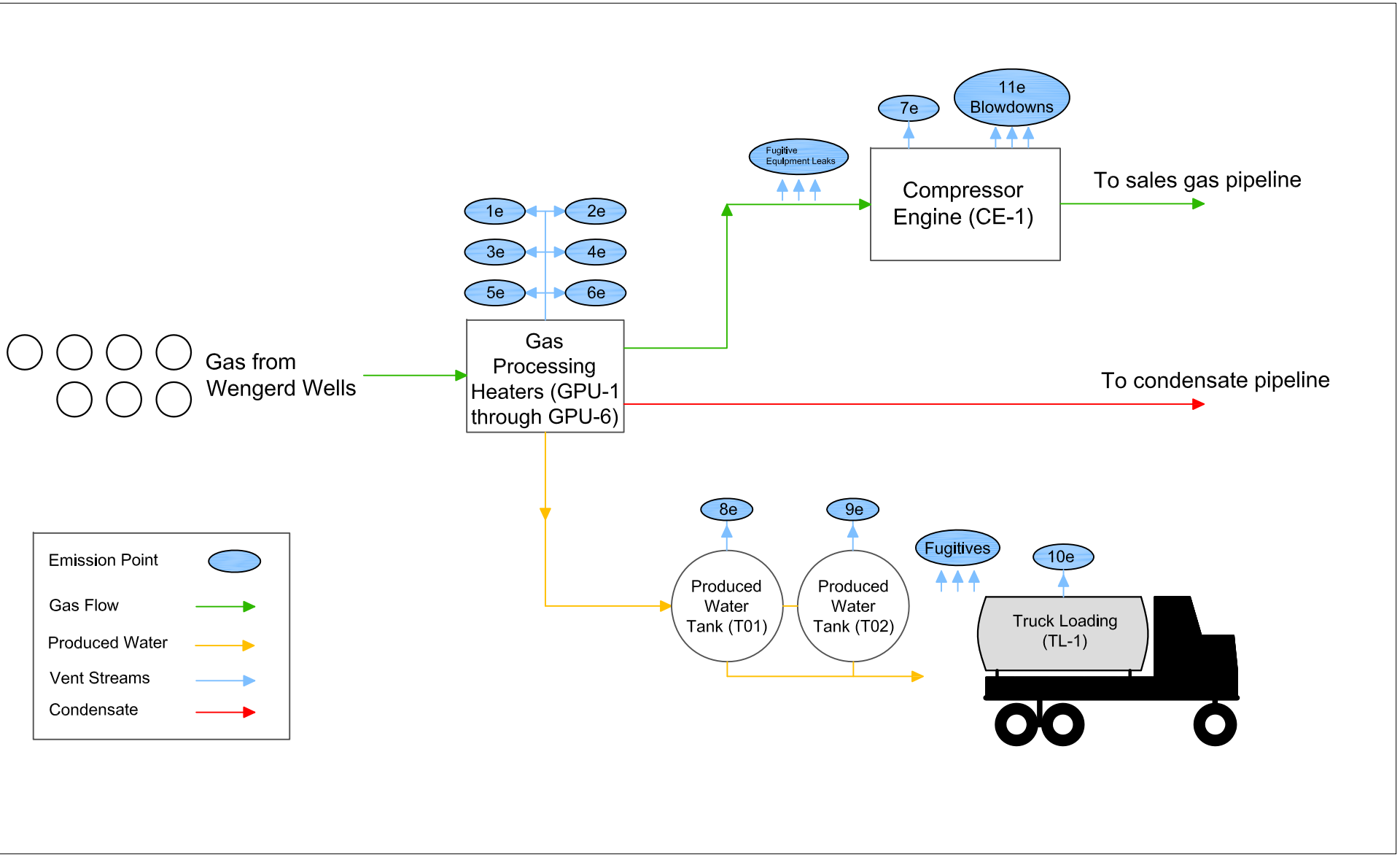
# PROCESS FLOW DIAGRAM

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017




| | | |
|---|---|---|
| SLR | Tug-Hill Operating, LLC | |
| | Attachment B - Process Flow Diagram | |
| | Wengerd Well Pad | Nov 2017 |

# ATTACHMENT C

# PROCESS DESCRIPTION

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017

# PROCESS DESCRIPTION

Natural gas, condensate and produced water are generated from (7) wells located onsite producing from the Marcellus formation. Each well stream passes through a gas processing unit (GPU), which consists of a 1.0 MMBtu/hr line heater and 3-phase separator.

In the separator, the multiphase stream is divided into sales gas and its associated liquids (produced water and condensate). The gas and condensate leave the separator and go directly into separate pipelines. The proposed G3508TALE compressor will be used to lower the well's operating pressure and boost pressure before entering the sales pipeline. The produced water will be routed to (2) 400 (bbl) tanks (T01-T02). The produced liquid is hauled from the site using 140 bbl tank trucks.

# ATTACHMENT D

# SAFETY DATA SHEETS

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017

# SAFETY DATA SHEET

Date Issued:
SDS NO:
Date Revised:
Revision No:

Non-Sour Natural Gas Condensate (Atmospheric Liquid)
(West Virginia)

******IMPORTANT******
This SDS has been prepared for Non-Sour Natural Gas Condensate at atmospheric pressure (i.e., atmospheric liquid). Refer to the following sections for important safety and response information.
**Section 4**- First Aid Measures (for accidental exposure).
**Section 5**- Fire Fighting Measures.
**Section 6**- Accidental Release Measures.

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Non-Sour Natural Gas Condensate (Atmospheric Liquid)
**GENERAL USE:** Condensate extracted from natural gas well production.
**Common Name and Synonyms:** Gas Liquid, Condensate Liquids, Drip Gas, Natural Gas Condensate

## 2. HAZARDS IDENTIFICATION

**This product has not been tested to determine its specific health hazards. Therefore, the information provided in this section includes health hazard information based on the product components.**

**GHS CLASSIFICATIONS**

| Health | Physical |
|---|---|
| H319 -- Eye damage/irritation -- Category 2<br>H315 -- Skin corrosion/irritation -- Category 2<br>H304 -- Aspiration Hazard -- Category 1<br>H331 -- Acute toxicity, Inhalation -- Category 3<br>H336 -- Specific target organ toxicity (single exposure) -- Category 3<br>H350 -- Carcinogenicity -- Category 1B<br>H412 – Harmful to aquatic life, chronic toxicity -- Category 3 | H224 – Extremely flammable liquid and vapor – Category 1 |

**GHS LABEL**

| | |
|---|---|
|  <br>WARNING<br>H320: Causes eye irritation.<br>H315: Causes skin irritation. |  <br>DANGER<br>H350: May cause cancer. |

WARNING

H224 Extremely flammable liquid and vapor

DANGER

H331 Toxic if inhaled

**PRECAUTIONARY STATEMENT(S)**

**Prevention:**

P201: Obtain special instructions before use.
P202: Do not handle until all safety precautions have been read and understood.
P210: Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
P233: Keep container tightly closed.
P235: Keep cool.
P240: Ground/bond container and receiving equipment.
P241: Use with explosion-proof equipment.
P242: Use only non-sparking tools.
P243: Take precautionary measures against static discharge.
P261: Avoid breathing dust/fume/gas/mist/vapours/spray.

P264: Wash thoroughly after handling.
P271: Use only outdoors or in a well-ventilated area.
P273: Avoid release to the environment.
P280: Wear protective gloves / protective clothing / eye protection / face protection.

**Response:**

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. (P304+P340)
If experiencing respiratory symptoms: Immediately call a POISON CENTER or doctor/physician. (P342+310)

IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. (P302+P310)
Call a POISON CENTER or doctor/physician. (P311)
Do NOT induce vomiting. (P331)

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. (P305+P351+338)
: If eye irritation persists: Get medical advice/attention. (P337+P313)

IF ON SKIN: Remove/Take off immediately all contaminated clothing. (P302+P361)
Wash with plenty of soap and water. (P352)
If skin irritation or a rash occurs: Get medical advice/attention. (P333+P313)

IF ON CLOTHING: Take off contaminated clothing and wash before reuse. (P306+P362)

IF exposed or concerned: Call a POISON CENTER or doctor/physician if you feel unwell. (P308+P312)

In case of fire: Use dry chemical, carbon dioxide, or foam for extinction. (P370+P378)
Collect spillage. (P391)*

Store in a well-ventilated place. Keep container tightly closed. Keep cool. (P403+P233+235)

Store locked up. (P405)

IF exposed or concerned: Call a POISON CENTER or doctor/physician if you feel unwell. (P308+3312)

**Disposal:**

Dispose of contents/container in accordance with local/regional/national regulations. (P501)

**EMERGENCY OVERVIEW**

**PHYSICAL APPEARANCE:** Clear liquid.

**IMMEDIATE CONCERNS: HAZARD DESCRIPTION / WARNING INFORMATION SUMMARY –** This product is a highly flammable liquid which may be harmful if ingested, inhaled, comes in contact with skin or eyes, or is released into the environment. Please read entire contents of Section 2 of this Safety Data Sheet (SDS) for details.

**POTENTIAL HEALTH EFFECTS**

**EYES:** Eye contact with vapors may cause eye irritation, watering of eyes and reddening. Eye contact with liquid may cause irritation and pain. Prolonged contact may result in tissue damage.

**SKIN:** Skin contact may cause skin irritation and redness. Repeated or prolonged skin contact may cause dermatitis.

**INGESTION:** Ingestion may cause irritation to the gastrointestinal tract with nausea and diarrhea. May be harmful if swallowed in large quantities.

**INHALATION:** Breathing the mist and vapors may be irritating to the respiratory tract.

**SIGNS AND SYMPTOMS OF OVEREXPOSURE**

**CHRONIC EFFECTS:** Skin, eye, and respiratory tract irritation. Gastrointestinal and vascular effects and death may occur at high concentrations. May cause nervous system effects, such as headache, nausea and drowsiness.

**CARCINOGENICITY:** Condensate contains Catergory 2 constituents (Benezene).

**MUTAGENICITY:** Not Established.

**REPRODUCTIVE TOXICITY**

**REPRODUCTIVE EFFECTS:** Not Established.

**TERATOGENIC EFFECTS:** Not Established.

**MEDICAL CONDITIONS AGGRAVATED: Benzene –** Pre-existing blood system disorders, respiratory conditions, central nervous, liver, kidney, and cardio-vascular conditions may be aggravated by severe or chronic overexposure to benzene. Skin disorders may also be aggravated by exposures to benzene.

**ROUTES OF ENTRY:** Inhalation, skin contact, eye contact, ingestion.

**TARGET ORGAN STATEMENT:** May cause damage to eyes, skin and respiratory system.

**CANCER STATEMENT:** This product may cause cancer. Refer to Section 11 of this SDS for details.

**SENSITIZATION:** Not Established.

**COMMENTS: ADDITIONAL MEDICAL AND TOXICOLOGICAL INFORMATION:** Natural gas condensate and some of its fractions have been shown to cause skin irritation, damage and even cancers when applied directly and repeatedly to skin. When laboratory animals inhale oil vapors at high concentration or ingest in repeated doses, various tumors have developed.

This product contains benzene, which can cause degeneration in blood forming bone marrow leading to anemia which may further degrade to leukemia, a type of cancer (see 29 CFR 1910.1028 of standard). Benzene is recognized as a human carcinogen by OSHA, NTP, ACGIH, and IARC.

## 3. COMPOSITION / INFORMATIO N ON INGREDIENTS

Compositions given are typical values, not specifications. Compositions provided may vary with geographic location, geologic formation, temperature and pressure and actual values could be higher or lower than the ranges provided.

| | Non-Sour Atmospheric Condensate Liquid | |
|---|---|---|
| **Chemical Name** | **WT % (All Vary)** | **CAS** |
| Water | <1.0 – 5.0 | 7732-18-5 |
| Nitrogen | 0.0 – 0.015 | 7727-37-9 |
| Carbon Dioxide | 0.0 – 0.04 | 124-38-9 |
| Benzene | <0.10 – 0.70 | 71-43-2 |
| Ethyl benzene | <1.0 – 3.0 | 100-41-4 |
| Toluene | <1.0 – 5.0 | 108-88-3 |
| Xylenes | <1.0 – 5.0 | 1330-20-7 |
| Methane | <1.0 – 5.0 | 74-82-8 |
| Ethane | <1.0 – 8.0 | 74-84-0 |
| Propane | 1.0 – 10.0 | 74-98-6 |
| Isobutane | 1.0 – 3.0 | 75-28-5 |
| n-Butane | 2.0 – 9.0 | 106-97-8 |
| 2,2-Dimethylpropane | 0.0 – 0.20 | 463-82-1 |
| Isopentane | 2.0 – 5.0 | 78-78-4 |
| n-Pentane | 2.0 – 7.0 | 109-66-0 |
| 2,2-Dimethylbutane | 0.10 – 0.40 | 75-83-2 |
| Cyclopentane | 0.000 | 287-92-3 |
| 2,3-Dimethylbutane | 0.30 – 0.70 | 79-29-8 |
| 2-Methylpentane | 1.0 – 4.0 | 107-83-5 |
| 3-Methylpentane | 1.0 – 3.0 | 96-14-0 |
| n-Hexane | 2.0 – 5.0 | 110-54-3 |
| Heptanes Plus | 45.0 – 80.0 | Mixture |
| Hydrogen Sulfide | <1.0 | 7783-06-4 |

**COMMENTS:** Some components of this material such as benzene, toluene and xylene have been shown to produce fetal toxicity and/or reduce female or male reproductive capacity in laboratory animals.

## 4. FIRST AID MEASURES

**EYES:** Immediately flush with large amounts of water, holding eyelids open, for at least 20 minutes. Repeat if necessary. Remove contact lenses, if present and easy to do. If pain or redness persists, seek medical attention. If eye is exposed to hot liquid, cover eyes with cloth and seek medical attention immediately.

**SKIN:** In case of hot liquid exposure, do not remove clothing or treat, wash only unburned area and seek medical attention immediately.

**INGESTION:** Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Have exposed individual rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person. Obtain medical assistance immediately and treat as directed by a medical professional.

**INHALATION:** Move victim to fresh air. Call 911, emergency medical service, or Emergency Phone Numbers(s) provided in Section 1 of this SDS. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth methods if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult.

**ANTIDOTES:** Not Established.

**NOTES TO PHYSICIAN:** No specific treatment. Treat symptomatically. General supportive measures with continual monitoring of gas exchange, acid-base balance, electrolytes, and fluid intake are also required. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

**CLINICAL TESTING & MEDICAL MONITORING FOR DELAYED EFFECTS –** Not Established.

**COMMENTS: CONTRAINDICATIONS –** Not Established.

## 5. FIRE FIGHTING MEASURES

**FLASH POINT: This material is capable of flashing at temperatures of** 22°C (72°F) or lower.

********IMPORTANT: This material is highly flammable. When separator condensate liquid under pressure encounters normal atmospheric pressures, each 42-gallon barrel equivalent of condensate is capable of flashing over 92 pounds of volatile vapors to the atmosphere in a relatively short amount of time********

**AUTOIGNITION TEMPERATURE:** Not Established.

**EXTINGUISHING MEDIA:**

**SMALL FIRE –** Class B fire extinguisher, carbon dioxide, multipurpose dry chemical, water fog or alcohol-resistant foam.

**LARGE FIRE –** Water fog or alcohol-resistant foam.

**COMMENTS:**

**SPECIFIC HAZARDS THAT MAY ARISE FROM THE PRODUCT -** Vapors are flammable and some constituents may be heavier than air. Vapors may travel through the air as well as across the ground and reach remote ignition sources causing a flashback fire danger. Sudden reaction and fire may result if product is mixed with an oxidizing agent.

**FIRE EXPLOSION:** This product is extremely flammable. Hydrocarbon vapors that are released are a potential fire hazard. The condensate as well as its related vapors can easily be ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Some vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Many liquids are lighter than water. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated.

**SENSITIVE TO STATIC DISCHARGE:** Not Established.

**SENSITIVITY TO IMPACT:** Not Established.

## 6. ACCIDENTAL RELEASE MEASURES

**SMALL SPILL:** For emergency information and procedures to follow in the case of an accidental release, call the Emergency Telephone Number(s) listed in Section 1 of this SDS. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). As an immediate precautionary measure, isolate spill or leak area 50 meters (160 feet) in all directions. Evacuate building and all affected areas. Keep unauthorized personnel away. Do not touch or walk through spilled material. Stay upwind. Keep out of low areas. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Dike far ahead of liquid for later disposal. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Use clean non-sparking tools to collect absorbed material. Water spray may reduce vapor; but may not prevent ignition in closed spaces. A vapor suppressing foam may be used to reduce vapors. Provide sufficient ventilation in the affected area(s) and wear appropriate personal protective equipment as indicated in Section 8 when handling spill material. This material has been reported to behave when spilled in water in a manner that it partitions and the lighter ends volatize off and the heaver ends can sink.

**LARGE SPILL:** Use similar response procedures as indicated under Small Spill. Consider initial downwind evacuation for at least 100 meters (330 feet). Large releases may require the notification of local emergency response agencies. Wear self-contained breathing apparatus if conditions or air monitoring warrants.

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Handle in accordance with good industrial hygiene and safety practices. These practices include but are not limited to avoiding unnecessary exposure and prompt removal of material from eyes, skin and clothing. Wash exposed skin and clothing frequently. If needed, take first aid actions as indicated in Section 4 of this SDS.

**HANDLING:** Wear appropriate personal protective equipment and use exposure controls as indicated in Section 8. Vent slowly to the atmosphere when opening. Avoid all contact with skin and eyes. Avoid breathing product dust or vapors. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Remove contaminated clothing immediately. Wash with soap and water after working with this product.

**STORAGE:** Keep in airtight container away from all heat sources. Store the container in a segregated and approved area. Store in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Keep container in a well-ventilated area. Ground all containers during transfer. Store containers away from incompatible materials. Store in the original container or an approved alternative made from compatible material. Do not store in unlabeled containers. Treat empty containers in a similar fashion as residual product may exist. Use appropriate containment to avoid environmental contamination.

**STORAGE TEMPERATURE:** Store containers of product in a cool (between 50°F or below), well ventilated location.

**STORAGE PRESSURE:** Store in a room with ambient atmospheric pressure.

**ELECTROSTATIC ACCUMULATION HAZARD:** Not Established.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

| OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200) | | | |
|---|---|---|---|
| | | EXPOSURE LIMITS | |
| | | OSHA PEL | ACGIH TLV |
| Chemical Name | | ppm | ppm |
| Benzene | TWA | 1 | 0.5 |
| | STEL | 5 | 2.5 |
| Toluene | TWA | 200 | 20 |
| | STEL | 300 | N/E |
| Ethyl benzene | TWA | 100 | 20 |

| | | | |
|---|---|---|---|
| | **STEL** | 125 | N/E |
| m-p Xylene | **TWA** | 100 | 100 |
| | **STEL** | 150 | 150 |
| o- Xylene | **TWA** | 100 | 100 |
| | **STEL** | 150 | 150 |
| Hexane | **TWA** | 50 | 50 |
| | **STEL** | N/E | N/E |
| Hydrogen Sulfide | **TWA** | N/E | 1 |
| | **STEL** | 20 | 5 |
| Propane | **TWA** | 1000 | N/E |
| | **STEL** | N/E | N/E |
| n-Pentane | **TWA** | 1000 | 1000 |
| | **STEL** | N/E | N/E |
| **Note:** OSHA has also assigned $H_2S$ a STEL value of 50 ppm for a 10-minute peak that may be reached only once per 8-hour shift. In the event no Federal OSHA PEL exists for a constituent, California/OSHA PELs have been substituted, as appropriate. | | | |

**EXPOSURE GUIDELINES**

**ENGINEERING CONTROLS:** Provide adequate general and local ventilation to maintain airborne chemical concentrations below applicable exposure limits, to prevent accumulation of flammable vapors and formation of explosive atmospheres, and to prevent formation of oxygen deficient atmospheres, especially in confined spaces. This product may release gases or vapors that can displace oxygen in enclosed areas.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Employees should be provided with and required to use splash-proof safety goggles and full face splash shields where there is any possibility of product coming in contact with eyes. Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses. Ensure that eye wash station is operable and nearby.

**SKIN:** Consider wearing long-sleeve, FRC, otherwise normal working clothes should be worn. Wash contaminated clothing prior to reuse. If gloves are required for job operations involving this product, wear nitrile rubber or polyvinylalcohol (PVAL) gloves.

**RESPIRATORY:** Respiratory protection is normally not required except in emergencies or when conditions cause excessive airborne levels of mists or vapors. Select NIOSH-approved organic vapor air-purifying respirator, SCBA or air-supplied respirator where there may be potential for overexposure.

**PROTECTIVE CLOTHING:** Long sleeve shirt and long pants or coveralls; Consider wearing long-sleeve, FRC, . Consider wearing butyl rubber apron or outerwear where splashing may occur. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.

**WORK HYGIENIC PRACTICES:** Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove contaminated clothing and launder before reuse. Shower after work using plenty of soap and water.

**OTHER USE PRECAUTIONS: FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR DEATH CONDITIONS -** A self-contained breathing apparatus with full face piece operated in a pressure-demand or other positive pressure mode is recommended for firefighting or other immediately dangerous to life and death conditions. Supplied-air respirator with full face piece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode may also be used.

**COMMENTS: EXPOSURE LIMITS & SOURCES -** Refer to Section 16 Table 1 for additional exposure limits and sources for this product or its components, whichever applies.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**ODOR:** Hydrocarbon.
**APPEARANCE:** Clear Liquid
**pH:** 5.5 to 8.0
**VAPOR PRESSURE:** Not Established.
**VAPOR DENSITY: > 1.0** (Air = 1)
**BOILING POINT:** Varies widely depending on hydrocarbon content.
**FREEZING POINT:** < 0°C (32°F)
**POUR POINT:** Not Established.
**FLASH POINT:** 22°C (72°F) May flash at lower temperatures..
**SOLUBILITY IN WATER:** Not Established.
**EVAPORATION RATE:** Not Established.
**SPECIFIC GRAVITY:** < 1.0 at 0°C (32°F)
**VISCOSITY:** Not Established.
**COEFF. OIL/WATER:** Not Established.
**ODOR THRESHOLD:** Not Established.
**RELATIVE DENSITY:** Not Established.
**DECOMPOSTION TEMP:** Not Established.
**AUTO-IGNITION TEMP:** Not Established.

## 10. STABILITY AND REACTIVITY

**STABLE:** Yes
**HAZARDOUS POLYMERIZATIO N:** No
**STABILITY: CHEMICAL STABILITY -** This product is anticipated to be stable under normal ambient storage and handling conditions of temperature and pressure.
**POLYMERIZATION:** This product is not anticipated to cause hazardous reactions or polymerizations under normal ambient storage and handling conditions of temperature and pressure.
**CONDITIONS TO AVOID:** Avoid contact with incompatible materials such as heat, open flame, other sources of ignition, and oxidizing materials such as chlorine and concentrated nitric acid.
**HAZARDOUS DECOMPOSITION PRODUCTS:** This product may produce carbon monoxide and carbon dioxide during decomposition.

## 11. TOXICOLOGICAL

**INFORMATION ACUTE**

| Chemical Name | ORAL $LD_{50}$ (rat) | DERMAL $LD_{50}$ (rabbit) | INHALATIO N $LC_{50}$ (rat) |
|---|---|---|---|
| Xylene | 5000 mg/kg | 12400 mg/kg | 4550 ppm (4 hours) |
| Hexane | 25 g/kg | Not Established. | 48000 ppm (4 hours) |
| Crude Oil | < 5000 mg/kg | > 2000 mg/kg | Not Established |
| Toluene | 636 mg/kg | 14100 ug/kg | 49 g/$m^3$ (4 hours) |

| | | | |
|---|---|---|---|
| Benzene | 930 mg/kg | < 9400 ug/kg | 10000 ppm (7 hours) |
| Ethyl benzene | <= 3500 mg/kg | <= 3500 mg/kg | <= 55000 $mg/m^3$ |
| Hydrogen Sulfide | Not Established. | Not Established. | 700 mg/m3 (4 hours) |

**EYE EFFECTS:** May cause moderate to severe eye irritation.

**SKIN EFFECTS:** May cause mild skin irritation. Prolonged or repeated contact may result in mild irritation. May be absorbed through skin with toxic effects.

**CHRONIC:** This product contains benzene, which can cause degeneration in blood forming bone marrow leading to anemia, which may further degrade to leukemia, a type of cancer. Chronic exposure affects the hematopoietic system causing blood disorders including anemia and pancytopenia.

**CARCINOGENICITY**

| Chemical Name | NTP Status | IARC Status | OSHA Status |
|---|---|---|---|
| Crude Oil | | 3 | |
| Benzene | 1 | 1 | Carcinogen. |

**SENSITIZATION:** This product is not expected to be a skin sensitizer.

**NEUROTOXICITY:** Not Established.

**GENETIC EFFECTS:** Not Established.

**REPRODUCTIVE EFFECTS:** Not Established.

**TERATOGENIC EFFECTS:** Not Established.

**MUTAGENICITY:** Not Established.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA: MOBILITY IN SOIL POTENTIAL -** Not Established.

**BIOACCUMULATION/ACCUMULATION:** Not Established.

**DISTRIBUTION:** Do not discharge into or allow runoff to flow into sewers and natural waterways. Contain spill material and dike for proper disposal.

**AQUATIC TOXICITY (ACUTE):** This product is not expected to be acutely harmful to aquatic life.

**CHEMICAL FATE INFORMATION: PERSISTENCE & DEGRADABILITY -** Not Established.

**GENERAL COMMENTS:** Any other adverse environmental effects, such as environmental fate (exposure), ozone depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and global warming potential are indicated in this section if data exists. Otherwise, this data has not been established.

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Properly characterize the material and to manage it in accordance with applicable Federal, state and local regulations.

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME:** Flammable liquid, n.o.s.

**PRIMARY HAZARD CLASS/DIVISION:** 3

**UN/NA NUMBER:** 1993

**PACKING GROUP:** II

**NAERG:** 128

## 15. REGULATORY

**INFORMATION UNITED**

**STATES**

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**311/312 HAZARD CATEGORIES:** Fire hazard. Immediate (acute) health hazard. Delayed (chronic) health hazard.

**FIRE:** Yes **PRESSURE GENERATING:** No **REACTIVITY:** No **ACUTE:** Yes **CHRONIC:** Yes

**EPCRA SECTION 313 SUPPLIER NOTIFICATION**

| Chemical Name | Vol. % | CAS |
|---|---|---|
| Benzene | <0-1.0 | 71-43-2 |

**CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)**

| Chemical Name | Vol. % | CERCLA RQ |
|---|---|---|
| Benzene | <0-1.0 | 10 |
| Hydrogen Sulfide | <0-1.0 | 100 |

**TSCA (TOXIC SUBSTANCE CONTROL ACT)**

| Chemical Name | CAS |
|---|---|
| Crude Oil | **8002-05-9** |
| Benzene | **71-43-2** |
| Hydrogen Sulfide | **7783-06-4** |

**CLEAN AIR ACT**

| Chemical Name | Vol. % | CAS |
|---|---|---|
| Hydrogen Sulfide | <0-1.0 | 7783-06-4 |

## 16. OTHER INFORMATIO N

**RELEVANT R-PHRASES:**

R36/37/38: Irritating to eyes, respiratory system and skin.
R45: May cause cancer.
R46: May cause heritable genetic damage.
R11: Highly flammable.
R36/38: Irritating to eyes and skin.
R65: Harmful: may cause lung damage if swallowed.
R12: Extremely flammable.
R26: Very toxic by inhalation.
R50: Very toxic to aquatic organisms.

**PREPARED BY:**

**REVISION SUMMARY:**

**NATIONAL FIRE PROTECTION ASSOCIATION®HAZARD RATING**

HEALTH: 2-Hazardous
FIRE: 3-Below 100°F (flashpoint)
REACTIVITY: 0- Stable

**HAZARDOUS MATERIAL IDENTIFICATION SYSTEM®HAZARD RATING**

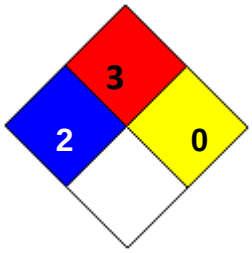
HEALTH: 2*- Moderate Hazard (*Chronic)
FIRE: 3- Serious Hazard

PHYSICAL: 0- Minimal Hazard

**HMIS RATING**

| | | |
|---|---|---|
| HEALTH | * | 2 |
| FLAMMABILITY | | 3 |
| PHYSICAL HAZARD | | 0 |
| PERSONAL PROTECTION | | G |

**NFPA CODES**




**DATA SOURCES: REFERENCES**

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**ADDITIONAL MSDS INFORMATION: KEY / LEGEND**

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous Goods by Road
CAA - Clean Air Act
CAS - Chemical Abstracts Service Registry Number
CDG - Carriage of Dangerous Goods By Road and Rail Manual
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
EINECS - European Inventory of Existing Chemical Substances Registry Number
ERG - Emergency Response Guidebook
EPCRA - Emergency Planning and Community Right-to-Know Act
GHS - Globally Harmonized System of Classification and Labeling of Chemicals
IARC - International Agency for Research on Cancer
IATA - International Air Transport Association
ICAO - International Civil Aviation Organization
IMDG - International Maritime Dangerous Goods Code
IMO - International Maritime Organization
N/E - Not Established
NTP - National Toxicology Program
OSHA - Occupational Safety and Health Administration
PEL - Permissible Exposure Limit
PPE - Personal Protective Equipment
RCRA - Resource Conversation and Recovery Act
RID - Regulations Concerning the International Transport of Dangerous Goods by Rail
RQ - Reportable Quantities
SARA - Superfund Amendments and Reauthorization Act of 1986
SDS - Safety Data Sheet
TCC - Tag Closed Cup
TDG - Transportation of Dangerous Goods
TLV - Threshold Limit Value
TSCA - Toxic Substance Control Act
UN/NA - United Nations / North American Number
UNECE - United Nations Economic Commission for Europe

US DOT - United States Department of Transportation
US EPA - United States Environmental Protection Agency
Vol. - Volume
WHMIS - Workplace Hazardous Materials Information System

**GENERAL STATEMENTS:** Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.

**MANUFACTURER DISCLAIMER:** This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

# SAFETY DATA SHEET

**Date Issued :**
**SDS No :**
**Date Revised :**
**Revision No :**

**Crude Oil**
**(West Virginia)**

******IMPORTANT******
This SDS has been prepared for Non-Sour Natural Gas Condensate at atmospheric pressure (i.e., atmospheric liquid). Refer to the following sections for important safety and response information.
**Section 4**- First Aid Measures (for accidental exposure).
**Section 5**- Fire Fighting Measures.
**Section 6**- Accidental Release Measures.

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Crude Oil (West Virginia)
**GENERAL USE:** Refinery Feedstock.

## 2. HAZARDS IDENTIFICATION

This product has not been tested to determine its specific health hazards. Therefore, the information provided in this section includes health hazard information based on the product components.

**GHS CLASSIFICATIONS**

| Health | Physical |
|---|---|
| H304- Aspiration Hazard, Category 1<br>Carcinogenicity, Category 2<br>H320- Eye Irritation, Category 2B<br>H315- Skin Irritant, Category 2 | H224- Extremely Flammable Liquids, Category 1 |

**GHS LABEL**

| | |
|---|---|
|  WARNING<br>H320: Causes eye irritation.<br>H315: Causes skin irritation. |  WARNING<br>H411: Toxic to aquatic life with long lasting effects. |
|  DANGER<br>H304: May be fatal if swallowed and enters airways.<br>H351: Suspected of causing cancer. |  DANGER<br>H224: Extremely flammable liquid and vapor. |

**PRECAUTIONARY**

**STATEMENT(S)**

**Prevention:**

P210: Keep away from heat/sparks/open flames/hot surfaces – no smoking. P233: Keep container tightly closed.
P240: Ground/bond container and receiving equipment.
P241: Use explosion-proof electrical / ventilating / lighting / transportation devices / other equipment associated with this product.
P242: Use only non-sparking tools.
P261:
P280: Wear protective gloves/protective clothing/eye protection/face protection. P201: Obtain special instructions before use.
P202: Do not handle until all safety precautions have been read and

**Response:**

P331: Do NOT induce vomiting.
P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313: If eye irritation persists: Get medical advice/attention.
P303+P361+P353: IF ON SKIN (or hair): Remove/take off immediately all contaminated clothing. Rinse skin with water/shower.
P308+P313: IF exposed or concerned: Get medical advice/attention. P302+P352: IF ON SKIN: Wash with plenty of soap and water. P332+P313: If skin irritation occurs: Get medical advice/attention. P362: Take off contaminated clothing and wash before reuse.
P391: Collect spillage.

**Storage:**

P403+P235: Store in a well-ventilated place. Keep cool.

**Disposal:**

P501: Dispose of contents/container in accordance with local/regional/national/international regulations.

**EMERGENCY OVERVIEW**

**PHYSICAL APPEARANCE:** Dark Green to Black liquid.

**IMMEDIATE CONCERNS:** This product is a flammable liquid which may be harmful if ingested, inhaled, comes in contact with skin or eyes or is released into the environment. Please read the entire contents of Section 2 of this Safety Data Sheet (SDS) for details.

**POTENTIAL HEALTH EFFECTS**

**EYES:** Eye contact with vapors may cause eye irritation, watering of eyes and reddening. Eye contact with liquid may cause irritation and pain. Prolonged contact may result in tissue damage.

**SKIN:** Skin contact may cause irritation and redness. Repeated or prolonged skin contact may cause dermatitis. Crude oil is a defatting agent and skin contact may cause dryness, itching, and cracked skin.

**INGESTION:** Ingestion of crude oil may cause a burning sensation in the mouth and stomach, nausea, vomiting, excess salivation and vomiting of blood. Ingestion of crude oil may cause tachycardia, staggering gait, dizziness, loss of consciousness and delirium, followed by chemical pneumonitis and collapse. May also cause abrupt CNS depression. Crude oil may present a potential aspiration hazard if ingested. Aspiration of even small amounts of crude oil into the lungs can result in immediate pulmonary edema (a potentially fatal accumulation of fluid in the lungs), chemical pneumonitis and hemorrhage of pulmonary tissue.

**INHALATION:** Vapors or mist from this material, at concentrations greater than the recommended exposure limits in Section 2, can cause irritation of the nose, throat, and lungs, headache, dizziness, drowsiness, loss of coordination, fatigue, nausea and labored breathing. Airborne concentrations above the recommended exposure limits are not anticipated during normal workplace activities due to the slow evaporation of this material at ambient temperatures.

**Warning:** Irritating and toxic hydrogen sulfide gas may be found in the confined vapor spaces. Greater than 15-20 ppm continuous exposure can cause mucous membrane and respiratory tract irritation. 50-500 ppm can cause headache,

nausea, and dizziness, loss of reasoning and balance, difficulty in breathing, fluid in lungs, and possible loss of consciousness. Greater than 500 ppm can cause rapid or immediate unconsciousness due to respiratory paralysis and death by suffocation unless the victim is removed from exposure and successfully resuscitated. The “rotten egg” odor of hydrogen sulfide is not a reliable indicator for warning of exposure, since olfactory fatigue (loss of smell) readily occurs, especially at concentrations above 50 ppm. At high concentrations, the victim may not even recognize the odor before becoming unconscious.

**Warning:** The burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products and inadequate oxygen levels, which may lead to suffocation, unconsciousness and death.

**SIGNS AND SYMPTOMS OF OVEREXPOSURE**

**ACUTE TOXICITY:** May cause adverse health effects if ingested. May cause irritation if inhaled or absorbed through skin. Prolonged or repeated contact may defat the skin and/or cause irritation to skin and eyes. Fire will produce irritating, toxic gases. Vapors may cause dizziness or suffocation.

**CHRONIC EFFECTS:** Chronic exposure to benzene (a component of crude oil) may cause serious damage to health by all routes of exposure. Chronic oral and inhalation exposure may cause severe effects on the blood system, including damage to the bone marrow, leading to a decrease in production or changes to the cells of hemoglobin, hematocrit, red and white blood cells. Effects may occur with an exposure level as low as 10 ppm for 24 weeks. Benzene may also cause harmful changes to the immune system. Benzene is a confirmed human carcinogen. See Section 11 of this SDS for further information.

**CARCINOGENICITY:** The NTP and IARC list benzene as a "human carcinogen." IARC lists ethyl benzene as a Group 2B carcinogen. OSHA reports an 8-hour TWA of 1ppm. See Section 11 of this SDS for more details.

**MUTAGENICITY:** May cause genetic defects. Some crude oils and crude oil fractions have been positive in mutagenicity studies.

**REPRODUCTIVE TOXICITY**

**REPRODUCTIVE EFFECTS:** Not Established.

**MEDICAL CONDITIONS AGGRAVATED:**

**Benzene:** Pre-existing blood system disorders, respiratory conditions, central nervous, liver, kidney, and cardio-vascular conditions may be aggravated by severe or chronic overexposure to benzene. Skin disorders may also be aggravated by exposures to benzene.

**Ethyl Benzene:** Pre-existing respiratory conditions, central nervous system, liver, kidney, and cardio-vascular conditions may be aggravated by severe or chronic overexposure to this product. Skin disorders may also be aggravated by exposures to this product.

**ROUTES OF ENTRY:** Inhalation, skin contact, eye contact, ingestion.

**TARGET ORGAN STATEMENT:** May cause damage to blood forming organs, eyes, skin, lungs, central nervous system, and respiratory system.

**SENSITIZATION:** Scientific evidence suggests that propane and butane may cause cardiac sensitization.

## 3. COMPOSITION / INFORMATIO N ON INGREDIENTS

| Chemical Name | Vol. % | CAS |
|---|---|---|
| Chloride | **<0-0.1** | 7782-50-5 |
| n- Hexane | **1-2** | 110-54-3 |
| Naphthalene | **<0- 0.1** | 91-20-3 |
| m-p xylene | **<0- 0.1** | 179601-23-1 |
| o- xylene | **<0-0.1** | 95-47-6 |
| Crude Oil | **85-90** | 8002-05-9 |
| 1,2,4 Trimethylbenzene | **<0- 0.1** | 95-63-6 |

| | | |
|---|---|---|
| Toluene | **<0- 0.1** | 108-88-3 |
| Benzene | **<0- 0.1** | 71-43-2 |
| Ethyl Benzene | **<0- 0.1** | 100-41-4 |
| Total Sulfur Compounds | **<0- 0.1** | |
| Hydrogen Sulfide | **<0- .01** | 7783-06-4 |

**COMMENTS:** Crude oil is a mixture of hundreds of hydrocarbon compounds and may also include components not listed. Components with percent volume prefaced with "~" are typical ranges found for crude oil.

## 4. FIRST AID MEASURES

**EYES:** Immediately flush with large amounts of water, holding eyelids open, for at least 20 minutes. Repeat if necessary. Remove contact lenses, if present and easy to do. Seek medical assistance if irritation persists.

**SKIN:** Immediately remove contaminated clothing or shoes, wipe excess from skin and flush with plenty of water for at least 15 minutes. Do not reuse clothing until thoroughly cleaned. Get medical attention.

**INGESTION:** Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Slowly give 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

**INHALATION:** Move victim to fresh air. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Get medical attention.

**ANTIDOTES:** Not Established.

**ADDITIONAL INFORMATIO N:** Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. First Aid Responders are advised to wear personal protective equipment as found in Section 8 of this SDS.

**COMMENTS: CONTRAINDICATIONS -** Not Established.

## 5. FIRE FIGHTING MEASURES

**FLASH POINT:** < 40°C (105°F)

**AUTOIGNITION TEMPERATURE:** 232°C (450°F)

**FLAMMABLE CLASS:** Class B.

**GENERAL HAZARD: DECOMPOSITION TEMPERATURE -** Not Established.

**EXTINGUISHING MEDIA:**

**SMALL FIRE -** Class B fire extinguisher, carbon dioxide, multipurpose dry chemical, water fog or alcohol-resistant foam.

**LARGE FIRE -** Water fog or alcohol-resistant foam.

**HAZARDOUS COMBUSTION PRODUCTS:** Any combustion, including incomplete combustion, may form carbon monoxide and carbon dioxide. Burning produces noxious and toxic fumes. Downwind personnel must be evacuated.

**OTHER CONSIDERATIONS: INAPPROPRIATE EXTINGUISHING MEDIA -** Do not use water jet.

**FIRE FIGHTING PROCEDURES: PROTECTIVE ACTIONS TO TAKE DURING FIRE FIGHTING -** Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Evacuate 800 meters (1/2 mile) in all directions. Persons involved in fire fighting response involving this product and its containers/packaging should refer to Section 8 of this SDS for the proper selection of exposure controls and personal protective equipment.

**FIRE FIGHTING EQUIPMENT: PRECAUTIONS FOR FIRE INVOLVING TANKS OR CAR/TRAILER LOADS -** Isolate and evacuate area for 800 meters (1/2 mile) in all directions. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire.

**COMMENTS:**

**SPECIFIC HAZARDS THAT MAY ARISE FROM THE PRODUCT -** Vapors are flammable and heavier than air. Vapors may travel across the ground and reach remote ignition sources causing a flashback fire danger. Sudden reaction and fire may result if product is mixed with an oxidizing agent.

**ADDITIONAL INFORMATION:** Reference current Emergency Response Guidebook.

## 6. ACCIDENTAL RELEASE MEASURES

**SMALL SPILL:** For emergency information and procedures to follow in the case of an accidental release, call the Emergency Telephone Number(s) listed in Section 1 of this SDS. In case of spillage, absorb with inert material and dispose of in accordance with applicable regulations. Dike far ahead of liquid spill for later disposal. Never discharge releases directly into sewers or surface waters. Remove any ignition sources and protect from ignition. Water spray may reduce vapor; but may not prevent ignition in closed spaces. A vapor suppressing foam may be used to reduce vapors. Provide sufficient ventilation in the affected area(s) and wear appropriate personal protective equipment as indicated in Section 8 of this SDS when handling spill material.

**LARGE SPILL:** Use similar response procedures as indicated under Small Spill.

**GENERAL PROCEDURES: MATERIALS & METHODS (EQUIPMENT & TECHNIQUES) FOR CONTAINMENT & CLEANUP -** Call Emergency Telephone Number(s) provided in Section 1 of this SDS. As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Ventilate closed spaces before entering.

**RELEASE NOTES: ENVIRONMENTAL PRECAUTIONS -** Avoid contact of spilled material with soil and prevent runoff entering surface waterways. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

**SPECIAL PROTECTIVE EQUIPMENT: EMERGENCY & NON-EMERGENCY RESPONDERS -** Refer to Section 8 of this SDS for appropriate exposure controls and personal protective equipment (PPE).

**COMMENTS: INAPPROPRIATE CONTAINMENT & CLEANUP TECHNIQUES -** Not Established.

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Handle in accordance with good industrial hygiene and safety practices. These practices include but are not limited to avoiding unnecessary exposure and prompt removal of material from eyes, skin and clothing. If needed, take first aid actions as indicated in Section 4 of this SDS.

**HANDLING :** Use only with adequate ventilation. Wear appropriate personal protective equipment and use exposure controls as indicated in Section 8 of this SDS. Vent slowly to the atmosphere when opening. Avoid all contact with skin and eyes. Avoid breathing product dust or vapors. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Do not reuse container. Remove contaminated clothing immediately. Wash with soap and water after working with this product.

**STORAGE:** Keep in airtight container away from all heat sources. Store in a segregated and approved area. Store in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Keep container in a well-ventilated area. Store away from incompatible materials. Store in the original container or an approved alternative made from compatible material. Do not store in unlabeled containers. Treat empty containers in a similar fashion as residual product may exist. Use appropriate containment to avoid environmental contamination.

**STORAGE TEMPERATURE:** Store in a room with ambient temperature.

**STORAGE PRESSURE:** Containers should be stored in room with ambient pressure.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**EXPOSURE GUIDELINES**

**OSHA HAZARDOUS COMPONENTS (29 CFR 1910.1200)**

| | | Exposure Limits | |
|---|---|---|---|
| | | OSHA PEL | ACGIH TLV |
| **Chemical Name** | | ppm | ppm |
| Naphthalene | **TWA** | 10 | 10 |
| | **STEL** | N/E | 15 |
| m-p Xylene | **TWA** | 100 | 100 |
| | **STEL** | N/E | 150 |
| o-xylene | **TWA** | 100 | 100 |
| | **STEL** | N/E | 150 |
| 1,2,4 Trimethylbenzene | **TWA** | N/E | 25 |
| | **STEL** | N/E | N/E |
| Hydrogen Sulfide | **TWA** | N/E | 1 |
| | **STEL** | 20 | 5 |
| Toluene | **TWA** | 200 | 20 |
| | **STEL** | 300 | N/E |
| Benzene | **TWA** | 0.1 | 0.5 |
| | **STEL** | 1 | 2.5 |
| Ethyl Benzene | **TWA** | 100 | N/E |
| | **STEL** | N/E | N/E |
| n-Hexane | **TWA** | 500 | 50 |
| | **STEL** | N/E | N/E |

**ENGINEERING CONTROLS:** Provide sufficient ventilation to control exposure levels below airborne exposure limits. Use local mechanical exhaust ventilation at sources of air contamination such as open process equipment. Consult current NFPA Standard 91 and ACGIH manual on Industrial Ventilation for design of exhaust system. Have eye baths available at locations where there is potential for eye contact. Provide a safety shower at locations where skin contact can occur.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Employees should be provided with and required to use splash-proof safety goggles and full face splash shields where there is any possibility of product coming in contact with eyes. Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses. Ensure that eye wash station is operable and nearby.

**SKIN: GLOVES AND BOOTS -** Any appropriate fire retardant and impervious gloves and boots including nitrile rubber or neoprene rubber.

**RESPIRATORY:** Avoid breathing mist, and/or vapor. Use NIOSH/MSHA approved equipment when airborne exposure limits are exceeded. Consult respirator manufacturer to determine appropriate type of equipment for given application. The respirator use limitations specified by NIOSH/MSHA and the manufacturer must be observed. High airborne concentrations may require use of self-contained breathing apparatus or supplied air respirator. Respiratory protection programs must be in compliance with 29 CFR 1910.134.

**WORK HYGIENIC PRACTICES:** Consider the potential hazards of this material, applicable exposure limits, job activities, environmental working conditions, and other substances in the workplace when designing engineering controls and selecting personal protective equipment (PPE). The user should read and understand all manufacturer instructions and limitations supplied with the personal protection equipment before use.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**ODOR:** Hydrocarbon.

**APPEARANCE:** Dark Green to Black liquid

**pH:** Not Established.

**BOILING POINT:** (20°F) to (40°F) 760 mmHg

**FREEZING POINT:** Not Established.

**MELTING POINT:** Not Established.

**FLASH POINT:** < 38°C (100°F)

**SOLUBILITY IN WATER:** Not Established.

**SPECIFIC GRAVITY:** 0.80

**Notes:** $H_2O$ = 1 at 60°F

**MOLECULAR WEIGHT:** 152

**COEFF. OIL/WATER:** Not Established.

**ODOR THRESHOLD:** Not Established.

**EVAPORATION RATE:** Not Established.

**%VOLITALES BY VOLUME:** 20-100%

**VAPOR DENSITY (Air=1):** 1.0-3.0

**VAPOR PRESSURE:** Not Established.

**COMMENTS: FLAMMABILITY -** Refer to Section 2 and Section 5 of this SDS for classification and flammability characteristics.

## 10. STABILITY AND REACTIVITY

**STABLE:** Yes

**HAZARDOUS POLYMERIZATIO N:** No

**STABILITY:** This product is anticipated to be stable under normal ambient storage and handling conditions of temperature and pressure.

**POLYMERIZATION:** This product is not anticipated to cause hazardous reactions or polymerizations under normal ambient storage and handling conditions of temperature and pressure.

**CONDITIONS TO AVOID:** Avoid contact with high temperatures, open flames, sparks, welding, smoking and other ignition sources.

**HAZARDOUS DECOMPOSITION PRODUCTS:** This product may produce carbon monoxide, carbon dioxide, aromatics, and other hydrocarbons during decomposition.

**INCOMPATIBLE MATERIALS:** Strong oxidizing agents.

## 11. TOXICOLOGICAL INFORMATION

**ACUTE**

| Chemical Name | ORAL $LD_{50}$ (rat) | DERMAL $LD_{50}$ (rabbit) | INHALATION $LC_{50}$ (rat) |
|---|---|---|---|
| Naphthalene | 490 mg/kg | 2001 mg/kg | 170 ppm (4 hours) |
| m-p xylene | 5000 mg/kg | 12400 mg/kg | 4550 ppm (4 hours) |
| o xylene | Not Established. | Not Established. | Not Established. |
| 1,2,3 Trimethylbenzene | 5000 mg/kg | Not Established. | 18000mg/$m^3$ (4 hours) |
| n-Hexane | 25 g/kg | Not Established. | 48000 ppm (4 hours) |
| Hydrogen Sulfide | Not Established. | Not Established. | 700 mg/$m^3$ (4 hours) |
| Toluene | 636 mg/kg | 14100 ug/kg | 49 g/$m^3$ (4 hours) |
| Benzene | 930 mg/kg | < 9400 ug/kg | 10000 ppm (7 hours) |
| Ethyl Benzene | <= 3500 mg/kg | <= 3500 mg/kg | <= 55000 mg/$m^3$ |

**NOTES: TOXICITY & HEALTH EFFECTS -** Refer to Section 2 of this SDS for additional hazards identification.

**EYE EFFECTS:** May cause moderate to severe eye irritation.

**SKIN EFFECTS:** Prolonged or repeated contact may result in mild irritation. May be absorbed through skin with toxic effects.

**CHRONIC: TOXICITY & HEALTH EFFECTS -** Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation. This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia.

**CARCINOGENICITY**

| Chemical Name | NTP Status | IARC Status | OSHA Status |
|---|---|---|---|
| Toluene | | 3 | |
| Benzene | 1 | 1 | Carcinogen. |
| Ethyl Benzene | | 2B | |

**Notes: Benzene -** Caused cancer (leukemia), damage to the blood-producing system and serious blood disorders from prolonged, high exposure based on human epidemiology studies. Caused genetic effects and effects on the immune system in laboratory animal and some human studies. Caused toxicity to the fetus in laboratory animal studies.
**Ethylbenzene -** Caused cancer in laboratory animal studies. The relevance of these findings to humans is uncertain.
**n-Hexane -** Prolonged and/or repeated exposures to n-Hexane can cause progressive and potentially irreversible damage to the peripheral nervous system. Simultaneous exposure to methyl ethyl ketone (MEK) or methyl isobutyl ketone (MIBK) and n-Hexane can potentiate the risk of adverse effects from n-Hexane on the peripheral nervous system. n-Hexane has been shown to cause testicular damage at high doses in male rats. The relevance of this effect for humans is unknown.

**REPEATED DOSE EFFECTS: TARGET ORGANS -** Repeated exposure may cause damage to organs such as liver, kidneys, blood and nervous system and skin, depending on routes of exposure.

**SENSITIZATION:** Scientific evidence suggests that propane and butane may cause cardiac sensitization.

**NEUROTOXICITY:** Not Established.

**GENETIC EFFECTS:** Not Established.

**REPRODUCTIVE EFFECTS:** Not Established.

**TERATOGENIC EFFECTS:** Not Established.

**MUTAGENICITY:** May cause genetic defects. Some crude oils and crude oil fractions have been positive in mutagenicity studies.

**GENERAL COMMENTS:**

**INTERACTIVE EFFECTS -** Not Established.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA:**

**MOBILITY IN SOIL POTENTIAL -** Not established for this mixture, however this mixture contains volatile constituents. Partly evaporates from water or soil surfaces, but significant proportion will remain after one day. If the product enters the soil, one or more constituents will or may be mobile and may contaminate groundwater.

**ECOTOXICOLOGICAL INFORMATION:** This product has no known ecotoxicological effects.

**TERRESTRIAL/MICROORGANISM TOXICITY –**

**ACUTE:** Ecological data does not exist for this mixture.

**CHRONIC:** Ecological data does not exist for this mixture.

**BIOACCUMULATION/ACCUMULATION:** Has the potential to bioaccumulate.

**AQUATIC TOXICITY (ACUTE):** This product is expected to be harmful to aquatic life.

**Notes: (CHRONIC) -** May cause long lasting harmful effects to aquatic life.

**CHEMICAL FATE INFORMATION:**

**PERSISTENCE & DEGRADABILITY -** Major constituents are inherently biodegradable, but contains components that may persist in the environment. The volatile constituents will oxidize rapidly by photochemical reactions in air.

**GENERAL COMMENTS:** Any other adverse environmental effects, such as environmental fate (exposure), ozone depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and global warming potential are indicated in this section if data exists. Otherwise, this data has not been established.

**COMMENTS:** Data from laboratory studies and from scientific literature is noted in this section if available. Otherwise, data has not been established.

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** The generator of a waste is responsible to determine if the material disposed of meets federal, state, or local criteria to be defined as a hazardous waste and dispose of accordance with applicable Federal, state and local regulations.

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME:** Petroleum crude oil.

**PRIMARY HAZARD CLASS/DIVISION:** 3

**UN/NA NUMBER:** 1267

**PACKING GROUP:** II

**NAERG:** 128

**VESSEL (IMO/IMDG)**

**SHIPPING NAME:** Petroleum crude oil.

**UN/NA NUMBER:** 1267

**PRIMARY HAZARD CLASS/DIVISION:** 3

**PACKING GROUP:** II

## 15. REGULATORY INFORMATION

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**311/312 HAZARD CATEGORIES:** Fire hazard. Immediate (acute) health hazard. Delayed (chronic) health hazard.

**FIRE:** Yes **PRESSURE GENERATING:** No **REACTIVITY:** No **ACUTE:** Yes **CHRONIC:** Yes

**EPCRA SECTION 313 SUPPLIER NOTIFICATION**

## Crude Oil

| Chemical Name | Wt.% | CAS |
|---|---|---|
| n-Hexane | 1-2 | 110-54-3 |
| Benzene | <0- 0.1 | 71-43-2 |

**CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)**

| Chemical Name | Wt.% | CERCLA RQ |
|---|---|---|
| n-Hexane | 1-2 | 5,000 |
| Toluene | <0- 0.1 | 1,000 |
| Benzene | <0- 0.1 | 10 |
| Ethyl Benzene | <0- 0.1 | 1,000 |

**TSCA (TOXIC SUBSTANCE CONTROL ACT)**

| | |
|---|---|
| Naphthalene | 91-20-3 |
| m-p- Xylene | 179601-23-1 |
| n-Hexane | 110-54-3 |
| 1,2,4- Trimethylbenzene | 95-63-6 |
| Propane | 74-98-6 |
| 2-methylpentane | 107-83-5 |
| Toluene | 108-88-3 |
| Benzene | 71-43-2 |
| Ethyl Benzene | 100-41-4 |

**OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)**

**29 CFR1910.119---PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS:** Benzene is subject to the requirements of CFR 29 1910.1028, the OSHA Benzene Standard. The Action Level for Benzene is 0.5 ppm as an 8-hour, time-weighted average under this regulation. · Benzene is not listed in Appendix A as a highly hazardous chemical, per 29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals. Under this regulation, however, any process that involves a flammable liquid on-site, in one location, in quantities of 10,000 lbs (4,553 kg) or greater is covered under this regulation unless it is used as a fuel.

**U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION**

This product contains constituent listed on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level. Consult those regulations applicable to your facility/operation.

**RCRA INFORMATION**

This product may be recycled. If disposed, this product is considered ignitable hazardous waste. Consult federal, state, and local waste regulations to determine appropriate disposal options.

**CLEAN WATER ACT (OIL SPILLS)**

Any spill or release of this product to “navigable waters” (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

**CERCLA SECTION 103 and SARA Section 304 (RELEASE TO THE ENVIRONMENT)**

The CERCLA definition of hazardous substance contains a “petroleum exclusion” clause that exempts crude oil, refined oil, and unrefined petroleum products, and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

**SARA SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES**

This material does not contain chemicals subject to the reporting requirements of SARA 302 and 40 CFR 372.

**SARA SECTION 311/312- HAZARD CATERGORIES**

| Acute Health | Chronic Health | Fire | Sudden Release of Pressure | Reactive |
|---|---|---|---|---|
| Immediate | Delayed | X | --- | -- |

This material is subject to the reporting requirements of Section 311-312 of the Emergency Planning and Community Right to Know Act (EPCRA) if stored at quantities in excess of 10,000 pounds at any one time.

**SARA SECTION 313- SUPPLIER NOTIFICATION**

This product contains the following toxic substances subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372. See Section 2 for composition, CAS numbers, and exposure limit information for these substances:

- Benzene
- Ethylbenzene
- N-Hexane
- Toluene
- 1,2,4- Trimethylbenzene
- Xylene (mixed isomers)

You may be required to report releases of chemicals listed in 40 CFR 372.28. However, Polycyclic Aromatic Compounds (PACs) are coincidentally manufactured from the combustion of various fuel oils and other petroleum products. Under SARA Section 313, the de minimis exemption has been eliminated for PACs and other listed persistent bio-accumulative and toxic chemicals (PBTs). Refer to EPA guidance for additional reporting information.

**EPA NOTIFICATION (OIL SPILLS)**

If there is a discharge of more than 1,000-gallons of oil into or upon navigable waters of the United States, or if it is the second spill event of 42 gallons or more of oil into the water within a twelve (12) month period, a written report must be submitted to the Regional Administrator of the SPA within sixty days of the event.

**CANADIAN REGULATORY INFORMATION (WHMIS)**

Class B (Flammable and combustible Material, Division 2 (Flammable Liquid)

**OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)**

**29 CFR1910.119---PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS:** Benzene is subject to the requirements of CFR 29 1910.1028, the OSHA Benzene Standard. The Action Level for Benzene is 0.5 ppm as an 8-hour, time-weighted average under this regulation. · Benzene is not listed in Appendix A as a highly hazardous chemical, per 29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals. Under this regulation, however, any process that involves a flammable liquid on-site, in one location, in quantities of 10,000 lbs (4,553 kg) or greater is covered under this regulation unless it is used as a fuel.

## 16. OTHER INFORMATIO N

**PREPARED BY:**

**REVISION SUMMARY:**

**NATIONAL FIRE PROTECTION ASSOCIATION® HAZARD RATING**

| | |
|---|---|
| HEALTH: | 2-Hazardous |
| FIRE: | 3-Below 100°F (flashpoint) |
| REACTIVITY: | 0- Stable |

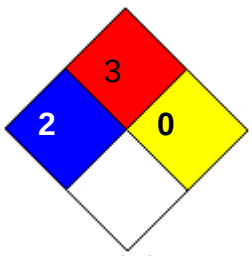
**HAZARDOUS MATERIAL IDENTIFICATION SYSTEM® HAZARD RATING**

| | |
|---|---|
| HEALTH: | 2*- Moderate Hazard (*Chronic) |
| FIRE: | 3- Serious Hazard |
| PHYSICAL: | 0- Minimal Hazard |

**HMIS RATING**

| | | |
|---|---|---|
| HEALTH | * | 2 |
| FLAMMABILITY | | 3 |
| PHYSICAL HAZARD | | 0 |
| PERSONAL PROTECTION | | H |

**NFPA CODES**




**HMIS RATINGS NOTES:** Please refer to Section 8 of this SDS for recommended personal protective equipment.

**ADDITIONAL MSDS INFORMATION:**

**KEY / LEGEND**

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous Goods by Road
CAA - Clean Air Act
CAS - Chemical Abstracts Service Registry Number
CDG - Carriage of Dangerous Goods By Road and Rail Manual
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
EINECS - European Inventory of Existing Chemical Substances Registry Number
ERG - Emergency Response Guidebook
EPCRA - Emergency Planning and Community Right-to-Know Act
GHS - Globally Harmonized System of Classification and Labeling of Chemicals
IARC - International Agency for Research on Cancer
IATA - International Air Transport Association
ICAO - International Civil Aviation Organization
IMDG - International Maritime Dangerous Goods Code
IMO - International Maritime Organization
N/E - Not Established
NTP - National Toxicology Program
OSHA - Occupational Safety and Health Administration
PEL - Permissible Exposure Limit
PPE - Personal Protective Equipment
RCRA - Resource Conversation and Recovery Act
RID - Regulations Concerning the International Transport of Dangerous Goods by Rail
RQ - Reportable Quantities
SARA - Superfund Amendments and Reauthorization Act of 1986
SDS - Safety Data Sheet
TCC - Tag Closed Cup
TDG - Transportation of Dangerous Goods
TLV - Threshold Limit Value
TSCA - Toxic Substance Control Act
UN/NA - United Nations / North American Number
UNECE - United Nations Economic Commission for Europe
US DOT - United States Department of Transportation
US EPA - United States Environmental Protection Agency
Vol. - Volume
WHMIS - Workplace Hazardous Materials Information System

**GENERAL STATEMENTS:** Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.

**MANUFACTURER DISCLAIMER:** This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement

## Crude Oil

# SAFETY DATA SHEET

**Date Issued :**
**SDS No :**
**Date Revised :**
**Revision No :** 1

**Non-Sour Natural Gas**
(West Virginia)

******IMPORTANT******
This SDS has been prepared for Non-Sour Natural Gas. Refer to the following sections for important safety and response information.
**Section 4**- First Aid Measures (for accidental exposure).
**Section 5**- Fire Fighting Measures.
**Section 6**- Accidental Release Measures.

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Non-Sour Natural Gas
**GENERAL USE:** Refinery Feedstock.
**Common Name and Synonyms:**

## 2. HAZARDS IDENTIFICATION

**This product has not been tested to determine its specific health hazards. Therefore, the information provided in this section includes health hazard information based on the product components.**

**GHS CLASSIFICATIONS**

| **Health** | **Physical** |
|---|---|
| Carcinogenicity, Category 1<br>Hazard Not Otherwise Classified, Simple Asphyxiant | Gases Under Pressure, Liquefied gas<br>Flammable Gases, Category 1 |

**GHS LABEL**

| | |
|---|---|
| WARNING<br>H000: May displace oxygen and cause rapid suffocation. |  <br>DANGER<br>H220: Extremely flammable gas. |
|  <br>WARNING<br>H280: Contains gas under pressure; may explode if heated. |  <br>DANGER<br>H350: May cause cancer. |

**PRECAUTIONARY STATEMENT(S) Prevention:**

P210: Keep away from heat/sparks/open flames/hot surfaces – no smoking.

P201: Obtain special instructions before use.
P202: Do not handle until all safety precautions have been read and understood. P281: Use personal protective equipment as required.

**Response:**

P377: Leaking gas fire: Do not extinguish unless leak can be stopped safely. P381: Eliminate all ignition sources if safe to do so.
P308+P313: IF exposed or concerned: Get medical advice/attention.

**Storage:**

P403: Store in a well-ventilated place.
P410+P403: Protect from sunlight. Store in a well-ventilated place

**Disposal:**

P501: Dispose of contents/container in accordance with local/regional/national regulations.

**EMERGENCY OVERVIEW**

**PHYSICAL APPERANCE:**

**IMMEDIATE CONCERNS: HAZARD DESCRIPTION / WARNING INFORMATION SUMMARY -** This material is a flammable gas. This product is toxic; inhalation of this material may cause severe injury or death. Please read entire contents of Section
2 of this Safety Data Sheet (SDS) for details.

**POTENTIAL HEALTH EFFECTS**

**EYES:** This product is unlikely to cause eye irritation.

**SKIN:** This product is unlikely to cause skin irritation or injury.

**INGESTION:** This product is a compressed gas; hence oral exposure and resulting acute toxicity are unlikely.

**INHALATION:** This product is a simple asphyxiant. Excessive exposure may cause central nervous system effects such as dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure and death.

**SIGNS AND SYMPTOMS OF OVEREXPOSURE**

**CARCINOGENICITY:** No component of this product present at levels greater than or equal to 0.1% is identified as a probable, possible, or confirmed carcinogen by IARC, NTP, OSHA or ACGIH.

**MUTAGENICITY:** Not Established.

**REPRODUCTIVE TOXICITY**

**REPRODUCTIVE EFFECTS:** Not Established.

**TERATOGENIC EFFECTS:** Not Established.

**MEDICAL CONDITIONS AGGRAVATED:** Persons with pre-existing central nervous system disorders should refrain from contact with this material.

**ROUTES OF ENTRY:** Inhalation, skin contact, eye contact.

**TARGET ORGAN STATEMENT:** May cause damage to lungs and central nervous system.

**SENSITIZATION:** Not Established.

**COMMENTS: OTHER HAZARDS -** Not Established.

## 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | Vol. % | CAS |
|---|---|---|
| Methane | 70 - 94 | 74-82-8 |
| Ethane | 5 - 10 | 74-84-0 |
| Propane | 1 - 4 | 74-98-6 |
| i-Butane | 0.5 - 3 | 75-28-5 |
| n-Butane | 0.5 - 2 | 106-97-8 |
| Carbon Dioxide | 0.5 - 10 | 124-38-9 |
| Nitrogen | 0.5 - 10 | 7727-37-9 |

| | | |
|---|---|---|
| Benzene | may contain | 71-43-2 |
| Hydrogen Sulfide | may contain | 7783-06-4 |

**COMMENTS:** This may not be a complete list of components. Compositions given are typical values, not specifications.

## 4. FIRST AID MEASURES

**EYES:** Immediately flush eyes with plenty of water. Get medical attention, if irritation persists.

**SKIN:** Wash with soap and water. Get medical attention if irritation develops or persists. **INGESTION:** This is not considered a major potential route of exposure.

**INHALATION:** Move victim to fresh air. Call 911, emergency medical service, or Emergency Phone Numbers(s) provided in Section 1 of this SDS. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult.

**ANTIDOTES:** Not Established.

**NOTES TO PHYSICIAN: CLINICAL TESTING & MEDICAL MONITORING FOR DELAYED EFFECTS -** Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Provide general supportive measures and treat symptomatically.

## 5. FIRE FIGHTING MEASURES

**FLASH POINT:** -188°C (-306.4°F) **Notes:** Based on methane. .

**AUTOIGNITION TEMPERATURE:** 482°C (900°F) to 649°C (1200°F)

**GENERAL HAZARD: DECOMPOSITION TEMPERATURE -** Not Established.

**EXTINGUISHING MEDIA:**

**SMALL FIRE -** Class B fire extinguisher, carbon dioxide, multipurpose dry chemical, water fog or alcohol-resistant foam.
**LARGE FIRE -** Water fog or alcohol-resistant foam.

**HAZARDOUS COMBUSTION PRODUCTS:** Any combustion, including incomplete combustion, may form carbon monoxide and carbon dioxide. Burning produces noxious and toxic fumes. Downwind personnel must be evacuated.

**OTHER CONSIDERATIONS: INAPPROPRIATE EXTINGUISHING MEDIA -** Do not use water jet.

**FIRE EXPLOSION:** HIGHLY FLAMMABLE. Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated.

**COMMENTS:**

**SPECIFIC HAZARDS THAT MAY ARISE FROM THE PRODUCT -** Vapors are flammable and heavier than air. Vapors may travel across the ground and reach remote ignition sources causing a flashback fire danger.

## 6. ACCIDENTAL RELEASE MEASURES

**SMALL SPILL:** For emergency information and procedures to follow in the case of an accidental release, call the Emergency Telephone Number(s) listed in Section 1 of this SDS. Remove any ignition sources and protect from ignition. Water spray may reduce vapor but may not prevent ignition in closed spaces. A vapor suppressing foam may be used to reduce vapors. Provide sufficient ventilation in the affected area(s) and wear appropriate personal protective equipment as indicated in Section 8 of this SDS when handling spill material. Isolate the area until gas has dispersed. Never discharge releases directly into sewers or surface waters.

**LARGE SPILL:** Use similar response procedures as indicated under Small Spill.

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Handle in accordance with good industrial hygiene and safety practices. These practices include but are not limited to avoiding unnecessary exposure and prompt removal of material from eyes, skin and clothing. If needed, take first aid actions as indicated in Section 4 of this SDS.

**HANDLING :** Use only with adequate ventilation. Wear appropriate personal protective equipment and use exposure controls as indicated in Section 8 of this SDS. Vent slowly to the atmosphere when opening. Avoid all contact with skin and eyes. Avoid breathing product dust or vapors. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Do not reuse container. Remove contaminated clothing immediately. Wash with soap and water after working with this product.

**STORAGE:** Keep in airtight container away from all heat sources. Store in a segregated and approved area. Store in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Keep container in a well-ventilated area. Ground all containers during transfer. Store away from incompatible materials. Cylinders should be separated from oxygen cylinders or other oxidizers by a minimum distance of 20 feet, or by a barrier of non-combustible material at least 5 feet high having a fire resistance rating of at least 1/2 hour. Store in the original container or an approved alternative made from compatible material. Do not store in unlabeled containers. Treat empty containers in a similar fashion as residual product may exist. Use appropriate containment to avoid environmental contamination.

**STORAGE TEMPERATURE:** Store containers in a room with ambient temperature.

**STORAGE PRESSURE:** Containers should be stored in room with ambient pressure.

**SHELF LIFE:**

**HOW TO MAINTAIN THE INTEGRITY OF THE SUBSTANCE BY USE OF STABILIZERS OR ANTIOXIDANTS -** Not Established.

**ELECTROSTATIC ACCUMULATION HAZARD:** To minimize the hazard of static electricity during transfer operations, bonding and grounding may be necessary, but may not by themselves be sufficient. For more information, refer to OSHA Standard 29 CFR 1910.106; National Fire Protection Standard (NFPA) 77 - "Recommended Practice on Static Electricity"; and/or the American Petroleum Institute (API) Recommended Practice 2003 - "Protection Against Ignitions Arising Out of Static, Lighting and Stray Currents."

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**EXPOSURE GUIDELINES**

| OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200) | | | | | |
|---|---|---|---|---|---|
| | | EXPOSURE LIMITS | | | |
| | | OSHA PEL | | ACGIH TLV | |
| **Chemical Name** | | **ppm** | **mg/m³** | **ppm** | **mg/m³** |
| Ethane | **TWA** | N/E | N/E | 1000 | N/E |
| | **STEL** | N/E | N/E | N/E | N/E |
| Propane | **TWA** | 1000 | 1800 | 1000 | N/E |
| | **STEL** | N/E | N/E | N/E | N/E |
| i-Butane | **TWA** | N/E | N/E | 1000 | N/E |
| | **STEL** | N/E | N/E | N/E | N/E |
| | **TWA** | N/E | N/E | 1000 | N/E |

| | | | | | |
|---|---|---|---|---|---|
| n-Butane | **STEL** | N/E | N/E | N/E | N/E |
| Carbon Dioxide | **TWA** | 5000 | 9000 | 5000 | 9000 |
| | **STEL** | N/E | N/E | 30000 | 54000 |

**ENGINEERING CONTROLS:** Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Employees should be provided with and required to use splash-proof safety goggles and splash shields where there is any possibility of product coming in contact with eyes. Ensure that eye wash station is operable and nearby.

**SKIN: GLOVES AND BOOTS -** Any impervious gloves and boots including butyl rubber, nitrile rubber or neoprene rubber.

**RESPIRATORY:** Depending on airborne concentration a full-face supplied air respirator is recommended, because air purifying respirators cannot provide adequate protection.

**PROTECTIVE CLOTHING:** Depending on the conditions of use, protective gloves, apron, boots, head and face protection should be worn. Cotton clothing is recommended.

**WORK HYGIENIC PRACTICES:** Consider the potential hazards of this material, applicable exposure limits, job activities, environmental working conditions, and other substances in the workplace when designing engineering controls and selecting personal protective equipment (PPE). The user should read and understand all manufacturer instructions and limitations supplied with the personal protection equipment before use.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**ODOR:** Generally odorless (if no $H_2S$ is present and no mercaptan added for odor).

**APPEARANCE:** Colorless gas.

**pH:** Not Applicable.

**PERCENT VOLATILE:** 100

**VAPOR PRESSURE:** Not Established.

**VAPOR DENSITY:** 0.6 to 0.8 (Air = 1)

**BOILING POINT:** -161°C (-258°F)

**Notes:** Based on methane.

**FREEZING POINT:** Not Applicable.

**MELTING POINT:** Not Applicable.

**FLASH POINT:** -188°C (-306.4°F)

**Notes:** Based on methane.

**AUTO IGNITION TEMP:** Not Established.

**DECOMPOSITION TEMP:** Not Established.

**EVAPORATION RATE:** Not Established.

**DENSITY:** Not Established.

**SPECIFIC GRAVITY:** Not Established.

**VISCOSITY:** Not Applicable.

**SOLUBILITY:** Not Established.

**COEFF. OIL/WATER:** Not Established.

**ODOR THRESHOLD:** Not Established.

**COMMENTS: FLAMMABILITY -** Refer to Section 2 and Section 5 of this SDS for classification and flammability characteristics.

## 10. STABILITY AND REACTIVITY

**STABLE:** Yes

**HAZARDOUS POLYMERIZATIO N:** No

**STABILITY:** This product is anticipated to be stable under normal ambient storage and handling conditions of temperature and pressure.

**POLYMERIZATION:** This product is not anticipated to cause hazardous reactions or polymerizations under normal ambient storage and handling conditions of temperature and pressure.

**CONDITIONS TO AVOID:** Avoid contact with incompatible materials. Avoid exposure to excess heat, sparks, open flame, or other potential ignition sources. Prevent vapor accumulation.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Products of thermal decomposition include carbon oxides and nitrogen oxides.

**INCOMPATIBLE MATERIALS:** Strong oxidizing agents, liquid oxygen, mineral acids and metal catalysts.

## 11. TOXICOLOGICAL INFORMATION

**ACUTE**

| Chemical Name | ORAL $LD_{50}$ (rat) | DERMAL $LD_{50}$ (rabbit) | INHALATION $LC_{50}$ (rat) |
|---|---|---|---|
| Ethane | Not Established. | Not Established. | > 800000 ppm (15 min) |
| Propane | Not Established. | Not Established. | 658 mg/L (4 hours) |
| i-Butane | Not Established. | Not Established. | 658 mg/L (4 hours) |
| n-Butane | Not Established. | Not Established. | 658 $g/m^3$ |
| Carbon Dioxide | Not Established. | Not Established. | 30000 to 50000 ppm (30 min) |
| Benzene | 930 mg/kg | > 9400 ug/kg | 10000 ppm (7 hours) |
| Hydrogen Sulfide | Not Established. | Not Established. | 444 ppm |

**NOTES: ACUTE TOXICITY & HEALTH EFFECTS -** This product is a simple asphyxiant; higher concentrations may cause dizziness. Refer to Section 2 of this SDS for additional hazards identification.

**EYE EFFECTS:** Not expected to cause prolonged or significant eye irritation.

**SKIN EFFECTS:** Not expected to cause prolonged or significant skin irritation.

**CHRONIC: TOXICITY & HEALTH EFFECTS -** This product is not expected to be toxic. Refer to Section 2 of this SDS for additional hazards identification.

**CARCINOGENICITY**

| Chemical Name | NTP Status | IARC Status | OSHA Status |
|---|---|---|---|
| Benzene | 1 | 1 | Carcinogen. |

**Notes:** No component of this product at levels greater than 0.1% is identified as a carcinogen by ACGIH, the International Agency for Research on Cancer (ARC), the U.S. National Toxicology Program (NTP) or the U.S. Occupational Safety and Health Act (OSHA).

**SENSITIZATION:** Not Established.

**NEUROTOXICITY:** Not Established.

**GENETIC EFFECTS:** Not Established.

**REPRODUCTIVE EFFECTS:** Not Established.

**TARGET ORGANS:** Contact may cause damage to the lungs and central nervous system.

**TERATOGENIC EFFECTS:** Not Established.

**MUTAGENICITY:** Not Established.

**SYNERGISTIC MATERIALS:** Not Established.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA: MOBILITY IN SOIL POTENTIAL -** Not Established.

**ECOTOXICOLOGICAL INFORMATION: TERRESTRIAL/MICROORGANISM TOXICITY -**

**ACUTE:** Ecological data does not exist for this mixture.

**CHRONIC:** Ecological data does not exist for this mixture.

**BIOACCUMULATION/ACCUMULATION:** Ecological data does not exist for this mixture.

**AQUATIC TOXICITY (ACUTE):** Ecological data does not exist for this mixture.

**Notes: (CHRONIC) -** Ecological data does not exist for this mixture.

**CHEMICAL FATE INFORMATION: PERSISTENCE & DEGRADABILITY -** Not Established.

**GENERAL COMMENTS:** Any other adverse environmental effects, such as environmental fate (exposure), ozone depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and global warming potential are indicated in this section if data exists. Otherwise, this data has not been established.

**COMMENTS:** Data from laboratory studies and from scientific literature is noted in this section if available. Otherwise, data has not been established.

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** It is recommended that this product, in any form, be incinerated in a suitable combustion chamber for disposal. Empty containers should be disposed of in a similar fashion due to presence of product residue. Follow applicable Federal, state, and local regulations.

**PRODUCT DISPOSAL:** Persons conducting disposal of this product and its containers/packaging should refer to Section 8 of this SDS for the proper selection of exposure controls and personal protective equipment.

**EMPTY CONTAINER:** Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death.

**GENERAL COMMENTS: PHYSICAL & CHEMICAL PROPERTIES THAT MAY AFFECT DISPOSAL OPTIONS -** Not Established.

**COMMENTS:** Dispose of material in accordance with national, state, regional, and local regulations. Never discharge directly into sewers or surface waters. Consult with environmental regulatory agencies for guidance on acceptable disposal practices for the product, in any form, and its containers/packaging.

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME:** Compressed gas, flammable, n.o.s.

**PRIMARY HAZARD CLASS/DIVISION:** 2.1

**UN/NA NUMBER:** 1954

**NAERG:** 115

**LABEL:** 2.1: Flammable Gas

**MARINE POLLUTANT #1:** Not Listed.

## 15. REGULATORY INFORMATION

**UNITED STATES**

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**311/312 HAZARD CATEGORIES:** Fire Hazard. Immediate (Acute) Health Hazard.

**FIRE:** Yes **PRESSURE GENERATING:** No **REACTIVITY:** No **ACUTE:** Yes **CHRONIC:** Yes

**CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)**

| Chemical Name | Wt.% | CERCLA RQ |
|---|---|---|
| Benzene | may contain | 10 |
| Hydrogen Sulfide | may contain | 100 |

**TSCA (TOXIC SUBSTANCE CONTROL ACT)**

| Chemical Name | CAS |
|---|---|
| Methane | 74-82-8 |
| Ethane | 74-84-0 |
| Propane | 74-98-6 |
| i-Butane | 75-28-5 |
| n-Butane | 106-97-8 |
| Carbon Dioxide | 124-38-9 |
| Nitrogen | 7727-37-9 |

**CLEAN AIR ACT**

| Chemical Name | Vol. % | CAS |
|---|---|---|
| Ethane | 5 - 10 | 74-84-0 |
| Propane | 1 - 4 | 74-98-6 |
| i-Butane | 0.5 - 3 | 75-28-5 |
| n-Butane | 0.5 - 2 | 106-97-8 |

## 16. OTHER INFORMATIO N

**RELEVANT R-PHRASES:**R61: May cause harm to the unborn child.
R26: Very toxic by inhalation.
R48/23: Toxic : danger of serious damage to health by prolonged exposure through inhalation.
R50/53: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R12: Extremely flammable.
R45: May cause cancer.
R46: May cause heritable genetic damage.
R11: Highly flammable.
R36/38: Irritating to eyes and skin.
R65: Harmful: may cause lung damage if swallowed.

**PREPARED BY:**

**REVISION SUMMARY:**

**NATIONAL FIRE PROTECTION ASSOCIATION® HAZARD RATING**

| | |
|---|---|
| HEALTH: | 1-Hazard No greater than Ordinary Material |
| FIRE: | 4-Will Not Burn |
| REACTIVITY: | 0- Stable |

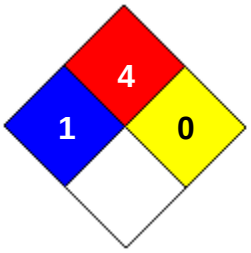
**HAZARDOUS MATERIAL IDENTIFICATION SYSTEM® HAZARD RATING**

| | |
|---|---|
| HEALTH: | 0- Minimal Hazard |
| FIRE: | 0- Minimal Hazard |
| PHYSICAL: | 0- Minimal Hazard |

**HMIS RATING**

| | |
|---|---|
| HEALTH | 1 |
| FLAMMABILITY | 4 |
| PHYSICAL HAZARD | 0 |
| PERSONAL PROTECTION | H |

**NFPA CODES**




**HMIS RATINGS NOTES:** Please refer to Section 8 of this SDS for recommended personal protective equipment.

**DATA SOURCES:**

**REFERENCES**

ACGIH. 2012 Guide to Occupational Exposure Values. Cincinnati, OH. Signature Publications, 2012.
Forsberg, K.; Mansdorf, S.Z. Quick Selection Guide to Chemical Protective Clothing. Fifth Edition. Hoboken, NJ. John Wiley & Sons, 2007.
Lide, D.R. CRC Handbook of Chemistry and Physics. 88th Edition. Boca Raton, FL. CRC Press, 2008.
UNECE. Globally Harmonized System of Classification and labelling of Chemicals (GHS). Third Revised Edition. New York and Geneva. United Nations, 2009.
US DOT; Pipeline and Hazardous Materials Safety Administration. 2008 Emergency Response Guidebook. Neenah, WI. J.J. Keller & Associates, Inc. 2008.
US EPA. Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA) and Section 112(r) of the Clean Air Act. [Available] Online: http://www.epa.go v/ceppo/pubs/title3.pdf. Retrieved 02/02/2011.

**ADDITIONAL MSDS INFORMATION:**

**KEY / LEGEND**

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous Goods by Road
CAA - Clean Air Act
CAS - Chemical Abstracts Service Registry Number
CDG - Carriage of Dangerous Goods By Road and Rail Manual
CERCLA - Comprehensive Environmental Response, Conmensation, and Liability Act
CFR - Code of Federal Regulations

EINECS - European Inventory of Existing Chemical Substances Registry Number
ERG - Emergency Response Guidebook
EPCRA - Emergency Planning and Community Right-to-Know Act
GHS - Globally Harmonized System of Classification and Labelling of Chemicals
IARC - International Agency for Research on Cancer
IATA - International Air Transport Association
ICAO - International Civil Aviation Organization
IMDG - International Maritime Dangerous Goods Code
IMO - International Maritime Organization
N/E - Not Established
NTP - National Toxicology Program
OSHA - Occupational Safety and Health Administration
PEL - Permissible Exposure Limit
PPE - Personal Protective Equipment
RCRA - Resource Conversation and Recovery Act
RID - Regulations Concerning the International Transport of Dangerous Goods by Rail
RQ - Reportable Quantities
SARA - Superfund Amendments and Reauthorization Act of 1986
SDS - Safety Data Sheet
TCC - Tag Closed Cup
TDG - Transportation of Dangerous Goods
TLV - Threshold Limit Value
TSCA - Toxic Substance Control Act
UN/NA - United Nations / North American Number
UNECE - United Nations Economic Commission for Europe
US DOT - United States Department of Transportation
US EPA - United States Environmental Protection Agency
Vol. - Volume
WHMIS - Workplace Hazardous Materials Information System

**GENERAL STATEMENTS:** Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.

**MANUFACTURER DISCLAIMER:** This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitabliity and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringemen

## Sweet Natural Gas

# SAFETY DATA SHEET

**Date Issued :**
**SDS No :**
**Date Revised :**
**Revision No :**

**Non-Sour Produced Water (West Virginia)**

******IMPORTANT******
This SDS has been prepared for Non-Sour Produced Water. Refer to the following sections for important safety and response information.
**Section 4**- First Aid Measures (for accidental exposure).
**Section 5**- Fire Fighting Measures.
**Section 6**- Accidental Release Measures.

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Non-Sour Produced Water (West Virginia)
**GENERAL USE:** Water extracted from natural gas well production.

## 2. HAZARDS IDENTIFICATION

**This material is not considered hazardous according to OSHA criteria.**

## 3. COMPOSITION / INFORMATIO N ON INGREDIENTS

| Chemical Name | Vol. % | CAS |
|---|---|---|
| Water | >90 | 7732-18-5 |
| Sodium Chloride | <10 | 7647-14-5 |

**COMMENTS:** Compositions given are typical values, not specifications. Composition may vary with geographic location, geologic formation, temperature and pressure.

## 4. FIRST AID MEASURES

**EYES:** Immediately flush with large amounts of water, holding eyelids open, for at least 20 minutes. Repeat if necessary. Remove contact lenses, if present and easy to do. If pain or redness persists, seek medical attention. If eye is exposed to hot liquid, cover eyes with cloth and seek medical attention immediately.

**SKIN:** In case of hot liquid exposure, do not remove clothing or treat, wash only unburned area and seek medical attention immediately.

**INGESTION:** Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Have exposed individual rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person. Obtain medical assistance immediately and treat as directed by a medical professional.

**INHALATION:** Move victim to fresh air. Call 911, emergency medical service,

**NOTES:** Contact poison treatment center immediately if large quantities have been ingested or inhaled.

## 5. FIRE FIGHTING MEASURES

**FLASH POINT:** N/A

**EXTINGUISHING MEDIA:** Material is not flammable.

**FIRE FIGHTING PROCEDURES: PROTECTIVE ACTIONS TO TAKE DURING FIRE FIGHTING -** Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Do not get water inside containers.

**FIRE FIGHTING EQUIPMENT: PRECAUTIONS FOR FIRE INVOLVING TANKS OR CAR/TRAILER LOADS -** Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.

## 6. ACCIDENTAL RELEASE MEASURES

**SMALL SPILL:** For emergency information and procedures to follow in the case of an accidental release, call the Emergency Telephone Number(s) listed in Section 1 of this SDS. As an immediate precautionary measure, isolate spill or leak area 50 meters (160 feet) in all directions. Keep unauthorized personnel away. Do not touch or walk through spilled material. 7Stop leak if you can do it without risk. Prevent entry into waterways, sewers. Dike far ahead of liquid for later disposal. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.

**LARGE SPILL:** Use similar response procedures as indicated under Small Spill. Large releases may require the notification of local emergency response agencies.

**COMMENT:** CAUTION This material is capable of off gassing volatiles.

## 7. HANDLING AND STORAGE

**GENERAL PROCEDURES:** Handle in accordance with good industrial hygiene and safety practices. These practices include but are not limited to avoiding unnecessary exposure and prompt removal of material from eyes, skin and clothing. Wash exposed skin and clothing frequently. If needed, take first aid actions as indicated in Section 4 of this SDS.

**HANDLING:** Wear appropriate personal protective equipment and use exposure controls as indicated in Section 8. Avoid all contact with skin and eyes. Avoid breathing product dust or vapors. Wash with soap and water after working with this product.

**STORAGE:** Keep in airtight container away from all heat sources. Store in a segregated and approved area. Store in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Keep container in a well-ventilated area. Ground all containers during transfer. Store in the original container or an approved alternative made from compatible material. Do not store in unlabeled containers. Treat empty containers in a similar fashion as residual product may exist. Use appropriate containment to avoid environmental contamination.

**STORAGE TEMPERATURE:** Store containers of product in cool well ventilated location.

**STORAGE PRESSURE:** Store in a room with ambient pressure.

**ELECTROSTATIC ACCUMULATION HAZARD:** Not Established.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**EXPOSURE GUIDELINES**

| OSHA HAZARDOUS COMPONENTS (29 CFR1910.1200) | | | |
|---|---|---|---|
| | | EXPOSURE LIMITS | |
| | | OSHA PEL | ACGIH TLV |
| **Chemical Name** | | ppm | ppm |
| Sodium Chloride | TWA | N/E | N/E |
| | STEL | N/E | N/E |

**ENGINEERING CONTROLS:** Provide adequate general and local ventilation to maintain airborne chemical concentrations below applicable exposure limits.

**PERSONAL PROTECTIVE EQUIPMENT**

**EYES AND FACE:** Employees should be provided with and required to use splash-proof safety goggles and full face splash shields where there is any possibility of product coming in contact with eyes. Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses. Ensure that eye wash station is operable and nearby.

**SKIN:** Consider wearing long-sleeve, FRC, otherwise normal working clothes should be worn. Wash contaminated clothing prior to reuse. If gloves are required for job operations involving this product, wear nitrile rubber or butyl rubber gloves.

**RESPIRATORY:** Respiratory protection is normally not required except in emergencies or when conditions cause excessive airborne levels of mists or vapors. Select NIOSH-approved organic vapor air-purifying respirator, SCBA or air-supplied respirator where there may be potential for overexposure.

**PROTECTIVE CLOTHING:** Long sleeve shirt and long pants or coveralls. Consider wearing butyl rubber apron or outerwear where splashing may occur. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.

**WORK HYGIENIC PRACTICES:** Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove contaminated clothing and launder before reuse. Shower after work using plenty of soap and water.

**COMMENTS: EXPOSURE LIMITS & SOURCES -** Refer to Section 16 Table 1 for additional exposure limits and sources for this product or its components, whichever applies.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**ODOR:** Salty.

**APPEARANCE:** Clear or opaque liquid.

**pH:** 6-8

**PERCENT VOLATILE:**

Negligible. **VAPOR PRESSURE:**

Not Established. **VAPOR**

**DENSITY:** >1.0 (Air = 1)

**BOILING POINT:** 212° F / 100° C

**FREEZING POINT:** < 0°C (<32°F)

**POUR POINT:** Not Established.

**FLASH POINT:** Not Applicable

**LOWER EXPLOSIVE LIMITS:** Not Applicable

**SOLUBILITY IN WATER:** Not

Established. **EVAPORATION RATE:**

Not Established. **SPECIFIC**

**GRAVITY:** > 1.000 at 0°C (32°F)

**VISCOSITY:** Not Established.

**COEFF. OIL/WATER:** Not Established.

**ODOR THRESHOLD:** Not Established.

## 10. STABILITY AND REACTIVITY

**STABLE:** Yes

**HAZARDOUS POLYMERIZATIO N:** No

**STABILITY: CHEMICAL STABILITY -** This product is anticipated to be stable under normal ambient storage and handling conditions of temperature and pressure.

**POLYMERIZATION:** This product is not anticipated to cause hazardous reactions or polymerizations under normal ambient storage and handling conditions of temperature and pressure.

**CONDITIONS TO AVOID:** Avoid contact with incompatible materials such as heat.

## 11. TOXICOLOGICAL INFORMATION ACUTE

| Chemical Name | ORAL $LD_{50}$ (rat) | DERMAL $LD_{50}$ (rabbit) | INHALATION $LC_{50}$ (rat) |
|---|---|---|---|
| Sodium Chloride | 3000 mg/kg | N/E | N/E |

**EYE EFFECTS:** May cause moderate to severe eye irritation.

**SKIN EFFECTS:** May cause mild skin irritation. Prolonged or repeated contact may result in mild irritation.

**CHRONIC:** Not Established.

**CARCINOGENICITY:** Not expected to cause cancer. This substance is not listed as a carcinogen by IARC, NTP, or OSHA.

**SENSITIZATION:** This product is not expected to be a skin sensitizer.

**NEUROTOXICITY:** Not Established.

**GENETIC EFFECTS:** Not Established.

**REPRODUCTIVE EFFECTS:** Not Established.

**TERATOGENIC EFFECTS:** Not Established.

**MUTAGENICITY:** Not Established.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL DATA: MOBILITY IN SOIL POTENTIAL -** Not Established.

**BIOACCUMULATION/ACCUMULATION:** Not Established.

**DISTRIBUTION:** Do not discharge into or allow runoff to flow into sewers and natural waterways. Contain spill material and dike for proper disposal.

**AQUATIC TOXICITY (ACUTE):** This product is not expected to be harmful to aquatic life.

**96-HOUR $LC_{50}$:** 3930 - 5360 mg/L Pimephales promelas for calcium chloride.

**48-HOUR $EC_{50}$:** 52 mg/L for Daphnia magna for calcium chloride.

**CHEMICAL FATE INFORMATION: PERSISTENCE & DEGRADABILITY -** Not Established.

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** The generator of a waste is responsible to determine if the material disposed of meets federal, state, or local criteria to be defined as a hazardous waste and dispose of accordance with applicable Federal, state and local regulations.

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

Not Regulated

## 15. REGULATORY INFORMATION UNITED STATES

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**311/312 HAZARD CATEGORIES:** Fire hazard. Immediate (acute) health hazard. Delayed (chronic) health hazard.

**FIRE:** No **PRESSURE GENERATING:** No **REACTIVITY:** No **ACUTE:** No **CHRONIC:** No

**EPCRA SECTION 313 SUPPLIER NOTIFICATION**

**This material does not contain any chemicals subject to the reporting requirements of SARA 313 and 40 CFR 372.**

**CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)**

This material does not contain any chemicals with CERCLA Reportable Quantities.

**TSCA (TOXIC SUBSTANCE CONTROL ACT)**

All components are either listed on the TSCA Inventory, or are not regulated under TSCA.

## 16. OTHER INFORMATIO N

**RELEVANT R-PHRASES:**

R36/37/38: Irritating to eyes, respiratory system and skin.
R36/38: Irritating to eyes and skin.
R65: Harmful: may cause lung damage if swallowed.

**PREPARED BY:**

**REVISION SUMMARY:**

**NATIONAL FIRE PROTECTION ASSOCIATION® HAZARD RATING**

| | |
|---|---|
| HEALTH: | 0-Hazard No greater than Ordinary Material |
| FIRE: | 0-Will Not Burn |
| REACTIVITY: | 0- Stable |

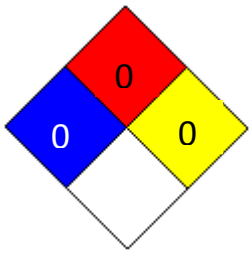
**HAZARDOUS MATERIAL IDENTIFICATION SYSTEM® HAZARD RATING**

| | |
|---|---|
| HEALTH: | 0- Minimal Hazard |
| FIRE: | 0- Minimal Hazard |
| PHYSICAL: | 0- Minimal Hazard |

**HMIS RATING**

| | |
|---|---|
| HEALTH | 0 |
| FLAMMABILITY | 0 |
| PHYSICAL HAZARD | 0 |
| PERSONAL PROTECTION | B |

**NFPA CODE**



**ADDITIONAL MSDS INFORMATION: KEY / LEGEND**

ACGIH - American Conference of Governmental Industrial Hygienists
ADR - Agreement on Dangerous Goods by Road
CAA - Clean Air Act
CAS - Chemical Abstracts Service Registry Number
CDG - Carriage of Dangerous Goods by Road and Rail Manual
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
EINECS - European Inventory of Existing Chemical Substances Registry Number
NAERG - Emergency Response Guidebook
EPCRA - Emergency Planning and Community Right-to-Know Act
GHS - Globally Harmonized System of Classification and Labeling of Chemicals
IARC - International Agency for Research on Cancer
IATA - International Air Transport Association
ICAO - International Civil Aviation Organization
IMDG - International Maritime Dangerous Goods Code
IMO - International Maritime Organization
MSDS - Material Safety Data Sheet
N/E - Not Established
NOV - National Oil well Varco
NTP - National Toxicology Program
OSHA - Occupational Safety and Health Administration
PEL - Permissible Exposure Limit
PPE - Personal Protective Equipment
RCRA - Resource Conversation and Recovery Act
RID - Regulations Concerning the International Transport of Dangerous Goods by Rail
RQ - Reportable Quantities
SARA - Superfund Amendments and Reauthorization Act of 1986
SDS - Safety Data Sheet
TCC - Tag Closed Cup
TDG - Transportation of Dangerous Goods
TLV - Threshold Limit Value
TSCA - Toxic Substance Control Act
UN/NA - United Nations / North American Number
UNECE - United Nations Economic Commission for Europe
US DOT - United States Department of Transportation
US EPA - United States Environmental Protection Agency
Vol. - Volume
WHMIS - Workplace Hazardous Materials Information System

**GENERAL STATEMENTS:** Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.

**MANUFACTURER DISCLAIMER:** This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

# ATTACHMENT E

# EMISSION CALCULATIONS

## Permit Determination

**Wengerd Well Pad**
**Proctor, West Virginia**

Tug Hill Operating, LLC
380 Southpointe Blvd., Suite 200
Canonsburg, PA 15317

November 2017

**Table 1. Annual Potential To Emit (PTE) Summary**
**Tug Hill Operating, LLC Wengerd Well Pad**

***Criteria Pollutants***

**Proposed Facility Wide PTE - Criteria Pollutants**

| Source | PM | PM10 | PM2.5 | SO2 | NOx | CO | VOC | CO2e |
|---|---|---|---|---|---|---|---|---|
| Engines (ton/yr) | 0.238 | 0.238 | 0.238 | 0.014 | 12.167 | 0.913 | 1.399 | 4528.123 |
| Line Heaters (ton/yr) | 0.196 | 0.196 | 0.196 | 0.015 | 2.576 | 2.164 | 0.142 | 3075.020 |
| Tanks (ton/yr) | - | - | - | - | - | - | 8.770 | - |
| Truck Loading (ton/yr) | - | - | - | - | - | - | 0.002 | - |
| Compressor Blowdowns (ton/yr) | - | - | - | - | - | - | 0.108 | - |
| Fugitives (ton/yr) | - | - | - | - | - | - | 1.379 | 32.059 |
| **Total Emissions (ton/yr)** | 0.434 | 0.434 | 0.434 | 0.030 | 14.743 | 3.077 | 11.800 | 7635.201 |
| **Total Emissions (lb/hr)** | 0.099 | 0.099 | 0.099 | 0.007 | 3.366 | 0.702 | 2.694 | 1743.197 |

***Hazardous Air Pollutants (HAPs)***

**Proposed Facility Wide PTE - HAPs**

| Source | Acetaldehyde | Benzene | Toluene | Ethylbenzene | Xylene | n-Hexane | Formaldehyde | Total HAPs |
|---|---|---|---|---|---|---|---|---|
| Engines (ton/yr) | 0.1997 | 0.0105 | 0.0097 | 0.0009 | 0.0044 | 0.0265 | 0.426 | 0.928 |
| Line Heaters (ton/yr) | -- | 0.0001 | 0.0001 | -- | -- | 0.0464 | 0.002 | 0.049 |
| Tanks (ton/yr) | - | - | - | - | - | - | - | - |
| Truck Loading (ton/yr) | - | - | - | - | - | - | - | - |
| Compressor Blowdowns (ton/yr) | - | - | - | - | - | - | - | - |
| Fugitives (ton/yr) | - | - | - | - | - | - | - | - |
| **Total Emissions (ton/yr)** | 0.200 | 0.011 | 0.010 | 0.001 | 0.004 | 0.073 | 0.428 | 0.977 |
| **Total Emissions (lb/hr)** | 0.046 | 0.002 | 0.002 | 0.000 | 0.001 | 0.017 | 0.098 | 0.223 |

**Table 1 Compressor Engine Emissions (CE-1)**
**Caterpillar G3508TALE**
**Tug Hill Operating, LLC Yoder Pad**

| Pollutant | Emission Factor | | PTE (lb/hr) | | PTE (tons/yr) | |
|---|---|---|---|---|---|---|
| **Criteria Pollutants** | | | | | | |
| PM/PM10/PM2.5** | 9.98E-03 lb/MMBtu | (1) | 0.05 | (a) | 0.24 | (c) |
| $SO_2$ | 5.88E-04 lb/MMBtu | (1) | 0.00 | (a) | 0.01 | (c) |
| NOx | 2.00E+00 g/hp-hr | (2) | 2.78 | (b) | 12.17 | (d) |
| CO | 1.50E-01 g/hp-hr | (2) | 0.21 | (b) | 0.91 | (d) |
| VOC* | 2.30E-01 g/hp-hr | (2) | 0.32 | (b) | 1.40 | (d) |
| *VOC's does not include formaldehude | | | | | | |
| **Hazardous Air Pollutants** | | | | | | |
| 1,1,2,2-Tetrachloroethane | 4.00E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| 1,1,2-Trichloroethane | 3.18E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| 1,3-Butadiene | 2.67E-04 lb/MMBtu | (1) | 0.001 | (a) | 0.006 | (c) |
| 1,3-Dichloropropene | 2.64E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| 2-Methylnapthalene | 3.32E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| 2,2,4-Trimethylpentane | 2.50E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Acetaldehyde | 8.36E-03 lb/MMBtu | (1) | 0.046 | (a) | 0.200 | (c) |
| Acrolein | 5.14E-03 lb/MMBtu | (1) | 0.028 | (a) | 0.123 | (c) |
| Benzene | 4.40E-04 lb/MMBtu | (1) | 0.002 | (a) | 0.011 | (c) |
| Biphenyl | 2.12E-03 lb/MMBtu | (1) | 0.012 | (a) | 0.051 | (c) |
| Carbon Tetrachloride | 3.67E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Chlorobenzene | 3.04E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Chloroform | 2.85E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Ethylbenzene | 3.97E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Ethylene Dibromide | 4.43E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Formaldehyde | 7.00E-02 g/hp-hr | (2) | 0.097 | (b) | 0.426 | (d) |
| Methanol | 2.50E-03 lb/MMBtu | (1) | 0.014 | (a) | 0.060 | (c) |
| Methylene Chloride | 2.00E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.000 | (c) |
| n-Hexane | 1.11E-03 lb/MMBtu | (1) | 0.006 | (a) | 0.027 | (c) |
| Naphthalene | 7.44E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.002 | (c) |
| PAH (POM) | 2.69E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Phenol | 1.04E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.000 | (c) |
| Styrene | 2.36E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.001 | (c) |
| Toluene | 4.08E-04 lb/MMBtu | (1) | 0.002 | (a) | 0.010 | (c) |
| Vinyl Chloride | 1.49E-05 lb/MMBtu | (1) | 0.000 | (a) | 0.000 | (c) |
| Xylenes | 1.84E-04 lb/MMBtu | (1) | 0.001 | (a) | 0.004 | (c) |
| **Total HAP** | | | **0.212** | | **0.928** | |
| **Greenhouse Gas Emissions** | | | | | Metric Tonne/yr | |
| $CO_2$ | 7.72E+02 g/hp-hr | (2) | 1072.22 | (b) | 4269.39 | (d) |
| $CH_4$ | 1.86E+00 g/hp-hr | (2) | 2.58 | (b) | 10.29 | (d) |
| $N_2O$ | 2.2E-04 lb/MMBtu | (3) | 0.00 | (a) | 0.01 | (c) |
| $CO_2e^{(e)}$ | - - | | 1137.16 | | 4528.12 | |

** includes condensible PM

**Calculations:**

**Hourly Emissions - If emission factor note 1 is used, use calculation (a). If emission factor note 2 is used, use calculation (b).**

(a) Hourly Emissions (lb/hr) = Emission factor (lb/MMBtu) * (1MMBtu/1000000 Btu) * Engine Power Output (hp) * BSFC (Btu/hp-hr)

(b) Hourly Emissions (lb/hr) = Emission factor (g/hp-hr) * Engine Power Output (hp) * (lb/453.6g)

**Annual Emissions - If emission factor note 1 is used, use calculation (c). If emission factor note 2 is used, use calculation (d).**

(c) Annual emissions (tons/yr) = Emission factor (lb/MMBtu) * (1MMBtu/1000000Btu) * Engine Power Output (hp) * BSFC (Btu/hp-hr) * Annual Hours of operation (hr/yr) * (1ton/2000lbs)

(d) Annual emissions (tons/yr) = Emission factor (g/hp-hr) * Engine Power Output (hp) * Annual Hours of operation (hr/yr) * (1ton/2000lbs) * (lb/453.6g)

**MAXIMUM HOURLY EMISSION INPUTS**

| | | |
|---|---|---|
| Engine Power Output (kW) = | 470 | |
| Engine Power Output (hp) = | 630 | |
| Number of Engines = | 1 | |
| BSFC (BTU/HP-hr) = | 8,658 | (4) |
| Heat Content Natural Gas(Btu/scf) = | 1,262.0 | (5) |
| Fuel Throughput (ft3/hr) = | 4,322.1 | (6) |
| PTE Hours of Operation = | 8,760 | |

(e) $CO_2$ equivalent = $[(CO_2 \text{ emissions})*(GWP_{CO2})]+[(CH_4 \text{ emissions})*(GWP_{CH4})]+[(N_2O \text{ emissions})*(GWP_{N2O})]$

Global Warming Potential (GWP)

| | | |
|---|---|---|
| $CO_2$ | 1 | (7) |
| $CH_4$ | 25 | (7) |
| $N_2O$ | 298 | (7) |

**Notes:**

(1) AP-42, Chapter 3.2, Table 3.2-2. Natural Gas-fired Reciprocating Engines (7/00). *Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines.*

(2) Emission limits supplied from manufacturer's specification sheet

(3) Emission limits supplied from 40 CFR 98, Subpart C, Table C-1 and C-2.

(4) Fuel consumption from manufacturer's specification sheet.

(5) Value obtained from fuel gas analysis.

(6) Fuel throughput = BSFC (BTU/HP-hr) x Power (HP) / Heat Content (BTU/scf)

(7) Global Warming Potentials obtained from 40 CFR 98, Subpart A, Table A-1

**Table 3. Tank Emissions**
**Tug Hill Operating, LLC Wengerd Well Pad**

| Emission Unit ID | Tank Capacity (gal) | Tank Contents | Control Devices | Tank Throughput (bbls/day) | VOC Emission Factor (lbs/bbls) | | VOC Emissions (lbs/yr)[(a)] | VOC Emissions (lb/hr)[(b)] | VOC Emissions (tons/yr)[(c)] |
|---|---|---|---|---|---|---|---|---|---|
| T-1 | 16800 | Produced Water | None | 10.25 | 2.35E+00 | (1) | 8770.00 | 1.001 | 4.385 |
| T-2 | 16800 | Produced Water | None | 10.25 | 2.35E+00 | (1) | 8770.00 | 1.001 | 4.385 |
| **Totals** | | | | | | | **17540.00** | **2.00** | **8.77** |

**Calculations:**

(a) VOC Emissions (lb/yr) = Tank Throughput (bbls/day) * VOC Emission Factor (lbs/bbls) * (365days/yr)

(b) VOC Emissions (lb/hr) = VOC Emissions (lbs/yr) * (yr/8760hr)

(c) VOC Emissions (ton/yr) = VOC Emissions (lbs/yr) * (1ton/2000lbs)

**Notes:**

(1) VOC emission factor includes Flashing/Working/Breathing losses as calculated from the Promax Model Simulation report

**Table 4 GPU Heater (GPU-1 through GPU-6) Rates and Emissions**
**Tug Hill Operating, LLC Wengerd Well Pad**

| Pollutant | Emission Factor | | | 1.50 MBtu/hr GPU Emissions (lb/hr) | 1.50 MMBtu/hr GPU Emissions (ton/yr) | 1.50 MBtu/hr GPU Emissions (lb/hr) x6 | 1.50 MMBtu/hr GPU Emissions (ton/yr) x6 |
|---|---|---|---|---|---|---|---|
| **Criteria Pollutants** | | | | | | | |
| PM/PM10/PM2.5 | 7.6 | lb/MMcf | (1) | 0.007 | 0.033 | 0.268 | 0.196 |
| $SO_2$ | 0.6 | lb/MMcf | (1) | 0.001 | 0.003 | 0.021 | 0.015 |
| NOx | 100 | lb/MMcf | (2) | 0.098 | 0.429 | 3.529 | 2.576 |
| CO | 84 | lb/MMcf | (2) | 0.082 | 0.361 | 2.965 | 2.164 |
| VOC | 5.5 | lb/MMcf | (1) | 0.005 | 0.024 | 0.194 | 0.142 |
| **Hazardous Air Pollutants** | | | | | | | |
| Arsenic | 2.0E-04 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Benzene | 2.1E-03 | lb/MMcf | (4) | 0.000 | 0.000 | 0.000 | 0.000 |
| Beryllium | 1.2E-05 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Cadmium | 1.1E-03 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Chromium | 1.4E-03 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Cobalt | 8.4E-05 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Dichlorobenzene | 1.2E-03 | lb/MMcf | (4) | 0.000 | 0.000 | 0.000 | 0.000 |
| Formaldehyde | 7.5E-02 | lb/MMcf | (4) | 0.000 | 0.000 | 0.003 | 0.002 |
| Hexane | 1.8E+00 | lb/MMcf | (4) | 0.002 | 0.008 | 0.064 | 0.046 |
| Lead | 5.0E-04 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Manganese | 3.8E-04 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Mercury | 2.6E-04 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Naphthalene | 6.1E-04 | lb/MMcf | (4) | 0.000 | 0.000 | 0.000 | 0.000 |
| Nickel | 2.1E-03 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| PAH/POM | 1.3E-03 | lb/MMcf | (4) | 0.000 | 0.000 | 0.000 | 0.000 |
| Selenium | 2.4E-05 | lb/MMcf | (3) | 0.000 | 0.000 | 0.000 | 0.000 |
| Toluene | 3.4E-03 | lb/MMcf | (4) | 0.000 | 0.000 | 0.000 | 0.000 |
| **Total HAP** | **1.9E+00** | **lb/MMCF** | | 0.002 | 0.008 | 0.067 | 0.049 |
| **Greenhouse Gas Emissions** | | | | | | | |
| $CO_2$ | 116.89 | lb/MMBtu | (5) | 116.889 | 511.974 | 701.335 | 3071.845 |
| $CH_4$ | 2.2E-03 | lb/MMBtu | (5) | 0.002 | 0.010 | 0.013 | 0.058 |
| $N_2O$ | 0.0 | lb/MMBtu | (5) | 0.000 | 0.001 | 0.001 | 0.006 |
| $CO_2e^{(b)}$ | - | - | | 117.010 | 512.503 | 702.059 | 3075.020 |

**Calculations:**

(a) Annual emissions (tons/yr) = [Annual Usage (MMBtu/yr or MMCF/yr)]x [Number of Identical Heaters]x [Emission Factor (lb/MMBtu or lb/MMCF)] / [2,000 lb/ton]

Number of Heaters= 6
Fuel Use (MMBtu/hr) = 1
Hours of Operation (hr/yr)= 8760
PTE Fuel Use (MMcf/yr) = 8.6

(b) $CO_2$ equivalent = [($CO_2$ emissions)*($GWP_{CO2}$)]+[($CH_4$ emissions)*(GWP \
Global Warming Potential (GWP)

| | | |
|---|---|---|
| $CO_2$ | 1 | (6) |
| $CH_4$ | 25 | (6) |
| $N_2O$ | 298 | (6) |

**Notes:**

(1) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors For Criteria Pollutants and Greenhouse Gases From Natural Gas Combustion, July 1998.
(2) AP-42, Chapter 1.4, Table 1.4-1. Emission Factors For Nitrogen Oxides (Nox) and Carbon Monoxide(CO) From Natural Gas Combustion, July 1998.
(3) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors For Metals From Natural Gas Combustion, July 1998.
(4) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998.
(5) Emission factors are from 40 CFR 98, Subpart C, Table C-1 and C-2.
(6) Global Warming Potentials obtained from 40 CFR 98, Subpart A, Table A-1
(7) MMBtu to MMcf conversion factor is 1020. AP-42, Chapter 1.4

**Table 5. Truck Loading (TL-1) VOC Emissions**
**Tug Hill Operating, LLC Wengerd Well Pad**

| Contents | Volume Transferred [3] | PTE VOC Emissions (lb/hr) | PTE VOC Emissions (ton/yr) [(a)] |
|---|---|---|---|
| Pipeline Liquids | 314,202 gal/yr | 4.67E-04 | 2.05E-03 |
| **Total** | | **4.67E-04** | **2.05E-03** |

**Calculations:**

**(a) PTE VOC Emissions (ton/yr) given as calculated in the Promax Model simulation report**

| | Pipeline liquids | |
|---|---|---|
| Saturation factor | 0.60 | Note [(1)] |
| Pvap (psia) | 0.27 | Note [(2)] |
| Molecular Weight Vap (lb/lbmol) | 18.26 | Note [(2)] |
| Bulk Liquid Tempurature (F) | 52.14 | Note [(2)] |

**Notes:**

(1) AP-42 Section 5.2, Table 5.2-1 Saturation Factors for Calculating Petroleum Liquid Loading Losses, Submerged loading - dedicated normal service

(2) Input parameters as defined by the Promax Model simulation report

## Table 6. Fugitive Leak Emissions
## Tug Hill Operating, LLC Wengerd Well Pad

| Pollutant | Emission Factor | | | PTE[(a) Gas Service] (tons/yr) |
|---|---|---|---|---|
| Valves | 9.9E-03 | lb/hr/source | (1) | 10.51 |
| Connectors | 8.6E-04 | lb/hr/source | (1) | 4.01 |
| Open-Ended Lines | 4.4E-03 | lb/hr/source | (1) | 0.30 |
| Pressure Relief Valves | 1.9E-02 | lb/hr/source | (1) | 0.50 |
| Compressors | 1.9E-02 | lb/hr/source | (1) | 0.08 |
| **Total Gas Released** | - | - | | 15.32 |
| Total **VOC** Released (gas service) | | | (b) | **1.38** |
| **Calculations:** | | | **CO2e** | **32.06** |

(a) Annual emissions (tons/yr) = [Emission Factor (lb/hr/source)] x [Number of Sources] x [Hours of Operation per Year] x [0.0005 tons/ lb]

(b) Gas sample from station's gas analysis assumed to be worst case at 9 wt % VOC from 2012 fractional gas analysis measurements

Number of Components in Gas Service

| | | |
|---|---|---|
| Valves= | 242 | (2) |
| Pressure Relief Valves= | 6 | (2) |
| Connectors= | 1,064 | (2) |
| Open-Ended Lines= | 16 | (2) |
| Compressors= | 1.000 | (2) |
| Maximum Hour of Operation = | 8,760 | |

Global Warming Potential (GWP)

| | | |
|---|---|---|
| $CO_2$ | 1 | (3) |
| $CH_4$ | 25 | (3) |
| $N_2O$ | 298 | (3) |

(1) Emission factors from 1995 EPA Protocol for Equipment Leak Emission Estimates, Table 2-4 Oil and Gas Production

(2) *Default Average Component Counts for Major Onshore Natural Gas Production Equipment* from 40 CFR 98, Subpart W, Table W-1B

(3) Global Warming Potentials obtained from 40 CFR 98, Subpart A, Table A-1

**Table 6. Reciprocating Engine / Integral Compressor Emissions (E01) Blowdown Venting**
**Caterpillar G3508TALE**
**Tug Hill Operating, LLC Wengerd Well Pad**

| Pollutant | Maximum Hourly Emissions | | Annual Emissions | |
|---|---|---|---|---|
| | Emission Factor | PTE per Engine Event (lb/hr) | Emission Factor | Annual PTE (tons/yr) |
| **Criteria Pollutants** | | | | |
| VOC | 3.60E+00 lb/Event (1) | 3.60 (a) | 3.60E+00 lb/Event (1) | 0.11 (a) |

(1) - 3.6lbs VOC/ Engine blowdown event; based on 717 scf/event of 21.48 MW gas with 9 wt % VOC

(a) - Worst case blowdowns per year equal normal rate 6 times 10 = 60 Events/yr

Bryan Research & Engineering, Inc.

# ProMax® 4.0



## Simulation Report

**Project: TugHill_Shields_WellPad Rev 1.pmx**

**Licensed to SLR International Corporation and Affiliates**

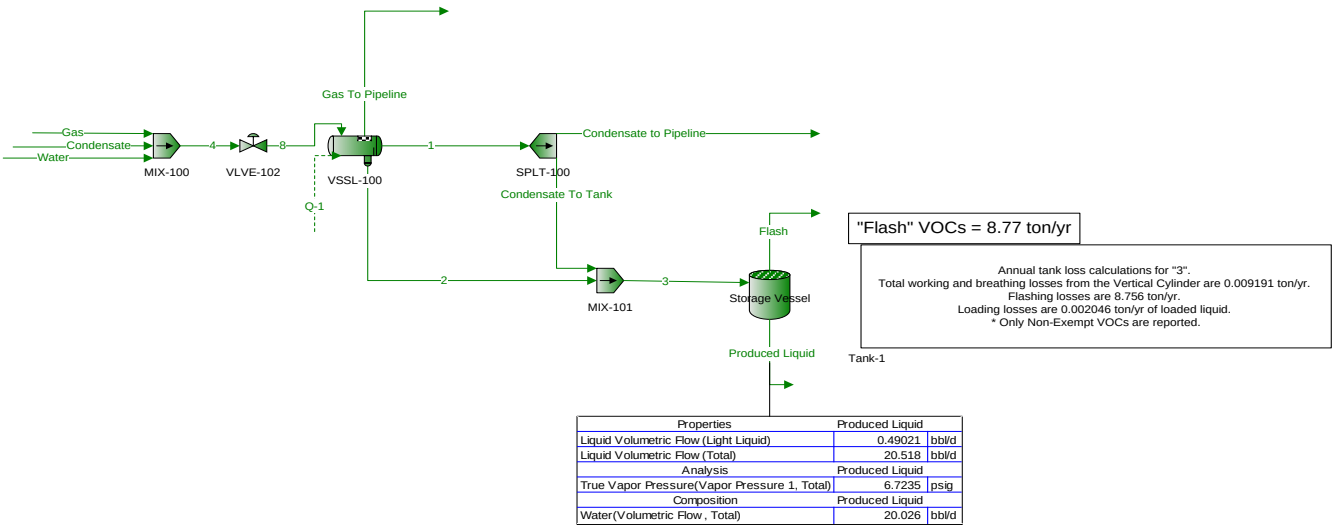
**Client Name:** Tug Hill
**Location:** Wengerd
**Job:** G70-D Permit

**ProMax Filename:** N:\West Virginia\Tug Hill\Projects\Determination\Wengerd\ProMax\TugHill_Shields_WellP
**ProMax Version:** 4.0.16071.0
**Simulation Initiated:** 11/27/2017 8:27:42 AM

**Bryan Research & Engineering, Inc.**
Chemical Engineering Consultants
P.O. Box 4747 Bryan, Texas 77805
Office: (979) 776-5220
FAX: (979) 776-4818
mailto:sales@bre.com
http://www.bre.com/

Report Navigator can be activated via the ProMax Navigator Toolbar.
An asterisk (*), throughout the report, denotes a user specified value.
A question mark (?) after a value, throughout the report, denotes an extrapolated or approximate value.

Wengerd Well Pad




| Properties | Produced Liquid | |
|---|---|---|
| Liquid Volumetric Flow (Light Liquid) | 0.49021 | bbl/d |
| Liquid Volumetric Flow (Total) | 20.518 | bbl/d |
| Analysis | Produced Liquid | |
| True Vapor Pressure(Vapor Pressure 1, Total) | 6.7235 | psig |
| Composition | Produced Liquid | |
| Water(Volumetric Flow , Total) | 20.026 | bbl/d |

| Process Streams | | Condensate | Condensate to Pipeline | Condensate To Tank | Flash | Gas | Gas To Pipeline | Produced Liquid | Water | 1 | 2 | 3 | 4 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Composition** | Status: | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved |
| Phase: **Total** | From Block: | -- | SPLT-100 | SPLT-100 | Storage Vessel | -- | VSSL-100 | Storage Vessel | -- | VSSL-100 | VSSL-100 | MIX-101 | MIX-100 | VLVE-102 |
| | To Block: | MIX-100 | -- | MIX-101 | -- | MIX-100 | -- | -- | MIX-100 | SPLT-100 | MIX-101 | Storage Vessel | VLVE-102 | VSSL-100 |
| **Mole Fraction** | | % | % | % | % | % | % | % | % | % | % | % | % | % |
| C1 | | 9.00218* | 9.95936 | 9.95936 | 26.5710 | 75.001* | 75.0610 | 0.00108211 | 0* | 9.95936 | 0.0448325 | 0.108743 | 72.3956 | 72.3956 |
| C2 | | 11.0092* | 10.8959 | 10.8959 | 19.5612 | 15.375* | 15.3720 | 0.00279576 | 0* | 10.8959 | 0.0118860 | 0.0820460 | 15.0437 | 15.0437 |
| C3 | | 13.0203* | 12.3170 | 12.3170 | 18.3908 | 5.545* | 5.53793 | 0.00754626 | 0* | 12.3170 | 0.00265459 | 0.0820348 | 5.62584 | 5.62584 |
| iC4 | | 2.86806* | 2.78233 | 2.78233 | 3.58155 | 0.552* | 0.547716 | 0.00360390 | 0* | 2.78233 | 0.000167444 | 0.0181017 | 0.594842 | 0.594842 |
| nC4 | | 10.8612* | 10.8610 | 10.8610 | 12.7381 | 1.518* | 1.49266 | 0.0190400 | 0* | 10.8610 | 0.000569561 | 0.0705773 | 1.70164 | 1.70164 |
| iC5 | | 4.72009* | 4.37763 | 4.37763 | 3.64543 | 0.275* | 0.272189 | 0.0135672 | 0* | 4.37763 | 6.49406E-05 | 0.0282834 | 0.369195 | 0.369195 |
| nC5 | | 8.29617* | 7.90118 | 7.90118 | 5.64375 | 0.387* | 0.376632 | 0.0282124 | 0* | 7.90118 | 3.44635E-05 | 0.0509665 | 0.556162 | 0.556162 |
| N2 | | 0.0200004* | 0.0306859 | 0.0306859 | 0.101543 | 0.682* | 0.682655 | 1.72558E-06 | 0* | 0.0306859 | 0.000216761 | 0.000413169 | 0.656939 | 0.656939 |
| CO2 | | 0.0550011* | 0.0633458 | 0.0633458 | 0.555282 | 0.188* | 0.187886 | 0.000312522 | 0* | 0.0633458 | 0.00216688 | 0.00256125 | 0.182187 | 0.182187 |
| Benzene | | 0.0820016* | 0.0957786 | 0.0957786 | 0.0266074 | 0.002* | 0.00144191 | 0.000580922 | 0* | 0.0957786 | 6.94243E-05 | 0.000686380 | 0.00374030 | 0.00374030 |
| Ethylbenzene | | 0.262005* | 0.219846 | 0.219846 | 0.00716901 | 0* | 0.000413612 | 0.00140393 | 0* | 0.219846 | 1.01940E-05 | 0.00142729 | 0.00579943 | 0.00579943 |
| Toluene | | 0.300006* | 0.290959 | 0.290959 | 0.0276270 | 0.002* | 0.00147327 | 0.00181725 | 0* | 0.290959 | 4.65672E-05 | 0.00192183 | 0.00856578 | 0.00856578 |
| o-Xylene | | 0.479010* | 0.407737 | 0.407737 | 0.0102915 | 0* | 0.000607762 | 0.00261906 | 0* | 0.407737 | 2.19508E-05 | 0.00265015 | 0.0106028 | 0.0106028 |
| C6 | | 6.03512* | 7.02120 | 7.02120 | 2.03780 | 0.145* | 0.104710 | 0.0371590 | 0* | 7.02120 | 5.80368E-06 | 0.0452655 | 0.273164 | 0.273164 |
| C7 | | 3.59007* | 3.56354 | 3.56354 | 0.365730 | 0.028* | 0.0196217 | 0.0215773 | 0* | 3.56354 | 7.11902E-07 | 0.0229718 | 0.106418 | 0.106418 |
| C8 | | 1.75604* | 1.68818 | 1.68818 | 0.0551277 | 0.006* | 0.00329343 | 0.0107023 | 0* | 1.68818 | 4.38227E-08 | 0.0108823 | 0.0446451 | 0.0446451 |
| C9 | | 0.939019* | 0.863251 | 0.863251 | 0.00860730 | 0.001* | 0.000558842 | 0.00555227 | 0* | 0.863251 | 6.96196E-09 | 0.00556465 | 0.0217476 | 0.0217476 |
| C10 | | 0.477010* | 0.425536 | 0.425536 | 0.00136969 | 0* | 0.000107056 | 0.00274866 | 0* | 0.425536 | 3.23588E-10 | 0.00274307 | 0.0105585 | 0.0105585 |
| C11 | | 1.46703* | 1.31708 | 1.31708 | 0.00127874 | 0* | 0.000115738 | 0.00851942 | 0* | 1.31708 | 3.38428E-10 | 0.00849008 | 0.0324724 | 0.0324724 |
| C12 | | 0.899018* | 0.808861 | 0.808861 | 0.000260027 | 0* | 2.65695E-05 | 0.00523419 | 0* | 0.808861 | 2.60374E-10 | 0.00521404 | 0.0198996 | 0.0198996 |
| C13 | | 0.592012* | 0.533054 | 0.533054 | 5.63605E-05 | 0* | 6.98164E-06 | 0.00344990 | 0* | 0.533054 | 1.50761E-10 | 0.00343615 | 0.0131041 | 0.0131041 |
| 2,2-Dimethylpropane | | 0.138003* | 0.133218 | 0.133218 | 0.144179 | 0.015* | 0.0147942 | 0.000278196 | 0* | 0.133218 | 2.55436E-06 | 0.000861280 | 0.0174937 | 0.0174937 |
| 2,2-Dimethylbutane | | 0.172003* | 0.232277 | 0.232277 | 0.122289 | 0.009* | 0.00703642 | 0.00100643 | 0* | 0.232277 | 5.76438E-07 | 0.00149787 | 0.0124707 | 0.0124707 |
| Cyclopentane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| 2,3-Dimethylbutane | | 0.403008* | 0.563200 | 0.563200 | 0.238194 | 0.018* | 0.0129099 | 0.00267854 | 0* | 0.563200 | 2.37868E-06 | 0.00363284 | 0.0262474 | 0.0262474 |
| 2-Methylpentane | | 3.04006* | 3.53775 | 3.53775 | 1.37818 | 0.094* | 0.0737102 | 0.0172992 | 0* | 3.53775 | 8.65422E-06 | 0.0228135 | 0.157776 | 0.157776 |
| 3-Methylpentane | | 1.89704* | 2.17847 | 2.17847 | 0.780675 | 0.053* | 0.0410753 | 0.0109357 | 0* | 2.17847 | 1.20225E-05 | 0.0140547 | 0.0930086 | 0.0930086 |
| Methylcyclopentane | | 0.822016* | 0.759290 | 0.759290 | 0.231019 | 0.012* | 0.0115377 | 0.00398037 | 0* | 0.759290 | 5.86426E-06 | 0.00490032 | 0.0297464 | 0.0297464 |
| Cyclohexane | | 0.874017* | 0.906666 | 0.906666 | 0.213845 | 0.014* | 0.0109708 | 0.00501110 | 0* | 0.906666 | 1.28712E-05 | 0.00585729 | 0.0328227 | 0.0328227 |
| 2-Methylhexane | | 2.00404* | 1.90191 | 1.90191 | 0.279010 | 0.017* | 0.0145571 | 0.0111758 | 0* | 1.90191 | 1.07013E-06 | 0.0122611 | 0.0607233 | 0.0607233 |
| 3-Methylhexane | | 1.77704* | 1.78327 | 1.78327 | 0.237241 | 0.017* | 0.0123623 | 0.0105779 | 0* | 1.78327 | 1.09668E-06 | 0.0114963 | 0.0556986 | 0.0556986 |
| 2,2,4-Trimethylpentane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Methylcyclohexane | | 1.87704* | 1.85417 | 1.85417 | 0.191715 | 0.014* | 0.00984832 | 0.0112253 | 0* | 1.85417 | 4.41130E-06 | 0.0119567 | 0.0550243 | 0.0550243 |
| m-Xylene | | 0.263005* | 0.221943 | 0.221943 | 0.00660045 | 0* | 0.000383114 | 0.00141550 | 0* | 0.221943 | 5.87361E-06 | 0.00143651 | 0.00582157 | 0.00582157 |
| p-Xylene | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Water | | 0* | 0.0441102 | 0.0441102 | 2.51145 | 0* | 0.109208 | 99.6870 | 100* | 0.0441102 | 99.9372 | 99.2933 | 1.52605 | 1.52605 |
| Tetradecane | | 0.396008* | 0.356679 | 0.356679 | 1.29587E-05 | 0* | 1.88230E-06 | 0.00230851 | 0* | 0.356679 | 7.23346E-11 | 0.00229921 | 0.00876555 | 0.00876555 |
| Pentadecane | | 0.250005* | 0.225204 | 0.225204 | 2.82547E-06 | 0* | 4.76457E-07 | 0.00145759 | 0* | 0.225204 | 3.37833E-11 | 0.00145170 | 0.00553381 | 0.00553381 |
| Hexadecane | | 0.133003* | 0.119814 | 0.119814 | 5.49649E-07 | 0* | 1.08713E-07 | 0.000775480 | 0* | 0.119814 | 1.86572E-11 | 0.000772340 | 0.00294399 | 0.00294399 |
| Heptadecane | | 0.0760015* | 0.0684665 | 0.0684665 | 1.25387E-07 | 0* | 2.91300E-08 | 0.000443141 | 0* | 0.0684665 | 1.21778E-11 | 0.000441345 | 0.00168228 | 0.00168228 |
| Octadecane | | 0.0640013* | 0.0576565 | 0.0576565 | 4.17445E-08 | 0* | 1.11744E-08 | 0.000373175 | 0* | 0.0576565 | 1.04223E-11 | 0.000371663 | 0.00141666 | 0.00141666 |
| Nonadecane | | 0.0390008* | 0.0351346 | 0.0351346 | 9.05816E-09 | 0* | 2.86340E-09 | 0.000227404 | 0* | 0.0351346 | 6.61348E-12 | 0.000226483 | 0.000863274 | 0.000863274 |
| Eicosane | | 0.0180004* | 0.0162160 | 0.0162160 | 1.04193E-09 | 0* | 4.04007E-10 | 0.000104956 | 0* | 0.0162160 | 2.71235E-12 | 0.000104531 | 0.00039834 | 0.00039834 |
| Heneicosane | | 0.0100002* | 0.00900890 | 0.00900890 | 2.55514E-10 | 0* | 1.14896E-10 | 5.83090E-05 | 0* | 0.00900890 | 1.45994E-12 | 5.80727E-05 | 0.000221352 | 0.000221352 |
| Docosane | | 0.00600012* | 0.00540534 | 0.00540534 | 6.80789E-11 | 0* | 3.52558E-11 | 3.49854E-05 | 0* | 0.00540534 | 1.14315E-12 | 3.48436E-05 | 0.00013281 | 0.00013281 |
| Tricosane | | 0.00300006* | 0.00270267 | 0.00270267 | 9.72311E-12 | 0* | 6.08733E-12 | 1.74927E-05 | 0* | 0.00270267 | 7.69443E-13 | 1.74218E-05 | 6.64057E-05 | 6.64057E-05 |
| Tetracosane | | 0.00200004* | 0.00180178 | 0.00180178 | 2.22570E-12 | 0* | 1.65449E-12 | 1.16618E-05 | 0* | 0.00180178 | 5.19785E-13 | 1.16145E-05 | 4.42705E-05 | 4.42705E-05 |
| Pentacosane | | 0.00100002* | 0.000900890 | 0.000900890 | 4.36417E-13 | 0* | 3.77466E-13 | 5.83090E-06 | 0* | 0.000900890 | 3.41400E-13 | 5.80727E-06 | 2.21352E-05 | 2.21352E-05 |
| Hexacosane | | 0.00300006* | 0.00270267 | 0.00270267 | 4.27753E-13 | 0* | 4.44096E-13 | 1.74927E-05 | 0* | 0.00270267 | 1.29023E-12 | 1.74218E-05 | 6.64057E-05 | 6.64057E-05 |
| Heptacosane | | 0.00100002* | 0.000900890 | 0.000900890 | 3.63026E-14 | 0* | 4.59912E-14 | 5.83090E-06 | 0* | 0.000900890 | 5.30724E-13 | 5.80727E-06 | 2.21352E-05 | 2.21352E-05 |
| Octacosane | | 0.00100002* | 0.000900890 | 0.000900890 | 1.89542E-14 | 0* | 2.73225E-14 | 5.83090E-06 | 0* | 0.000900890 | 7.76686E-13 | 5.80727E-06 | 2.21352E-05 | 2.21352E-05 |
| Nonacosane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Triacontane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Hentriacontane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Other C10s | | 1.84704* | 1.64284 | 1.64284 | 0.00722273 | 0* | 0.000539538 | 0.0106039 | 0* | 1.64284 | 1.97689E-07 | 0.0105902 | 0.0408838 | 0.0408838 |
| Other C7s | | 0.867017* | 1.12638 | 1.12638 | 0.139737 | 0.016* | 0.00719640 | 0.00672324 | 0* | 1.12638 | 1.41128E-06 | 0.00726221 | 0.0345929 | 0.0345929 |
| Other C8s | | 4.17308* | 3.90960 | 3.90960 | 0.162638 | 0.013* | 0.00917962 | 0.0246454 | 0* | 3.90960 | 2.70158E-06 | 0.0252046 | 0.104884 | 0.104884 |
| Other C9s | | 2.11204* | 1.87796 | 1.87796 | 0.0253935 | 0.001* | 0.00163340 | 0.0120521 | 0* | 1.87796 | 6.07313E-07 | 0.0121062 | 0.0477122 | 0.0477122 |
| **Molar Flow** | | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h | lbmol/h |
| C1 | | 2.27285* | 2.78073 | 0.0104724 | 0.0175626 | 823.498* | 822.972 | 0.000175801 | 0* | 2.79120 | 0.00726604 | 0.0177384 | 825.771 | 825.771 |
| C2 | | 2.77958* | 3.04222 | 0.0114572 | 0.0129293 | 168.815* | 168.539 | 0.000454204 | 0* | 3.05368 | 0.00192637 | 0.0133835 | 171.594 | 171.594 |
| C3 | | 3.28732* | 3.43900 | 0.0129515 | 0.0121557 | 60.8831* | 60.7181 | 0.00122598 | 0* | 3.45195 | 0.000430232 | 0.0133817 | 64.1704 | 64.1704 |
| iC4 | | 0.724120* | 0.776847 | 0.00292565 | 0.00236729 | 6.06086* | 6.00518 | 0.000585496 | 0* | 0.779772 | 2.71377E-05 | 0.00295279 | 6.78498 | 6.78498 |
| nC4 | | 2.74221* | 3.03246 | 0.0114204 | 0.00841948 | 16.6674* | 16.3656 | 0.00309326 | 0* | 3.04388 | 9.23092E-05 | 0.0115127 | 19.4096 | 19.4096 |
| iC5 | | 1.19172* | 1.22227 | 0.00460314 | 0.00240952 | 3.01945* | 2.98429 | 0.00220414 | 0* | 1.22687 | 1.05250E-05 | 0.00461366 | 4.21117 | 4.21117 |
| nC5 | | 2.09460* | 2.20607 | 0.00830819 | 0.00373035 | 4.24919* | 4.12940 | 0.00458343 | 0* | 2.21438 | 5.58552E-06 | 0.00831378 | 6.34379 | 6.34379 |
| N2 | | 0.00504965* | 0.00856773 | 3.22666E-05 | 6.71168E-05 | 7.48824* | 7.48465 | 2.80341E-07 | 0* | 0.00859999 | 3.51306E-05 | 6.73972E-05 | 7.49329 | 7.49329 |
| CO2 | | 0.0138865* | 0.0176866 | 6.66089E-05 | 0.000367024 | 2.06421* | 2.05999 | 5.07728E-05 | 0* | 0.0177532 | 0.000351188 | 0.000417797 | 2.07809 | 2.07809 |
| Benzene | | 0.0207036* | 0.0267421 | 0.00010712 | 1.75866E-05 | 0.0219596* | 0.0158091 | 9.43774E-05 | 0* | 0.0268428 | 1.12517E-05 | 0.00011164 | 0.0426632 | 0.0426632 |
| Ethylbenzene | | 0.0661505* | 0.0613828 | 0.000231171 | 4.73849E-06 | 0* | 0.00453486 | 0.000228085 | 0* | 0.0616139 | 1.65215E-06 | 0.000232823 | 0.0661505 | 0.0661505 |
| Toluene | | 0.0757448* | 0.0812379 | 0.000305947 | 1.82606E-05 | 0.0219596* | 0.0161530 | 0.000295233 | 0* | 0.0815439 | 7.54719E-06 | 0.000313494 | 0.0977044 | 0.0977044 |
| o-Xylene | | 0.120939* | 0.113843 | 0.000428741 | 6.80239E-06 | 0* | 0.00666352 | 0.000425496 | 0* | 0.114272 | 3.55759E-06 | 0.000432298 | 0.120939 | 0.120939 |
| C6 | | 1.52373* | 1.96037 | 0.00738288 | 0.00134692 | 1.59207* | 1.14805 | 0.00603690 | 0* | 1.96776 | 9.40608E-07 | 0.00738382 | 3.11581 | 3.11581 |
| C7 | | 0.906413* | 0.994968 | 0.00374711 | 0.000241736 | 0.307435* | 0.215133 | 0.00350549 | 0* | 0.998715 | 1.15379E-07 | 0.00374722 | 1.21385 | 1.21385 |
| C8 | | 0.443360* | 0.471354 | 0.00177515 | 3.64377E-05 | 0.0658789* | 0.0361092 | 0.00173872 | 0* | 0.473129 | 7.10239E-09 | 0.00177515 | 0.509238 | 0.509238 |
| C9 | | 0.237081* | 0.241026 | 0.000907718 | 5.68916E-06 | 0.0109798* | 0.00612717 | 0.000902030 | 0* | 0.241934 | 1.12833E-09 | 0.000907720 | 0.248061 | 0.248061 |
| C10 | | 0.120434* | 0.118813 | 0.000447457 | 9.05320E-07 | 0* | 0.00117376 | 0.000446551 | 0* | 0.119260 | 5.24442E-11 | 0.000447457 | 0.120434 | 0.120434 |
| C11 | | 0.370392* | 0.367738 | 0.00138492 | 8.45206E-07 | 0* | 0.00126895 | 0.00138408 | 0* | 0.369123 | 5.48493E-11 | 0.00138492 | 0.370392 | 0.370392 |
| C12 | | 0.226982* | 0.225840 | 0.000850527 | 1.71870E-07 | 0* | 0.000291309 | 0.000850355 | 0* | 0.226691 | 4.21991E-11 | 0.000850527 | 0.226982 | 0.226982 |
| C13 | | 0.149470* | 0.148833 | 0.000560512 | 3.72526E-08 | 0* | 7.65470E-05 | 0.000560475 | 0* | 0.149393 | 2.44340E-11 | 0.000560512 | 0.149470 | 0.149470 |
| 2,2-Dimethylpropane | | 0.0348426* | 0.0371954 | 0.000140080 | 9.52980E-05 | 0.164697* | 0.162204 | 4.51961E-05 | 0* | 0.0373355 | 4.13987E-07 | 0.000140494 | 0.199540 | 0.199540 |
| 2,2-Dimethylbutane | | 0.0434270* | 0.0648536 | 0.000244242 | 8.08294E-05 | 0.0988184* | 0.0771475 | 0.000163506 | 0* | 0.0650978 | 9.34238E-08 | 0.000244336 | 0.142245 | 0.142245 |
| Cyclopentane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| 2,3-Dimethylbutane | | 0.101751* | 0.157250 | 0.000592212 | 0.000157439 | 0.197637* | 0.141545 | 0.000435159 | 0* | 0.157842 | 3.85515E-07 | 0.000592597 | 0.299387 | 0.299387 |
| 2-Methylpentane | | 0.767547* | 0.987768 | 0.00371999 | 0.00091933 | 1.03210* | 0.808162 | 0.00281046 | 0* | 0.991488 | 1.40260E-06 | 0.00372139 | 1.79965 | 1.79965 |
| 3-Methylpentane | | 0.478960* | 0.608246 | 0.00229069 | 0.00051602 | 0.581931* | 0.450351 | 0.00177664 | 0* | 0.610537 | 1.94850E-06 | 0.00229264 | 1.06089 | 1.06089 |
| Methylcyclopentane | | 0.207541* | 0.212000 | 0.000798403 | 0.000152696 | 0.131758* | 0.126500 | 0.000646656 | 0* | 0.212798 | 9.50426E-07 | 0.000799353 | 0.339299 | 0.339299 |
| Cyclohexane | | 0.220670* | 0.253148 | 0.000953370 | 0.000141345 | 0.153718* | 0.120284 | 0.000814111 | 0* | 0.254101 | 2.08605E-06 | 0.000955456 | 0.374387 | 0.374387 |
| 2-Methylhexane | | 0.505975* | 0.531028 | 0.00199988 | 0.000184417 | 0.186657* | 0.159604 | 0.00181564 | 0* | 0.533028 | 1.73437E-07 | 0.00200006 | 0.692632 | 0.692632 |
| 3-Methylhexane | | 0.448662* | 0.497903 | 0.00187513 | 0.000156809 | 0.186657* | 0.135541 | 0.00171850 | 0* | 0.499778 | 1.77740E-07 | 0.00187531 | 0.635319 | 0.635319 |
| 2,2,4-Trimethylpentane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Methylcyclohexane | | 0.473910* | 0.517700 | 0.00194969 | 0.000126718 | 0.153718* | 0.107977 | 0.00182368 | 0* | 0.519649 | 7.14944E-07 | 0.00195040 | 0.627627 | 0.627627 |
| m-Xylene | | 0.0664029* | 0.0619681 | 0.000233376 | 4.36269E-06 | 0* | 0.00420048 | 0.000229965 | 0* | 0.0622015 | 9.51941E-07 | 0.000234328 | 0.0664029 | 0.0664029 |
| p-Xylene | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Water | | 0* | 0.0123159 | 4.63824E-05 | 0.00165999 | 0* | 1.19736 | 16.1953 | 17.4066* | 0.0123623 | 16.1969 | 16.1970 | 17.4066 | 17.4066 |
| Tetradecane | | 0.0999831* | 0.0995874 | 0.000375052 | 8.56528E-09 | 0* | 2.06376E-05 | 0.000375044 | 0* | 0.0999625 | 1.17233E-11 | 0.000375052 | 0.0999831 | 0.0999831 |
| Pentadecane | | 0.0631207* | 0.0628786 | 0.000236805 | 1.86755E-09 | 0* | 5.22390E-06 | 0.000236803 | 0* | 0.0631154 | 5.47529E-12 | 0.000236805 | 0.0631207 | 0.0631207 |
| Hexadecane | | 0.0335802* | 0.0334530 | 0.000125986 | 3.63301E-10 | 0* | 1.19194E-06 | 0.000125986 | 0* | 0.0335790 | 3.02378E-12 | 0.000125986 | 0.0335802 | 0.0335802 |
| Heptadecane | | 0.0191887* | 0.0191164 | 7.19934E-05 | 8.28767E-11 | 0* | 3.19383E-07 | 7.19933E-05 | 0* | 0.0191884 | 1.97367E-12 | 7.19934E-05 | 0.0191887 | 0.0191887 |
| Octadecane | | 0.0161589* | 0.0160981 | 6.06265E-05 | 2.75918E-11 | 0* | 1.22517E-07 | 6.06265E-05 | 0* | 0.0161588 | 1.68914E-12 | 6.06265E-05 | 0.0161589 | 0.0161589 |
| Nonadecane | | 0.00984682* | 0.00980985 | 3.69445E-05 | 5.98716E-12 | 0* | 3.13945E-08 | 3.69444E-05 | 0* | 0.00984679 | 1.07185E-12 | 3.69445E-05 | 0.00984682 | 0.00984682 |
| Eicosane | | 0.00454469* | 0.00452763 | 1.70513E-05 | 6.88685E-13 | 0* | 4.42954E-09 | 1.70513E-05 | 0* | 0.00454468 | 4.39594E-13 | 1.70513E-05 | 0.00454469 | 0.00454469 |
| Heneicosane | | 0.00252483* | 0.00251535 | 9.47296E-06 | 1.68887E-13 | 0* | 1.25973E-09 | 9.47296E-06 | 0* | 0.00252483 | 2.36614E-13 | 9.47296E-06 | 0.00252483 | 0.00252483 |
| Docosane | | 0.00151490* | 0.00150921 | 5.68378E-06 | 4.49980E-14 | 0* | 3.86546E-10 | 5.68378E-06 | 0* | 0.00151490 | 1.85272E-13 | 5.68378E-06 | 0.00151490 | 0.00151490 |
| Tricosane | | 0.000757448* | 0.000754606 | 2.84189E-06 | 6.42667E-15 | 0* | 6.67417E-11 | 2.84189E-06 | 0* | 0.000757448 | 1.24704E-13 | 2.84189E-06 | 0.000757448 | 0.000757448 |
| Tetracosane | | 0.000504965* | 0.000503071 | 1.89459E-06 | 1.47112E-15 | 0* | 1.81399E-11 | 1.89459E-06 | 0* | 0.000504965 | 8.42420E-14 | 1.89459E-06 | 0.000504965 | 0.000504965 |
| Pentacosane | | 0.000252483* | 0.000251535 | 9.47297E-07 | 2.88458E-16 | 0* | 4.13855E-12 | 9.47297E-07 | 0* | 0.000252483 | 5.53310E-14 | 9.47297E-07 | 0.000252483 | 0.000252483 |
| Hexacosane | | 0.000757448* | 0.000754606 | 2.84189E-06 | 2.82732E-16 | 0* | 4.86908E-12 | 2.84189E-06 | 0* | 0.000757448 | 2.09109E-13 | 2.84189E-06 | 0.000757448 | 0.000757448 |
| Heptacosane | | 0.000252483* | 0.000251535 | 9.47297E-07 | 2.39949E-17 | 0* | 5.04249E-13 | 9.47297E-07 | 0* | 0.000252483 | 8.60149E-14 | 9.47297E-07 | 0.000252483 | 0.000252483 |
| Octacosane | | 0.000252483* | 0.000251535 | 9.47297E-07 | 1.25281E-17 | 0* | 2.99565E-13 | 9.47297E-07 | 0* | 0.000252483 | 1.25878E-13 | 9.47297E-07 | 0.000252483 | 0.000252483 |
| Nonacosane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Triacontane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Hentriacontane | | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Other C10s | | 0.466335* | 0.458692 | 0.00172746 | 4.77400E-06 | 0* | 0.00591552 | 0.00172272 | 0* | 0.460420 | 3.20397E-08 | 0.00172749 | 0.466335 | 0.466335 |
| Other C7s | | 0.218902* | 0.314493 | 0.00118440 | 9.23617E-05 | 0.175677* | 0.0789016 | 0.00109227 | 0* | 0.315678 | 2.28727E-07 | 0.00118463 | 0.394580 | 0.394580 |
| Other C8s | | 1.05361* | 1.09159 | 0.00411099 | 0.000107499 | 0.142738* | 0.100646 | 0.00400393 | 0* | 1.09570 | 4.37848E-07 | 0.00411143 | 1.19635 | 1.19635 |
| Other C9s | | 0.533243* | 0.524340 | 0.00197469 | 1.67843E-05 | 0.0109798* | 0.0179086 | 0.00195801 | 0* | 0.526314 | 9.84277E-08 | 0.00197479 | 0.544223 | 0.544223 |

| Mass Fraction | % | % | % | % | % | % | % | % | % | % | % | % | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 2.00638* | 2.25025 | 2.25025 | 10.3556 | 56.0100* | 56.3349 | 0.000950361 | 0* | 2.25025 | 0.0399178 | 0.0950210 | 51.5109 | 51.5109 |
| C2 | 4.59908* | 4.61436 | 4.61436 | 14.2893 | 21.5210* | 21.6242 | 0.00460222 | 0* | 4.61436 | 0.0198361 | 0.134377 | 20.0628 | 20.0628 |
| C3 | 7.97645* | 7.64944 | 7.64944 | 19.7012 | 11.3821* | 11.4244 | 0.0182169 | 0* | 7.64944 | 0.00649675 | 0.197034 | 11.0027 | 11.0027 |
| IC4 | 2.31592* | 2.27761 | 2.27761 | 5.05719 | 1.49351* | 1.48933 | 0.0114673 | 0* | 2.27761 | 0.000540149 | 0.0573070 | 1.53341 | 1.53341 |
| nC4 | 8.77031* | 8.89076 | 8.89076 | 17.9863 | 4.10715* | 4.05878 | 0.0605837 | 0* | 8.89076 | 0.00183732 | 0.223437 | 4.38659 | 4.38659 |
| IC5 | 4.73123* | 4.44833 | 4.44833 | 6.38960 | 0.923611* | 0.918737 | 0.0535878 | 0* | 4.44833 | 0.000260045 | 0.111150 | 1.18141 | 1.18141 |
| nC5 | 8.31574* | 8.02879 | 8.02879 | 9.89221 | 1.29977* | 1.27127 | 0.111434 | 0* | 8.02879 | 0.000138004 | 0.200291 | 1.77970 | 1.77970 |
| N2 | 0.00778393* | 0.0121069 | 0.0121069 | 0.0691055 | 0.889360* | 0.894662 | 2.64636E-06 | 0* | 0.0121069 | 0.000337015 | 0.000630436 | 0.816220 | 0.816220 |
| CO2 | 0.0336289* | 0.0392639 | 0.0392639 | 0.593685 | 0.385151* | 0.386841 | 0.000752965 | 0* | 0.0392639 | 0.00529278 | 0.00613967 | 0.355615 | 0.355615 |
| Benzene | 0.0889885* | 0.105369 | 0.105369 | 0.0504911 | 0.00727234* | 0.00526922 | 0.00248417 | 0* | 0.105369 | 0.000300976 | 0.00292031 | 0.0129580 | 0.0129580 |
| Ethylbenzene | 0.386443* | 0.328722 | 0.328722 | 0.0184900 | 0* | 0.00205431 | 0.00815971 | 0* | 0.328722 | 6.00660E-05 | 0.00825356 | 0.0273076 | 0.0273076 |
| Toluene | 0.384030* | 0.377573 | 0.377573 | 0.0618401 | 0.00857824* | 0.00635061 | 0.00916650 | 0* | 0.377573 | 0.000238135 | 0.00964503 | 0.0350045 | 0.0350045 |
| o-Xylene | 0.706513* | 0.609664 | 0.609664 | 0.0265435 | 0* | 0.00301861 | 0.0152221 | 0* | 0.609664 | 0.000129341 | 0.0153249 | 0.0499249 | 0.0499249 |
| C6 | 7.22543* | 8.52165 | 8.52165 | 4.26620 | 0.581672* | 0.422148 | 0.175305 | 0* | 8.52165 | 2.77581E-05 | 0.212470 | 1.04405 | 1.04405 |
| C7 | 4.99774* | 5.02906 | 5.02906 | 0.890293 | 0.130605* | 0.0919822 | 0.118364 | 0* | 5.02906 | 3.95912E-06 | 0.125377 | 0.472943 | 0.472943 |
| C8 | 2.78678* | 2.71596 | 2.71596 | 0.152982 | 0.0319046* | 0.0176001 | 0.0669268 | 0* | 2.71596 | 2.77828E-07 | 0.0677086 | 0.226185 | 0.226185 |
| C9 | 1.67318* | 1.55934 | 1.55934 | 0.0268187 | 0.00597038* | 0.00335317 | 0.0389846 | 0* | 1.55934 | 4.95575E-08 | 0.0388741 | 0.123709 | 0.123709 |
| C10 | 0.942911* | 0.852736 | 0.852736 | 0.00473441 | 0* | 0.000712609 | 0.0214100 | 0* | 0.852736 | 2.55531E-09 | 0.0212585 | 0.0666297 | 0.0666297 |
| C11 | 3.18578* | 2.89949 | 2.89949 | 0.00485579 | 0* | 0.000846349 | 0.0729020 | 0* | 2.89949 | 2.93596E-09 | 0.0722838 | 0.225119 | 0.225119 |
| C12 | 2.12748* | 1.94047 | 1.94047 | 0.00107602 | 0* | 0.000211729 | 0.0488091 | 0* | 1.94047 | 2.46152E-09 | 0.0483755 | 0.150336 | 0.150336 |
| C13 | 1.51633* | 1.38411 | 1.38411 | 0.000252430 | 0* | 6.02171E-05 | 0.0348196 | 0* | 1.38411 | 1.54263E-09 | 0.0345055 | 0.107150 | 0.107150 |
| 2,2-Dimethylpropane | 0.138328* | 0.135369 | 0.135369 | 0.252713 | 0.0503788* | 0.0499358 | 0.00109882 | 0* | 0.135369 | 1.02285E-05 | 0.00338470 | 0.0559793 | 0.0559793 |
| 2,2-Dimethylbutane | 0.205928* | 0.281915 | 0.281915 | 0.256016 | 0.0361038* | 0.0283679 | 0.00474804 | 0* | 0.281915 | 2.75701E-06 | 0.00703078 | 0.0476640 | 0.0476640 |
| Cyclopentane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| 2,3-Dimethylbutane | 0.482493* | 0.683557 | 0.683557 | 0.498665 | 0.0722076* | 0.0520474 | 0.0126365 | 0* | 0.683557 | 1.13769E-05 | 0.0170520 | 0.100319 | 0.100319 |
| 2-Methylpentane | 3.63965* | 4.29378 | 4.29378 | 2.88526 | 0.377084* | 0.297169 | 0.0816127 | 0* | 4.29378 | 4.13918E-05 | 0.107083 | 0.603032 | 0.603032 |
| 3-Methylpentane | 2.27119* | 2.64402 | 2.64402 | 1.63437 | 0.212611* | 0.165598 | 0.0515916 | 0* | 2.64402 | 5.75017E-05 | 0.0659709 | 0.355486 | 0.355486 |
| Methylcyclopentane | 0.961121* | 0.899994 | 0.899994 | 0.472332 | 0.0470123* | 0.0454270 | 0.0183389 | 0* | 0.899994 | 2.73917E-05 | 0.0224634 | 0.111033 | 0.111033 |
| Cyclohexane | 1.02192* | 1.07468 | 1.07468 | 0.437218 | 0.0548477* | 0.0431949 | 0.0230879 | 0* | 1.07468 | 6.01209E-05 | 0.0268502 | 0.122516 | 0.122516 |
| 2-Methylhexane | 2.78983* | 2.68408 | 2.68408 | 0.679192 | 0.0792962* | 0.0682404 | 0.0613060 | 0* | 2.68408 | 5.95135E-06 | 0.0669194 | 0.269866 | 0.269866 |
| 3-Methylhexane | 2.47381* | 2.51665 | 2.51665 | 0.577512 | 0.0792962* | 0.0579518 | 0.0580260 | 0* | 2.51665 | 6.09901E-06 | 0.0627455 | 0.247535 | 0.247535 |
| 2,2,4-Trimethylpentane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Methylcyclohexane | 2.56046* | 2.56407 | 2.56407 | 0.457301 | 0.0639890* | 0.0452381 | 0.0603388 | 0* | 2.56407 | 2.40392E-05 | 0.0639451 | 0.239619 | 0.239619 |
| m-Xylene | 0.387918* | 0.331857 | 0.331857 | 0.0170236 | 0* | 0.00190284 | 0.00822697 | 0* | 0.331857 | 3.46090E-05 | 0.00830689 | 0.0274118 | 0.0274118 |
| p-Xylene | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Water | 0* | 0.0111920 | 0.0111920 | 1.09916 | 0* | 0.0920424 | 98.3167 | 100* | 0.0111920 | 99.9243 | 97.4335 | 1.21934 | 1.21934 |
| Tetradecane | 1.09147* | 0.996601 | 0.996601 | 6.24557E-05 | 0* | 1.74701E-05 | 0.0250723 | 0* | 0.996601 | 7.96460E-10 | 0.0248451 | 0.0771278 | 0.0771278 |
| Pentadecane | 0.737781* | 0.673735 | 0.673735 | 1.45804E-05 | 0* | 4.73479E-06 | 0.0169499 | 0* | 0.673735 | 3.98281E-10 | 0.0167961 | 0.0521344 | 0.0521344 |
| Hexadecane | 0.418418* | 0.382113 | 0.382113 | 3.02369E-06 | 0* | 1.15167E-06 | 0.00961332 | 0* | 0.382113 | 2.34479E-10 | 0.00952601 | 0.0295670 | 0.0295670 |
| Heptadecane | 0.253906* | 0.231880 | 0.231880 | 7.32495E-07 | 0* | 3.27710E-07 | 0.00583372 | 0* | 0.231880 | 1.62528E-10 | 0.00578073 | 0.0179420 | 0.0179420 |
| Octadecane | 0.226288* | 0.206659 | 0.206659 | 2.58091E-07 | 0* | 1.33044E-07 | 0.00519921 | 0* | 0.206659 | 1.47212E-10 | 0.00515198 | 0.0159904 | 0.0159904 |
| Nonadecane | 0.145494* | 0.132875 | 0.132875 | 5.90900E-08 | 0* | 3.59710E-08 | 0.00334291 | 0* | 0.132875 | 9.85623E-11 | 0.00331254 | 0.0102812 | 0.0102812 |
| Eicosane | 0.0706589* | 0.0645304 | 0.0645304 | 7.15199E-09 | 0* | 5.34038E-09 | 0.00162348 | 0* | 0.0645304 | 4.25344E-11 | 0.00160873 | 0.00499303 | 0.00499303 |
| Heneicosane | 0.0412037* | 0.0376299 | 0.0376299 | 1.84096E-09 | 0* | 1.59416E-09 | 0.000946708 | 0* | 0.0376299 | 2.40310E-11 | 0.000938107 | 0.00291161 | 0.00291161 |
| Docosane | 0.0258915* | 0.0236458 | 0.0236458 | 5.13702E-10 | 0* | 5.12301E-10 | 0.000594890 | 0* | 0.0236458 | 1.97065E-11 | 0.000589485 | 0.00182959 | 0.00182959 |
| Tricosane | 0.0135304* | 0.0123568 | 0.0123568 | 7.66807E-11 | 0* | 9.24493E-11 | 0.000310878 | 0* | 0.0123568 | 1.38632E-11 | 0.000308053 | 0.000956107 | 0.000956107 |
| Tetracosane | 0.00940999* | 0.00859383 | 0.00859383 | 1.83113E-11 | 0* | 2.62128E-11 | 0.000216207 | 0* | 0.00859383 | 9.76973E-12 | 0.000214242 | 0.000664946 | 0.000664946 |
| Pentacosane | 0.00489987* | 0.00447489 | 0.00447489 | 3.73920E-12 | 0* | 6.22804E-12 | 0.000112581 | 0* | 0.00447489 | 6.68263E-12 | 0.000111558 | 0.000346244 | 0.000346244 |
| Hexacosane | 0.0152842* | 0.0139586 | 0.0139586 | 3.81073E-12 | 0* | 7.61882E-12 | 0.000351175 | 0* | 0.0139586 | 2.62597E-11 | 0.000347985 | 0.00108004 | 0.00108004 |
| Heptacosane | 0.00528962* | 0.00483083 | 0.00483083 | 3.35780E-13 | 0* | 8.19195E-13 | 0.000121536 | 0* | 0.00483083 | 1.12148E-11 | 0.000120432 | 0.000373785 | 0.000373785 |
| Octacosane | 0.00548449* | 0.00500880 | 0.00500880 | 1.81775E-13 | 0* | 5.04599E-13 | 0.000126013 | 0* | 0.00500880 | 1.70169E-11 | 0.000124869 | 0.000387555 | 0.000387555 |
| Nonacosane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Triacontane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Hentriacontane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Other C10s | 3.64640* | 3.28789 | 3.28789 | 0.0249340 | 0* | 0.00358681 | 0.0824909 | 0* | 3.28789 | 1.55912E-06 | 0.0819680 | 0.257668 | 0.257668 |
| Other C7s | 1.20539* | 1.58751 | 1.58751 | 0.339712 | 0.0745334* | 0.0336908 | 0.0368324 | 0* | 1.58751 | 7.83826E-06 | 0.0395840 | 0.153535 | 0.153535 |
| Other C8s | 6.61395* | 6.28161 | 6.28161 | 0.450742 | 0.0690367* | 0.0489921 | 0.153919 | 0* | 6.28161 | 1.71053E-05 | 0.156616 | 0.530684 | 0.530684 |
| Other C9s | 3.75848* | 3.38789 | 3.38789 | 0.0790193 | 0.00596269* | 0.00978811 | 0.0845136 | 0* | 3.38789 | 4.31748E-06 | 0.0844637 | 0.271057 | 0.271057 |
| **Mass Flow** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** | **lb/h** |
| C1 | 36.4621* | 44.6097 | 0.168003 | 0.281748 | 13210.9* | 13202.5 | 0.00282027 | 0* | 44.7777 | 0.116565 | 0.284568 | 13247.4 | 13247.4 |
| C2 | 83.5793* | 91.4767 | 0.344506 | 0.388773 | 5076.10* | 5067.80 | 0.0136575 | 0* | 91.8212 | 0.0579240 | 0.402430 | 5159.68 | 5159.68 |
| C3 | 144.957* | 151.645 | 0.571104 | 0.536015 | 2684.68* | 2677.40 | 0.0540602 | 0* | 152.216 | 0.0189714 | 0.590075 | 2829.64 | 2829.64 |
| IC4 | 42.0875* | 45.1520 | 0.170045 | 0.137592 | 352.271* | 349.034 | 0.0340303 | 0* | 45.3221 | 0.00157731 | 0.171622 | 394.358 | 394.358 |
| nC4 | 159.384* | 176.253 | 0.663781 | 0.489359 | 968.744* | 951.205 | 0.179787 | 0* | 176.917 | 0.00536522 | 0.669146 | 1128.13 | 1128.13 |
| IC5 | 85.9810* | 88.1852 | 0.332111 | 0.173844 | 217.850* | 215.313 | 0.159026 | 0* | 88.5173 | 0.000759364 | 0.332870 | 303.831 | 303.831 |
| nC5 | 151.123* | 159.165 | 0.599426 | 0.269140 | 306.574* | 297.931 | 0.330689 | 0* | 159.765 | 0.000402989 | 0.599829 | 457.697 | 457.697 |
| N2 | 0.141458* | 0.240011 | 0.000909896 | 0.00188017 | 209.771* | 209.671 | 7.85329E-06 | 0* | 0.240915 | 0.000984128 | 0.00188802 | 209.913 | 209.913 |
| CO2 | 0.611140* | 0.778380 | 0.00293142 | 0.0161525 | 90.8447* | 90.6591 | 0.00223449 | 0* | 0.781311 | 0.0154556 | 0.0183870 | 91.4558 | 91.4558 |
| Benzene | 1.61719* | 2.08888 | 0.00786683 | 0.00137372 | 1.71531* | 1.23488 | 0.00737199 | 0* | 2.09674 | 0.000878889 | 0.00874572 | 3.33250 | 3.33250 |
| Ethylbenzene | 7.02286* | 6.51670 | 0.0245423 | 0.000503062 | 0* | 0.481443 | 0.0242146 | 0* | 6.54124 | 0.000175401 | 0.0247177 | 7.02286 | 7.02286 |
| Toluene | 6.97901* | 7.48513 | 0.0281895 | 0.00168250 | 2.02333* | 1.48831 | 0.0272023 | 0* | 7.51332 | 0.000695386 | 0.0288848 | 9.00233 | 9.00233 |
| o-Xylene | 12.8395* | 12.0862 | 0.0455173 | 0.000722176 | 0* | 0.707433 | 0.0451728 | 0* | 12.1317 | 0.000377692 | 0.0458950 | 12.8395 | 12.8395 |
| C6 | 131.308* | 168.936 | 0.636222 | 0.116072 | 137.198* | 98.9336 | 0.520232 | 0* | 169.572 | 8.10572E-05 | 0.636304 | 268.506 | 268.506 |
| C7 | 90.8243* | 99.6977 | 0.375467 | 0.0242224 | 30.8056* | 21.5567 | 0.351256 | 0* | 100.073 | 1.15612E-05 | 0.375479 | 121.630 | 121.630 |
| C8 | 50.6443* | 53.8421 | 0.202772 | 0.00416222 | 7.52525* | 4.12470 | 0.198611 | 0* | 54.0448 | 8.11295E-07 | 0.202773 | 58.1696 | 58.1696 |
| C9 | 30.4069* | 30.9128 | 0.116420 | 0.000729664 | 1.40822* | 0.785840 | 0.115690 | 0* | 31.0293 | 1.44714E-07 | 0.116420 | 31.8151 | 31.8151 |
| C10 | 17.1356* | 16.9049 | 0.0636649 | 0.000128810 | 0* | 0.167005 | 0.0635361 | 0* | 16.9686 | 7.46184E-09 | 0.0636649 | 17.1356 | 17.1356 |
| C11 | 57.8953* | 57.4805 | 0.216475 | 0.000132113 | 0* | 0.198348 | 0.216343 | 0* | 57.6970 | 8.57340E-09 | 0.216475 | 57.8953 | 57.8953 |
| C12 | 38.6629* | 38.4684 | 0.144874 | 2.92755E-05 | 0* | 0.0496201 | 0.144845 | 0* | 38.6133 | 7.18797E-09 | 0.144874 | 38.6629 | 38.6629 |
| C13 | 27.5564* | 27.4390 | 0.103337 | 6.86794E-06 | 0* | 0.0141123 | 0.103330 | 0* | 27.5423 | 4.50468E-09 | 0.103337 | 27.5564 | 27.5564 |
| 2,2-Dimethylpropane | 2.51385* | 2.68360 | 0.0101066 | 0.00687563 | 11.8827* | 11.7028 | 0.00326084 | 0* | 2.69371 | 2.98687E-05 | 0.0101365 | 14.3966 | 14.3966 |
| 2,2-Dimethylbutane | 3.74234* | 5.58878 | 0.0210477 | 0.00696551 | 8.51571* | 6.64822 | 0.0140902 | 0* | 5.60983 | 8.05083E-06 | 0.0210557 | 12.2581 | 12.2581 |
| Cyclopentane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| 2,3-Dimethylbutane | 8.76839* | 13.5511 | 0.0510341 | 0.0135673 | 17.0314* | 12.1977 | 0.0375000 | 0* | 13.6021 | 3.32219E-05 | 0.0510673 | 25.7998 | 25.7998 |
| 2-Methylpentane | 66.1437* | 85.1212 | 0.320571 | 0.0785000 | 88.9419* | 69.6436 | 0.242192 | 0* | 85.4418 | 0.000120869 | 0.320692 | 155.086 | 155.086 |
| 3-Methylpentane | 41.2745* | 52.4158 | 0.197401 | 0.0444666 | 50.1481* | 38.8092 | 0.153102 | 0* | 52.6132 | 0.000167912 | 0.197569 | 91.4226 | 91.4226 |
| Methylcyclopentane | 17.4665* | 17.8418 | 0.0671931 | 0.0128509 | 11.0887* | 10.6462 | 0.0544223 | 0* | 17.9090 | 7.99873E-05 | 0.0672731 | 28.5552 | 28.5552 |
| Cyclohexane | 18.5715* | 21.3048 | 0.0802351 | 0.0118955 | 12.9368* | 10.1230 | 0.0685152 | 0* | 21.3850 | 0.000175561 | 0.0804107 | 31.5082 | 31.5082 |
| 2-Methylhexane | 50.6997* | 53.2100 | 0.200392 | 0.0184790 | 18.7034* | 15.9926 | 0.181931 | 0* | 53.4104 | 1.73787E-05 | 0.200409 | 69.4031 | 69.4031 |
| 3-Methylhexane | 44.9568* | 49.8908 | 0.187892 | 0.0157125 | 18.7034* | 13.5814 | 0.172197 | 0* | 50.0787 | 1.78099E-05 | 0.187910 | 63.6602 | 63.6602 |
| 2,2,4-Trimethylpentane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Methylcyclohexane | 46.5313* | 50.8309 | 0.191432 | 0.0124419 | 15.0929* | 10.6019 | 0.179060 | 0* | 51.0223 | 7.01975E-05 | 0.191502 | 61.6243 | 61.6243 |
| m-Xylene | 7.04967* | 6.57885 | 0.0247763 | 0.000463165 | 0* | 0.445944 | 0.0244142 | 0* | 6.60362 | 0.000101063 | 0.0248774 | 7.04967 | 7.04967 |
| p-Xylene | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Water | 0* | 0.221874 | 0.000835592 | 0.0299052 | 0* | 21.5708 | 291.763 | 313.585* | 0.222710 | 291.792 | 291.793 | 313.585 | 313.585 |
| Tetradecane | 19.8355* | 19.7570 | 0.0744058 | 1.69925E-06 | 0* | 0.00409426 | 0.0744041 | 0* | 19.8314 | 2.32577E-09 | 0.0744058 | 19.8355 | 19.8355 |
| Pentadecane | 13.4077* | 13.3563 | 0.0503007 | 3.96694E-07 | 0* | 0.00110963 | 0.0503003 | 0* | 13.4066 | 1.16303E-09 | 0.0503007 | 13.4077 | 13.4077 |
| Hexadecane | 7.60394* | 7.57514 | 0.0285284 | 8.22663E-08 | 0* | 0.00269903 | 0.0285283 | 0* | 7.60367 | 6.84709E-10 | 0.0285284 | 7.60394 | 7.60394 |
| Heptadecane | 4.61426* | 4.59687 | 0.0173121 | 1.99292E-08 | 0* | 7.68013E-05 | 0.0173121 | 0* | 4.61418 | 4.74604E-10 | 0.0173121 | 4.61426 | 4.61426 |
| Octadecane | 4.11235* | 4.09689 | 0.0154291 | 7.02196E-09 | 0* | 3.11799E-05 | 0.0154291 | 0* | 4.11231 | 4.29878E-10 | 0.0154291 | 4.11235 | 4.11235 |
| Nonadecane | 2.64408* | 2.63415 | 0.00992036 | 1.60768E-09 | 0* | 8.43007E-06 | 0.00992036 | 0* | 2.64407 | 2.87815E-10 | 0.00992036 | 2.64408 | 2.64408 |
| Eicosane | 1.28409* | 1.27927 | 0.00481781 | 1.94586E-10 | 0* | 1.25156E-06 | 0.00481781 | 0* | 1.28409 | 1.24206E-10 | 0.00481781 | 1.28409 | 1.28409 |
| Heneicosane | 0.748798* | 0.745988 | 0.00280943 | 5.00874E-11 | 0* | 3.73602E-07 | 0.00280943 | 0* | 0.748798 | 7.01737E-11 | 0.00280943 | 0.748798 | 0.748798 |
| Docosane | 0.470528* | 0.468762 | 0.00176539 | 1.39764E-11 | 0* | 1.20061E-07 | 0.00176539 | 0* | 0.470527 | 5.75455E-11 | 0.00176539 | 0.470528 | 0.470528 |
| Tricosane | 0.245888* | 0.244966 | 0.000922555 | 2.08627E-12 | 0* | 2.16662E-08 | 0.000922555 | 0* | 0.245888 | 4.04824E-11 | 0.000922555 | 0.245888 | 0.245888 |
| Tetracosane | 0.171008* | 0.170367 | 0.000641611 | 4.98199E-13 | 0* | 6.14315E-09 | 0.000641611 | 0* | 0.171008 | 2.85289E-11 | 0.000641611 | 0.171008 | 0.171008 |
| Pentacosane | 0.0890457* | 0.0887116 | 0.000334093 | 1.01734E-13 | 0* | 1.45959E-09 | 0.000334093 | 0* | 0.0890457 | 1.95142E-11 | 0.000334093 | 0.0890457 | 0.0890457 |
| Hexacosane | 0.277761* | 0.276719 | 0.00104214 | 1.03680E-13 | 0* | 1.78553E-09 | 0.00104214 | 0* | 0.277761 | 7.66818E-11 | 0.00104214 | 0.277761 | 0.277761 |
| Heptacosane | 0.0961286* | 0.0957679 | 0.000360668 | 9.13565E-15 | 0* | 1.91984E-10 | 0.000360668 | 0* | 0.0961286 | 3.27488E-11 | 0.000360668 | 0.0961286 | 0.0961286 |
| Octacosane | 0.0996701* | 0.0992961 | 0.000373955 | 4.94561E-15 | 0* | 1.18256E-10 | 0.000373955 | 0* | 0.0996701 | 4.96917E-11 | 0.000373955 | 0.0996701 | 0.0996701 |
| Nonacosane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Triacontane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Hentriacontane | 0* | 0 | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Other C10s | 66.2663* | 65.1802 | 0.245472 | 0.000678386 | 0* | 0.840595 | 0.244799 | 0* | 65.4257 | 4.55284E-06 | 0.245477 | 66.2663 | 66.2663 |
| Other C7s | 21.9056* | 31.4714 | 0.118523 | 0.00924263 | 17.5800* | 7.89569 | 0.109303 | 0* | 31.5899 | 2.28888E-05 | 0.118546 | 39.4856 | 39.4856 |
| Other C8s | 120.196* | 124.529 | 0.468982 | 0.0122635 | 16.2835* | 11.4817 | 0.456769 | 0* | 124.998 | 4.99497E-05 | 0.469032 | 136.479 | 136.479 |
| Other C9s | 68.3031* | 67.1627 | 0.252939 | 0.00214990 | 1.40641* | 2.29391 | 0.250801 | 0* | 67.4156 | 1.26076E-05 | 0.252951 | 69.7095 | 69.7095 |

| Process Streams | | Condensate | Condensate to Pipeline | Condensate To Tank | Flash | Gas | Gas To Pipeline | Produced Liquid | Water | 1 | 2 | 3 | 4 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Properties** | **Status:** | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved | Solved |
| Phase: Total | **From Block:** | -- | SPLT-100 | SPLT-100 | Storage Vessel | -- | VSSL-100 | Storage Vessel | -- | VSSL-100 | VSSL-100 | MIX-101 | MIX-100 | VLVE-102 |
| | **To Block:** | MIX-100 | -- | MIX-101 | -- | MIX-100 | -- | -- | MIX-100 | SPLT-100 | MIX-101 | Storage Vessel | VLVE-102 | VSSL-100 |
| **Property** | **Units** | | | | | | | | | | | | | |
| Temperature | °F | 100* | 71.0000 | 71.0000 | 70.4698 | 100* | 71.0000 | 70.4698 | 100* | 71.0000 | 71.0000 | 71.0000 | 99.0686 | 58.2102 |
| Pressure | psig | 1000* | 364 | 364 | -1.35077E-13 | 1000* | 364 | -1.35077E-13 | 1000* | 364 | 364 | 364 | 1000 | 366 |
| Molecular Weight | lb/lbmol | 71.9790 | 71.0021 | 71.0021 | 41.1627 | 21.4819 | 21.3751 | 18.2664 | 18.0153 | 71.0021 | 18.0176 | 18.3592 | 22.5467 | 22.5467 |
| Mass Density | lb/ft^3 | 39.2290 | 39.6459 | 39.6459 | 0.107886 | 4.60899 | 1.58334 | 61.8244 | 62.0089 | 39.6459 | 62.2466 | 61.3744 | 5.02811 | 1.81030 |
| Mass Flow | lb/h | 1817.31 | 1982.43 | 7.46596 | 2.72073 | 23586.8 | 23435.7 | 296.758 | 313.585 | 1989.90 | 292.013 | 299.479 | 25717.6 | 25717.6 |
| Std Vapor Volumetric Flow | MMSCFD | 0.229947 | 0.254292 | 0.000957677 | 0.000601985 | 10* | 9.98562 | 0.147964 | 0.158533 | 0.255249 | 0.147608 | 0.148566 | 10.3885 | 10.3885 |
| Std Liquid Volumetric Flow | sgpm | 5.83333* | 6.39027 | 0.0240661 | 0.0110120 | 135.493 | 134.954 | 0.597620 | 0.626880* | 6.41434 | 0.584566 | 0.608632 | 141.953 | 141.953 |
| Gross Ideal Gas Heating Value | Btu/ft^3 | 3971.83 | 3920.32 | 3920.32 | 2311.01 | 1286.51 | 1279.66 | 66.8950 | 50.3101 | 3920.32 | 51.0461 | 75.9881 | 1327.08 | 1327.08 |
| Gross Liquid Heating Value | Btu/lb | 20763.4 | 20776.8 | 20776.8 | 21149.3 | 22659.4 | 22651.2 | 344.670 | 0 | 20776.8 | 16.1176 | 533.677 | 22249.2 | 22249.2 |

# Environments Report

| | | | |
|---|---|---|---|
| **Client Name:** | G70-D Permit | **Job:** | N:\West Virginia\Tug Hill\Projects\Determination\Wengerd\ProMax\TugHill_Shields_WellPad Rev 1.pmx |
| **Location:** | 0 | | |
| **Flowsheet:** | Flowsheet1 | | |

## Project-Wide Constants

| | | | |
|---|---|---|---|
| Atmospheric Pressure | 14.6959 psia | Ideal Gas Reference Volume | 379.484 ft^3/lbmol |
| Ideal Gas Reference Pressure | 14.6959 psia | Liquid Reference Temperature | 60 °F |
| Ideal Gas Reference Temperature | 60 °F | | |

## Environment1

### Environment Settings

| | | | |
|---|---|---|---|
| Number of Poynting Intervals | 0 | Phase Tolerance | 1 % |
| Gibbs Excess Model Evaluation Temperature | 77 °F | Emulsion Enabled | FALSE |
| Freeze Out Temperature Threshold Difference | 10 °F | | |

### Components

| Component | Henry's Law Comp. | Phase Initiator | Component | Henry's Law Comp. | Phase Initiator |
|---|---|---|---|---|---|
| C1 | FALSE | FALSE | C2 | FALSE | FALSE |
| C3 | FALSE | FALSE | iC4 | FALSE | FALSE |
| nC4 | FALSE | FALSE | iC5 | FALSE | FALSE |
| nC5 | FALSE | FALSE | N2 | FALSE | FALSE |
| CO2 | FALSE | FALSE | Benzene | FALSE | FALSE |
| Ethylbenzene | FALSE | FALSE | Toluene | FALSE | FALSE |
| o-Xylene | FALSE | FALSE | C6 | FALSE | FALSE |
| C7 | FALSE | FALSE | C8 | FALSE | FALSE |
| C9 | FALSE | FALSE | C10 | FALSE | FALSE |
| C11 | FALSE | FALSE | C12 | FALSE | FALSE |
| C13 | FALSE | FALSE | 2,2-Dimethylpropane | FALSE | FALSE |
| 2,2-Dimethylbutane | FALSE | FALSE | Cyclopentane | FALSE | FALSE |
| 2,3-Dimethylbutane | FALSE | FALSE | 2-Methylpentane | FALSE | FALSE |
| 3-Methylpentane | FALSE | FALSE | Methylcyclopentane | FALSE | FALSE |
| Cyclohexane | FALSE | FALSE | 2-Methylhexane | FALSE | FALSE |
| 3-Methylhexane | FALSE | FALSE | 2,2,4-Trimethylpentane | FALSE | FALSE |
| Methylcyclohexane | FALSE | FALSE | m-Xylene | FALSE | FALSE |
| p-Xylene | FALSE | FALSE | Water | FALSE | TRUE |
| Tetradecane | FALSE | FALSE | Pentadecane | FALSE | FALSE |
| Hexadecane | FALSE | FALSE | Heptadecane | FALSE | FALSE |
| Octadecane | FALSE | FALSE | Nonadecane | FALSE | FALSE |
| Eicosane | FALSE | FALSE | Heneicosane | FALSE | FALSE |
| Docosane | FALSE | FALSE | Tricosane | FALSE | FALSE |
| Tetracosane | FALSE | FALSE | Pentacosane | FALSE | FALSE |
| Hexacosane | FALSE | FALSE | Heptacosane | FALSE | FALSE |
| Octacosane | FALSE | FALSE | Nonacosane | FALSE | FALSE |
| Triacontane | FALSE | FALSE | Hentriacontane | FALSE | FALSE |
| Other C10s | FALSE | FALSE | Other C7s | FALSE | FALSE |
| Other C8s | FALSE | FALSE | Other C9s | FALSE | FALSE |

### Physical Property Method Sets

| | | | |
|---|---|---|---|
| Liquid Molar Volume | COSTALD | Vapor Package | Peng-Robinson |
| Overall Package | Peng-Robinson | Light Liquid Package | Peng-Robinson |
| Stability Calculation | Peng-Robinson | Heavy Liquid Package | Peng-Robinson |

**Notes:**

# Calculators Report

| | | | |
|---|---|---|---|
| **Client Name:** | G70-D Permit | **Job:** | N:\W |
| **Location:** | 0 | | |
| **Flowsheet:** | Flowsheet1 | | |

## Simple Solver 1

### Source Code

Residual Error (for CV1) = ProducedWater-20.

### Calculated Variable [CV1]

| | |
|---|---|
| SourceMoniker | ProMax:ProMax!Project!Flowsheets!Flowsheet1!PStreams!Water!Phases!Total!Properties!Std Liquid Volumetric Flow |
| Value | 21.4930 |
| Units | bbl/d |

### Measured Variable [ProducedWater]

| | |
|---|---|
| SourceMoniker | ProMax:ProMax!Project!Flowsheets!Flowsheet1!PStreams!Produced Liquid!Phases!Heavy Liquid!Properties!Std Liquid Volumetric Flow |
| Value | 20.0000 |
| Units | bbl/d |

### Solver Properties

Status: **Solved**

| | | | | |
|---|---|---|---|---|
| Error | -2.14517E-08 | | Iterations | 3 |
| Calculated Value | 0.626880 | sgpm | Max Iterations | 20 |
| Lower Bound | | sgpm | Weighting | 1 |
| Upper Bound | | sgpm | Priority | 0 |
| Step Size | | sgpm | Solver Active | Active |
| Is Minimizer | FALSE | | Group | |
| Algorithm | Default | | Skip Dependency Check | FALSE |

**Notes:**

## Simple Solver 2

### Source Code

Residual Error (for CV1) = ProducedCondensate-.49

### Calculated Variable [CV1]

| | |
|---|---|
| SourceMoniker | ProMax:ProMax!Project!Flowsheets!Flowsheet1!Blocks!SPLT-100!Properties!Fraction to PStream Condensate To Tank |
| Value | 0.375193 |
| Units | % |

### Measured Variable [ProducedCondensate]

| | |
|---|---|
| SourceMoniker | ProMax:ProMax!Project!Flowsheets!Flowsheet1!PStreams!Produced Liquid!Phases!Light Liquid!Properties!Std Liquid Volumetric Flow |
| Value | 0.489821 |
| Units | bbl/d |

### Solver Properties

Status: **Solved**

| | | | | |
|---|---|---|---|---|
| Error | -0.000179165 | | Algorithm | Default |
| Calculated Value | 0.375193 | % | Iterations | 1 |
| Lower Bound | | % | Max Iterations | 20 |
| Upper Bound | | % | Weighting | 1 |
| Step Size | | % | Solver Active | Active |
| Is Minimizer | FALSE | | Skip Dependency Check | TRUE |

**Notes:**

## Simple Solver 3

### Source Code

Residual Error (for CV1) = GPUTemp-71

### Calculated Variable [CV1]

| | |
|---|---|
| SourceMoniker | ProMax:ProMax!Project!Flowsheets!Flowsheet1!QStreams!Q-1!Energy Rate |
| Value | 0.244388 |
| Units | MMBtu/h |

| Measured Variable [GPUTemp] | |
|---|---|
| SourceMoniker | ProMax:ProMax!Project!Flowsheets!Flowsheet1!PStreams!Gas To Pipeline!Phases!Total!Properties!Temperature |
| Value | 71.0000 |
| Units | °F |

**Solver Properties**

Status: **Solved**

| | | | | |
|---|---|---|---|---|
| Error | 1.61936E-08 | | Iterations | 3 |
| Calculated Value | 244388 | Btu/h | Max Iterations | 20 |
| Lower Bound | | Btu/h | Weighting | 1 |
| Upper Bound | | Btu/h | Priority | 0 |
| Step Size | | Btu/h | Solver Active | Active |
| Is Minimizer | FALSE | | Group | |
| Algorithm | Default | | Skip Dependency Check | FALSE |

**Notes:**

# User Value Sets Report

| | | | |
|---|---|---|---|
| **Client Name:** | G70-D Permit | **Job:** | N:\West Virginia\ |
| **Location:** | 0 | | |
| **Flowsheet:** | Flowsheet1 | | |

## Tank-1

### User Value [BlockReady]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 1* | | Upper Bour | | |
| Lower Bound | | | Enforce Bou | FALSE | |

### User Value [ShellLength]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 20* | ft | Upper Bour | | ft |
| Lower Bound | 0* | ft | Enforce Bou | FALSE | |

### User Value [ShellDiam]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 12* | ft | Upper Bour | | ft |
| Lower Bound | 0* | ft | Enforce Bou | FALSE | |

### User Value [BreatherVP]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.0300000* | psig | Upper Bour | | psig |
| Lower Bound | | psig | Enforce Bou | FALSE | |

### User Value [BreatherVacP]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | -0.0300000* | psig | Upper Bour | | psig |
| Lower Bound | | psig | Enforce Bou | FALSE | |

### User Value [DomeRadius]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.17* | ft | Upper Bour | | ft |
| Lower Bound | | ft | Enforce Bou | FALSE | |

### User Value [OpPress]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 0* | psig | Upper Bour | | psig |
| Lower Bound | | psig | Enforce Bou | FALSE | |

### User Value [AvgPercentLiq]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 50* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

### User Value [MaxPercentLiq]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 90* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

### User Value [AnnNetTP]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 20.4770* | bbl/day | Upper Bour | | bbl/day |
| Lower Bound | 0* | bbl/day | Enforce Bou | FALSE | |

### User Value [OREff]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 0* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

### User Value [MaxAvgT]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 61.15* | °F | Upper Bour | | °F |
| Lower Bound | | °F | Enforce Bou | FALSE | |

### User Value [MinAvgT]

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 36.9667* | °F | Upper Bour | | °F |
| Lower Bound | | °F | Enforce Bou | FALSE | |

| User Value [BulkLiqT] | | | | | |
|---|---|---|---|---|---|
| Parameter | 52.1383* | °F | Upper Bour | | °F |
| Lower Bound | | °F | Enforce Bou | FALSE | |

| User Value [AvgP] | | | | | |
|---|---|---|---|---|---|
| Parameter | 13.7315* | psia | Upper Bour | | psia |
| Lower Bound | | psia | Enforce Bou | FALSE | |

| User Value [Therml] | | | | | |
|---|---|---|---|---|---|
| Parameter | 1193.89* | Btu/ft^2/day | Upper Bour | | Btu/ft^2/day |
| Lower Bound | | Btu/ft^2/day | Enforce Bou | FALSE | |

| User Value [AvgWindSpeed] | | | | | |
|---|---|---|---|---|---|
| Parameter | 6.16667* | mi/h | Upper Bour | | mi/h |
| Lower Bound | | mi/h | Enforce Bou | FALSE | |

| User Value [MaxHourlyLoadingRate] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.853208* | bbl/hr | Upper Bour | | bbl/hr |
| Lower Bound | 0* | bbl/hr | Enforce Bou | FALSE | |

| User Value [EntrainedOilFrac] | | | | | |
|---|---|---|---|---|---|
| Parameter | 1* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

| User Value [TurnoverRate] | | | | | |
|---|---|---|---|---|---|
| Parameter | 10.3057* | | Upper Bour | | |
| Lower Bound | | | Enforce Bou | FALSE | |

| User Value [LLossSatFactor] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.5* | | Upper Bour | | |
| Lower Bound | | | Enforce Bou | FALSE | |

| User Value [AtmPressure] | | | | | |
|---|---|---|---|---|---|
| Parameter | 13.7315* | psia | Upper Bour | | psia |
| Lower Bound | | psia | Enforce Bou | FALSE | |

| User Value [TVP] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.271762* | psia | Upper Bour | | psia |
| Lower Bound | | psia | Enforce Bou | FALSE | |

| User Value [MaxVP] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.375822* | psia | Upper Bour | | psia |
| Lower Bound | | psia | Enforce Bou | FALSE | |

| User Value [MinVP] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.195166* | psia | Upper Bour | | psia |
| Lower Bound | | psia | Enforce Bou | FALSE | |

| User Value [AvgLiqSurfaceT] | | | | | |
|---|---|---|---|---|---|
| Parameter | 57.1967* | °F | Upper Bour | | °F |
| Lower Bound | | °F | Enforce Bou | FALSE | |

| User Value [MaxLiqSurfaceT] | | | | | |
|---|---|---|---|---|---|
| Parameter | 67.2326* | °F | Upper Bour | | °F |
| Lower Bound | | °F | Enforce Bou | FALSE | |

| User Value [TotalLosses] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.00919140* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |

| User Value [WorkingLosses] | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.00151550* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [StandingLosses]** | | | | | |
| Parameter | 0.00308020* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [RimSealLosses]** | | | | | |
| Parameter | 0* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [WithdrawalLoss]** | | | | | |
| Parameter | 0* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [LoadingLosses]** | | | | | |
| Parameter | 0.00204589* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [MaxHourlyLoadingLoss]** | | | | | |
| Parameter | 0.000467098* | lb/hr | Upper Bour | | lb/hr |
| Lower Bound | | lb/hr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [PStar]** | | | | | |
| Parameter | | | Upper Bour | | |
| Lower Bound | | | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [AllCTotalLosses]** | | | | | |
| Parameter | 0.0496437* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [AllCLoadingLosses]** | | | | | |
| Parameter | 0.0110501* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [AllCMaxHLoadingLoss]** | | | | | |
| Parameter | 0.00252285* | lb/hr | Upper Bour | | lb/hr |
| Lower Bound | | lb/hr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [AllCFlashingLosses]** | | | | | |
| Parameter | 11.8996* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [DeckFittingLosses]** | | | | | |
| Parameter | 0* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [DeckSeamLosses]** | | | | | |
| Parameter | 0* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [FlashingLosses]** | | | | | |
| Parameter | 8.75553* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [TotalResidual]** | | | | | |
| Parameter | 1299.77* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |
| | | | | | |
| **User Value [GasMoleWeight]** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 0.0214926* | kg/mol | Upper Bour | | kg/mol |
| Lower Bound | | kg/mol | Enforce Bou | FALSE | |

**User Value [VapReportableFrac]**

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 18.5147* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

**User Value [LiqReportableFrac]**

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 1.67811* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

**User Value [FlashReportableFrac]**

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 73.5785* | % | Upper Bour | | % |
| Lower Bound | | % | Enforce Bou | FALSE | |

**Notes:**
This User Value Set was programmatically generated. GUID={1EDE36BA-2D5D-4876-9370-5B5F79CCFF0E}

**Sum Component Flow/Frac**

**User Value [CompSum]**

| | | | | | |
|---|---|---|---|---|---|
| Parameter | 8.76993* | ton/yr | Upper Bour | | ton/yr |
| Lower Bound | | ton/yr | Enforce Bou | FALSE | |

**Notes:**
This User Value Set was programmatically generated. GUID={06B303CE-D6A3-4C69-ABCE-29F0C05F34E0}

November 15, 2016

**FESCO, Ltd.**
**1100 Fesco Ave. - Alice, Texas 78332**

**For:** SLR International Corporation
8 Capitol Street, Suite 300
Charleston, West Virginia 25301

**Sample:** Tug Hill - Shields No. 9 & No. 10
GPU Sales Line
Spot Gas Sample @ 366 psig & 71 °F

Date Sampled: 11/01/16 Job Number: 63606.021

**CHROMATOGRAPH EXTENDED ANALYSIS - GPA 2286**

| COMPONENT | MOL% | GPM |
|---|---|---|
| Nitrogen | 0.682 | |
| Carbon Dioxide | 0.188 | |
| Methane | 75.001 | |
| Ethane | 15.375 | 4.104 |
| Propane | 5.545 | 1.525 |
| Isobutane | 0.552 | 0.180 |
| n-Butane | 1.518 | 0.478 |
| 2-2 Dimethylpropane | 0.015 | 0.006 |
| Isopentane | 0.275 | 0.100 |
| n-Pentane | 0.387 | 0.140 |
| Hexanes | 0.319 | 0.131 |
| Heptanes Plus | 0.143 | 0.061 |
| Totals | 100.000 | 6.725 |

**Computed Real Characteristics Of Heptanes Plus:**

| | | |
|---|---|---|
| Specific Gravity | 3.411 | (Air=1) |
| Molecular Weight | 98.43 | |
| Gross Heating Value | 5207 | BTU/CF |

**Computed Real Characteristics Of Total Sample:**

| | | |
|---|---|---|
| Specific Gravity | 0.744 | (Air=1) |
| Compressibility (Z) | 0.9962 | |
| Molecular Weight | 21.48 | |
| Gross Heating Value | | |
| Dry Basis | 1287 | BTU/CF |
| Saturated Basis | 1266 | BTU/CF |

Base Conditions: 14.650 PSI & 60 Deg F

Sampled By: (SLR) N. Lanham
Analyst: MR
Processor: OA
Cylinder ID: T-4675

Certified: FESCO, Ltd. - Alice, Texas

David Dannhaus 361-661-7015

**CHROMATOGRAPH EXTENDED ANALYSIS - GPA 2286**
**TOTAL REPORT**

| COMPONENT | MOL % | GPM | WT % |
|---|---|---|---|
| Nitrogen | 0.682 | | 0.889 |
| Carbon Dioxide | 0.188 | | 0.385 |
| Methane | 75.001 | | 56.011 |
| Ethane | 15.375 | 4.104 | 21.522 |
| Propane | 5.545 | 1.525 | 11.382 |
| Isobutane | 0.552 | 0.180 | 1.494 |
| n-Butane | 1.518 | 0.478 | 4.107 |
| 2,2 Dimethylpropane | 0.015 | 0.006 | 0.050 |
| Isopentane | 0.275 | 0.100 | 0.924 |
| n-Pentane | 0.387 | 0.140 | 1.300 |
| 2,2 Dimethylbutane | 0.009 | 0.004 | 0.036 |
| Cyclopentane | 0.000 | 0.000 | 0.000 |
| 2,3 Dimethylbutane | 0.018 | 0.007 | 0.072 |
| 2 Methylpentane | 0.094 | 0.039 | 0.377 |
| 3 Methylpentane | 0.053 | 0.022 | 0.213 |
| n-Hexane | 0.145 | 0.060 | 0.582 |
| Methylcyclopentane | 0.012 | 0.004 | 0.047 |
| Benzene | 0.002 | 0.001 | 0.007 |
| Cyclohexane | 0.014 | 0.005 | 0.055 |
| 2-Methylhexane | 0.017 | 0.008 | 0.079 |
| 3-Methylhexane | 0.017 | 0.008 | 0.079 |
| 2,2,4 Trimethylpentane | 0.000 | 0.000 | 0.000 |
| Other C7's | 0.016 | 0.007 | 0.074 |
| n-Heptane | 0.028 | 0.013 | 0.131 |
| Methylcyclohexane | 0.014 | 0.006 | 0.064 |
| Toluene | 0.002 | 0.001 | 0.009 |
| Other C8's | 0.013 | 0.006 | 0.067 |
| n-Octane | 0.006 | 0.003 | 0.032 |
| Ethylbenzene | 0.000 | 0.000 | 0.000 |
| M & P Xylenes | 0.000 | 0.000 | 0.000 |
| O-Xylene | 0.000 | 0.000 | 0.000 |
| Other C9's | 0.001 | 0.001 | 0.006 |
| n-Nonane | 0.001 | 0.001 | 0.006 |
| Other C10's | 0.000 | 0.000 | 0.000 |
| n-Decane | 0.000 | 0.000 | 0.000 |
| Undecanes (11) | 0.000 | 0.000 | 0.000 |
| Totals | 100.000 | 6.725 | 100.000 |

| Computed Real Characteristics of Total Sample | | |
|---|---|---|
| Specific Gravity | 0.744 | (Air=1) |
| Compressibility (Z) | 0.9962 | |
| Molecular Weight | 21.48 | |
| Gross Heating Value | | |
| Dry Basis | 1287 | BTU/CF |
| Saturated Basis | 1266 | BTU/CF |

November 15, 2016

**FESCO, Ltd.**
**1100 Fesco Ave. - Alice, Texas 78332**

**Sample:** Tug Hill - Shields No. 9 & No. 10
GPU Sales Line
Spot Gas Sample @ 366 psig & 71 °F

Date Sampled: 11/01/16 Job Number: 63606.021

**GLYCALC FORMAT**

| COMPONENT | MOL% | GPM | Wt % |
|---|---|---|---|
| Carbon Dioxide | 0.188 | | 0.385 |
| Hydrogen Sulfide | ---- | | ---- |
| Nitrogen | 0.682 | | 0.889 |
| Methane | 75.001 | | 56.011 |
| Ethane | 15.375 | 4.104 | 21.522 |
| Propane | 5.545 | 1.525 | 11.382 |
| Isobutane | 0.552 | 0.180 | 1.494 |
| n-Butane | 1.533 | 0.483 | 4.157 |
| Isopentane | 0.275 | 0.100 | 0.924 |
| n-Pentane | 0.387 | 0.140 | 1.300 |
| Cyclopentane | 0.000 | 0.000 | 0.000 |
| n-Hexane | 0.145 | 0.060 | 0.582 |
| Cyclohexane | 0.014 | 0.005 | 0.055 |
| Other C6's | 0.174 | 0.072 | 0.698 |
| Heptanes | 0.090 | 0.040 | 0.410 |
| Methylcyclohexane | 0.014 | 0.006 | 0.064 |
| 2,2,4 Trimethylpentane | 0.000 | 0.000 | 0.000 |
| Benzene | 0.002 | 0.001 | 0.007 |
| Toluene | 0.002 | 0.001 | 0.009 |
| Ethylbenzene | 0.000 | 0.000 | 0.000 |
| Xylenes | 0.000 | 0.000 | 0.000 |
| Octanes Plus | 0.021 | 0.010 | 0.111 |
| Totals | 100.000 | 6.725 | 100.000 |

**Real Characteristics Of Octanes Plus:**

| | | |
|---|---|---|
| Specific Gravity | 3.916 | (Air=1) |
| Molecular Weight | 112.99 | |
| Gross Heating Value | 5791 | BTU/CF |

**Real Characteristics Of Total Sample:**

| | | |
|---|---|---|
| Specific Gravity | 0.744 | (Air=1) |
| Compressibility (Z) | 0.9962 | |
| Molecular Weight | 21.48 | |
| Gross Heating Value | | |
| Dry Basis | 1287 | BTU/CF |
| Saturated Basis | 1266 | BTU/CF |

November 16, 2016

**FESCO, Ltd.**
**1100 FESCO Avenue - Alice, Texas 78332**

**For:** SLR International Corporation
8 Capitol Street, Suite 300
Charleston, West Virginia 25301

**Sample:** Tug Hill - Shields No. 9 & No. 10
Condensate Separator Hydrocarbon Liquid
Sampled @ 366 psig & 71 °F

Date Sampled: 11/01/16 Job Number: 63606.002

**CHROMATOGRAPH EXTENDED ANALYSIS - GPA 2186-M**

| COMPONENT | MOL % | LIQ VOL % | WT % |
|---|---|---|---|
| Nitrogen | 0.020 | 0.006 | 0.008 |
| Carbon Dioxide | 0.055 | 0.026 | 0.034 |
| Methane | 9.002 | 4.177 | 2.022 |
| Ethane | 11.009 | 8.062 | 4.635 |
| Propane | 13.020 | 9.822 | 8.038 |
| Isobutane | 2.868 | 2.570 | 2.334 |
| n-Butane | 10.861 | 9.376 | 8.839 |
| 2,2 Dimethylpropane | 0.138 | 0.145 | 0.140 |
| Isopentane | 4.720 | 4.727 | 4.768 |
| n-Pentane | 8.296 | 8.235 | 8.381 |
| 2,2 Dimethylbutane | 0.172 | 0.197 | 0.208 |
| Cyclopentane | 0.000 | 0.000 | 0.000 |
| 2,3 Dimethylbutane | 0.403 | 0.452 | 0.486 |
| 2 Methylpentane | 3.040 | 3.455 | 3.668 |
| 3 Methylpentane | 1.897 | 2.121 | 2.289 |
| n-Hexane | 6.035 | 6.795 | 7.281 |
| Heptanes Plus | 28.464 | 39.833 | 46.869 |
| Totals: | 100.000 | 100.000 | 100.000 |

**Characteristics of Heptanes Plus:**

| | | |
|---|---|---|
| Specific Gravity | 0.7292 | (Water=1) |
| °API Gravity | 62.54 | @ 60°F |
| Molecular Weight | 117.6 | |
| Vapor Volume | 19.68 | CF/Gal |
| Weight | 6.08 | Lbs/Gal |

**Characteristics of Total Sample:**

| | | |
|---|---|---|
| Specific Gravity | 0.6197 | (Water=1) |
| °API Gravity | 96.82 | @ 60°F |
| Molecular Weight | 71.4 | |
| Vapor Volume | 27.54 | CF/Gal |
| Weight | 5.16 | Lbs/Gal |

Base Conditions: 14.850 PSI & 60 °F

Certified: FESCO, Ltd. - Alice, Texas

Sampled By: SLR
Analyst: XG
Processor: XGdjv
Cylinder ID: PW-35024

David Dannhaus 361-661-7015

**TOTAL EXTENDED REPORT - GPA 2186-M**

| COMPONENT | Mol % | LiqVol % | Wt % |
|---|---|---|---|
| Nitrogen | 0.020 | 0.006 | 0.008 |
| Carbon Dioxide | 0.055 | 0.026 | 0.034 |
| Methane | 9.002 | 4.177 | 2.022 |
| Ethane | 11.009 | 8.062 | 4.635 |
| Propane | 13.020 | 9.822 | 8.038 |
| Isobutane | 2.868 | 2.570 | 2.334 |
| n-Butane | 10.861 | 9.376 | 8.839 |
| 2,2 Dimethylpropane | 0.138 | 0.145 | 0.140 |
| Isopentane | 4.720 | 4.727 | 4.768 |
| n-Pentane | 8.296 | 8.235 | 8.381 |
| 2,2 Dimethylbutane | 0.172 | 0.197 | 0.208 |
| Cyclopentane | 0.000 | 0.000 | 0.000 |
| 2,3 Dimethylbutane | 0.403 | 0.452 | 0.486 |
| 2 Methylpentane | 3.040 | 3.455 | 3.668 |
| 3 Methylpentane | 1.897 | 2.121 | 2.289 |
| n-Hexane | 6.035 | 6.795 | 7.281 |
| Methylcyclopentane | 0.822 | 0.797 | 0.969 |
| Benzene | 0.082 | 0.063 | 0.090 |
| Cyclohexane | 0.874 | 0.815 | 1.030 |
| 2-Methylhexane | 2.004 | 2.551 | 2.812 |
| 3-Methylhexane | 1.777 | 2.234 | 2.494 |
| 2,2,4 Trimethylpentane | 0.000 | 0.000 | 0.000 |
| Other C-7's | 0.867 | 1.093 | 1.204 |
| n-Heptane | 3.590 | 4.535 | 5.036 |
| Methylcyclohexane | 1.877 | 2.066 | 2.581 |
| Toluene | 0.300 | 0.275 | 0.387 |
| Other C-8's | 4.173 | 5.664 | 6.440 |
| n-Octane | 1.756 | 2.463 | 2.808 |
| E-Benzene | 0.262 | 0.277 | 0.390 |
| M & P Xylenes | 0.263 | 0.280 | 0.392 |
| O-Xylene | 0.479 | 0.499 | 0.712 |
| Other C-9's | 2.112 | 3.202 | 3.733 |
| n-Nonane | 0.939 | 1.447 | 1.687 |
| Other C-10's | 1.847 | 3.076 | 3.653 |
| n-decane | 0.477 | 0.802 | 0.950 |
| Undecanes(11) | 1.467 | 2.507 | 3.019 |
| Dodecanes(12) | 0.899 | 1.660 | 2.027 |
| Tridecanes(13) | 0.592 | 1.171 | 1.450 |
| Tetradecanes(14) | 0.396 | 0.840 | 1.055 |
| Pentadecanes(15) | 0.250 | 0.567 | 0.720 |
| Hexadecanes(16) | 0.133 | 0.323 | 0.413 |
| Heptadecanes(17) | 0.076 | 0.196 | 0.253 |
| Octadecanes(18) | 0.064 | 0.173 | 0.226 |
| Nonadecanes(19) | 0.039 | 0.111 | 0.145 |
| Eicosanes(20) | 0.018 | 0.054 | 0.071 |
| Heneicosanes(21) | 0.010 | 0.031 | 0.041 |
| Docosanes(22) | 0.006 | 0.019 | 0.025 |
| Tricosanes(23) | 0.003 | 0.009 | 0.013 |
| Tetracosanes(24) | 0.002 | 0.007 | 0.009 |
| Pentacosanes(25) | 0.001 | 0.005 | 0.007 |
| Hexacosanes(26) | 0.003 | 0.013 | 0.017 |
| Heptacosanes(27) | 0.001 | 0.003 | 0.004 |
| Octacosanes(28) | 0.001 | 0.002 | 0.003 |
| Nonacosanes(29) | 0.000 | 0.001 | 0.002 |
| Triacontanes(30) | 0.000 | 0.001 | 0.001 |
| Hentriacontanes Plus(31+) | 0.000 | 0.002 | 0.003 |
| Total | 100.000 | 100.000 | 100.000 |

November 16, 2016

**FESCO, Ltd.**
**1100 Fesco Avenue - Alice, Texas 78332**

**For:** SLR International Corporation
8 Capitol Street, Suite 300
Charleston, West Virginia 25301

**Date Sampled:** 11/01/16

**Date Analyzed:** 11/11/16

**Job Number:** J63606

**Sample:** Tug Hill - Shields No. 9 & No. 10

| FLASH LIBERATION OF SEPARATOR WATER | | |
|---|---|---|
| | **Separator** | **Stock Tank** |
| Pressure, psig | 366 | 0 |
| Temperature, °F | 71 | 70 |
| Gas Water Ratio (1) | ------ | 1.45 |
| Gas Specific Gravity (2) | ------ | 0.742 |

(1) - Scf of water saturated vapor per barrel of stock tank water
(2) - Air = 1.000
(3) - Separator volume / Stock tank volume
Analyst: T.G.

Piston No. : PW-31464

**Base Conditions: 14.65 PSI & 60 °F**

Certified: FESCO, Ltd. - Alice, Texas

David Dannhaus 361-661-7015

November 14, 2016

**FESCO, Ltd.**
**1100 Fesco Ave. - Alice, Texas 78332**

**For:** SLR International Corporation
8 Capitol Street, Suite 300
Charleston, West Virginia 25301

**Sample:** Tug Hill - Shields No. 9 & No. 10
Gas Liberated From Separator Water
From 366 psig & 71 °F to 0 psig & 70 °F

Date Sampled: 11/01/16 Job Number: 63606.011

**CHROMATOGRAPH EXTENDED ANALYSIS - GPA 2286**

| COMPONENT | MOL% | GPM |
|---|---|---|
| Hydrogen Sulfide* | < 0.001 | |
| Nitrogen | 0.874 | |
| Carbon Dioxide | 2.675 | |
| Methane | 75.496 | |
| Ethane | 15.043 | 4.015 |
| Propane | 3.544 | 0.974 |
| Isobutane | 0.215 | 0.070 |
| n-Butane | 0.756 | 0.238 |
| 2-2 Dimethylpropane | 0.000 | 0.000 |
| Isopentane | 0.190 | 0.069 |
| n-Pentane | 0.234 | 0.085 |
| Hexanes | 0.396 | 0.163 |
| Heptanes Plus | 0.577 | 0.242 |
| Totals | 100.000 | 5.856 |

**Computed Real Characteristics Of Heptanes Plus:**

| | | |
|---|---|---|
| Specific Gravity | 3.447 | (Air=1) |
| Molecular Weight | 99.47 | |
| Gross Heating Value | 5174 | BTU/CF |

**Computed Real Characteristics Of Total Sample:**

| | | |
|---|---|---|
| Specific Gravity | 0.742 | (Air=1) |
| Compressibility (Z) | 0.9964 | |
| Molecular Weight | 21.41 | |
| Gross Heating Value | | |
| Dry Basis | 1216 | BTU/CF |
| Saturated Basis | 1196 | BTU/CF |

*Hydrogen Sulfide tested in laboratory by: Stain Tube Method (GPA 2377)
Results: <0.013 Gr/100 CF, <0.2 PPMV or <0.001 Mol %

Base Conditions: 14.650 PSI & 60 Deg F

Sampled By: (16)T. Gonzalez
Analyst: MR
Processor: OA
Cylinder ID: WF# 1S

Certified: FESCO, Ltd. - Alice, Texas

David Dannhaus 361-661-7015

**CHROMATOGRAPH EXTENDED ANALYSIS - GPA 2286**
**TOTAL REPORT**

| COMPONENT | MOL % | GPM | WT % |
|---|---|---|---|
| Hydrogen Sulfide* | < 0.001 | | < 0.001 |
| Nitrogen | 0.874 | | 1.144 |
| Carbon Dioxide | 2.675 | | 5.500 |
| Methane | 75.496 | | 56.581 |
| Ethane | 15.043 | 4.015 | 21.132 |
| Propane | 3.544 | 0.974 | 7.301 |
| Isobutane | 0.215 | 0.070 | 0.584 |
| n-Butane | 0.756 | 0.238 | 2.053 |
| 2,2 Dimethylpropane | 0.000 | 0.000 | 0.000 |
| Isopentane | 0.190 | 0.069 | 0.640 |
| n-Pentane | 0.234 | 0.085 | 0.789 |
| 2,2 Dimethylbutane | 0.009 | 0.004 | 0.036 |
| Cyclopentane | 0.000 | 0.000 | 0.000 |
| 2,3 Dimethylbutane | 0.031 | 0.013 | 0.125 |
| 2 Methylpentane | 0.104 | 0.043 | 0.419 |
| 3 Methylpentane | 0.068 | 0.028 | 0.274 |
| n-Hexane | 0.184 | 0.076 | 0.741 |
| Methylcyclopentane | 0.032 | 0.011 | 0.126 |
| Benzene | 0.047 | 0.013 | 0.172 |
| Cyclohexane | 0.047 | 0.016 | 0.185 |
| 2-Methylhexane | 0.038 | 0.018 | 0.178 |
| 3-Methylhexane | 0.041 | 0.019 | 0.192 |
| 2,2,4 Trimethylpentane | 0.000 | 0.000 | 0.000 |
| Other C7's | 0.043 | 0.019 | 0.199 |
| n-Heptane | 0.081 | 0.037 | 0.379 |
| Methylcyclohexane | 0.058 | 0.023 | 0.266 |
| Toluene | 0.041 | 0.014 | 0.176 |
| Other C8's | 0.062 | 0.029 | 0.319 |
| n-Octane | 0.034 | 0.017 | 0.181 |
| Ethylbenzene | 0.000 | 0.000 | 0.000 |
| M & P Xylenes | 0.011 | 0.004 | 0.055 |
| O-Xylene | 0.000 | 0.000 | 0.000 |
| Other C9's | 0.026 | 0.013 | 0.153 |
| n-Nonane | 0.010 | 0.006 | 0.060 |
| Other C10's | 0.000 | 0.000 | 0.000 |
| n-Decane | 0.006 | 0.004 | 0.040 |
| Undecanes (11) | 0.000 | 0.000 | 0.000 |
| Totals | 100.000 | 5.856 | 100.000 |

**Computed Real Characteristics Of Total Sample:**

| | | |
|---|---|---|
| Specific Gravity | 0.742 | (Air=1) |
| Compressibility (Z) | 0.9964 | |
| Molecular Weight | 21.41 | |
| Gross Heating Value | | |
| Dry Basis | 1216 | BTU/CF |
| Saturated Basis | 1196 | BTU/CF |

USA COMPRESSION

## USA Compression Unit 1550 Caterpillar G3508TALE Engine Emissions

| | | | | | |
|---|---|---|---|---|---|
| Date of Manufacture | October 31, 2005 | Engine Serial Number | 9TG00469 | Date Modified/Reconstructed | Not Any |
| Driver Rated HP | 630 | Rated Speed in RPM | 1400 | Combustion Type | Spark Ignited 4 Stroke |
| Number of Cylinders | 8 | Compression Ratio | 8:1 | Combustion Setting | Lean Burn |
| Total Displacement, in[3] | 2105 | Fuel Delivery Method | Carburetor | Combustion Air Treatment | T.C./Aftercooled |

**Raw Engine Emissions (customer supplied Fuel Gas with little to no H2S)**

*Fuel Consumption* *7854 LHV BTU/bhp-hr or 8658 HHV BTU/bhp-hr*
*Altitude* *1200 ft*
*Maximum Air Inlet Temp* *90 F*

| | g/bhp-hr [1] | lb/MMBTU [2] | lb/hr | TPY |
|---|---|---|---|---|
| Nitrogen Oxides (NOx) | 2.0 | | 2.78 | 12.17 |
| Carbon Monoxide (CO) | 2.16 | | 3.00 | 13.14 |
| Volatile Organic Compounds (VOC or NMNEHC) | 0.45 | | 0.63 | 2.74 |
| Formaldehyde (CH2O) | 0.29 | | 0.40 | 1.76 |
| Particulate Matter (PM) Filterable+Condensable | | 9.99E-03 | 5.45E-02 | 2.39E-01 |
| Sulfur Dioxide (SO2) | | 5.88E-04 | 3.21E-03 | 1.40E-02 |

| | g/bhp-hr [1] | lb/hr | Metric Tonne/yr |
|---|---|---|---|
| Carbon Dioxide (CO2) | 556 | 772 | 3068 |
| Methane (CH4) | 1.34 | 1.86 | 7.39 |

[1] g/bhp-hr are based on Caterpillar Specifications (GERP) customer supplied fuel gas, 1200 ft elevation, and 90 F Max Air Inlet Temperature.
Note that g/bhp-hr values are Nominal and are not representative of Not-To-Exceed Values and are based on 100% Load Operation.
It is recommended to add a safety margin to the above emissions for Air Permitting to allow for operational flexibility and variations in fuel gas composition.
[2] Emission Factor obtained from EPA's AP-42, Fifth Edition, Volume I, Chapter 3: Stationary Internal Combution Sources (Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2).

**Catalytic Converter Emissions**

*Catalytic Converter Make and Model:* *Miratech IQ-26*
*Element Type:* *Oxidation*
*Number of Elements in Housing:* *1*
*Air/Fuel Ratio Control* *Caterpillar Oxygen Feedback*

| | % Reduction | g/hbp-hr | lb/hr | TPY |
|---|---|---|---|---|
| Nitrogen Oxides (NOx) | 0 | 2 | **2.78** | **12.17** |
| Carbon Monoxide (CO) | 93 | 0.15 | **0.21** | **0.92** |
| Volatile Organic Compounds (VOC or NMNEHC) | 50 | 0.23 | **0.31** | **1.37** |
| Formaldehyde (CH2O) | 76 | 0.07 | **0.10** | **0.42** |
| Particulate Matter (PM) | 0 | 0.039222026 | **5.45E-02** | **2.39E-01** |
| Sulfur Dioxide (SO2) | 0 | 0.002309234 | **3.21E-03** | **1.40E-02** |

| | % Reduction | lb/hr | Metric Tonne/yr |
|---|---|---|---|
| Carbon Dioxide (CO2) | 0 | **772** | **3068** |
| Methane (CH4) | 0 | **1.86** | **7.39** |

# G3508

**NON-CURRENT**

GAS COMPRESSION APPLICATION

## GAS ENGINE SITE SPECIFIC TECHNICAL DATA

## Tug Hill "WENGARD" U1550

| | | | |
|---|---|---|---|
| ENGINE SPEED (rpm): | 1400 | RATING STRATEGY: | STANDARD |
| COMPRESSION RATIO: | 8 | RATING LEVEL: | CONTINUOUS |
| AFTERCOOLER TYPE: | SCAC | FUEL SYSTEM: | HPG IMPCO |
| AFTERCOOLER WATER INLET (°F): | 130 | | WITH AIR FUEL RATIO CONTROL |
| JACKET WATER OUTLET (°F): | 210 | **SITE CONDITIONS:** | |
| ASPIRATION: | TA | FUEL: | TUG HILL WENGARD 11-6-17 |
| COOLING SYSTEM: | JW+OC, AC | FUEL PRESSURE RANGE(psig): (See note 1) | 35.0-40.0 |
| CONTROL SYSTEM: | EIS | FUEL METHANE NUMBER: | 57.7 |
| EXHAUST MANIFOLD: | ASWC | FUEL LHV (Btu/scf): | 1139 |
| COMBUSTION: | LOW EMISSION | ALTITUDE(ft): | 1200 |
| NOx EMISSION LEVEL (g/bhp-hr NOx): | 2.0 | MAXIMUM INLET AIR TEMPERATURE(°F): | 90 |
| SET POINT TIMING: | 25 | STANDARD RATED POWER: | 630 bhp@1400rpm |

| | | | | MAXIMUM RATING | SITE RATING AT MAXIMUM INLET AIR TEMPERATURE | | |
|---|---|---|---|---|---|---|---|
| **RATING** | | **NOTES** | **LOAD** | **100%** | **100%** | **75%** | **51%** |
| ENGINE POWER | (WITHOUT FAN) | (2) | bhp | 630 | 623 | 467 | 315 |
| INLET AIR TEMPERATURE | | | °F | 83 | 90 | 90 | 90 |
| **ENGINE DATA** | | | | | | | |
| FUEL CONSUMPTION (LHV) | | (3) | Btu/bhp-hr | 7854 | 7872 | 8296 | 9234 |
| FUEL CONSUMPTION (HHV) | | (3) | Btu/bhp-hr | 8658 | 8678 | 9145 | 10179 |
| AIR FLOW (@inlet air temp, 14.7 psia) | (WET) | (4)(5) | ft3/min | 1327 | 1331 | 1042 | 746 |
| AIR FLOW | (WET) | (4)(5) | lb/hr | 5819 | 5761 | 4510 | 3229 |
| FUEL FLOW (60ºF, 14.7 psia) | | | scfm | 72 | 72 | 57 | 43 |
| INLET MANIFOLD PRESSURE | | (6) | in Hg(abs) | 64.0 | 63.3 | 50.1 | 37.4 |
| EXHAUST TEMPERATURE - ENGINE OUTLET | | (7) | °F | 867 | 866 | 859 | 846 |
| EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia) | (WET) | (8)(5) | ft3/min | 3506 | 3470 | 2704 | 1922 |
| EXHAUST GAS MASS FLOW | (WET) | (8)(5) | lb/hr | 6056 | 5995 | 4695 | 3368 |
| **EMISSIONS DATA - ENGINE OUT** | | | | | | | |
| NOx (as NO2) | | (9)(10) | g/bhp-hr | 2.00 | 2.00 | 2.00 | 2.00 |
| CO | | (9)(10) | g/bhp-hr | 2.16 | 2.16 | 2.27 | 2.26 |
| THC (mol. wt. of 15.84) | | (9)(10) | g/bhp-hr | 2.29 | 2.29 | 2.41 | 2.54 |
| NMHC (mol. wt. of 15.84) | | (9)(10) | g/bhp-hr | 0.95 | 0.95 | 1.00 | 1.05 |
| NMNEHC (VOCs) (mol. wt. of 15.84) | | (9)(10)(11) | g/bhp-hr | 0.45 | 0.45 | 0.47 | 0.50 |
| HCHO (Formaldehyde) | | (9)(10) | g/bhp-hr | 0.29 | 0.29 | 0.29 | 0.32 |
| CO2 | | (9)(10) | g/bhp-hr | 556 | 557 | 585 | 650 |
| EXHAUST OXYGEN | | (9)(12) | % DRY | 7.3 | 7.3 | 7.2 | 6.7 |
| **HEAT REJECTION** | | | | | | | |
| HEAT REJ. TO JACKET WATER (JW) | | (13) | Btu/min | 22837 | 22746 | 19808 | 17436 |
| HEAT REJ. TO ATMOSPHERE | | (13) | Btu/min | 3188 | 3163 | 2638 | 2126 |
| HEAT REJ. TO LUBE OIL (OC) | | (13) | Btu/min | 3611 | 3597 | 3132 | 2757 |
| HEAT REJ. TO AFTERCOOLER (AC) | | (13)(14) | Btu/min | 4598 | 4598 | 2508 | 899 |
| **COOLING SYSTEM SIZING CRITERIA** | | | | | | | |
| TOTAL JACKET WATER CIRCUIT (JW+OC) | | (14) | Btu/min | 29454 | | | |
| TOTAL AFTERCOOLER CIRCUIT (AC) | | (14)(15) | Btu/min | 4828 | | | |
| A cooling system safety factor of 0% has been added to the cooling system sizing criteria. | | | | | | | |

**CONDITIONS AND DEFINITIONS**

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site inlet air temperature. 100% rating at maximum inlet air temperature is the maximum engine capability for the specified fuel at site altitude and maximum site inlet air temperature. Maximum rating is the maximum capability at the specified aftercooler inlet temperature for the specified fuel at site altitude and reduced inlet air temperature. Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

*****WARNINGS ISSUED FOR THIS RATING CONSULT PAGE 3*****

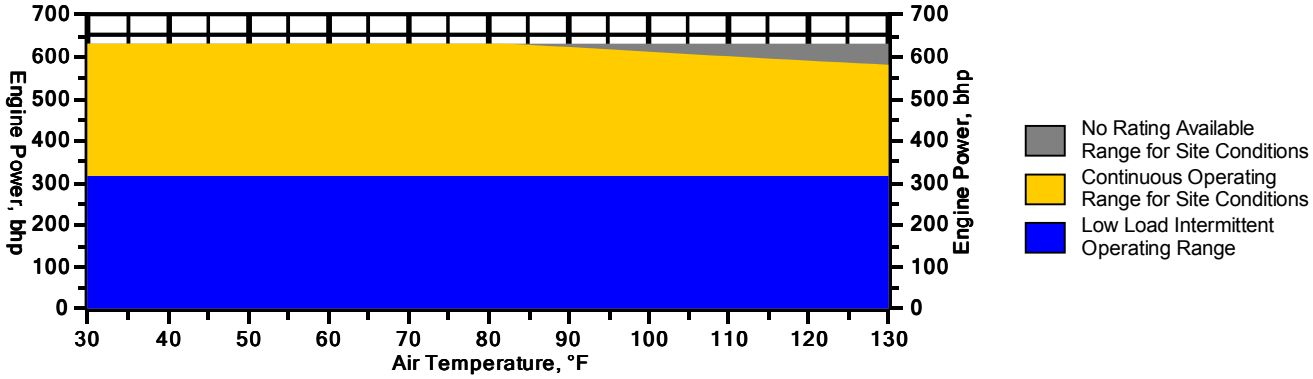
PREPARED BY: Chris Magee, USAC

Data generated by Gas Engine Rating Pro Version 6.06.00

Ref. Data Set DM5888-04-001, 9TG, Printed 06Nov2017

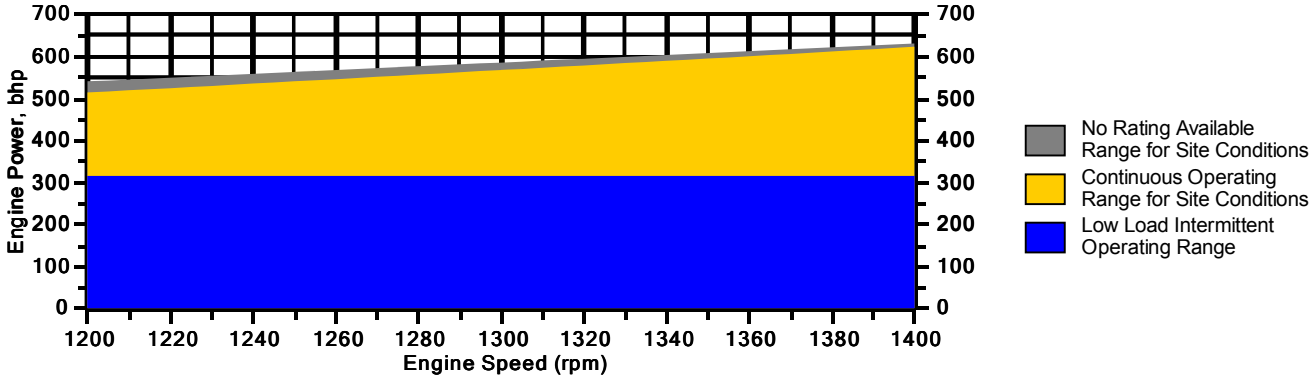
## Engine Power vs. Inlet Air Temperature

Data represents temperature sweep at 1200 ft and 1400 rpm



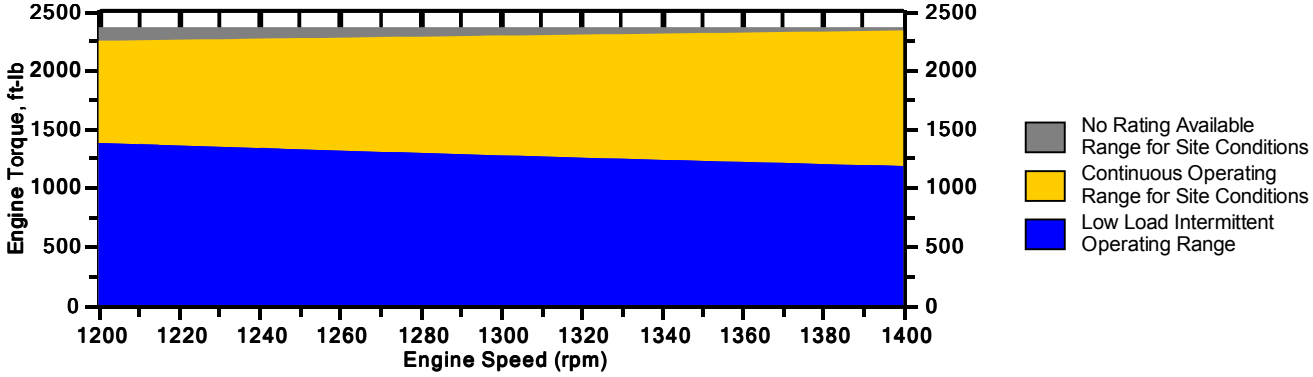

## Engine Power vs. Engine Speed

Data represents speed sweep at 1200 ft and 90 ºF




## Engine Torque vs. Engine Speed

Data represents speed sweep at 1200 ft and 90 ºF




Note: At site conditions of 1200 ft and 90°F inlet air temp., constant torque can be maintained down to 1400 rpm. The minimum speed for loading at these conditions is 1200 rpm.

## NOTES

1. Fuel pressure range specified is to the engine fuel pressure regulator. Additional fuel train components should be considered in pressure and flow calculations.

2. Engine rating is with two engine driven water pumps. Tolerance is ± 3% of full load.

3. Fuel consumption tolerance is ± 3.0% of full load data.

4. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.

5. Inlet and Exhaust Restrictions must not exceed A&I limits based on full load flow rates from the standard technical data sheet.

6. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.

7. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.

8. Exhaust flow value is on a "wet" basis. Flow is a nominal value with a tolerance of ± 6 %.

9. Emissions data is at engine exhaust flange prior to any after treatment.

10. NOx tolerance's are ± +111 %, -96% of specified value. All other emission values listed are higher than nominal levels to allow for instrumentation, measurement, and engine-to-engine variations. They indicate the maximum values expected under steady state conditions. Fuel methane number cannot vary more than ± 3. THC, NMHC, and NMNEHC do not include aldehydes, adjusted to the specified NOx level at 100% load.

11. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ

12. Exhaust Oxygen level is the result of adjusting the engine to operate at the specified NOx level. Tolerance is ± 0.5.

13. Heat rejection values are nominal. Tolerances, based on treated water, are ± 10% for jacket water circuit, ± 50% for radiation, ± 20% for lube oil circuit, and ± 5% for aftercooler circuit.

14. Aftercooler heat rejection includes an aftercooler heat rejection factor for the site elevation and inlet air temperature specified. Aftercooler heat rejection values at part load are for reference only. Do not use part load data for heat exchanger sizing.

15. Cooling system sizing criteria are maximum circuit heat rejection for the site, with applied tolerances.

WARNING(S):
1. The lower heating value of the fuel is higher than or equal to 1050 Btu/scf and lower than 1400 Btu/scf. The lower heating value of the fuel is higher than the known capabilities of the air fuel ratio control system. To achieve part load NOx emissions, manual adjustment of the air fuel ratio control settings may be required. May require on-site adjustment or tuning of the fuel system and up to two 7E-1569 valve washers to lean out part load operating points.

RECOMMENDED ACTION
For additional information please contact your Caterpillar engine dealer.

August 24, 2017

**FESCO, Ltd.**
**104 Fesco Run Rd Bridgeport, WV 26330**

**For:** Tug Hill Operating, LLC
1320 S. University Drive, Suite 500
Fort Worth, Texas 76107

**Sample:** Wengerd Pad
Meter Run Gas @ 352 psig & 68 °F

**Field:** Marshall West

**Station:** GSC-051
**Date Sampled:** 7/28/2017 at 10:15 hours

**CHROMATOGRAPH ANALYSIS - GPA 2261**

| COMPONENT | MOL% | GPM |
|---|---|---|
| Nitrogen | 0.469 | |
| Carbon Dioxide | 0.228 | |
| Methane | 77.539 | |
| Ethane | 14.450 | 3.877 |
| Propane | 4.723 | 1.306 |
| Isobutane | 0.523 | 0.172 |
| n-Butane | 1.191 | 0.376 |
| Isopentane | 0.267 | 0.098 |
| n-Pentane | 0.279 | 0.101 |
| Hexanes Plus | 0.331 | 0.145 |
| **Totals:** | **100.000** | **6.075** |

**Computed Real Properties:**

| | |
|---|---|
| Specific Gravity | 0.720 (Air=1.000) |
| Compressibility(Z) | 0.9964 |
| Gross Heating Value at 14.730 psia and 60 °F | |
| Dry Basis | 1260 BTU/CF |
| Saturated Basis | 1238 BTU/CF |

Base Conditions: 14.730 psia and 60 °F

Certified: FESCO, Ltd. - Bridgeport, WV

Jeff Fluharty 304-592-3366

**Job Number:** 01966.037
**Analyst ID:** AC

**Cyl Number:** T-2484