SLURRY HYDROCRACKER PROJECT

Appendix G – Safety & Risk Assessment

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G.1 SUMMARY

This appendix shows the process hazard analyses (PHA). A What-if analysis, Dow's fire and explosion indexes (FEI), and Dow's chemical exposure indexes (CEI), and Material Safety Data Sheets along with the methodologies and assumptions used are discussed.

G.2 WHAT-IF ANALYSIS

The PHA What if analysis was performed using the process PFD and risk matrix. The risk matrix will be limited to the consequence categories of damage to the asset, health, and safety/ environmental risk evaluations, and the probability of an event occurring. After the possible causes are evaluated and the possible consequences are ranked based on the level of severity and likelihood then engineering safeguards action are determined to bring the risk to an acceptable level according to the risk matrix.

Table G1. Risk Matrix.

REPUTATION/ SOCIETAL	LEGAL/ FINANCIAL	ENVIRONMENTAL & PUBLIC HEALTH	HEALTH & SAFETY
	$100M <-- Cost	Multiple fatalities	Multiple fatalities
Recurring national attention/punitive action by government/long term impact on market share and share price	Material (corporate) long-term liability $30M <-Cost< $100M	Catastrophic impact Permanent disability / fatality	Permanent disability / fatality
National news / public outrage / short term drop in market share and share price	Significant long-term liability enforcement action $3M <- Cost < $30M	Significant adverse impact	Temporary disability/ lost time
Provincial news/ adverse impact to reputation at provincial level	Permit violation or administrative penalties $300K <- Cost < $3M	Minor environmental impact	Medical aid injury or illness/ restricted work/ nuisance to public
Community concern/ local media attention/ no impact to reputation	Uncontained release below legal limit $30K <- Cost < $300K	Small uncontained release with minor impacts	First aid/ minor illness possible cumulative impact onsite
Individual concern/ local media attention/ no impact to reputation	Cost < $30K	Release onsite - contained immediately	incident - no treatment
REPUTATION/ SOCIETAL	LEGAL/ FINANCIAL	ENVIRONMENTAL & PUBLIC HEALTH	HEALTH & SAFETY

CONSEQUENCE

LIKELIHOOD INCREASING

M(6)	M-H	H	H	H	H
M(5)	M	M-H	H	H	H
L(4)	M	M	M-H	H	H
L(3)	L	M	M	M-H	H
L(2)	L	L	M	M	M-H
L(1)	L(2)	L(3)	L(4)	M(5)	M(6)

LIKELIHOOD INCREASING

EVALUATION DESCRIPTOR	Expected never to happen	Not during the lifetime of the project	Could happen once in the project lifetime	Could happen once in ten years	Could happen as much as once per year	Could happen many times per year
PROBABILITY	p < 1/10,000 years	1/1000 yr <- p < 1/10,000 years	1/100 yr <- p < 1/1000 years	1/10 year <- p < 1/100 years	1/year <- p < 1/10 years	p -> 1/year

Risk Acceptance Level	
Risk Ranking	**Risk Acceptance Level**
High	Not acceptable: Management MUST take steps to reduce or control the risks to a tolerable or acceptable level, or terminate the project or activity entirely.
Medium High	Highly Conditional: If this level of risk is accepted, management MUST be involved to ensure the risk is kept under control. Management's responsibilities come to the front line as they are assuming the responsibility for tolerating this level of risk. preference is to implement additional safeguards to reduce the risk.
Medium	Acceptable to tolerable: May consider additional management involvement or design additions. Develop and establish risk management programs specific to these concerns to sustain performance/ does not deteriorate over a period of time.
Low	Acceptable: No further management involvement or design additions. Employees are aware of the risks and follow established procedures. Develop and establish risk management programs that generally cover these concerns to sustain performance such that performance does not deteriorate over a period of time.

Table G2: What If Analysis

ITEM	GUIDE WORD	SITUATION		BEFORE SAFEGUARDS				AFTER SAFEGUARDS			AFTER RECOMMENDATIONS		
		CAUSE (What if/ What happened?)	CONSEQUENCE (What is the result?)	CONSEQUENCE CATEGORY	CONSEQUENCE (Severity)	LIKELIHOOD	RISK RANK	MITIGATING MEASURES (Safeguards in Place and Safeguard Category)	MITIGATED LIKELIHOOD	RESIDUAL RISK RANK	RECOMMENDATIONS (Additional safeguards or actions required to be implemented to reduce Residual Risk Rank to acceptable level)	POST RECOMMENDATION LIKELIHOOD	RISK RANK AFTER RECOMMENDATIONS
1	**High Pressure**	Pressure build-up in bitumen storage vessel due to downstream pipe blockage or valve failure.	Vessel can burst, leading to potential fire and explosion hazard.	**Assets (MPPD)**	**6**	**3**	**8**	A PSV flare brings the conditions to atmospheric pressure in case of a pressure build-up.	**2**	**7**	1. Monitor the pressure in the vessel using a pressure indicator. 2. Execute an emergency shutdown of the unit if pressure continues to increase after PSV is opened. 3. Do not resume operation until any downstream obstacles have been removed or a bypass has been used.	**1**	**6**
2	**Contamination**	Release of hot bitumen.	Can cause thermal burns, formation or release of hydrocarbon fumes	**People workers and public**	**5**	**2**	**6**	Pressure drop alarm and emergency shutdown of the system can avoid feed contamination	**1**	**5**	1. Perform shutdowns and turnarounds on the reactors every three to five years. 2. Implement first aid response. 3. Workers must wear PPE all the time during operation.	**1**	**5**

3	**Loss of Containment**	Sour Gas and hydrogen sulfide release.	Highly fatal if inhaled, can cause severe injuries	**People workers and public**	**6**	**2**	**7**	1. If the release happens in one of the trains, a train emergency shutdown will be performed and the rest of the trains can operate normally. 2. If the release happens in the streams without possible bypass, a unit emergency shutdown will be performed.	**1**	**6**	1. Implement first aid response in case of emergency. 2. Workers must wear PPE all the time.	**1**	**6**
4	**High Flow**	Higher mass flow rate through the reactor, causing downstream flash drums (D-04, D-05) to operate at over capacity.	1. Separator burst. 2. High pressure and temperature material is released to atmosphere. 3. Fire and explosion hazard.	**People workers and public**	**6**	**2**	**7**	A train emergency shutdown will be performed and the rest of the trains can operate normally.	**1**	**6**	1. Implement first aid response in case of emergency. 2. Workers must wear PPE all the time.	**1**	**6**
5	**Low/No Flow**	Bitumen is fed to the reactors at lower mass flow rates.	Loss of production.	**Assets (MPPD)**	**1**	**2**	**2**	None.	**2**	**2**	Monitor liquid hold-up levels in process vessels to ensure they are in normal range.	**1**	**1**
6	**Utility Failure**	Failure on the bitumen feed furnace fuel gas storage.	An unburned mixture of gas and air can enter the gas fire which can enter the hot fire box and ignite.	**Assets (MPPD)**	**6**	**2**	**7**	A train emergency shutdown will be performed and the rest of the trains can operate normally.	**1**	**6**	Check if fuel gas lines are liquid free. Ensure that the burner and pilot gas valves are fully closed before pulling blinds.	**1**	**6**
7	**High Flow**	Leakage on bitumen feed pump P1.	1. Pump damage. 2. Major release of process chemicals (carbon aromatics and parafins) 3. Potential fire or explosion hazard.	**People workers and public**	**6**	**2**	**7**	1. Pressure indicators on pipelines and vessels will alarm when pressure drops. 2. A train emergency shutdown will be performed and the rest of the trains can operate normally.	**1**	**6**	1. Perform routine pump inspections and maintenance. 2. Workers must wear PPE all the time. 3. Implement first aid response in case of injury.	**1**	**6**
8	**Startup / Shutdown Hazards**	Pump P1 discharge valve is closed.	Can cause pump failures due to overpressure and mechanical stress.	**Assets (MPPD)**	**4**	**2**	**5**	1-A pump discharge check valve will prevent backflow. 2-Ensure proper training is provided to the employee operating the equipment.	**1**	**4**			

9	**Startup / Shutdown Hazards**	Pump P1 suction valve is closed	Can cause failure including overpressure and mechanical stress in the pump inlet and possibly causing the pipe to burst	**Assets (MPPD)**	**2**	**2**	**3**	1- Unit emergency shutdown 2-Install a pressure indicar 3-Ensure proper training is provided to the employee operating the equipment 4-consider installation of isolation valves	**1**	**2**			
10	**Low / No Flow**	Pump P1 operates at low flow rate	Loss of production	**Assets (MPPD)**	**3**	**2**	**4**	1-Install a low suction pressure alarm 2-Vibration monitor	**1**	**3**			
11	**High Pressure**	Piping downstream to the reactor is blocked and the reactor continues to send high pressure fluid.	1. Piping burst. 2. High pressure and temperature material released to atmosphere, potentially causing explosion.	**People workers and public**	**6**	**2**	**7**	1. Pressure safety valve monitors and releases pressure inside the reactor to prevent pressure build-up. 2. High pressue alarm on reactors and pipings. 3. Train is shutdown until maintenance is completed. The alternative trains can continue to operate.	**1**	**6**	1. Perform routine process equipment inspections and maintenance. 2. Workers must wear PPE all the time. 3. Implement first aid response in case of injury.	**1**	**6**
12	**High Pressure**	Upstream equipment delivers higher pressure fluid, causing the distillation columns to operate at over pressure.	1. Reboiler or piping leaks. 2. High pressure and temperature material released to atmosphere, potentially causing explosion.	**People workers and public**	**6**	**2**	**7**	1. Pressure safety valve monitors and releases pressure inside the reactor to prevent pressure build-up. 2. High pressue alarm on vessels and pipings. 3. Train is shutdown until maintenance is completed. The alternative trains can continue to operate.	**1**	**6**	1. Perform routine process equipment inspections and maintenance. 2. Workers must wear PPE all the time. 3. Implement first aid response in case of injury.	**1**	**6**
13	**Reverse or Misdirected flow**	Separator (D-08) operates at a lower pressure than downstream units.	Fluid flow backwords from mixer (M-07) to the separator, causing contaminations.	**Assets (MPPD)**	**4**	**2**	**5**	A pressure check valve at the separator discharge will prevent backflow.	**1**	**4**	Monitor the pressure indicators in each process vessel to ensure the pressures are maintained in normal ranges.	**1**	**4**
14	**High Pressure**	Excessive pressure on the 3-phase Separator (D-03)	1. Potential leak and explosion hazard. 2. Leakage of dangerous gas exposure (H2S) to the surrounding environment	**People workers and public**	**6**	**3**	**8**	1. Pressure valve controls 2.Pressure gauges 3.Themometers 4. Emergency shutdown of the unit.	**2**	**7**	1. Wear proper PPE to prevent inhalation of toxic gases 2. Emergency response team on site 3. To avoid the explosion to occur in a domino effect emergency response plan must be evaluated in order to antecipate explosion	**1**	**6**

15	**High Level**	Increase of flow into separators, causing liquid hold-up height to rise.	Insufficient vapor-liquid disengagement space. Liquid entrained in gas enters compressor, causing damage to the equipment.	**Assets (MPPD)**	**4**	**2**	**5**	The high level of liquid triggers the level control system of the separators, increasing liquid flow rate and bringing liquid hold-up height back in normal range.	**1**	**4**	Monitor the level indicator of the vessels and ensure the liquid level in maintained within normal range.	**1**	**4**
16	**Low level**	Decrease of flow into separators, causing liquid hold-up height to drop.	Loss of liquid hold-up at the bottom of the vessel. Unseparated fluid bypasses at the bottom.	**Assets (MPPD)**	**3**	**2**	**4**	The low level of liquid triggers the level control system of the separators, reducing liquid flow rate and bringing liquid hold-up height back in normal range.	**1**	**3**	Monitor the level indicator of the vessels and ensure the liquid level in maintained within normal range.	**1**	**3**
17	**Utility Failure**	Sudden power cut to the pump drivers.	1. Reverse flow though the pumps. 2. Internal pump components may be damaged or dislodged.	**Assets (MPPD)**	**4**	**3**	**6**	A dicharge check valve will allow forward flow.	**1**	**4**	Perform inspections and maintenance on the pumps after power failures to ensure the internal components have not been dislodged or damaged.	**1**	**4**
18	**Maintenance Hazards**	Corrosion in the slurry bubble reactor due to catalyst poisoning and deactivation	Reactor and piping leaking. High pressure and temperature material released to atmosphere, potentially causing explosion.	**People workers and public**	**6**	**2**	**7**	Perform mantainance around the reactor regularly	**1**	**6**	1. Perform mantainance around the reactor regularly. 2. Workers must wear PPE all the time. 3. Implement first aid response in case of injury.	**1**	**6**
19	**High Temperature**	Bitumen is fed at a higher temperature than being specified due to operation error.	Reactor does not operate at designed condition. Products may not meet specifications.	**Assets (MPPD)**	**4**	**1**	**4**	Install temperature indicators on the reactors to monitor temperature change.	**1**	**4**	Provide proper training and accessible operating procedure for the workers.	**1**	**4**
20	**Low / No Flow**	Pressure safety valve fails to release pressure inside separators.	Pressure build-up in the vessels, causing overpressure operation. Vessel or pipes may eventually burst and release flammable material,	**Assets (MPPD)**	**6**	**1**	**6**	Emergency shutdown of the train. The alternative trains can continue to operate normally.	**1**	**6**	Monitor the pressure indicators of the vessels.	**1**	**6**

21	**Contamination**	Leakage in heat exchanger EX-01. Product gas is contaminated with unreacted feed fluid.	Final product fail to meet specifications.	**Assets (MPPD)**	**4**	**2**	**5**	1. Stainless clad material is used for the heat exchangers to avoid corrosion. 2. A composition indicator can be installed to monitor product compositions.	**1**	**4**	Perform routine inspections and maintenance on the heat exchangers.	**1**	**4**
22	**Loss of Containment**	Storage tank overfill.	1. Loss of material. 2. Spill of flammable material to the working environment.	**Assets (MPPD)**	**3**	**3**	**5**	None.	**3**	**5**	1. Provide proper training and accessible operating procedure for the workers. 2. Perform management of changes. Expand the storage unit when needed.	**1**	**3**
23	**Contamination**	Water comes in contact with bitumen	1. Corrosion to the process equipment. 2. Moisture buildup in the tank insulation 3. Potential spills and falls	**Assets (MPPD)**	**3**	**1**	**3**	Stainless clad material is used for most of the process euipment to prevent corrosion.	**1**	**3**	Monitor the composition of the process fluid. In case of excess moisture, a potential dehydration strategy is the installation of a glycol dehydration unit.	**1**	**3**
24	**High Level**	Blockage in liquid discharge stream of the reactor or increase in the reactor feed flow.	1. Liquid accumulation in the column. 2. Reduced gas hold up volume in the reactor. 3. Loss of production due to entrapment of unreacted residue in the product.	**Assets (MPPD)**	**4**	**2**	**5**	Level indicator and low level alarm in the reactor.	**1**	**4**	Monitor the level indicator of the vessels and ensure the liquid level in maintained within normal range.	**1**	**4**
25	**Low level**	Blockage in the gas product stream of the reactor or decrease in the reactor feed flow.	1. Reduced liquid level in the column. 2. Increased gas hold up volume. 3. If the liquid level drops below the height of the feed pipe, gas can potentially backflow into the feed pipe	**Assets (MPPD)**	**4**	**2**	**5**	Level indicator and low level alarm in the reactor.	**1**	**4**	Monitor the level indicator of the vessels and ensure the liquid level in maintained within normal range.	**1**	**4**

G.3 DOW FIRE AND EXPLOSION INDECIES

The fire and explosion indexes were evaluated using the Dow's Fire and Explosion Index Hazard Classification Guide, from the American Institute of Chemical Engineers, 1994, to give a comprehensive and realistic potential process unit loss in the case of fire or explosion. For this assessment the fire and explosion indexes based on the material factor using table G.3 as a guide, general process hazards factor and special process hazards factor for each process unit.

After the FEI analysis, the equipment placement on the plot plan was made based on the area of exposure where the equipment could be exposed to a fire or fuel-air explosion. Equipment such as reactors trains (R-01A to R-04B), furnace (F-01 and F-02), and heat exchangers (C-01B and E-2) have a large area of exposure and cover the area of others equipment.

Table G3: Material Factor Determination Guide.

MATERIAL FACTOR DETERMINATION GUIDE						
	Flammability Ranking	**Instability Ranking**				
Liquids & Gases Flammability or Combustibility	NFPA 325M or 49	0	1	2	3	4
Non-combustible2	0	1	14	24	29	40
F.P. > 200 F (> 93.3 C)	1	4	14	24	29	40
F.P. > 100 F (> 37.8 C) 200 F (93.3 C)	2	10	14	24	29	40
F.P. 73 F (22.8 C) < 100 °F (< 37.8 C) or F.P. < 73 F (< 22.8 C) & BP. 100 F (37.8 C)	3	16	16	24	29	40
F.P. < 73 F (< 22.8 C) & B.P. < 100 F (< 37.8 C)	4	21	21	24	29	40
Combustible Dust or Mist						
St-1 (K_{St} 200 bar m/sec)		16	16	24	29	40
St-2 (K_{St} = 201-300 bar m/sec)		21	21	24	29	40
St-3 (K_{St} > 300 bar m/sec)		24	24	24	29	40
Combustible Solids						
Dense > 40 mm thick	1	4	14	24	29	40
Open < 40 mm thick	2	10	14	24	29	40
Foam, fiber, powder, etc.	3	16	16	24	29	40

F.P. = Flash Point, closed cup B.P. = Boiling Point at Standard Temperatures and Pressure (STP)

G.3.1 F&EI Sheets

Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Bitumen Feed Pump		
Materials in Unit: Aromatic Hydrocarbons		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**21.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.85
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.15
General Process Hazards Factor (F1)		2.20
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.30
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.39
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.20
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.30
J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		2.39
Process Unit Hazard Factor F3= (F1 x F2)		5.26

Fire and Explosion Index F&EI= (F3 x MF)		**110.53**
Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Bitumen Feed Furnace F-01		
Materials in Unit: Aromatic Hydrocarbons		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**24.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.80
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.40
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.50
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.76
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.50
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.10
J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.30
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		3.26
Process Unit Hazard Factor F3= (F1 x F2)		7.82

Fire and Explosion Index F&EI= (F3 x MF)		**187.71**

Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Hydrogen Furnace F-02		
Materials in Unit: Hydrogen		
Basis Material for Material Factor: Hydrogen		
Material Factor		**21.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.85
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.20
General Process Hazards Factor (F1)		2.55
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.50
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.76
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.00
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.00
J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		2.46

Process Unit Hazard Factor F3= (F1 x F2)		6.27
Fire and Explosion Index F&EI= (F3 x MF)		**131.67**

Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Overhead Gas Flash Drum D-01		
Materials in Unit: Hydrogen, Methane, Propane, n-Butane, Water, Ammonium, Hydrogen sulfide and Hydrocarbons		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**24.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.80
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.25
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.50
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.56
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.00
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.00
J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00

L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		1.76
Process Unit Hazard Factor F3= (F1 x F2)		3.96
Fire and Explosion Index F&EI= (F3 x MF)		**95.13**
Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Overhead Gas Flash Drum D-02		
Materials in Unit: Hydrogen, Methane, Propane, n-Butane, Water, Ammonium, Hydrogen sulfide and Hydrocarbons		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**24.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.80
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.25
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.50
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.56
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.00
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.00
J. Use of Fired Equipment		0.00

K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		1.76
Process Unit Hazard Factor F3= (F1 x F2)		3.96
Fire and Explosion Index F&EI= (F3 x MF)		**95.13**
Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Three phase separator D-03		
Materials in Unit: Hydrogen, Methane, Propane, n-Butane, Water, Ammonium, Hydrogen sulfide and Hydrocarbons		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**21.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.80
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.25
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.80
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.65
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
M. Corrosion and Erosion	0.00 -0.75	0.00
N. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.00

O. Use of Fired Equipment		0.00
P. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00
Q. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		2.65
Process Unit Hazard Factor F3= (F1 x F2)		5.96
Fire and Explosion Index F&EI= (F3 x MF)		**125.17**
Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Slurry Reactor R-01A		
Materials in Unit: Hydrogen, Aromatic Hydrocarbons, Iron (III) Sulfate		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**24.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.20
C. Material Handling and Transfer	0.25 - 0.80	0.50
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.10
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.50
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.76
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.20
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.10

J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.75
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		2.76
Process Unit Hazard Factor F3= (F1 x F2)		5.80
Fire and Explosion Index F&EI= (F3 x MF)		**139.03**

Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Airfin Cooler C-01B		
Materials in Unit: Hydrogen, Methane, Propane, n-Butane, Water, Ammonium, Hydrogen sulfide		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**21.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.80
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.25
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.80
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.76
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		
1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00

H. Corrosion and Erosion	0.00 -0.75	0.10
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.10
J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		2.96
Process Unit Hazard Factor F3= (F1 x F2)		6.66
Fire and Explosion Index F&EI= (F3 x MF)		**139.76**

Location: Edmonton, AB	**Business Group:** TR Solution	
Prepared by: Naira	**Date:** March, 2020	
Process Unit: Reactor Overhead Cooler E-02		
Materials in Unit: Hydrogen, Methane, Propane, n-Butane, Water, Ammonium, Hydrogen sulfide		
Basis Material for Material Factor: Hydrocarbons		
Material Factor		**24.00**
1. General Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Exothermic Reaction	0.3 - 1.25	0.00
B. Endothermic Reaction	0.2 - 0.4	0.00
C. Material Handling and Transfer	0.25 - 0.80	0.80
D. Enclosed or Indoor Process or storage Units handling Flammable materials	0.00- 0.90	0.00
E. Ease of Access for Emergency Responders	0.00- 0.35	0.20
F. Drainage and Spill Control	0.00- 0.50	0.25
General Process Hazards Factor (F1)		2.25
2. Special Process Hazards	**Penalty Factor Range**	**Penalty Factor Used**
Base Factor	1.00	1.00
A. Toxicity of the material handled.	0.00- 0.80	0.20
B. Process or Storage operates at vacuum	0.50	0.00
C. Operation in or near the flammable range	0.00 - 0.8	0.30
D. Dust Explosion	0.00 - 2.0	0.00
E. Pressure Penalty		0.99
F. Low Temperature Operation	0.00- 0.30	0.00
G. Quality of Flammable/ Unstable Material		

1. Combustible and Flammable materials in Process		0.00
2. Liquids or gases in Storage		0.00
3. Solids in Storage or Process		0.00
H. Corrosion and Erosion	0.00 -0.75	0.10
I. Leakage, Joints, packing, flexible joints	0.00- 1.50	0.10
J. Use of Fired Equipment		0.00
K. Hot Oil Heat Exchange Equipment	0.00- 1.15	0.00
L. Rotating Equipment	0.00- 0.50	0.00
Special Process Hazards Factor (F2)		2.69
Process Unit Hazard Factor F3= (F1 x F2)		6.05
Fire and Explosion Index F&EI= (F3 x MF)		**145.01**

Table G4. Process units F&EI and area of exposure summary.

Equipment	Fire & Explosion Index	Radius of Exposure (m)	Area of Exposure (m^2)
P-01	111	27.4	2359
F-01	188	48.8	7482
F-02	132	33.5	3526
D-01	95	24.4	1870
D-02	95	24.4	1870
D-03	125	32.0	3217
R-01	139	35.7	4004
C-01B	140	36.6	4208
E-02	145	37.8	4489

G.4 DOW CHEMICAL EXPOSURE INDEX

The chemical exposure indexes were evaluated using the Dow's Chemical Exposure Index Guide, from the American Institute of Chemical Engineers, 1994, to estimate the airborne quantity released and rate the potential health hazard to neighbor plants and communities in the event of chemical release incidents. For this assessment the chemical exposure indexes based on Emergency Response Planning Guidelines (ERPG) and Dow Emergency Exposure Planning Guidelines (EEPG), using table G5 as a guide. Then the airborne quantity for gas and liquid releases are estimated, following by the CEI and hazard distance calculation.

Table G5: ERPGs and Physical Properties.

	Molecular Weight	Boiling Point	ERPG-1	ERPG-1	ERPG-2	ERPG-2	ERPG-3	ERPG-3	Vapour Pressure	Liquid Density	Heat Capacity	Latent Heat	Ratio of Cp/Hv
		(℃)	(mg/m3)	(ppm)	(mg/m3)	(ppm)	(mg/m3)	(ppm)	(kPa)	(kg/m3)	(J/kg-℃)	(J/kg)	(1/℃)
Acetone cyanohydrin *	85.1	-	-	-	35	10	-	-	-	-	-	-	-
Acrolein	56.1	52.5	-	0.1	1	0.5	7	3	36	835.1	2.00E+03	5.37E+05	0.0037
Acrylic acid	72.1	141.4	6	2	147	50	2210	750	0.5	1046.7	1.80E+03	6.95E+05	0.0026
Acrylonitrile *	53.1	77.2	22	10	76	35	163	75	14	778.7	2.06E+03	6.31E+05	0.0033
Allyl chloride	76.5	44.8	9	3	125	40	939	300	48.6	932.1	1.53E+03	3.73E+05	0.0041
Ammonia	17	-33.4	17	25	104	150	522	750	1013.1	602.2	4.74E+03	1.16E+06	0.0041
Benzene	78.1	80.1	-	-	-	-	-	-	12.7	874.5	1.74E+03	4.30E+05	0.004
Bromine	159.8	58.7	1	0.2	7	1	33	5	28.5	3106.4	4.65E+02	1.96E+05	0.0024
Butadiene	54.1	-4.4	22	10	442	200	11060	5000	-	-	-	-	-
n-butyl acrylate	128.2	-	0.26	0.05	131	25	1310	250	0.7	894.5	1.82E+03	3.61E+05	0.005
n-butylisocyanate	99.1	-	0.04	0.01	0.2	0.05	4	1	2.6	886.6	1.60E+03	4.07E+05	0.0039
Carbon disulfide	76.1	46.3	3	1	156	50	1557	500	48.3	1256.3	1.09E+03	3.61E+05	0.003
Carbon monoxide	28	-191.5	-	200	-	350	-	500	-	-	-	-	-
Carbon tetrachloride	153.8	76.8	126	20	629	100	4718	750	15.2	1582.9	8.24E+02	2.11E+05	0.0039
Chlorine	70.9	-34	3	1	9	3	58	20	779.4	1400.3	9.85E+02	2.47E+05	0.004
Chlorine trifluoride	92.5	-	0.38	0.1	4	1	38	10	-	-	-	-	-
Chloroacetyl chloride	112.9	106	0.25	0.05	2.5	0.5	23	5	3.3	1410.8	1.17E+03	3.62E+05	0.0032
Chloroform *	119.4	61.7	-	-	244	50	24413	5000	26.3	1480.8	9.54E+02	2.61E+05	0.0037
Chloropicrin	164.4	112	1	0.1	2	0.3	10	1.5	3.4	1646	8.55E+02	2.36E+05	0.0036
Chlorosulfonic acid	116.5	-	2	0.4	10	2.1	30	6.3	-	-	-	-	-
Chlorotrifluoroethylene	116.5	-28.2	95	20	476	100	1429	300	641.9	1292	1.20E+03	1.46E+05	0.0082
Crotonaldehyde	70.1	102.4	6	2	29	10	143	50	4.8	849.4	2.00E+03	5.45E+05	0.0037
Diketene	82.1	-	3	1	17	5	168	50	-	-	-	-	-
Dimethylamine	45.1	6.9	2	1	184	100	922	500	205.9	650.4	2.77E+03	5.61E+05	0.0049
Epichlorohydrin	92.5	116.4	8	2	76	20	378	100	2.3	1175.1	1.44E+03	4.51E+05	0.0032
Ethyl chloride *	64.5	12.3	-	-	13192	5000	-	-	160.3	893	1.62E+03	3.74E+05	0.0043
Ethylene dichloride *	99	83.5	-	-	405	100	-	-	10.6	1247.1	1.31E+03	3.54E+05	0.0037
Ethylene oxide *	44.1	10.5	-	-	90	50	901	500	174.4	867.7	2.07E+03	5.61E+05	0.0037
Formaldehyde	30	-	1	1	12	10	31	25	515.6	728.7	2.55E+03	7.13E+05	0.0036
Hexachlorobutadiene	260.8	-	32	3	107	10	320	30	0	1673.9	6.83E+02	2.14E+05	0.0032
Hexafluoroacetone	166	-	-	-	7	1	339	50	-	-	-	-	-
Hydrogen bromide *	80.9	-66.7	10	3	66	20	248	75	2359.7	1760.3	1.02E+03	1.59E+05	0.0064
Hydrogen chloride	36.5	-85	4	3	30	20	224	150	4812.5	804.9	3.40E+03	2.36E+05	0.0144
Hydrogen cyanide	27	25.7	-	-	11	10	28	25	-	-	-	-	-
Hydrogen fluoride	20	19.6	4	5	16	20	41	50	123	983.3	########	3.72E+05	-0.0019
Hydrogen sulfide	34.1	-60.3	0.14	0.1	42	30	139	100	2022.4	767.2	2.33E+03	4.11E+05	0.0057
Isobutyronitrile	69.1	-	28	10	141	50	565	200	-	-	-	-	-
2-isocyanatoethyl methacrylate	155.2	-	-	-	1	0.1	6	1	0	1095.9	1.83E+03	3.58E+05	0.0051
Methacrylonitrile *	67.1	90.3	-	-	27	10	-	-	9.5	795.5	1.99E+03	4.89E+05	0.0041
Methanol	32	64.5	262	200	1310	1000	6551	5000	17	786.7	2.54E+03	1.20E+06	0.0021
Methyl chloride	50.5	-24.1	-	-	826	400	2065	1000	577.3	916.9	1.62E+03	3.76E+05	0.0043
Methyl iodide	141.9	-	145	25	290	50	726	125	-	-	-	-	-
Methyl isocyanate	57.1	-	0.058	0.025	1	0.5	12	5	62	947.8	1.44E+03	4.90E+05	0.0029
Methyl mercaptan	48.1	6	0.01	0.005	49	25	197	100	202.2	857.7	1.89E+03	4.87E+05	0.0039
Monomethylamine	31.1	-6.3	13	10	127	100	635	500	349.1	655.9	3.10E+03	7.77E+05	0.004
Perfluoroisobutylene	218.1	-	-	-	1	0.1	3	0.3	-	-	-	-	-
Phenol	94.1	181.9	38	10	192	50	770	200	0.1	1070.6	2.05E+03	6.22E+05	0.0033
Phosgene	98.9	7.5	-	-	1	0.2	4	1	190.3	1361.7	1.03E+03	2.37E+05	0.0043
Phosphorous pentoxide	141.9	-	5	1	25	4	100	17	-	-	-	-	-
Propylene oxide *	58.1	34.2	119	50	594	250	1782	750	71.9	823.7	2.09E+03	4.80E+05	0.0043
Styrene	104.2	145.2	213	50	1065	250	4259	1000	0.8	902	1.75E+03	4.22E+05	0.0041
Sulfur dioxide	64.1	-10	1	0.3	8	3	39	15	393.6	1352.4	1.41E+03	3.57E+05	0.0039
Sulfuric acid (Sulfur trioxide)	98.1	44.4	2	0.5	10	2.5	30	7.5	-	-	-	-	-
Sulfuryl fluoride *	102.1	-	-	-	417	100	1252	300	1748	1321	1.50E+03	1.28E+05	0.0117
Tetrafluoroethylene	100	-	818	200	4090	1000	40902	10000	3249.7	880.9	3.48E+03	6.31E+04	0.0551
Titanium tetrachloride	189.7	-	5	1	20	3	100	13	1.4	1715.8	7.43E+02	2.16E+05	0.0034
Toluene diisocyanate *	174.2	252.9	-	-	1	0.2	-	-	0	1210.8	1.52E+03	3.92E+05	0.0039
Trimethylamine	59.1	2.9	-	0.1	242	100	1209	500	221.5	625.5	2.29E+03	3.68E+05	0.0062
Vinyl acetate	86.1	72.8	18	5	264	75	1760	500	15.3	925.4	1.76E+03	4.03E+05	0.0044
Vinyl chloride *	62.5	-13.8	-	-	2556	1000	12781	5000	395.7	903.2	1.55E+03	3.20E+05	0.0048
Vinylidene chloride *	96.9	31.7	-	-	198	50	793	200	79.7	1204	1.16E+03	2.74E+05	0.0042

ESTIMATING THE AIRBORNE QUANTITY FOR GAS RELEASES

The following equations, based on the sonic gas flow rate equation, are used to estimate the airborne quantity for a gas release.

SI Units

$$\text{Airborne Quantity (AQ)} = 4.751 \times 10^{-6}\, D^2\, P_a \sqrt{\frac{MW}{T+273}} \quad \{kg/sec\} \quad \text{(Equation 1A)}$$

where

P_a = absolute pressure = $(P_g + 101.35)$

P_g = gauge pressure (kPa gauge)

MW = molecular weight of the material

T = temperature (°C)

D = diameter of the hole (millimeters)

ESTIMATING THE AIRBORNE QUANTITY FOR LIQUID RELEASES

The following steps describe a simplified procedure for estimating the airborne quantity for liquid releases.

Step 1: Determine the liquid flow rate being released.

The liquid release rate (L) is given by the following equations:

These equations assume that release from all scenarios will continue for at least five minutes before releases can be stopped. If a five minute release would exceed the total inventory, the release rate is calculated by dividing the total inventory by five minutes.

SI Units

$$L = 9.44 \times 10^{-7}\, D^2\, \rho_l \sqrt{\frac{1000\, P_g}{\rho_l} + 9.8\Delta h} \quad \{kg/sec\} \quad \text{(Equation 2A)}$$

where

P_g = gauge pressure (kPa gauge)
(Note: for a tank open to the atmosphere $P_g = 0$)

ρ_l = density of the liquid at operating temperature (kg/m^3)

Δh = height of the liquid above the release point (meters)

D = diameter of the hole (millimeters)

CEI AND HAZARD DISTANCE CALCULATION

Chemical Exposure Index

All CEI calculations assume a windspeed of 5 m/sec (11.2 miles/hour) and neutral weather conditions.

The Chemical Exposure Index (CEI) is given by:

SI Units

$$CEI = 655.1\sqrt{\frac{AQ}{ERPG\text{-}2}} \qquad \text{(Equation 10A)}$$

where

AQ = airborne quantity (kg/sec)
ERPG-2 = value (mg/m^3)

Hazard Distance

The Hazard Distance (HD) is the distance to the ERPG-1, -2 or -3 concentration and is derived from the following equation:

SI Units

$$HD = 6551\sqrt{\frac{AQ}{ERPG}} \qquad \{meters\} \qquad \text{(Equation 11A)}$$

where

AQ = airborne quantity (kg/sec)
ERPG = ERPG-1, ERPG-2 or ERPG-3 (mg/m^3)

G.4.1 CEI Sheets

Table G6. Hydrogen sulfide vapor release for stream 30.

Piping release or vessel nozzle release	
Quantity of gas available for release kg	25914.5
Temperature of released material deg C	75
Molecular Weight	34.1
Boiling Point C	-60.3
Liquid Density kg/M3 at storage temp C	669.1
Liquid Density kg/M3 at BP	767.2
Gas Density kg/M3 at 25C	1.36
Heat Capacity C_p Joules/kg-deg C	2.33E+03
Latent Heat of Vaporisation H_v Joules/Kg	4.11E+05
Ratio of Cp/Hv	0.0057
Absolute Pressure (P_a) kPa	25100
Gauge Pressure in Process (P_g) kPa	25000
Temperature C	75
Diameter of hole mm	76.2
Height of leak above grade (Metres)	6
ERPG2 Mg/M3	42
ERPG3 Mg/M3	139
Dike area M2	0.018
Gas Releases	
Airborne Gas Release (continuous assuming large inventory) kg/sec	96.33
Airborne Gas Release (inventory exhausted within 5 minutes) kg/sec	86.38
CEI	**939**
Distance travel by ERPG2 concentration (Meters)	**9395**
Distance travel by ERPG3 concentration (Meters)	**5164**
Maximum Release Duration (Minutes)	**5**

Table G7: Hydrogen sulfide vapor release for stream 52.

Piping release	
Quantity of liquid available for release kg	
Quantity of gas available for release kg	489.2
Temperature of released material deg C	75.9
Molecular Weight	34.1
Boiling Point C	-60.3
Liquid Density kg/M3 at storage temp C	669.1
Liquid Density kg/M3 at BP	104.2
Gas Density kg/M3 at 25C	1.36
Heat Capacity C_p Joules/kg-deg C	2.33E+03
Latent Heat of Vaporisation H_v Joules/Kg	4.11E+05
Ratio of Cp/Hv	0.0057
Absolute Pressure (P_a) kPa	190
Gauge Pressure in Process (P_g) kPa	90
Temperature C	75.9
Diameter of hole mm	76.2
Height of leak above grade (Metres)	10
ERPG2 Mg/M3	42
ERPG3 Mg/M3	139
Dike area M2	0.018
Gas Releases	
Airborne Gas Release (continuous assuming large inventory) kg/sec	0.73
Airborne Gas Release (inventory exhausted within 5 minutes) kg/sec	0.73
CEI	**86**
Distance travel by ERPG2 concentration (Meters)	**863**
Distance travel by ERPG3 concentration (Meters)	**474**
Maximum Release Duration (Minutes)	**11**

Table G8. Vapor ammonia release for stream 52.

Piping release	
Quantity of gas available for release kg	2614.8
Temperature of released material deg C	75.9
Molecular Weight	17.031
Boiling Point C	-33.4
Vapour Pressure t 25 C kPa	1013.1
Liquid Density kg/M3 at storage temp C	602.2
Liquid Density kg/M3 at BP	704
Gas Density kg/M3 at 25C	0.771
Heat Capacity C_p Joules/kg-deg C	4.74E+03
Latent Heat of Vaporisation H_v Joules/Kg	1.16E+06
Ratio of Cp/Hv	0.0041
Absolute Pressure (P_a) kPa	190
Gauge Pressure in Process (P_g) kPa	90
Temperature C	75.9
Diameter of hole mm	76.2
Height of leak above grade (Metres)	10
ERPG2 Mg/M3	104
ERPG3 Mg/M3	522
Dike area M2	0.018
Gas Releases	
Airborne Gas Release (continuous assuming large inventory) kg/sec	0.51
Airborne Gas Release (inventory exhausted within 5 minutes) kg/sec	0.51
CEI	**46**
Distance travel by ERPG2 concentration (Meters)	**461**
Distance travel by ERPG3 concentration (Meters)	**206**
Maximum Release Duration (Minutes)	**5**

Table G9. Liquid ammonia release for stream 30.

Piping release or vessel nozzle release	
Quantity of liquid available for release kg	25914.5
Quantity of gas available for release kg	
Temperature of released material deg C	75
Molecular Weight	17.031
Boiling Point C	-33.4
Vapour Pressure t 25 C kPa	1013.1
Vapour Pressure at Pool Temperature kPa	
Liquid Density kg/M3 at storage temp C	602.2
Liquid Density kg/M3 at BP	704
Gas Density kg/M3 at 25C	0.771
Heat Capacity C_p Joules/kg-deg C	4.74E+03
Latent Heat of Vaporisation H_v Joules/Kg	1.16E+06
Ratio of Cp/Hv	0.0041
Absolute Pressure (P_a) kPa	25100
Gauge Pressure in Process (P_g) kPa	25000
Temperature C	75
Diameter of hole mm	76.2
Height of leak above grade (Metres)	10
ERPG2 Mg/M3	104
ERPG3 Mg/M3	522
Dike area M2	0.018
Liquid Releases	
Liquid release rate L kg/sec	86.38
Release quantity (unlimited) kg	77743.5
Actual Release Quantity (limited by emergency block valve or quantity available) kg	25914.5
Fraction Flashed	0.44
Airborne Quantity produced by the flash kg/sec	86.38
Characteristic pool temperature (Deg C)	-33.4
Total Airborne Quantity (kg/sec)	86.38
Chemical Exposure Index	**597**
Distance travel by ERPG2 concentration (Meters)	**5970**
Distance travel by ERPG3 concentration (Meters)	**2665**
Maximum Release Duration (Minutes)	**6**

Table G10. Chemical exposure index summary.

Stream	Chemical Released	CEI	Hazard Distance (m)	Maximum Release Duration (min)
30	Vapor H_2S	939	9395	5
52	Vapor H_2S	86	863	11
52	Vapor Ammonia	46	461	5
30	Liquid Ammonia	597	5970	6

G.5 MATERIAL SAFETY DATA SHEETS

The following sheets of material safety data sheets (SDS) for the chemicals involved in the plant process contain information on potential hazards and how to work safely around them. The SDS for the different chemicals gases and liquids were retrieved from Suncor Energy and Praxair Canada both in compliance with WHMIS 2015.

Ammonia - US

Safety Data Sheet P-4562

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.

Date of issue: 01/01/1981 Revision date: 08/28/2019 Supersedes: 03/23/2015

SECTION: 1. Product and company identification

1.1. Product identifier

Product form : Substance

Substance name : Ammonia - US

CAS-No. : 7664-41-7

Formula : NH3

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Industrial use; Use as directed.

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number : Onsite Emergency: 1-800-645-4633

CHEMTREC, 24hr/day 7days/week
— Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887
(collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS US classification

Flam. Gas 2	H221
Press. Gas (Liq.)	H280
Acute Tox. 4 (Inhalation:gas)	H332
Skin Corr. 1B	H314
STOT SE 3	H335
Aquatic Acute 1	H400

2.2. Label elements

GHS US labeling

Hazard pictograms (GHS US) :

GHS04 GHS05 GHS07 GHS09

Signal word (GHS US) : Danger

Hazard statements (GHS US) :
H221 - FLAMMABLE GAS
H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
H314 - CAUSES SEVERE SKIN BURNS AND EYE DAMAGE
H332 - HARMFUL IF INHALED
H400 - VERY TOXIC TO AQUATIC LIFE
CGA-HG01 - MAY CAUSE FROSTBITE.
CGA-HG22 - CORROSIVE TO THE RESPIRATORY TRACT (This statement supercedes H335)

Precautionary statements (GHS US) :
P202 - Do not handle until all safety precautions have been read and understood.
P210 - Keep away from Heat, Open flames, Sparks, Hot surfaces. - No smoking
P260 - Do not breathe gas
P262 - Do not get in eyes, on skin, or on clothing.
P280 - Wear protective gloves, protective clothing, eye protection, face protection.

Butane

Safety Data Sheet E-4572

according to the Hazardous Products Regulation (February 11, 2015)

Date of issue: 10 15 1979 Revision date: 03 18 2018 Supersedes: 10 15 2016

SECTION 1: Identification

1.1. Product identifier

Product form	:	Substance
Trade name	:	Butane
Chemical name	:	Butane
CAS No	:	106-97-8
Formula	:	C4H10
Other means of identification	:	Methylethylmethane, Diethyl, n-Butane, Butyl hydride.
Product group	:	Core Products

1.2. Recommended use and restrictions on use

Recommended uses and restrictions	:	Industrial use Welding

1.3. Supplier

Praxair Canada inc.
1200 – 1 City Centre Drive
Mississauga - Canada L5B 1M2
T 1-905-803-1600 - F 1-905-803-1602
www.praxair.ca

1.4. Emergency telephone number

Emergency number	:	1-800-363-0042 Call emergency number 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-CA classification

Flam. Gas 1 H220
Liquefied gas H280

2.2. GHS Label elements, including precautionary statements

GHS-CA labelling

Hazard pictograms :

GHS02 GHS04

Signal word : DANGER

Hazard statements : **EXTREMELY FLAMMABLE GAS**
CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
MAY CAUSE FROSTBITE.
MAY FORM EXPLOSIVE MIXTURES WITH AIR.

Precautionary statements : Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
Use and store only outdoors or in a well-ventilated area.
Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
In case of leakage, eliminate all ignition sources
Protect from sunlight when ambient temperature exceeds 52°C (125°F).
Use a back flow preventive device in the piping.

Carbon dioxide,

Safety Data Sheet E-4574

according to the Hazardous Products Regulation (February 11, 2015)

Date of issue: 10 15 1979 Revision date: 08 03 2016 Supersedes: 10 15 2014

SECTION 1: Identification

1.1. Product identifier

Product form	:	Substance
Name	:	Carbon dioxide,
CAS No	:	124-38-9
Formula	:	CO_2
Other means of identification	:	Carbon anhyoride, Carbonic acid gas, Carbon Dioxide,
Product group	:	Core Products

1.2. Recommended use and restrictions on use

Recommended uses and restrictions	:	Industrial use Medical applications Semiconductor Use as directed

1.3. Supplier

Praxair Canada inc.
1200 1 City Centre Drive
Mississauga - Canada L5B 1M2
T 1-905-803-1600 - F 1-905-803-1682
www.praxair.ca

1.4. Emergency telephone number

Emergency number	:	1-800-363-0042 Call emergency number 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-CA classification

Simple asphyxiant H380
Compressed gas H280

2.2. GHS Label elements, including precautionary statements

GHS-CA labelling

Hazard pictograms :

GHS07

Signal word : WARNING

Hazard statements : CONTAINS REFRIGERATED GAS; MAY CAUSE CRYOGENIC BURNS OR INJURY
MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION
MAY CAUSE FROSTBITE
MAY INCREASE RESPIRATION AND HEART RATE

Precautionary statements : Do not handle until all safety precautions have been read and understood
Use and store only outdoors or in a well-ventilated area
Wear cold insulating gloves and either face shield or eye protection
Protect from sunlight when ambient temperature exceeds 52°C (125°F)
Use a back flow preventive device in the piping
Close valve after each use and when empty

Carbon monoxide

Safety Data Sheet E-4576

according to the Hazardous Products Regulation (February 11, 2015)

Date of issue: 10 15 1979 Revision date: 08 05 2016 Supersedes: 10 15 2013

SECTION 1: Identification

1.1. Product identifier

Product form	:	Substance
Name	:	Carbon monoxide
CAS No	:	630-08-0
Formula	:	CO
Other means of identification	:	Carbon monoxide, compressed Compressed carbon monoxide Carbon oxide (CO)
Product group	:	Core Products

1.2. Recommended use and restrictions on use

Recommended uses and restrictions	:	Industrial use Use as directed

1.3. Supplier

Praxair Canada inc.
1200 1 City Centre Drive
Mississauga - Canada L5B 1M2
T 1-905-803-1600 - F 1-905-803-1682
www.praxair.ca

1.4. Emergency telephone number

Emergency number	:	1-800-363-0042 Call emergency number 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-CA classification

Flam. Gas 1	H220
Compressed gas	H280
Acute Tox. 3 (Inhalation:gas)	H331
Repr. 1A	H360
STOT RE 1	H372

2.2. GHS Label elements, including precautionary statements

GHS-CA labelling

Hazard pictograms :

GHS02 GHS04 GHS06 GHS08

Signal word : DANGER

Hazard statements : **EXTREMELY FLAMMABLE GAS**
CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
TOXIC IF INHALED
May damage fertility or the unborn child
CAUSES DAMAGE TO ORGANS (CENTRAL NERVOUS SYSTEM) THROUGH PROLONGED OR REPEATED EXPOSURE (Inhalation)
MAY FORM EXPLOSIVE MIXTURES WITH AIR

Ethane

Safety Data Sheet E-4592

according to the Hazardous Products Regulation (February 11, 2015)

Date of issue: 10 15 1979 Revision date: 09 15 2016 Supersedes: 10 15 2013

SECTION 1: Identification

1.1. Product identifier

Product form	:	Substance
Name	:	Ethane
CAS No	:	74-84-0
Formula	:	C2H6
Other means of identification	:	Methylmethane, bimethyl, dimethyl, ethyl hydride
Product group	:	Core Products

1.2. Recommended use and restrictions on use

Recommended uses and restrictions	:	Industrial use Use as directed

1.3. Supplier

Praxair Canada inc.
1200 1 City Centre Drive
Mississauga - Canada L5B 1M2
T 1-905-803-1600 - F 1-905-803-1682
www.praxair.ca

1.4. Emergency telephone number

Emergency number	:	1-800-363-0042 Call emergency number 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-CA classification

Flam. Gas 1 H220
Compressed gas H280

2.2. GHS Label elements, including precautionary statements

GHS-CA labelling

Hazard pictograms :

GHS02 GHS04

Signal word : DANGER

Hazard statements : **EXTREMELY FLAMMABLE GAS**
CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION
MAY CAUSE FROSTBITE
MAY FORM EXPLOSIVE MIXTURES WITH AIR

Precautionary statements : Do not handle until all safety precautions have been read and understood
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Use and store only outdoors or in a well-ventilated area
Leaking gas fire: Do not extinguish, unless leak can be stopped safely
In case of leakage, eliminate all ignition sources
Protect from sunlight when ambient temperature exceeds 52°C (125°F)

Hydrogen sulfide

Safety Data Sheet E-4611

according to the Hazardous Products Regulation (February 11, 2015)

Date of issue: 10 15 1979 Revision date: 08 10 2016 Supersedes: 10 15 2013

SECTION 1: Identification

1.1. Product identifier

Product form	:	Substance
Name	:	Hydrogen sulfide
CAS No	:	7783-06-4
Formula	:	H2S
Other means of identification	:	Hydrogen sulfide
Product group	:	Core Products

1.2. Recommended use and restrictions on use

Recommended uses and restrictions	:	Industrial use Use as directed

1.3. Supplier

Praxair Canada inc.
1200 1 City Centre Drive
Mississauga - Canada L5B 1M2
T 1-905-803-1600 - F 1-905-803-1682
www.praxair.ca

1.4. Emergency telephone number

Emergency number	:	1-800-363-0042 Call emergency number 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-CA classification

Flam. Gas 1	H220
Liquefied gas	H280
Acute Tox. 2 (Inhalation: gas)	H330
STOT SE 3	H335

2.2. GHS Label elements, including precautionary statements

GHS-CA labelling

Hazard pictograms :

GHS02 GHS04 GHS06 GHS07

Signal word : DANGER

Hazard statements : **EXTREMELY FLAMMABLE GAS**
CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
FATAL IF INHALED
MAY CAUSE RESPIRATORY IRRITATION
MAY FORM EXPLOSIVE MIXTURES WITH AIR
SYMPTOMS MAY BE DELAYED
EXTENDED EXPOSURE TO GAS REDUCES THE ABILITY TO SMELL SULFIDES

Precautionary statements : Do not handle until all safety precautions have been read and understood
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking

Hydrogen, compressed

Safety Data Sheet P-4604

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.

Date of issue: 01/01/1980 Revision date: 10/17/2016 Supersedes: 06/03/2015

SECTION: 1. Product and company identification

1.1. Product identifier

Product form	:	Substance
Name	:	Hydrogen, compressed
CAS No	:	1333-74-0
Formula	:	H2
Other means of identification	:	Dihydrogen, parahydrogen, refrigerant gas R702, water gas

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture	:	Industrial use. Use as directed.

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number	:	Onsite Emergency: 1-800-645-4633
		CHEMTREC, 24hr/day 7days/week — Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887 (collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-US classification

Flam. Gas 1 H220
Compressed gas H280

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS02 GHS04

Signal word (GHS-US) : DANGER

Hazard statements (GHS-US) :
H220 - **EXTREMELY FLAMMABLE GAS**
H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
OSHA-H01 - MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION
CGA-HG04 - MAY FORM EXPLOSIVE MIXTURES WITH AIR
CGA-HG08 - BURNS WITH INVISIBLE FLAME

Precautionary statements (GHS-US) :
P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from Heat, Open flames, Sparks, Hot surfaces. - No smoking
P271+P403 - Use and store only outdoors or in a well-ventilated place
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely
P381 - Eliminate all ignition sources if safe to do so
CGA-PG05 - Use a back flow preventive device in the piping
CGA-PG10 - Use only with equipment rated for cylinder pressure
CGA-PG12 - Do not open valve until connected to equipment prepared for use
CGA-PG06 - Close valve after each use and when empty
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F)

METHANE, COMPRESSED

Safety Data Sheet P-4618

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.

Date of issue: 01/01/1978 Revision date: 10/17/2016 Supersedes: 03/09/2015

SECTION: 1. Product and company identification

1.1. Product identifier

Product form : Substance

Name : METHANE, COMPRESSED

CAS No : 74-82-8

Formula : CH4

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Industrial use. Use as directed.

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number : Onsite Emergency: 1-800-645-4633

CHEMTREC, 24hr/day 7days/week
— Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887
(collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-US classification

Flam. Gas 1 H220
Compressed gas H280

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS02 GHS04

Signal word (GHS-US) : DANGER

Hazard statements (GHS-US) : H220 - **EXTREMELY FLAMMABLE GAS**
H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
OSHA-H01 - MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION
CGA-HG04 - MAY FORM EXPLOSIVE MIXTURES WITH AIR

Precautionary statements (GHS-US) : P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from Heat, Open flames, Sparks, Hot surfaces. - No smoking
P271+P403 - Use and store only outdoors or in a well-ventilated place
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely
P381 - Eliminate all ignition sources if safe to do so
CGA-PG05 - Use a back flow preventive device in the piping
CGA-PG10 - Use only with equipment rated for cylinder pressure
CGA-PG06 - Close valve after each use and when empty
CGA-PG11 - Never put cylinders into unventilated areas of passenger vehicles
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F)

Propane

Safety Data Sheet E-4646

according to the Hazardous Products Regulation (February 11, 2015)

Date of issue: 10 15 1979 Revision date: 08 03 2016 Supersedes: 10 15 2013

SECTION 1: Identification

1.1. Product identifier

Product form	:	Substance
Name	:	Propane
CAS No	:	74-98-6
Formula	:	C3H8
Other means of identification	:	Propane, Liquefied Petroleum Gas, n-propane,dimethylmethane,propyl hydride, refrigerant gas R290
Product group	:	Core Products

1.2. Recommended use and restrictions on use

Recommended uses and restrictions	:	Industrial use Use as directed

1.3. Supplier

Praxair Canada inc.
1200 – 1 City Centre Drive
Mississauga - Canada L5B 1M2
T 1-905-803-1600 - F 1-905-803-1682
www.praxair.ca

1.4. Emergency telephone number

Emergency number	:	1-800-363-0042 Call emergency number 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-CA classification

Flam. Gas 1 H220
Liquefied gas H280

2.2. GHS Label elements, including precautionary statements

GHS-CA labelling

Hazard pictograms :

GHS02 GHS04

Signal word : DANGER

Hazard statements : **EXTREMELY FLAMMABLE GAS**
CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION
MAY CAUSE FROSTBITE
MAY FORM EXPLOSIVE MIXTURES WITH AIR

Precautionary statements : Do not handle until all safety precautions have been read and understood
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Use and store only outdoors or in a well-ventilated area
Leaking gas fire: Do not extinguish, unless leak can be stopped safely
In case of leakage, eliminate all ignition sources

SAFETY DATA SHEET

BITUMEN

000003000832

Version 3.1 | Revision Date 2018/06/06 | Print Date 2018/06/06

SECTION 1. IDENTIFICATION

Product name	:	BITUMEN
Synonyms	:	MacKay River Bitumen, FireBag Hot Bitumen, Dover Bitumen, Bitumen, Off-Spec Bitumen, Sales Oil, FB HB, FHB, MKB, Natural Asphalt
Product code	:	100236
Manufacturer or supplier's details		SUNCOR ENERGY INC. P.O. Box 2844, 150 - 6th Avenue South-West Calgary Alberta T2P 3E3 Canada
Emergency telephone number		Suncor Energy: +1 403-296-3000; Canutec Transportation: 1-888-226-8832 (toll-free) or 613-996-6666; Poison Control Centre: Consult local telephone directory for emergency number(s).

Recommended use of the chemical and restrictions on use

Recommended use	:	Raw product for oil refineries to produce fuels and other petroleum based organic products.
Prepared by	:	Product Safety: +1 905-804-4752

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance	viscous liquid
Colour	black
Odour	Tarry odour. "Rotten egg" if H2S present, but odour is an unreliable warning, since it may deaden the sense of smell.

GHS Classification

Skin irritation : Category 2

GHS label elements

Hazard pictograms :

Signal word : Warning

SAFETY DATA SHEET

KEROSENE

000003000579

Version 2.1 | Revision Date 2018/06/07 | Print Date 2018/06/07

SECTION 1. IDENTIFICATION

Product name	:	KEROSENE
Synonyms	:	Low Sulphur Kerosene, Kerosine, KEROSENE (TYPE 1-K)
Product code	:	101867, 101866
Manufacturer or supplier's details		SUNCOR ENERGY INC. P.O. Box 2844, 150 - 6th Avenue South-West Calgary Alberta T2P 3E3 Canada
Emergency telephone number		Suncor Energy: +1 403-296-3000; Canutec Transportation: 1-888-226-8832 (toll-free) or 613-996-6666; Poison Control Centre: Consult local telephone directory for emergency number(s).

Recommended use of the chemical and restrictions on use

Recommended use	:	Kerosene is a refined petroleum distillate suitable for burning in wick lamps and space heaters designed for kerosene.
Prepared by	:	Product Safety: +1 905-804-4752

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance	Clear liquid.
Colour	Clear and bright
Odour	Hydrocarbon.

GHS Classification

Flammable liquids	:	Category 3
Skin irritation	:	Category 2
Specific target organ toxicity - single exposure	:	Category 3 (Central nervous system)
Aspiration hazard	:	Category 1

GHS label elements

SAFETY DATA SHEET

NAPHTHA (SWEET)

000003000638

Version 3.0 | Revision Date 2019/01/29 | Print Date 2019/01/29

SECTION 1. IDENTIFICATION

Product name	:	NAPHTHA (SWEET)
Synonyms	:	Light Naphtha, Heavy Naphtha, Reformer Feed, Platformer Feed, Hydrodesulfurized Naphtha, Hydrotreated Naphtha, ER57.
Manufacturer or supplier's details		SUNCOR ENERGY INC. P.O. Box 2844, 150 - 6th Avenue South-West Calgary Alberta T2P 3E3 Canada
Emergency telephone number		Suncor Energy: +1 403-296-3000; Canutec Transportation: 1-888-226-8832 (toll-free) or 613-996-6666; Poison Control Centre: Consult local telephone directory for emergency number(s).

Recommended use of the chemical and restrictions on use

Recommended use	:	Light and Heavy naphthas are intermediate refinery products used as feedstocks to platformer units for the production of high octane motor gasoline blending components.
Prepared by	:	Product Safety: +1 905-804-4752

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance	liquid
Colour	Clear to yellow
Odour	Gasoline like.

GHS Classification

Flammable liquids	:	Category 2
Skin irritation	:	Category 2
Germ cell mutagenicity	:	Category 1B
Carcinogenicity	:	Category 1A
Reproductive toxicity	:	Category 2
Specific target organ toxicity - single exposure	:	Category 3 (Central nervous system)

G.6 REFERENCES

CH E 465 Tutorial on PHA, F&EI and CEI

American Institute of Chemical Engineers (2004), Dow's Fire and Explosion Index Hazard Classification Guide, 7th Edition.

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Suncor Energy, Kerosene Safety Data Sheet. Retrieved March 18, 2020, from http://www.online.petro-canada.ca/datasheets/en_CA/w106.pdf

Suncor Energy, Naphtha Safety Data Sheet. Retrieved March 18, 2020, from http://www.online.petro-canada.ca/datasheets/en_CA/w344.pdf