CITY OF ALBUQUERQUE
ENVIRONMENTAL HEALTH DEPARTMENT
AIR QUALITY PROGRAM

Initial Air Quality Construct Permit Application

Kairos Power, LLC
Salt Production Facility

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1. EXECUTIVE SUMMARY

This application is being submitted for the proposed construction of the Salt Production Facility (SPF) which will be owned and operated by Kairos Power, LLC (Kairos). The main purpose of the SPF is to manufacture a high purity heat transfer fluid, or coolant, that is a mixture of lithium fluoride (LiF) and beryllium fluoride (BeF_2) otherwise known as "Flibe." The location of the SPF will be located at UTM Zone 13, 352,786 meters East and 3,874,804 meters North.

SPF employs technologies that are considered proprietary confidential information of Kairos Power and portions are treated as trade secret by Kairos Power. This application takes into consideration these trade secret requirements.

The proposed construction of the SPF will consist of the following sources of emissions:

- EP#1: One (1) vent stack that handles the main production area vent (Unit Vent-300):
  - Thirty-six (36) chemical process tanks (Unit Tanks);
  - Process vents associated with unit areas 100, 150, 300, and 400 tank groups
- EP#2: One (1) bleach synthesis column (Unit BSC-500);
- EP#3: One (1) vent stack associated with unit areas 600 and 950 (Unit Vent-600);
- EP#4A: One (1) 24.525 MMBtu/hr boiler (Unit Boiler-1);
- EP#4B: One (1) 32.700 MMBtu/hr boiler (Unit Boiler-2);
- EP#5: One (1) 7100 gpm cooling tower (Unit Cooling Tower-1);
- EP#6: One (1) 409 hp emergency generator (Unit GEN-1); and
- EP#7: Facility fugitive emissions (Unit FUG-1)

In accordance with 20.11.41.13.E NMAC, this application submittal includes all of the requirements set forth by the department including:

i. Application Forms
ii. Owner and Operator's Name and Mailing Address
iii. Application Date
iv. Sufficient Attachments: Calculations, Potential Emission Rate, Nature of All Regulated Contaminants, Actual emissions
v. Operational and Maintenance Strategy
vi. Topographical Map
vii. Aerial Photograph of proposed location
viii. Complete Description of all Sources of Regulated Air Contaminants and Process Flow Diagram
ix. Full Description of Air Pollution Control Equipment
x. Description of Equipment or Methods used for emission measurement
xi. Maximum and Normal Operating Time Schedules of the Source
xii. Other Relevant Information
xiii. Applicant Signature
xiv. Accompanied by a Registration Fee
xv. Proof of Public Notice Requirements

2. DESCRIPTION OF FACILITY AND EMISSIONS INFORMATION

The following section summarized the emission factors and methodology used to estimate air pollutant emissions from the Kairos Power LLC Salt Production Facility (SPF). This SPF is located on the same campus as the existing Kairos Power Southwest (KPSW) facility in Albuquerque, NM.

2.1 Description of the Facility

Kairos is developing advanced nuclear reactor technology for power generation. This technology utilizes a high purity heat transfer fluid, or coolant, that is a mixture of lithium fluoride (LiF) and beryllium fluoride (BeF_2) that is called “Flibe”. Flibe is known for its chemical stability, high thermal capacity, and other favorable properties for heat transfer. The new SPF will manufacture the Flibe heat transfer salt.

The Flibe coolant will be manufactured at the SPF in Albuquerque, New Mexico. SPF will use a proprietary chemical process to manufacture a coolant for nuclear reactors, Kairos Power calls this nuclear-grade Flibe. Nuclear-grade Flibe only refers to the highly pure nature of the Flibe, where the manufacturing of Flibe **does not** involve any radioactive or nuclear materials; only typical industrial processes and chemicals.

2.2 Process Flow Diagram

The SPF processes are used to make three products: nuclear-grade Flibe, high-purity lithium hydroxide monohydrate (LHM), and Bleach (for internal consumption). Refer to Figure 1 for the overall process flow diagram (PFD) for SPF.

- Process Units 300 and 500A generate intermediate chemicals for Unit 400:
  - Unit 300 reacts the chemicals shown in Process 1 inputs box Unit 400.
  - Unit 500A reacts LHM and hydrochloric acid to form a lithium salt that is used in Unit 400.

- Process Unit 400 separates, via a closed loop extraction, impurities and creates a purified material. Process output are two product streams that feed Unit Process 500B.

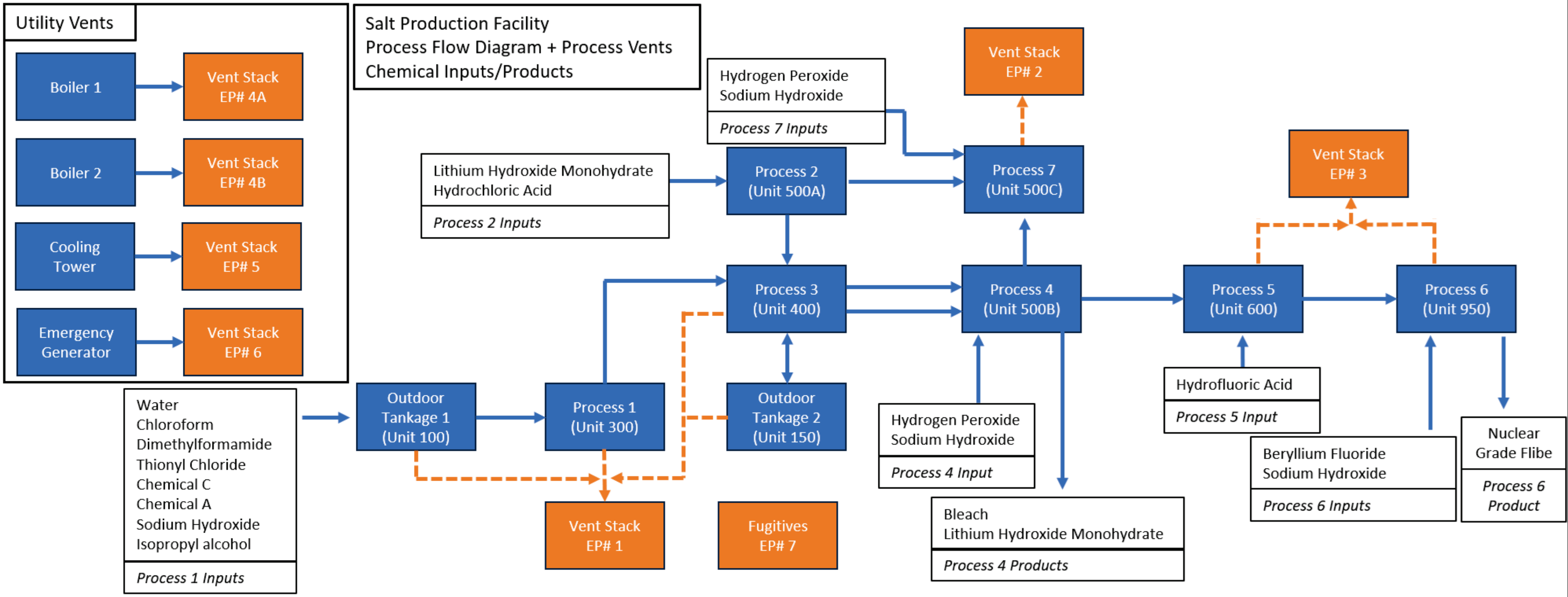
- Unit Process 500B converts purified lithium salts into LHM. One stream feeds Unit Process 600, and the second stream is a commercial product.

- Unit Process 600 reacts LHM with hydrofluoric acid into a lithium salt, which is dried as a solid. This solid feeds Unit Process 950.

- Unit Process 950 reacts the lithium salt from Unit Process 600 with beryllium salt to form the final product of Nuclear-Grade Flibe.

- Unit Process 500C generates bleach, used for in the cooling tower and other as a disinfectant

A process flow diagram (PFD) is attached below.



Utility Vents

Boiler 1
Vent Stack EP# 4A

Boiler 2
Vent Stack EP# 4B

Cooling Tower
Vent Stack EP# 5

Emergency Generator
Vent Stack EP# 6

Salt Production Facility
Process Flow Diagram + Process Vents
Chemical Inputs/Products

Water
Chloroform
Dimethylformamide
Thionyl Chloride
Chemical C
Chemical A
Sodium Hydroxide
Isopropyl alcohol
Process 1 Inputs

Outdoor Tankage 1 (Unit 100)

Process 1 (Unit 300)

Vent Stack EP# 1

Outdoor Tankage 2 (Unit 150)

Fugitives EP# 7

Lithium Hydroxide Monohydrate
Hydrochloric Acid
Process 2 Inputs

Process 2 (Unit 500A)

Process 3 (Unit 400)

Hydrogen Peroxide
Sodium Hydroxide
Process 7 Inputs

Process 7 (Unit 500C)

Vent Stack EP# 2

Process 4 (Unit 500B)

Hydrogen Peroxide
Sodium Hydroxide
Process 4 Input

Bleach
Lithium Hydroxide Monohydrate
Process 4 Products

Process 5 (Unit 600)

Hydrofluoric Acid
Process 5 Input

Vent Stack EP# 3

Process 6 (Unit 950)

Beryllium Fluoride
Sodium Hydroxide
Process 6 Inputs

Nuclear Grade Flibe
Process 6 Product

Kruizenga 4/14/2025 Non-Proprietary

2.3 Air Pollutant Emissions and Calculation Methodology

Emission Point 1: Vent Stack for Unit Areas 100, 150, 300, and 400 (Unit Vent-300)

Emissions from the vent stack are a result of tank emissions from fixed roof tanks, as well as non-tank emissions from various column overhead receivers.

Methodology for Tank Emissions

VOC, HAP, and PM tank emissions are from the fixed roof tanks as result of working and breathing losses. Emissions were calculated using the latest edition of EPA's AP-42 Chapter 7 "Liquid Storage Tanks." Specifically, AP-42 Section 7.1.3.1 "Routine Losses From Fixed Roof Tanks" was used. All constants and equations used are highlighted in the AP-42 Chapter 7 reference document in Appendix F. Supporting Documentation.

Hourly total routine losses (lb/hr) are the sum of standing losses, L_S, and working losses, L_W, per Eq. 1-1. Standing losses are the product of vapor stock volume, V_V, stock vapor density, W_V, vapor space expansion factor, K_E (Eq. 1-12), and vented vapor saturation factor, K_S (Eq. 1-21), as per Eq. 1-2. Working losses are the product of net working loss throughput, V_Q, working loss turnover (saturation) factor, K_N (from Eq. 1-35), working loss product factor, K_P (from Eq. 1-35), vapor density, W_V (Eq. 1-22), and vent setting correction factor, K_B (from Eq. 1-35), as per Eq. 1-35.

The average vapor pressure is assumed to be equal to the operating temperature. The vapor molecular weight is conservatively assumed to be equivalent to the liquid molecular weight. VOC, HAP, and PM emissions were determined by the contents of each tank. For a tank containing PM, it was conservatively assumed that the total working and standing losses of the tank would be equivalent to the PM from the tank. Hourly and annual emissions are based on the design of the facility.

Methodology for Non-Tank Emissions

VOC, SO_2, and HAP non-tank emissions are from column overheads from: an IPA distillation column; a chloroform recovery and neutralization column; a flash evaporator; a Wipe Film Evaporator (WFE); a Mother Liquor (ML) evaporator; and a dimethylformamide (DMF) distillation tower.

Hourly mass rates were determined based on the process design for each column. The hourly mass rates (lb/hr) were multiplied by the wt. % of each pollutant from their respective columns to determine individual pollutant rates. These were then summed to determine the total hourly non-vent emission rates for each pollutant. Annual emission rates followed the same methodology but use annual mass rates for each column. Annual mass rates were determined by how many hours the column is expected to run in any given year based on the process design.

Emission Point 2: Bleach Synthesis Column (Unit BSC-500)

HAP emissions from the bleach synthesis column are from analyte gas. Hourly mass rates were determined based on the process design for the bleach synthesis column. The hourly mass rates (lb/hr) were multiplied by the wt. % of each pollutant to determine individual pollutant rates. These were then summed to determine the total hourly emission rates for each pollutant. Annual emission rates followed the same methodology but use annual mass rates for each column. Annual mass rates were determined by how many hours the column is expected to run in any given year based on the process design.

Emission Point 3: Vent Stack for Unit Areas 600 and 950 (Unit Vent-600)

Emissions from the vent stack are a result of tank emissions from fixed roof tanks, as well as non-tank emissions from various processes in the area.

Methodology for Tank Emissions

VOC, HAP, and PM tank emissions are from the fixed roof tanks as result of working and breathing losses. Emissions were calculated using the latest edition of EPA's AP-42 Chapter 7 "Liquid Storage Tanks." Specifically, AP-42 Section 7.1.3.1 "Routine Losses From Fixed Roof Tanks" was used. All constants and equations used are highlighted in the AP-42 Chapter 7 reference document in Appendix F. Supporting Documentation.

Hourly total routine losses (lb/hr) are the sum of standing losses, L_S, and working losses, L_W, per Eq. 1-1. Standing losses are the product of vapor stock volume, V_V, stock vapor density, W_V, vapor space expansion factor, K_E (Eq. 1-12), and vented vapor saturation factor, K_S (Eq. 1-21), as per Eq. 1-2. Working losses are the product of net working loss throughput, V_Q, working loss turnover (saturation) factor, K_N (from Eq. 1-35), working loss product factor, K_P (from Eq. 1-35), vapor density, W_V (Eq. 1-22), and vent setting correction factor, K_B (from Eq. 1-35), as per Eq. 1-35.

The average vapor pressure is assumed to be equal to the operating temperature. The vapor molecular weight is conservatively assumed to be equivalent to the liquid molecular weight. VOC, HAP, and PM emissions were determined by the contents of each tank. For a tank containing PM, it was conservatively assumed that the total working and standing losses of the tank would be equivalent to the PM from the tank. Hourly and annual emissions are based on the design of the facility.

Methodology for Non-Tank Emissions

HAP non-tank emissions are from various process vents from: Nutsche Filter Vent; Paddle Dryer Vent; and Maint Vent Header.

Hourly mass rates were determined based on the process design for each vent. The hourly mass rates (lb/hr) were multiplied by the wt. % of each pollutant from their respective vents to determine individual pollutant rates. These were then summed to determine the total hourly non-vent emission rates for each pollutant. Annual emission rates followed the same methodology but use annual mass rates for each column. Annual mass rates were determined by how many hours the column is expected to run in any given year based on the process design.

Emission Point 4: Cooling Tower (Unit Cooling Tower-1)

Particulate matter emissions from the cooling tower are a result of particulate matter constituents in the liquid water entrained in the air stream and carried out of the tower as "drift" droplets. Particulate size distribution from the drift droplets was calculated based on the emission calculations outlined in Reisman, J. and G. Frisbie "Calculating Realistic PM10 Emissions from Cooling Towers", Greystone Environmental Consultants, Inc., 650 University Avenue, Suite 100, Sacramento, CA 95825. The diameter of the solid particle (µm) was determined from the diameter of the drift droplet and the total dissolved solids (TDS) of the water by the following equation from Reisman and Frisbie:

$$D_p = D_d \left[(TDS) (\rho_w / \rho_{TDS}) \right]^{1/3}$$

where TDS is in units of ppmw, D_p is the diameter of the solid particle in µm, and D_d is the diameter of the drift droplet in µm. A table was created to calculate the diameter of the solid particles based on various droplet diameters and TDS ppmw values. EPRI particle size distribution parameters comparing PM to the calculated PM diameter were also added based on the EPRI droplet diameters from the first and last columns from Table 1 of the Reisman and Frisbie study. Particle size distribution values were conservatively taken from the closest calculated diameter higher than 10 µm for PM_{10} and 2.5 µm for $PM_{2.5}$.

For this facility, the maximum total dissolved solids (TDS) ppmw was taken from the 2023 Consumer Confidence Report – Zone 3 by the Albuquerque Bernalillo County Water Utility Authority (Water Authority). The Water Authority max TDS was conservatively rounded up to 500 ppm.

Hourly PM emission rates were calculated by multiplying the water circulation rate (gpm) by the drift rate (%) and TDS concentration (ppmw), then multiplying by the density of water (8.34 lb/gal) and the conversion factor of 60 min/hr. Hourly PM_{10} emissions were determined by multiplying the hourly PM emission rate (lb/hr) by the PM_{10} portion of PM (%), and the same method was applied for the hourly $PM_{2.5}$ emission rates. For annual emissions, the hourly emission rate (lb/hr) was multiplied by 8,760 hr/yr and then divided by 2,000 lb/ton.

Emission Point 5A/B: Natural Gas Boilers (Units Boiler-1 and Boiler-2)

Emissions from the boilers are a result of the combustion of natural gas. The natural gas heat value was taken from AP-42 Appendix A. NO_x, CO, VOC, and PM emissions factors (lb/MMscf) are taken from AP-42 Section 1.4 Tables 1.4-1 and 1.4-2. SO_2 emissions are based on the assumption of 2 grains of elemental sulfur per 100 scf of natural gas. HAP emission factors (lb/MMscf) were taken from AP-42 Table 1.4-3. Total HAPs include formaldehyde, benzene, n-hexane, and toluene.

The hourly fuel usage (MMscf/hr) was found by taking the boiler capacity (MMBtu/hr) and dividing it by the fuel heat value (Btu/scf). For NO_x, CO, VOC, PM, and all HAPs, the emission factor (lb/MMscf) was multiplied by the fuel consumption (MMscf/hr) to obtain hourly emission rates (lb/hr). For SO_2, the emission factor (2 gr S / 100 scf) was divided by the conversion factor of 7,000 gr/lb and then multiplied by the molar ratio of 62 lb/lbmol SO_2 / 32 lb/lbmol S and then multiplied by the hourly fuel usage (scf/hr) to obtain hourly emission rates. This assumes a 100% conversion of elemental sulfur to SO_2. For all pollutants, the hourly emission rates were multiplied by 8,760 hours/year and divided by the conversion factor of 2,000 lb/ton to obtain annual emission rates (tpy). The boilers do not have any controls to reduce emissions.

Emission Point 6: Emergency Diesel Fired Generators (Unit GEN-1)

Emissions from the generator are a result of the combustion of diesel fuel. The diesel heat value was taken from AP-42 Appendix A. An assumed fuel consumption value of 43 gal/hr was taken based on similar models. NO_x, CO, VOC, and PM emissions are based on EPA NSPS Tier 4 emission factors for $255 \leq$ kW $<$ 450 rated power engines. SO_2 emissions are based AP-42 Table 3.3-1 emission factors for SO_2. HAP emissions are based on AP-42 Table 3.3-1 & 3.3-2 emission factors. HAPs include formaldehyde, acetaldehyde, acrolein, benzene, toluene, xylene, propylene, 1-3-Butadiene, and naphthalene.

For NO_x, CO, VOC, and PM emissions, the emission factors (g/kW-hr) were divided by 453.59 g/lb and multiplied by the engine power (kW) to calculate lb/hr emissions. The heat value (Btu/gal) was multiplied by the fuel consumption (gal/hr) and divided by 10^6 Btu/MMBtu to obtain a maximum heat rate (MMBtu/hr). For SO_2 and HAP emissions, the emission factors (lb/MMBtu) were multiplied by the heat rate (MMBtu/hr) to calculate lb/hr emissions. For uncontrolled annual emissions, the lb/hr rate was multiplied by 8,760 hr/yr and divided by 2,000 lb/ton. For controlled annual emissions, the lb/hr rate was multiplied by 500 hr/yr and divided by 2,000 lb/ton.

Emission Point 7: Facility Fugitive Emissions (Unit FUG-1)

Fugitive emission calculations were performed using “SOCMI Without Ethylene (C2)” emission factors from Table I: “Uncontrolled SOCMI Fugitive Emission Factors,” in Appendix A of the TCEQ Guidance Document “Air Permit Technical Guidance for Chemical Sources – Fugitive Guidance” (APDG 6422v2, Revised 06/18). Subcomponent counts for each equipment type and service (Gas/Vapor, Light Liquid, Heavy Liquid, or All) were based on estimated average component counts. For each service category, VOC and HAP contents were derived from the liquid with the highest pollutant concentrations (chloroform).

For each type of fugitive component and service, VOC and HAP emissions were calculated by multiplying the appropriate emission factor (lb/hr/source) by the number of components within each service category, and the respective VOC and HAP content (wt.%) for each service to produce hourly emission rates (lb/hr). For all pollutants, the hourly uncontrolled emission rates were multiplied by 8,760 hours/year and divided by the conversion factor of 2,000 lb/ton to obtain annual emission rates (tpy).

This facility will be enforce a Leak Detection and Repair (LDAR) program. Per the TCEQ guidance document, “LDAR programs are used to inspect fugitive components to identify leaks either by using instruments or in limited cases, by physical inspections. Leaks identified by the inspections are then repaired within a specified time period, thus reducing the emissions.” Additionally, the document specifies a reduction credit can be claimed for annual and quarterly connector monitoring:

> “Annual instrument monitoring of connectors/flanges at a 500 ppmv leak detection limit may receive a 75% reduction credit at petroleum refineries and SOCMI facilities. This determination is based on information contained in the 1993 EPA document “Protocol for Equipment Leak Fugitives” and the results from monitoring data. The control effectiveness percentages given in the protocol document are based on the type of facility, monitored data, and the corresponding reduction in the percentage of leaking flanges. The lowest percent reduction was used to establish the appropriate reduction credit as it is preferable to allow a single reduction credit for both chemical facilities and refineries. Thus, the 75% reduction credit is suitable for use at both petroleum refineries and SOCMI facilities where the connectors/flanges are monitored annually at 500 ppmv. The 28CNTA LDAR program specifies the monitoring and recordkeeping necessary to receive the 75% reduction credit. This program may be used in conjunction with any of the other 28 series LDAR programs, except 28LAER, which already includes connector monitoring.”

Therefore, this facility will perform annual monitoring of the connectors/flanges at a 500 ppmv leak detection limit to receive a 75% reduction credit for the controlled fugitive emissions rates.

2.4 Emission Calculations

The following pages contain the emission calculations for all sources of emission at the SPF.

Kairos Power

Kairos Power - Salt Production Facility

Emission Summary

Uncontrolled Emissions

EP No. / Unit ID	NO$_X$ lb/hr	NO$_X$ tons/yr	CO lb/hr	CO tons/yr	VOC lb/hr	VOC tons/yr	SO$_2$ lb/hr	SO$_2$ tons/yr	PM$_{10}$ lb/hr	PM$_{10}$ tons/yr	PM$_{2.5}$ lb/hr	PM$_{2.5}$ tons/yr	Total HAPs lb/hr	Total HAPs tons/yr
EP-1: Vent-300 [2]	-	-	-	-	85.98	36.41	-	-	1.37E-03	2.28E-04	1.37E-03	2.28E-04	46.37	2.13
EP-2: BSC-500	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.73
EP-3: Vent-600 [2]	-	-	-	-	-	-	-	-	-	-	-	-	0.13	0.59
EP-4: Cooling Tower-1	-	-	-	-	-	-	-	-	0.70	3.08	0.014	0.061	-	-
EP-5A: Boiler-1 [4]	1.20	5.27	2.02	8.85	0.13	0.58	0.14	0.60	0.18	0.80	0.18	0.80	0.045	0.20
EP-5B: Boiler-2 [4]	1.60	7.02	2.69	11.80	0.18	0.77	0.18	0.80	0.24	1.07	0.24	1.07	0.060	0.26
EP-6: GEN-1	2.63	11.53	0.99	4.34	0.14	0.61	0.88	3.85	0.099	0.43	0.099	0.43	0.019	0.084
EP-7: FUG-1	-	-	-	-	1.97	8.63	-	-	-	-	-	-	1.88	8.25
Total	**5.44**	**23.82**	**5.70**	**24.98**	**88.40**	**47.00**	**1.20**	**5.25**	**1.23**	**5.38**	**0.54**	**2.36**	**48.68**	**12.25**

Controlled Emissions

EP No. / Unit ID	NO$_X$ lb/hr	NO$_X$ tons/yr	CO lb/hr	CO tons/yr	VOC lb/hr	VOC tons/yr	SO$_2$ lb/hr	SO$_2$ tons/yr	PM$_{10}$ lb/hr	PM$_{10}$ tons/yr	PM$_{2.5}$ lb/hr	PM$_{2.5}$ tons/yr	Total HAPs lb/hr	Total HAPs tons/yr
EP-1: Vent-300 [3]	-	-	-	-	85.98	36.41	-	-	1.37E-03	2.28E-04	1.37E-03	2.28E-04	46.37	2.13
EP-2: BSC-500	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.73
EP-3: Vent-600 [3]	-	-	-	-	-	-	-	-	-	-	-	-	0.13	0.59
EP-4: Cooling Tower -1	-	-	-	-	-	-	-	-	0.70	3.08	0.014	0.061	-	-
EP-5A: Boiler-1 [4]	1.20	5.27	2.02	8.85	0.13	0.58	0.14	0.60	0.18	0.80	0.18	0.80	0.045	0.20
EP-5B: Boiler-2 [4]	1.60	7.02	2.69	11.80	0.18	0.77	0.18	0.80	0.24	1.07	0.24	1.07	0.060	0.26
EP-6: GEN-1	2.63	0.66	0.99	0.25	0.14	0.035	0.88	0.22	0.099	0.025	0.099	0.025	0.019	4.82E-03
EP-7: FUG-1	-	-	-	-	0.49	2.16	-	-	-	-	-	-	0.47	2.06
Total	**5.44**	**12.94**	**5.70**	**20.89**	**86.92**	**39.96**	**1.20**	**1.62**	**1.23**	**4.97**	**0.54**	**1.95**	**47.27**	**5.98**
Total w/o Fugitives	**5.44**	**12.94**	**5.70**	**20.89**	**86.43**	**37.80**	**1.20**	**1.62**	**1.23**	**4.97**	**0.54**	**1.95**	**46.80**	**3.92**

Controlled HAP Emissions

EP No. / Unit ID	Total HAPs lb/hr	Total HAPs tons/yr	Formaldehyde lb/hr	Formaldehyde tons/yr	n-Hexane lb/hr	n-Hexane tons/yr	Hydrogen Chloride lb/hr	Hydrogen Chloride tons/yr	Chloroform lb/hr	Chloroform tons/yr	Chlorine lb/hr	Chlorine tons/yr	Hydrogen Fluoride lb/hr	Hydrogen Fluoride tons/yr
EP-1: Vent-300 [3]	46.37	2.13	-	-	-	-	7.78E-05	1.06E-04	46.37	2.13	-	-	-	-
EP-2: BSC-500	0.17	0.73	-	-	-	-	-	-	-	-	0.17	0.73	-	-
EP-3: Vent-600 [3]	0.13	0.59	-	-	-	-	-	-	-	-	-	-	0.13	0.59
EP-4: Cooling Tower -1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EP-5A: Boiler-1	0.045	0.20	1.80E-03	7.90E-03	0.043	0.19	-	-	-	-	-	-	-	-
EP-5B: Boiler-2	0.060	0.26	2.40E-03	0.011	0.058	0.25	-	-	-	-	-	-	-	-
EP-6: GEN-1	0.019	4.82E-03	3.57E-03	8.93E-04	-	-	-	-	-	-	-	-	-	-
EP-7: FUG-1	0.47	2.06	-	-	-	-	-	-	0.47	2.06	-	-	-	-
Total	**47.27**	**5.98**	**7.78E-03**	**0.019**	**0.10**	**0.44**	**7.78E-05**	**1.06E-04**	**46.84**	**4.20**	**0.17**	**0.73**	**0.13**	**0.59**

Notes:

[1] Uncontrolled emissions are represented from Tank Vents

[2] Uncontrolled emissions are represented from Non-Tank Vents

[3] Controlled emissions are represented from Tank Vents & Non-Tank Vents [Main Header Vent Collection]

[4] Assumed PM = PM$_{10}$ = PM$_{2.5}$

Kairos Power

Kairos Power - Salt Production Facility

Inputs Summary

	Tank ID	Number of Tanks on Site	Unit Area	Description	Pollutant Classification	Inherent Condenser?	Control Method	Type of Roof	Insulated	Capacity (Gallons)	Tank Throughput (lb/hr)	Tank throughput (lb/yr)	Tank Throughput (tn/yr)	Source (Throughput)	Dimensions		MAWP (PSIG)	Material
															Diameter (ft)	Height (ft)		
Unit 100,150 & 300 Tank Vents	TK-100-1-01	1	100	Chloroform Tank	HAP; VOC, CHCl3	Inherent Chloroform (CHCL$_3$) Condenser	N/A	Fixed Roof	Yes	6,267	75,450	405,000	203	Raw Chemical Usage Requirement	8	16	14	SS316L
	TK-101-1-01	2	100	Process Water Tank	HAP, VOC, Metal Chloride Salt, CHCl3	Vent to ATM	N/A	Fixed Roof	No	6,267	7,040	36,041,221	18,021	PFD/Mass Balance	8	16	2.5	SS316L
	TK-105-1-01	3	100	Isopropanol Tank	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	8,226	56,281	2,475,000	1,238	Raw Chemical Usage Requirement	10	14	2.5	HDPE
	TK-105-1-02	4	100	Isopropanol Tank	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	No	6,315	33,000.0	12,059,040	6,030	PFD/Mass Balance	8.5	14	2.5	HDPE
	TK-107-1-01	5	100	Aqueous Waste Tank	HAP, VOC, CHCl3	Vent to ATM	N/A	Fixed Roof	Yes	8,226	11,065	24,004,238	12,002	PFD/Mass Balance	13	16	5	SS316L
	TK-108-1-01	6	100	Organic Waste Tank	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	7,051	341	2,283,297	1,142	PFD/Mass Balance	10	12	5	SS316L
	TK-TBD	7	150	Separation Feed Tank	HAP; VOC; CHCl3	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	No	15,580	17	150,792	75	KP Estimate (09/09/2024)	TBD	TBD	TBD	TBD
	TK-TBD	8	150	Separation Feed Tank	HAP; CHCl3	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	15,580	17	150,792	75	KP Estimate (09/09/2024)	TBD	TBD	TBD	TBD
	TK-150-1-01	9	150	In-Process Tank #1	HAP, VOC, Metal Chloride Salt; CHCl3	Vent to ATM	N/A	Fixed Roof	Yes	5,000	25,087	576,000	288	PID-150-1-01 Rev A	TBD	TBD	5	SS316L
	TK-151-1-01	10	150	In-Process Tank #2	HAP, VOC, Metal Chloride Salt; CHCl3	Vent to ATM	N/A	Fixed Roof	Yes	5,000	25,087	576,000	288	PID-151-1-01 Rev A	TBD	TBD	5	SS316L
	TK-156-1-01	11	150	LHM Buffer Tank #1	Metal Chloride Salt	Vent to ATM	N/A	Fixed Roof	No	500	16	140,160	70	NESI-1001-4001-PFD-01	6	10	5	SS316L
	TK-157-1-01	12	150	LHM Buffer Tank #2	Metal Chloride Salt	Vent to ATM	N/A	Fixed Roof	No	500	16	140,160	70	NESI-1001-4001-PFD-01	6	10	5	SS316L
	TK-158-1-01	13	150	Organic Phase Surge Tank	HAP, VOC, Metal Chloride Salt; CHCl3	Vent to ATM	N/A	Fixed Roof	No	5,000	25,087	576,000	288	PID-150-1-01 Rev A	TBD	TBD	5	SS316L
	TK-159-1-01	14	150	Brine Surge Tank	Metal hydroxide	Vent to ATM	N/A	Fixed Roof	No	5,000	69	604,440	302	NESI-1001-4001-PFD-01	TBD	TBD	40	SS316L
	TK-160-1-01	15	150	Fresh Brine Tank	Metal Chloride Salt	Vent to ATM	N/A	Fixed Roof	No	1,800	32	280,320	140	NESI-1001-4001-PFD-01	8	14	5	SS316L
	TK-165	16	150	In-Process Tank #3	HAP; CHCl3	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	15,580	17	150,792	75	KP Estimate (09/09/2024)	TBD	TBD	TBD	TBD
	TK-TBD	17	300	Aqueous Hazardous Waste Tank	VOC	Vent to ATM	N/A	Fixed Roof	Yes	11,000	515	173,040	87	KP Estimate (09/09/2024)	TBD	TBD	TBD	TBD
	TK-TBD	18	300	Chloroform Tank	HAP; CHCl3	Inherent Chloroform (CHCL$_3$) Condenser	N/A	Fixed Roof	Yes	200	1,351	7,229,883	3,615	PFD/Mass Balance	TBD	TBD	TBD	TBD
	TK-301-1-02	19	300	Neutralization Tank	HAP, VOC; CHCl3; HCl	Vent to ATM	N/A	Fixed Roof	No	2,669	3,946	10,522,701	5,261	PFD/Mass Balance	6	12	14	316 SS
	TK-304-1-03	20	300	Recycle Water Tank	HAP, VOC; CHCl3	Vent to ATM	N/A	Fixed Roof	Yes	2,700	13	66,900	33	PFD/Mass Balance	TBD	TBD	14	316L SS
	TK-306-1-01	21	300	Dissolving Vessel	HAP, VOC, PMx	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	603	50	66,900	33	PFD/Mass Balance	TBD	TBD	TBD	TBD
	TK-307-1-01	22	300	Intermediate Tank	HAP, VOC; CHCl3	Vent to ATM	N/A	Fixed Roof	No	458	1,075	722,064	361	PFD/Mass Balance	TBD	TBD	14	316L SS
	TK-308-1-01	23	300	DMF Tank	HAP, VOC	Vent to ATM	N/A	Fixed Roof	No	458	41,510.0	711,147	356	PFD/Mass Balance	TBD	TBD	14	316 SS
	TK-309-1-01	24	300	Reactor 2	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	5,000	28,980.0	9,737,280	4,869	PFD/Mass Balance	TBD	TBD	100	Glass Lined Carbon Steel
	TK-311-1-01	25	300	Isopropanol Tank	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	6,315	33,000.0	12,059,040	6,030	PFD/Mass Balance	8.5	14	2.5	HDPE
	TK-323-1-01	26	300	Chloroform Tank	HAP, VOC; CHCl3	Inherent Chloroform (CHCL$_3$) Condenser	N/A	Fixed Roof	No	2,200	48,122.0	7,088,055	3,544	PFD/Mass Balance	TBD	TBD	14	316 SS
	TK-341-1-01	27	300	Isopropanol Tank	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	2,250	1,365.9	7,310,163	3,655	PFD/Mass Balance	6	10	14	316 SS
	TK-341-1-02	28	300	Isopropanol Tank	VOC	Inherent Isopropanol (IPA) Condenser	N/A	Fixed Roof	Yes	2,250	750	2,016,000	1,008	PFD/Mass Balance	TBD	TBD	5	316 SS

Kairos Power - Salt Production Facility

Inputs Summary

	Tank ID	Operating Temp (° F)	Operating Pressure (PSIG)	Tank Material Composition (wt%)																					Total (wt%)
				$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF	
Unit 100,150 & 300 Tank Vents	TK-100-1-01	80	3.5	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				100																					100
	TK-101-1-01	80	1	0.015%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.003%	0%	0%	0%	100.0%
				2	14,276																0				14,278
	TK-105-1-01	80	1	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
											100														100
	TK-105-1-02	77	1	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
											35,890														35,890
	TK-107-1-01	80	1	0.000%	78.7%	0.3%	0%	8.5%	11.6%	0%	0.6%	0%	0%	0%	0%	0%	0.3%	0%	0%	0.000%	0%	0%	0%	0%	100.0%
				0	13,578	55		1,468	2,005		106						47			0					17,259
	TK-108-1-01	80	1	0%	0%	0%	0%	0%	0.4%	0%	60.0%	0%	2.6%	16.8%	17.2%	0%	0%	0%	3.1%	0%	0%	0%	0%	0%	100.0%
									12		2,048		88	572	587				106						3,413
	TK-TBD	69.5	0	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				100																					100
	TK-TBD	69.5	0	60.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				60										40											100
	TK-150-1-01	80	1	67.3%	4.3%	0%	0%	0%	0%	0%	0%	0%	0%	22.8%	0%	0%	0%	0%	0%	0%	5.6%	0%	0%	0%	100.0%
				7,196	463									2,433							600				10,692
	TK-151-1-01	80	1	67.3%	4.3%	0%	0%	0%	0%	0%	0%	0%	0%	22.8%	0%	0%	0%	0%	0%	0%	5.6%	0%	0%	0%	100.0%
				7,196	463									2,433							600				10,692
	TK-156-1-01	100	1	0%	55.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44.7%	0%	0%	0%	100.0%
					4																3				8
	TK-157-1-01	100	1	0%	55.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44.7%	0%	0%	0%	100.0%
					4																3				8
	TK-158-1-01	80	1	67.3%	4.3%	0%	0%	0%	0%	0%	0%	0%	0%	22.8%	0%	0%	0%	0%	0%	0%	5.6%	0%	0%	0%	100.0%
				7,196	463									2,433							600				10,692
	TK-159-1-01	110	1	0%	94.5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5.5%	0%	0%	0%	100.0%
					33																2				34
	TK-160-1-01	80	1	0%	55.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	45.0%	0%	0%	0%	100.0%
					8																7				15
	TK-165	69.5	0	60.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				60										40											100
	TK-TBD	69.5	0	0%	56.0%	0%	0%	12.5%	12.5%	0%	11.0%	0%	0%	0%	0%	0%	0%	0%	0%	8.0%	0%	0%	0%	0%	100.0%
					56			13	13		11									8					100
	TK-TBD	90	1	99.8%	0.2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				100	0																				100
	TK-301-1-02	77	1	2.3%	86.2%	0.076%	0.070%	7.8%	3.6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				367	13,551	12	11	1,222	566																15,729
	TK-304-1-03	100	1	0.8%	99.2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				1	99																				100
	TK-306-1-01	77	1	0%	0%	0%	0%	0%	0%	0%	60.0%	0%	40.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
											60		40												100
	TK-307-1-01	77	1	1.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	99.0%	0%	0%	0%	0%	0%	100.0%
				21															2,128						2,149
	TK-308-1-01	77	1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	100.0%
																				1,063					1,063
	TK-309-1-01	100.4	1	0%	3.5%	0.2%	0%	0%	3.2%	0%	85.6%	0%	0.3%	5.2%	1.7%	0%	0%	0%	0.3%	0%	0%	0%	0%	0%	100.0%
					1,190	84			1,076		28,980		88	1,760	587				106						33,871
	TK-311-1-01	77	1	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
											35,890														35,890
	TK-323-1-01	77	1	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				10,595																					10,595
	TK-341-1-01	100.4	1	0%	12.1%	0%	0%	0%	0%	0%	87.9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					1,322						9,605														10,927
	TK-341-1-02	180	15	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
											10														10

Kairos Power

Kairos Power - Salt Production Facility

Inputs Summary

	Tank ID	Component Molar Mass (lb/lb-mol)																				
		$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF
Unit 100,150 & 300 Tank Vents	TK-100-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-101-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-105-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-105-1-02	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-107-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-108-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-TBD	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-TBD	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-150-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-151-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-156-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-157-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-158-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-159-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-160-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-165	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-TBD	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-TBD	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-301-1-02	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-304-1-03	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-306-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-307-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-308-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-309-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-311-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-323-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-341-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-341-1-02	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99

Kairos Power

Kairos Power - Salt Production Facility

Inputs Summary

	Tank ID	Tank Material Composition (mol%)																					Avg Molecular Wt (lb/lbmol)	Total (mol%)
		$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF		
Unit 100,150 & 300 Tank Vents	TK-100-1-01	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	119.38	100.00%
		0.008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0084
	TK-101-1-01	0.0023%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0012%	0%	0%	0%	18.02	100.00%
		1.30E-06	0.055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.61E-07	0	0	0		0.0555
	TK-105-1-01	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60.10	100.00%
		0	0	0	0	0	0	0	0.017	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0166
	TK-105-1-02	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60.10	100.00%
		0	0	0	0	0	0	0	0.017	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0166
	TK-107-1-01	0.0000%	93.9%	0.2%	0%	1.5%	4.3%	0%	0.2%	0%	0%	0%	0%	0%	0.0301%	0%	0%	0.0000%	0%	0%	0%	0%	21.50	100.00%
		2.43E-12	0.044	7.97E-05	0	6.75E-04	0.002	0	1.02E-04	0	0	0	0	0	1.40E-05	0	0	1.59E-11	0	0	0	0		0.0465
	TK-108-1-01	0%	0%	0%	0%	0%	0.5%	0%	87.9%	0%	2.1%	5.5%	2.8%	0%	0%	0%	1.2%	0%	0%	0%	0%	0%	88.04	100.00%
		0	0	0	0	0	6.02E-05	0	0.010	0	2.34E-04	6.25E-04	3.21E-04	0	0	0	1.34E-04	0	0	0	0	0		0.0114
	TK-TBD	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	119.38	100.00%
		0.008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0084
	TK-TBD	0.771235	0%	0%	0%	0%	0%	0%	0%	0%	0%	22.9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	24.31	100.00%
		0.005	0	0	0	0	0	0	0	0	0	0.001	0	0	0	0	0	0	0	0	0	0		0.0065
	TK-150-1-01	55.2%	23.5%	0%	0%	0%	0%	0%	0%	0%	0%	8.3%	0%	0%	0%	0%	0%	0%	13.0%	0%	0%	0%	97.91	100.00%
		0.006	0.002	0	0	0	0	0	0	0	0	8.48E-04	0	0	0	0	0	0	0.001	0	0	0		0.0102
	TK-151-1-01	55.2%	23.5%	0%	0%	0%	0%	0%	0%	0%	0%	8.3%	0%	0%	0%	0%	0%	0%	13.0%	0%	0%	0%	97.91	100.00%
		0.006	0.002	0	0	0	0	0	0	0	0	8.48E-04	0	0	0	0	0	0	0.001	0	0	0		0.0102
	TK-156-1-01	0%	74.4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25.6%	0%	0%	0%	24.26	100.00%
		0	0.031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.011	0	0	0		0.0412
	TK-157-1-01	0%	74.4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25.6%	0%	0%	0%	24.26	100.00%
		0	0.031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.011	0	0	0		0.0412
	TK-158-1-01	55.2%	23.5%	0%	0%	0%	0%	0%	0%	0%	0%	8.3%	0%	0%	0%	0%	0%	0%	13.0%	0%	0%	0%	97.91	100.00%
		0.006	0.002	0	0	0	0	0	0	0	0	8.48E-04	0	0	0	0	0	0	0.001	0	0	0		0.0102
	TK-159-1-01	0%	97.6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2.4%	0%	0%	0%	18.61	100.00%
		0	0.052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.001	0	0	0		0.0537
	TK-160-1-01	0%	74.2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25.8%	0%	0%	0%	24.31	100.00%
		0	0.031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.011	0	0	0		0.0411
	TK-165	77.1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	22.9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	24.31	100.00%
		0.005	0	0	0	0	0	0	0	0	0	0.001	0	0	0	0	0	0	0	0	0	0		0.0065
	TK-TBD	0%	83.7%	0%	0%	2.7%	5.8%	0%	4.9%	0%	0%	0%	0%	0%	0%	0%	0%	2.9%	0%	0%	0%	0%	26.93	100.00%
		0	0.031	0	0	9.92E-04	0.002	0	0.002	0	0	0	0	0	0	0	0	0.001	0	0	0	0		0.0371
	TK-TBD	98.7%	1.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	118.05	100.00%
		0.008	1.11E-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0085
	TK-301-1-02	0.4%	97.0%	0.0387%	0.0389%	1.3%	1.2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	20.29	100.00%
		1.95E-04	0.048	1.91E-05	1.92E-05	6.16E-04	6.16E-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0493
	TK-304-1-03	0.1%	99.9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18.15	100.00%
		6.84E-05	0.055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0551
	TK-306-1-01	0%	0%	0%	0%	0%	0%	0%	73.3%	0%	26.7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	73.44	100.00%
		0	0	0	0	0	0	0	0.010	0	0.004	0	0	0	0	0	0	0	0	0	0	0		0.0136
	TK-307-1-01	1.9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	98.1%	0%	0%	0%	0%	0%	229.02	100.00%
		8.19E-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.004	0	0	0	0	0		0.0044
	TK-308-1-01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	73.09	100.00%
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.014	0	0	0	0		0.0137
	TK-309-1-01	0%	11.4%	0.4%	0%	0%	3.2%	0%	83.5%	0%	0.1%	1.1%	0.2%	0%	0%	0%	0.0794%	0%	0%	0%	0%	0%	58.64	100.00%
		0	0.002	6.20E-05	0	0	5.44E-04	0	0.014	0	2.36E-05	1.94E-04	3.23E-05	0	0	0	1.35E-05	0	0	0	0	0		0.0171
	TK-311-1-01	0%	11.4%	0.4%	0%	0%	3.2%	0%	83.5%	0%	0.1%	1.1%	0.2%	0%	0%	0%	0.0794%	0%	0%	0%	0%	0%	58.64	100.00%
		0	0.002	6.20E-05	0	0	5.44E-04	0	0.014	0	2.36E-05	1.94E-04	3.23E-05	0	0	0	1.35E-05	0	0	0	0	0		0.0171
	TK-323-1-01	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	119.38	100.00%
		0.008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0084
	TK-341-1-01	0%	31.5%	0%	0%	0%	0%	0%	68.5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	46.86	100.00%
		0	0.007	0	0	0	0	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0213
	TK-341-1-02	0%	0%	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60.1	100.00%
		0	0	0	0	0	0	0	0.017	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0166

Kairos Power

Kairos Power - Salt Production Facility

Inputs Summary

		Albuquerque, NM (Kairos Power Site Elevation) = ~ 5,300 ft																					Albuquerque, NM (Kairos Power elevation) pressure = ~ 12.08 PSIA		
	Tank ID	Component Vapor Pressure (mmHg @ 20° C)																					Tank Material Vapor Pressure (mmHg @ 20° C)	Tank Material Vapor Pressure (PSIA @ 20° C)	Density (lb/ft^3)
		$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF			
Unit 100,150 & 300 Tank Vents	TK-100-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	160.0	3.1	92.60
	TK-101-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.5	0.3	61.30
	TK-105-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	32.3	0.6	49.00
	TK-105-1-02	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	32.3	0.6	49.00
	TK-107-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	16.6	0.3	59.30
	TK-108-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	28.4	0.5	72.10
	TK-TBD	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	160.0	3.1	92.60
	TK-TBD	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	123.5	2.4	41.0
	TK-150-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	92.5	1.8	94.00
	TK-151-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	92.5	1.8	94.00
	TK-156-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	13.1	0.3	73.60
	TK-157-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	13.1	0.3	73.60
	TK-158-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	92.5	1.8	94.00
	TK-159-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.1	0.3	65.70
	TK-160-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	13.0	0.3	80.00
	TK-165	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	123.5	2.4	41.0
	TK-TBD	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	16.4	0.3	70.1
	TK-TBD	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	158.1	3.1	92.0
	TK-301-1-02	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	29.8	0.6	67.5
	TK-304-1-03	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.7	0.3	62.4
	TK-306-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	23.7	0.5	58.8
	TK-307-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	3.0	0.1	73.80
	TK-308-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	2.9	0.1	58.92
	TK-309-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	29.0	0.6	53.02
	TK-311-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	29.0	0.6	49.00
	TK-323-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	160.0	3.1	92.00
	TK-341-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	27.6	0.5	50.36
	TK-341-1-02	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	32.3	0.6	50.1

Inputs Summary

	Tank ID	Number of Tanks on Site	Unit Area	Description	Pollutant Classification	Inherent Condenser?	Control Method	Type of Roof	Insulated	Capacity (Gallons)	Tank Throughput (lb/hr)	Tank throughput (lb/yr)	Tank Throughput (tn/yr)	Source (Throughput)	Dimensions		MAWP (PSIG)	Material
															Diameter (ft)	Height (ft)		
Unit 100,150 & 300 Tank Vents (cont.)	TK-342-1-01	29	300	Drain Tank 1	HAP; VOC; CHCl3	Vent to ATM	N/A	Fixed Roof	Yes	500	51	448,950	224	KP Best Estimate (09/09/2024)	TBD	TBD	TBD	TBD
	TK-344-1-01	30	300	Drain Tank 2	VOC	Vent to ATM	N/A	Fixed Roof	Yes	500	31	268,275	134	KP Best Estimate (09/09/2024)	TBD	TBD	TBD	TBD
	TK-345-1-01	31	300	Dissolving Tank	HAP, VOC; CHCl3	Inherent Chloroform ($CHCL_3$) Condenser	N/A	Fixed Roof	Yes	1,104	11,882	998,088	499	KP Best Estimate (01/08/2024)	TBD	TBD	TBD	TBD
Unit 600 Tank Vent	TK-1-01	32	600	LiOH Feed Tank Vent to Stack	Metal Hydroxide	Vent to ATM	N/A	Fixed Roof	No	250	14	122,640	61	LiOH-LiF Mass Balance_Working-02_23_22	2.57	6.43	TBD	TBD
	TK-1-02	33	600	HF Feed Tank Vent to Atmosphere	HAP, HF	Vent to ATM	N/A	Fixed Roof	No	880	22,000	192,720,000	96,360	LiOH-LiF Mass Balance_Working-02_23_23	3.91	9.78	TBD	TBD
	RR-1-01	34	600	LiOH HF Reactor Vent to Atmosphere	HAP, HF	Vent to ATM	N/A	Fixed Roof	No	470	1,477	12,938,520	6,469	LiOH-LiF Mass Balance_Working-02_23_24	3.17	7.93	TBD	TBD
	TK-1-03	35	600	Mother Liquor Hold Tank Vent to Atmosphere	HAP, HF	Vent to ATM	N/A	Fixed Roof	No	520	1,323	11,589,480	5,795	LiOH-LiF Mass Balance_Working-02_23_25	3.28	8.20	TBD	TBD
	TK-1-05	36	600	Evaporator Tank Vent to Condenser	HAP, HF	Condenser	N/A	Fixed Roof	No	520	2,404	21,059,040	10,530	LiOH-LiF Mass Balance_Working-02_23_26	3.28	8.20	TBD	TBD
	TK-1-06	37	600	Waste Water Neutralization Tank Vent to Atmosphere	HAP, HF	Vent to ATM	N/A	Fixed Roof	No	250	300.00	2,628,000	1,314	LiOH-LiF Mass Balance_Working-02_23_27	2.57	6.43	TBD	TBD
	TK-1-07	38	600	Caustic Solution Tank Vent to Atmosphere	N/A	Vent to ATM	N/A	Fixed Roof	No	5,250	0.013	114	0	LiOH-LiF Mass Balance_Working-02_23_28	7.09	17.03	TBD	TBD

	Tank ID	Operating Temp (° F)	Operating Pressure (PSIG)	Tank Material Composition (wt%)																					Total (wt%)
				$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF	
Unit 100,150 & 300 Tank Vents (cont.)	TK-342-1-01	69.5	0	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				100																					100
	TK-344-1-01	69.5	0	0%	50.0%	0%	0%	0%	0%	0%	50.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					50						50														100
	TK-345-1-01	77	1	60.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
				7,129										4,753											11,882
Unit 600 Tank Vent	TK-1-01	80	TBD	0%	94.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6.0%	0%	0%	100.0%
					94																	6			100
	TK-1-02	80	TBD	0%	52.0%	0%	0%	0%	0%	0%	0%	48.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					52							48													100
	RR-1-01	80	TBD	0%	91.0%	0%	0%	0%	0%	0%	0%	4.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5.0%	0%	0%	100.0%
					91							4										5			100
	TK-1-03	80	TBD	0%	100.0%	0%	0%	0%	0%	0%	0%	0.018%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					55							0													55
	TK-1-05	212	TBD	0%	100.0%	0%	0%	0%	0%	0%	0%	0.018%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					55							0													55
	TK-1-06	80	TBD	0%	100.0%	0%	0%	0%	0%	0%	0%	0.018%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					55							0													55
	TK-1-07	80	TBD	0%	50.0%	50.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
					50	50																			100

Kairos Power

Kairos Power - Salt Production Facility

Inputs Summary

	Tank ID	Component Molar Mass (lb/lb-mol)																				
		$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF
Unit 100,150 & 300 Tank Vents (cont.)	TK-342-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-344-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-345-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
Unit 600 Tank Vent	TK-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-1-02	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	RR-1-01	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-1-03	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-1-05	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-1-06	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99
	TK-1-07	119.38	18.02	40.00	36.46	126.04	58.44	28.02	60.10	20.01	110.11	268.31	536.62	64.07	194.23	96.75	231.11	73.09	42.39	23.95	26.00	41.99

Inputs Summary

	Tank ID	Tank Material Composition (mol%)																					Avg Molecular Wt (lb/lbmol)	Total (mol%)
		$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF		
Unit 100,150 & 300 Tank Vents (cont.)	TK-342-1-01	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	119.38	100.00%
		0.008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0084
	TK-344-1-01	0%	76.9%	0%	0%	0%	0%	0%	23.1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	27.73	100.00%
		0	0.028	0	0	0	0	0	0.008	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0361
	TK-345-1-01	77.1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	22.9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	153.45	100.00%
		0.005	0	0	0	0	0	0	0	0	0	0.001	0	0	0	0	0	0	0	0	0	0		0.0065
Unit 600 Tank Vent	TK-1-01	0%	95.4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4.6%	0%	0%	18.29	100.00%
		0	0.052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.003	0	0		0.0547
	TK-1-02	0%	54.6%	0%	0%	0%	0%	0%	0%	45.4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18.92	100.00%
		0	0.029	0	0	0	0	0	0	0.024	0	0	0	0	0	0	0	0	0	0	0	0		0.0528
	RR-1-01	0%	92.5%	0%	0%	0%	0%	0%	0%	3.7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3.8%	0%	0%	18.32	100.00%
		0	0.050	0	0	0	0	0	0	0.002	0	0	0	0	0	0	0	0	0	0.002	0	0		0.0546
	TK-1-03	0%	100.0%	0%	0%	0%	0%	0%	0%	0.0163%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18.02	100.00%
		0	0.055	0	0	0	0	0	0	9.06E-06	0	0	0	0	0	0	0	0	0	0	0	0		0.0555
	TK-1-05	0%	100.0%	0%	0%	0%	0%	0%	0%	0.0163%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18.02	100.00%
		0	0.055	0	0	0	0	0	0	9.06E-06	0	0	0	0	0	0	0	0	0	0	0	0		0.0555
	TK-1-06	0%	100.0%	0%	0%	0%	0%	0%	0%	0.0163%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18.02	100.00%
		0	0.055	0	0	0	0	0	0	9.06E-06	0	0	0	0	0	0	0	0	0	0	0	0		0.0555
	TK-1-07	0%	68.9%	31.1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	24.85	100.00%
		0	0.028	0.013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0402

Kairos Power

Kairos Power - Salt Production Facility

Inputs Summary

		Albuquerque, NM (Kairos Power Site Elevation) = ~ 5,300 ft																					Albuquerque, NM (Kairos Power elevation) pressure = ~ 12.08 PSIA		
	Tank ID	Component Vapor Pressure (mmHg @ 20° C)																					Tank Material Vapor Pressure (mmHg @ 20° C)	Tank Material Vapor Pressure (PSIA @ 20° C)	Density (lb/ft^3)
		$CHCl_3$	Water	NaOH	HCl	Na_2SO_3	NaCl	Nitrogen	IPA	HF	Chemical A	Chemical B	Heavies	SO2	Chemical C	$SOCl_2$	Chemical D	DMF	LiCl	LiOH	LIF	NaF			
Unit 100,150 & 300 Tank Vents (cont.)	TK-342-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	160.0	3.1	92.3
	TK-344-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	20.9	0.4	54.9
	TK-345-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	123.5	2.4	41.0
Unit 600 Tank Vent	TK-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	16.7	0.3	94.30
	TK-1-02	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	10.2	0.2	66.50
	RR-1-01	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	16.3	0.3	67.10
	TK-1-03	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.5	0.3	62.40
	TK-1-05	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.5	0.3	62.40
	TK-1-06	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.5	0.3	62.40
	TK-1-07	160	17.54	18	31184	0	0	900	32.25	1.3	0.15	0.5	0	2475	0.07	96.75	0.00234	2.875	0.01	0.01	0	0.01	17.7	0.3	95.50

Kairos Power

Kairos Power - Salt Production Facility

Non-Tank Inputs Summary

	Equipment ID	#	Block Number	Description	Pollutant Classification	Stream #	Condenser?	Inherent Design	Mass Rate (lb/hr)	Mass Rate (lb/yr)	Mass Rate (tn/yr)	Mass Rate (source/basis)
Unit 100,150 & 300 Non-Tank Vents	KP-340-1-01	1	300	Distillation Column #1	VOC	43	No	Inherent Isopropanol (IPA) Condenser	1.62	544	0.3	Emission Reference Calc
	CI-301-1-01	2	300	Recovery Column (RX 1 CHCl3 Feed Step)	HAP, VOC	N/A	Yes	Chloroform Recovery Column & Condenser	9.70	2851.80	1.43	CHCl3 Recovery Column Calculations.xlsx; Exhanger Data Sheet; Aspen Model
	CI-301-1-01	3	300	Recovery Column (RX 1 Buffer Tank Feed Step)	HAP, VOC	N/A	Yes	Chloroform Recovery Column & Condenser	5.40	1586.20	0.79	CHCl3 Recovery Column Calculations.xlsx; Exhanger Data Sheet; Aspen Model
	CI-301-1-01	4	300	Recovery Column (RX 1 RXN Step)	HAP, VOC, Criteria Pollutant	5	Yes	Chloroform Recovery Column & Condenser	350.38	618075.61	309.04	KP_SPF_HX_DESIGNBASIS.docx; Exchanger Data Sheet
	KP-320-1-01	5	300	ML Evaporator	VOC	Emission Calc	No	Vent to ATM	0.23	772.8	0.39	Emission Reference Calc
	TK-303-1-02	6	300	Distillation Column #2	HAP, VOC	N/A	No	Vent to ATM	12.1	8094.9	4.05	Emission Reference Calc
	TK-305-1-03	7	300	CHCl3 Drying Column Feed Tank, WFE Vent, Flash Evaporator	HAP; VOC	N/A	Yes	Inherent Condenser	5.20	24479.15	12.24	KP_SPF_HX_DESIGNBASIS.docx; Exchanger Data Sheet
	341-02	8	300	Membrane Vent	VOC	N/A	No	Vent to ATM	0.52	2970.24	1.49	DeltaMem
	341-03	9	300	Stripper #2	VOC	N/A	Yes	Inherent Isopropanol (IPA) Condenser	39.5	225624	112.81	Aspen Model
	CI-321-1-01	10	300	Stripper #3	HAP; VOC	N/A	Yes	Inherent Condenser	6.61	31090.15	15.55	MB; Aspen Model
Unit 500 Non-Tank Vents	SP-508-1-01	1	500	Inlet to Bleach Column - Train 1	HAP	5406A	No	Bleach Synthesis Column	8.00	70080.00	35.04	PFD/MB
	SP-513-1-01	2	500	Inlet to Bleach Column - Train 2	HAP	5406B	No	Bleach Synthesis Column	8.00	70080.00	35.04	PFD/MB
Unit 600 Non-Tank Vents	TBD	1	600	Nutsche Filter Vent	HAP	N/A	No	Vent to ATM	1.51E-08	1.33E-04	6.64E-08	Emission Reference Calc
	TBD	2	600	Dryer Vent	Water	N/A	No	Vent to ATM	NA	NA	NA	Emission Reference Calc if needed
Unit 950 Non-Tank Vents	TBD	1	950	Main Vent Header	HAP	N/A	No	Vent to ATM	0.019	165.35	0.083	Kairos

Kairos Power

Kairos Power - Salt Production Facility

Non-Tank Inputs Summary

	Equipment ID	Tank Material Composition (lbs.)													Total Mass (lbs)
		$CHCl_3$	Water	HCl	Nitrogen	IPA	HF	SO_2	$SOCl_2$	DMF	LiCl	LiF	Cl_2	O_2	
Unit 100,150 & 300 Non-Tank Vents	KP-340-1-01					24566.00									24566.00
	CI-301-1-01	2.30			7.40										9.70
	CI-301-1-01	1.70			3.68				0.015	1.10E-04					5.40
	CI-301-1-01	153.74		706.68				1241.88							2102.30
	KP-320-1-01					10170.00									10170.00
	TK-303-1-02									12.10					12.10
	TK-305-1-03	64.16	0.48		10.88									7.75	83.27
	341-02					100.00									100.00
	341-03		13.00			87.00									100.00
	CI-321-1-01	8.51			80.00					17.24					105.75
Unit 500 Non-Tank Vents	SP-508-1-01		0.10								0.10		3.80		4.00
	SP-513-1-01		0.10								0.10		3.80		4.00
Unit 600 Non-Tank Vents	TBD		99.97				0.030								100
	TBD		50.00									50.00			100
Unit 950 Non-Tank Vents	TBD						0.019								0.019

Kairos Power - Salt Production Facility

Non-Tank Inputs Summary

	Equipment ID	Tank Material Composition (wt%)													Total Mass %
		$CHCl_3$	Water	HCl	Nitrogen	IPA	HF	SO_2	$SOCl_2$	DMF	LICl	LiF	Cl_2	O_2	
Unit 100,150 & 300 Non-Tank Vents	KP-340-1-01	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
	CI-301-1-01	23.7%	0%	0%	76.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
	CI-301-1-01	31.5%	0%	0%	68.2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
	CI-301-1-01	7.3%	0%	33.6%	0%	0%	0%	59%	0%	0%	0%	0%	0%	0%	100.0%
	KP-320-1-01	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
	TK-303-1-02	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100.0%
	TK-305-1-03	77.1%	0.6%	0%	13.1%	0%	0%	0%	0%	0%	0%	0%	0%	9%	100.0%
	341-02	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
	341-03	0%	13.0%	0%	0%	87.0%	0%	0%	0%	0%	0%	0%	0%	0%	100.0%
	CI-321-1-01	8.0%	0%	0%	75.7%	0%	0%	0%	0%	16%	0%	0%	0%	0%	100.0%
Unit 500 Non-Tank Vents	SP-508-1-01	0%	2.5%	0%	0%	0%	0%	0%	0%	0%	3%	0%	95%	0%	100.0%
	SP-513-1-01	0%	2.5%	0%	0%	0%	0%	0%	0%	0%	3%	0%	95%	0%	100.0%
Unit 600 Non-Tank Vents	TBD	0%	99.97%	0%	0%	0%	0.03%	0%	0%	0%	0%	0%	0%	0%	100.0%
	TBD	0%	50.0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	0%	100.0%
Unit 950 Non-Tank Vents	TBD	0%	0%	0%	0%	0%	100.0%	0%	0%	0%	0%	0%	0%	0%	100.0%

Kairos Power - Salt Production Facility

Inputs Summary

Cooling Tower Information

Number of Units:	1		
Number of Cells per Unit:	2		
Circulation Rate	6174	gpm	Manufacturer specification
Operating Hours	8760	hr/yr	
Drift rate	0.05	%	Assumed
Water TDS	314	ppm	Max TDS value taken from 2023 Consumer Confidence Report – Zone 3, Albuquerque Bernalillo County Water Utility Authority (ABCWUA).

Boilers information

Number of Unit:	1	2	
Input Capacity:	24.525	32.700	MMBtu/hr
Fuel Heating Value:	1020	1020	Btu/scf

Component Properties

Component	Vapor Pressure (mmHg @20° C)	Molar Mass (lb/lb-mol)
Organic Intermediate	0.07	194.23
Organic Intermediate	96.75	96.75
CHCl3	160.00	119.38
Organic Intermediate	2.88	73.09
SO2	2475.00	64.07
Organic Intermediate	0.00	231.11
H2O	17.54	18.02
NaOH	18.00	40.00
HCl	31184.00	36.46
Na2SO3	0.00	126.04
NaCl	0.00	58.44
Nitrogen	900.00	28.02
Organic Intermediate	0.15	110.11
IPA	32.25	60.10
Intermediate	0.50	268.31
LiCl	0.01	42.39
LiOH	0.01	23.95
HF	1.30	20.01
LIF	0.00	26.00
NaF	0.01	41.99
Heavies	0.00	536.62

PM_x Emission Information

Emission Point ID	Block Number	Solids Handling	Description	Pollutant Classification	Solids Throughput	UoM	Solids Throughput Annually	UoM	Basis	Material
1	300	Yes	Intermediate Product	PMx	1118	lb/batch	375648	lb/yr	180 MTA	Provide SDS to Trinity (Chemical B)
2	300	Yes	Intermediate and CHCl3 Mix Tank	PMx	4753	lb/batch	399,252	lbs/yr	180 MTA	Provide SDS to Trinity (Chemical B)
3	300	Yes	Super Sack Dumping Station	PMx	1102	lb/batch	370,272	lb/yr	180 MTA	Provide SDS to Trinity (Chemical A)
4	500	Yes	LiOH H2O Handling/Mixing	PMx	400	lb/batch	142,400	lb/yr	66 MTA (LiOH H2O Feed)	Provide SDS to Trinity (Lithium Hydroxide Monohydrate)
5	500	Yes	LiOH H2O 1 solids handling	PMx	6.8	lb/hr	59,568	lb/yr	24 MT LiOH H2O Train 1	Provide SDS to Trinity (LiOH)
6	500	Yes	LiOH H2O 2 Solids handling	PMx	6.8	lb/hr	59,568	lb/yr	24 MT LiOH H2O Train 2	
7	600	Yes	LiOH H2O Handling	PMx	163	lb/batch	59,568	lb/yr	16.7 MTA LiF	
8	600	Yes	LiF Solids Handling	PMx	101	lb/batch	36,865	lb/yr	16.7 MTA LiF	Provide SDS to Trinity (LiF)
9	950	Yes	LiF Solids Handling	PMx	114	lb/batch	34,585	lb/yr	75 MTA Product FLiBe	
10	950	Yes	BeF2 Solids Handling	PMx	103	lb/batch	31,269	lb/yr	75 MTA Product FLiBe	Provide SDS to Trinity (BeF2)

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Kairos Power - Salt Production Facility

Tank Emission Calculation

	Tank ID	SL #	Description	Pollutant Classification	Emission Point?	Capacity (Gallons)	Density (lb/ft^3)	Density [1] (lb/gal)	Total Vapor Pressure (TVP) (psia)	Tank Throughput (lb/hr)	Tank throughput (lb/yr)	Tank Throughput (gal/hr)	Tank throughput (gal/yr)	Tank Throughput [2] (ft^3/hr)	Tank throughput [3] (ft^3/yr)
Unit 100,150 & 300 Tank Vents	TK-100-1-01	1	Chloroform Tank	HAP; VOC, CHCl3	Yes	6,267	92.60	12.38	3.1	75,450	405,000	6,095.09	32,717.17	814.79	4,373.65
	TK-101-1-01	2	Process Water Tank	HAP, VOC, Metal Chloride Salt, CHCl3	Yes	6,267	61.30	8.19	0.34	7,040	36,041,221	859.10	4,398,157.52	114.85	587,948.14
	TK-105-1-01	3	Isopropanol Tank	VOC	Yes	8,226	49.00	6.55	0.62	56,281	2,475,000	8,592.12	377,842.57	1,148.60	50,510.20
	TK-105-1-02	4	Isopropanol Tank	VOC	Yes	6,315	49.00	6.55	0.62	33,000.00	12,059,040	5,037.90	1,840,977.22	673.47	246,102.86
	TK-107-1-01	5	Aqueous Waste Tank	HAP, VOC, CHCl3	Yes	8,226	59.30	7.93	0.32	11,065	24,004,238	1,395.82	3,028,063.57	186.59	404,793.22
	TK-108-1-01	6	Organic Waste Tank	VOC	Yes	7,051	72.10	9.64	0.55	341	2,283,297	35.41	236,896.64	4.73	31,668.47
	TK-TBD	7	Separation Feed Tank	HAP; VOC; CHCl3	Yes	15,580	92.60	12.38	3.09	17	150,792	1.39	12,181.45	0.19	1,628.42
	TK-TBD	8	Separation Feed Tank	HAP; CHCl3	Yes	15,580	41.00	5.48	2.39	17	150,792	3.14	27,511.61	0.42	3,677.77
	TK-150-1-01	9	In-Process Tank #1	HAP, VOC, Metal Chloride Salt; CHCl3	Yes	5,000	94.00	12.57	1.79	25,087	576,000	1,996.40	45,838.08	266.88	6,127.66
	TK-151-1-01	10	In-Process Tank #2	HAP, VOC, Metal Chloride Salt; CHCl3	Yes	5,000	94.00	12.57	1.79	25,087	576,000	1,996.40	45,838.08	266.88	6,127.66
	TK-156-1-01	11	LHM Buffer Tank #1	Metal Chloride Salt	Yes	500	73.60	9.84	0.25	16	140,160	1.63	14,245.51	0.22	1,904.35
	TK-157-1-01	12	LHM Buffer Tank #2	Metal Chloride Salt	Yes	500	73.60	9.84	0.25	16	140,160	1.63	14,245.51	0.22	1,904.35
	TK-158-1-01	13	Organic Phase Surge Tank	HAP, VOC, Metal Chloride Salt; CHCl3	Yes	5,000	94.00	12.57	1.79	25,087	576,000	1,996.40	45,838.08	266.88	6,127.66
	TK-159-1-01	14	Brine Surge Tank	Metal hydroxide	Yes	5,000	65.70	8.78	0.33	69	604,440	7.86	68,820.78	1.05	9,200.00
	TK-160-1-01	15	Fresh Brine Tank	Metal Chloride Salt	Yes	1,800	80.00	10.69	0.25	32	280,320	2.99	26,211.74	0.40	3,504.00
	TK-165	16	In-Process Tank #3	HAP; CHCl3	Yes	15,580	41.00	5.48	2.39	17	150,792	3.14	27,512.26	0.42	3,677.85
	TK-TBD	17	Aqueous Hazardous Waste Tank	VOC	Yes	11,000	70.12	9.37	0.32	515	173,040	54.94	18,460.41	7.34	2,467.80
	TK-TBD	18	Chloroform Tank	HAP; CHCl3	Yes	200	92.00	12.30	3.06	1,351	7,229,883	109.83	587,861.75	14.68	78,585.68
	TK-301-1-02	19	Neutralization Tank	HAP, VOC; CHCl3; HCl	Yes	2,669	67.50	9.02	0.58	3,946	10,522,701	437.31	1,166,152.15	58.46	155,891.87
	TK-304-1-03	20	Recycle Water Tank	HAP, VOC; CHCl3	Yes	2,700	62.40	8.34	0.34	12.50	66,900.00	1.50	8,019.98	0.20	1,072.12
	TK-306-1-01	21	Dissolving Vessel	HAP, VOC, PMx	Yes	603	58.80	7.86	0.46	50.00	66,900.00	6.36	8,511.00	0.85	1,137.76
	TK-307-1-01	22	Intermediate Tank	HAP, VOC; CHCl3	Yes	458	73.80	9.87	0.06	1,075	722,064	108.91	73,189.89	14.56	9,784.07
	TK-308-1-01	23	DMF Tank	HAP, VOC	Yes	458	58.92	7.88	0.06	41,510.00	711,147	5,270.05	90,286.13	704.50	12,069.50
	TK-309-1-01	24	Reactor 2	VOC	Yes	5,000	53.02	7.09	0.56	28,980.00	9,737,280	4,088.56	1,373,754.78	546.56	183,644.30
	TK-311-1-01	25	Isopropanol Tank	VOC	Yes	6,315	49.00	6.55	0.56	33,000.00	12,059,040	5,037.90	1,840,977.22	673.47	246,102.86
	TK-323-1-01	26	Chloroform Tank	HAP, VOC; CHCl3	Yes	2,200	92.00	12.30	3.09	48,122.00	7,088,055	3,912.80	576,329.71	523.07	77,044.08
	TK-341-1-01	27	Isopropanol Tank	VOC	Yes	2,250	50.36	6.73	0.53	1,365.88	7,310,163	202.88	1,085,793.47	27.12	145,149.47
	TK-341-1-02	28	Isopropanol Tank	VOC	Yes	2,250	50.15	6.70	0.62	750.00	2,016,000.00	111.88	300,742.39	14.96	40,203.41
	TK-342-1-01	29	Drain Tank 1	HAP; VOC; CHCl3	Yes	500	92.30	12.34	3.09	51.25	448,950.00	4.15	36,385.47	0.56	4,864.03
	TK-344-1-01	30	Drain Tank 2	VOC	Yes	500	54.91	7.34	0.40	30.63	268,275.00	4.17	36,548.65	0.56	4,885.84
	TK-345-1-01	31	Dissolving Tank	HAP, VOC; CHCl3	Yes	1,104	41.00	5.48	2.39	11,882.00	998,088.00	2,167.89	182,102.85	289.80	24,343.61
Unit 600 Tank Vent	TK-1-01	32	LiOH Feed Tank Vent to Stack	Metal Hydroxide	Yes	250	94.30	12.61	0.32	14.00	122,640	1.11	9,728.64	0.15	1,300.53
	TK-1-02	33	HF Feed Tank Vent to Atmosphere	HAP, HF	Yes	880	66.50	8.89	0.20	22,000.00	192,720,000	2,474.76	21,678,882.92	330.83	2,898,045.11
	RR-1-01	34	LiOH HF Reactor Vent to Atmosphere	HAP, HF	Yes	470	67.10	8.97	0.31	1,477.00	12,938,520	164.66	1,442,426.99	22.01	192,824.44
	TK-1-03	35	Mother Liquor Hold Tank Vent to Atmosphere	HAP, HF	Yes	520	62.40	8.34	0.34	1,323.00	11,589,480	158.60	1,389,348.25	21.20	185,728.85
	TK-1-05	36	Evaporator Tank Vent to Condenser	HAP, HF	Yes	520	62.40	8.34	0.34	2,404.00	21,059,040	288.19	2,524,560.24	38.53	337,484.62
	TK-1-06	37	Waste Water Neutralization Tank Vent to Atmosphere	HAP, HF	Yes	250	62.40	8.34	0.34	300.00	2,628,000	35.96	315,044.96	4.81	42,115.38
	TK-1-07	38	Caustic Solution Tank Vent to Atmosphere	N/A	Yes	5,250	95.50	12.77	0.34	0.01	114	0.00	8.92	0.00	1.19

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Tank Emission Calculation

	Tank ID	SL #	Working loss turnover factors, K_N [4]	Working loss product factor, K_P [5]	Vent setting correction factor, K_B [6]	Vapor space expansion factor, K_E [7]	Vented vapor saturation factor, K_S [8]	Temp. for True Vapor Pressure (°C)	Average Vapor Temperature, T_V [9] (°F)	Average Vapor Temperature, T_V [10] (°R)	Ideal Gas constant, R (psia-ft^3 / lb-mol-°R)	Vapor Molecular weight, MW_V [11] (lb/lb-mole)	Vapor Density, W_V [12] (lb/ft^3)	Condenser Reduction Efficiency [13] (%)	Control Method Efficiency (%)	Working Loss, L_W [14] (lb/hr)	Standing Loss, L_S [15] (lb/hr)
Unit 100,150 & 300 Tank Vents	TK-100-1-01	1	1	1	1	0	1	20	80	540	10.731	119.38	0.0638	75%	0%	12.99	0
	TK-101-1-01	2	1	1	1	0.04	1	20	80	540	10.731	18.02	0.0011	0%	0%	0.12	1.47E-03
	TK-105-1-01	3	1	1	1	0	1	20	80	540	10.731	60.10	0.0065	75%	0%	1.86	0
	TK-105-1-02	4	1	1	1	0.04	1	20	77	537	10.731	60.10	0.0065	75%	0%	1.10	2.28E-03
	TK-107-1-01	5	1	1	1	0	1	20	80	540	10.731	21.50	0.0012	0%	0%	0.22	0
	TK-108-1-01	6	1	1	1	0	1	20	80	540	10.731	88.04	0.0083	75%	0%	9.87E-03	0
	TK-TBD	7	1	1	1	0.04	1	20	70	529	10.731	119.38	0.0650	75%	0%	3.02E-03	0.06
	TK-TBD	8	1	1	1	0	1	20	70	529	10.731	24.31	0.0102	75%	0%	1.07E-03	0
	TK-150-1-01	9	1	1	1	0	1	20	80	540	10.731	97.91	0.0302	0%	0%	8.07	0
	TK-151-1-01	10	1	1	1	0	1	20	80	540	10.731	97.91	0.0302	0%	0%	8.07	0
	TK-156-1-01	11	1	1	1	0.04	1	20	100	560	10.731	24.26	0.0010	0%	0%	2.22E-04	1.13E-04
	TK-157-1-01	12	1	1	1	0.04	1	20	100	560	10.731	24.26	0.0010	0%	0%	2.22E-04	1.13E-04
	TK-158-1-01	13	1	1	1	0.04	1	20	80	540	10.731	97.91	0.0302	0%	0%	8.07	0.03
	TK-159-1-01	14	1	1	1	0.04	1	20	110	570	10.731	18.61	0.0010	0%	0%	1.06E-03	1.12E-03
	TK-160-1-01	15	1	1	1	0.04	1	20	80	540	10.731	24.31	0.0011	0%	0%	4.23E-04	4.23E-04
	TK-165	16	1	1	1	0	1	20	70	529	10.731	24.31	0.0102	75%	0%	1.07E-03	0
	TK-TBD	17	1	1	1	0	1	20	70	529	11.731	26.93	0.0014	0%	0%	0.01	0
	TK-TBD	18	1	1	1	0	1	20	90	550	12.731	118.05	0.0516	75%	0%	0.19	0
	TK-301-1-02	19	1	1	1	0.04	1	20	77	537	12.731	20.29	0.0017	0%	0%	0.10	1.02E-03
	TK-304-1-03	20	1	1	1	0	1	20	100.00	560	10.731	18.15	0.0010	0%	0%	2.07E-04	0
	TK-306-1-01	21	1	1	1	0	1	20	77.00	537	10.731	73.44	0.0058	75%	0%	1.24E-03	0
	TK-307-1-01	22	1	1	1	0.04	1	20	77	537	10.731	229.02	0.0023	0%	0%	0.03	2.35E-04
	TK-308-1-01	23	1	1	1	0.04	1	20	77	537	10.731	73.09	0.0007	0%	0%	0.50	7.18E-05
	TK-309-1-01	24	1	1	1	0	1	20	100	560	10.731	58.64	0.0055	75%	0%	0.75	0
	TK-311-1-01	25	1	1	1	0	1	20	77	537	11.731	58.64	0.0052	75%	0%	0.88	0
	TK-323-1-01	26	1	1	1	0.04	1	20	77	537	10.731	119.38	0.0641	75%	0%	8.39	7.84E-03
	TK-341-1-01	27	1	1	1	0	1	20	100	560	10.731	46.86	0.0042	75%	0%	0.03	0
	TK-341-1-02	28	1	1	1	0	1	20	180.00	640	10.731	60.10	0.0055	75%	0%	0.02	0
	TK-342-1-01	29	1	1	1	0	1	20	69.50	529	11.731	119.38	0.0595	0%	0%	0.03	0
	TK-344-1-01	30	1	1	1	0	1	20	69.50	529	12.731	27.73	0.0017	0%	0%	9.29E-04	0
	TK-345-1-01	31	1	1	1	0	1	20	77.00	537	10.731	153.45	0.0636	75%	0%	4.61	0
Unit 600 Tank Vent	TK-1-01	32	1	1	1	0.04	1	20	80	540	10.731	18.29	0.0010	0%	0%	1.52E-04	5.68E-05
	TK-1-02	33	1	1	1	0.04	1	20	80	540	10.731	18.92	0.0006	0%	0%	0.21	1.26E-04
	RR-1-01	34	1	1	1	0.04	1	20	80	540	10.731	18.32	0.0010	0%	0%	0.02	1.04E-04
	TK-1-03	35	1	1	1	0.04	1	20	80	540	10.731	18.02	0.0011	0%	0%	0.02	1.22E-04
	TK-1-05	36	1	1	1	0.04	1	20	212	672	10.731	18.02	0.0008	0%	0%	0.03	9.80E-05
	TK-1-06	37	1	1	1	0.04	1	20	80	540	10.731	18.02	0.0011	0%	0%	5.07E-03	5.86E-05
	TK-1-07	38	1	1	1	0.04	1	20	80	540	10.731	24.85	0.0015	0%	0%	2.00E-07	1.71E-03

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Tank Emission Calculation

	Tank ID	SL #	Routine Uncontrolled Emissions, L_T[16] (lb/hr)	Working Loss, L_W[16] (tpy)	Standing Loss, L_S[16] (tpy)	Routine Uncontrolled Emissions, L_T[16] (tpy)	Controlled Routine Emissions, L_T[17] (lb/hr)	Controlled Routine Emissions, L_T[17] (tpy)
Unit 100,150 & 300 Tank Vents	TK-100-1-01	1	12.99	8.72E-03	0	8.72E-03	12.99	8.72E-03
	TK-101-1-01	2	0.12	0.31	6.44E-03	0.32	0.12	0.32
	TK-105-1-01	3	1.86	0.010	0	0.010	1.86	0.01
	TK-105-1-02	4	1.10	0.050	2.50E-03	0.053	1.10	0.053
	TK-107-1-01	5	0.22	0.24	0	0.24	0.22	0.24
	TK-108-1-01	6	9.87E-03	8.26E-03	0	8.26E-03	9.87E-03	8.26E-03
	TK-TBD	7	0.059	3.31E-03	0.062	0.065	0.059	0.065
	TK-TBD	8	1.07E-03	1.18E-03	0	1.18E-03	1.07E-03	1.18E-03
	TK-150-1-01	9	8.07	0.093	0	0.093	8.07	0.09
	TK-151-1-01	10	8.07	0.093	0	0.093	8.07	0.09
	TK-156-1-01	11	3.35E-04	9.71E-04	4.96E-04	1.47E-03	3.35E-04	1.47E-03
	TK-157-1-01	12	3.35E-04	9.71E-04	4.96E-04	1.47E-03	3.35E-04	1.47E-03
	TK-158-1-01	13	8.10	0.093	0.15	0.24	8.10	0.24
	TK-159-1-01	14	2.18E-03	4.63E-03	4.90E-03	9.54E-03	2.18E-03	9.54E-03
	TK-160-1-01	15	8.45E-04	1.85E-03	1.85E-03	3.70E-03	8.45E-04	3.70E-03
	TK-165	16	1.07E-03	1.18E-03	0	1.18E-03	1.07E-03	1.18E-03
	TK-TBD	17	0.010	1.69E-03	0	1.69E-03	0.010	1.69E-03
	TK-TBD	18	0.19	0.13	0	0.13	0.19	0.13
	TK-301-1-02	19	0.10	0.13	4.45E-03	0.14	0.10	0.14
	TK-304-1-03	20	2.07E-04	5.55E-04	0	5.55E-04	2.07E-04	5.55E-04
	TK-306-1-01	21	1.24E-03	2.08E-04	0	2.08E-04	1.24E-03	2.08E-04
	TK-307-1-01	22	0.034	0.011	1.03E-03	0.012	0.034	0.012
	TK-308-1-01	23	0.50	4.26E-03	3.15E-04	4.57E-03	0.50	4.57E-03
	TK-309-1-01	24	0.75	0.031	0	0.031	0.75	0.031
	TK-311-1-01	25	0.88	0.040	0	0.040	0.88	0.040
	TK-323-1-01	26	8.39	0.15	8.58E-03	0.16	8.39	0.16
	TK-341-1-01	27	0.028	0.019	0	0.019	0.028	0.019
	TK-341-1-02	28	0.020	6.86E-03	0	6.86E-03	0.020	6.86E-03
	TK-342-1-01	29	0.033	0.14	0	0.14	0.033	0.14
	TK-344-1-01	30	9.29E-04	4.07E-03	0	4.07E-03	9.29E-04	4.07E-03
	TK-345-1-01	31	4.61	0.048	0	0.048	4.61	0.048
Unit 600 Tank Vent	TK-1-01	32	2.09E-04	6.65E-04	2.49E-04	9.13E-04	2.09E-04	9.13E-04
	TK-1-02	33	0.21	0.93	5.50E-04	0.93	0.21	0.93
	RR-1-01	34	0.022	0.096	4.55E-04	0.096	0.022	0.096
	TK-1-03	35	0.022	0.098	5.34E-04	0.099	0.022	0.099
	TK-1-05	36	0.033	0.14	4.29E-04	0.14	0.033	0.14
	TK-1-06	37	5.13E-03	0.022	2.57E-04	0.022	5.13E-03	0.022
	TK-1-07	38	1.71E-03	8.75E-07	7.50E-03	7.50E-03	1.71E-03	7.50E-03

Total[18]	VOC	**Unit 100,150 & 300 Tank Vents**	61.44	0.11	61.56	1.66	0.26	1.92	61.56	1.92
	Metal Chloride Salt		26.76	0.039	26.80	0.65	0.17	0.82	26.80	0.82
	Metal hydroxide		1.16E-03	1.23E-03	2.40E-03	5.10E-03	5.39E-03	0.010	2.40E-03	0.010
	PMx		1.37E-03	0	1.37E-03	2.28E-04	0	2.28E-04	1.37E-03	2.28E-04
	HAP		44.73	0.095	44.83	0.72	0.19	0.91	44.83	0.91
	HF		0	0	0	0	0	0	0	0
	$CHCl_3$		44.73	0.095	44.83	0.72	0.19	0.91	44.83	0.91
	HCl		7.70E-05	7.81E-07	7.78E-05	1.03E-04	3.42E-06	1.06E-04	7.78E-05	1.06E-04
Total[18]	VOC	**Unit 600 Tank Vent**	0	0	0	0	0	0	0	0
	Metal Chloride Salt		0	0	0	0	0	0	0	0
	Metal hydroxide		1.67E-04	6.25E-05	2.29E-04	7.31E-04	2.74E-04	1.00E-03	2.29E-04	1.00E-03
	PMx		0	0	0	0	0	0	0	0
	HAP		0.11	7.10E-05	0.11	0.50	3.11E-04	0.50	0.11	0.50
	HF		0.11	7.10E-05	0.11	0.50	3.11E-04	0.50	0.11	0.50
	$CHCl_3$		0	0	0	0	0	0	0	0
	HCl		0	0	0	0	0	0	0	0

Notes:

[1] Density (lb/gal) = Density (lb/ft^3) * (0.13368 ft^3/gal). For this conversion, we used excel CONVERT() function.

[2] Tank Throughput (ft^3/hr) =Tank Throughput (gal/hr) * 0.13368 ft^3/gal. For this conversion, we used excel CONVERT() function.

[3] Tank Throughput (ft^3/yr) =Tank Throughput (gal/yr) * 0.13368 ft^3/gal. For this conversion, we used excel CONVERT() function.

[4] K_N is working loss turnover (saturation) factor [dimensionless factor] based on AP 42 section 7.1.3.1.2 [Working Loss]. K_N = 1 if turnover ≤ 36.

[5] K_P is working loss product factor [dimensionless factor] based on AP 42 section 7.1.3.1.2 [Working Loss]. K_P = 0.75 [Crude oils], K_P = 1.0 [all other organic liquids]. We assumed K_P = 1.0 for more conservative assumption.

[6] K_B is venting setting correction factor [dimensionless factor] based on AP 42 section 7.1.3.1.2 [Working Loss]. K_B = 1 for vent setting range up to ± 0.03 psig.

[7] K_E is vapor space expansion factor [per day] based on AP 42 section 7.1.3.1.1 [Standing Loss], Equation 1-13. K_E = 0.04/day based on typical meteorological conditions in the lower 48 states. This is based on a typical value of daily insolation of 1370 Btu/ft^2-day, the average daily range of ambient temperatures of 21 °R and the tank surface solar absorbance of 0.25 for white paint in average condition. For conservative estimation, we assumed K_E = 0.04/day for all uninsulated tanks. For fully insulated tanks, the average daily range of ambient temperature is 0°R reducing K_E down to 0.

[8] K_S is vented vapor saturation factor [dimensionless] based on AP 42 section 7.1.3.1.1 [Standing Loss], Equation 1-23. $K_S = 1/(1+0.053 * P_{VA} * H_{VO})$. Based on Equation 1-23 format, $K_S \leq 1$ and K_S is a numerator of standing loss equation [AP 42, Section 7.1.3.1.1, equation 1-2], $L_S = 365\ V_V*W_V*K_E*K_S$. We consider K_S=1 for more conservative assumption.

[9] Average Vapor Pressure is assumed to be equal to Operating Temperature.

[10] Temperature, R = Temperature in F + 459.67

[11] Assumed vapor molecular weight is similar to molar weight or average molar weight.

[12] Vapor Density, W_V (lb/ft^3) = $M_V * P_{VA}$ / [R * T_V] ; AP 42: Chapter 7, Equation 1-24

[13] Inherent Design Condenser Efficiency:

Inherent Isopropanol (IPA) Condenser	75%
Inherent Chloroform (CHCL3) Condenser	75%

[14] Working Loss, L_W (lb/hr) = V_Q (ft^3/hr) * K_N * K_P *W_V * K_B ; AP 42 Chapter 7 Equation 1-37

Working Loss, L_W (lb/yr) = V_Q (ft^3/yr) * K_N * K_P *W_V * K_B ;

Working Loos L_W (tpy) = L_W (lb/yr) /2000 (lb/ton);

Where, V_Q = Net working loss throughput; K_N = working loss turnover factor; K_P = working loss product factor; W_V = vapor density (lb/ft^3) ; K_B = vent setting correction factor

[15] Standing Loss, L_S (lb/hr) = 1/24 (day/hr) * V_V * W_V * K_E * K_S ;

Standing Loss, L_S (lb/yr) = 365 (days/year) * V_V * W_V * K_E * K_S ; AP 42 Chapter 7, Equation 1-2

Standing Loos, L_S (tpy) = L_S (lb/yr) / 2000 (lb/ton) ;

where, V_V = Vapor space volume (ft^3) ; W_V = Vapor density (lb/ft^3) ; K_E = Vapor space expansion factor (per day) ; K_S = Vented vapor saturation factor.

[16] Total Uncontrolled Routine Losses L_T = (Standing Loss, L_S + Working Loss, L_W) * (1 - Condenser Reduction Efficiency %) ; AP 42: Chapter 7, Equation 1-1

[17] Total Controlled Routine Losses L_T = (Total Uncontrolled Routine Losses) * (1 - Control Method Reduction Efficiency %)

[18] A safety factor of 10% was applied to the calculated emission rates.

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Non-Tank Vent Calculations

	Equipment ID	SL #	Description	Pollutant Classification	Mass Rate (lb/hr)	Mass Rate (tn/yr)	Tank Material Composition (wt%)													Column Reduction[1] (%)	VOC		SO$_2$		HAP	
							CHCl$_3$	Water	HCl	Nitrogen	IPA	HF	SO$_2$	SOCl$_2$	DMF	LICl	LiF	Cl$_2$	O$_2$		lb/hr [2]	tpy [3]	lb/hr [2]	tpy [3]	lb/hr [2]	tpy [3]
Unit 100,150 & 300 Non-Tank Vents	KP-340-1-01	1	Distillation Column #1	VOC	1.62	0.27	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	75%	0.45	0.07	0	0	0	0
	CI-301-1-01	2	Recovery Column (RX 1 CHCl3 Feed Step)	HAP, VOC	9.70	1.43	24%	0%	0%	76%	0%	0%	0%	0%	0%	0%	0%	0%	0%	86%	0	0	0	0	0.35	0.05
	CI-301-1-01	3	Recovery Column (RX 1 Buffer Tank Feed Step)	HAP, VOC	5.40	0.79	32%	0%	0%	68%	0%	0%	0%	0%	0%	0%	0%	0%	0%	61%	4.78E-05	7.02E-06	0	0	0.74	0.11
	CI-301-1-01	4	Recovery Column (RX 1 RXN Step)	HAP, VOC, Criteria Pollutant	350.383	309.038	7%	0%	34%	0%	0%	0%	59%	0%	0%	0%	0%	0%	0%	100%	0	0	0	0	0	0
	KP-320-1-01	5	ML Evaporator	VOC	0.23	0.39	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.25	0.43	0	0	0	0
	TK-303-1-02	6	Distillation Column #2	HAP, VOC	12.10	4.05	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	13.31	4.45	0	0	0	0
	TK-305-1-03	7	CHCl3 Drying Column Feed Tank, WFE Vent, Flash Evaporator	HAP; VOC	5.204	12.24	77%	1%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	9%	94%	0	0	0	0	0.26	0.61
	341-02	8	Membrane Vent	VOC	0.52	1.49	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.57	1.63	0	0	0	0
	341-03	9	Stripper #2	VOC	39.50	112.81	0%	13%	0%	0%	87%	0%	0%	0%	0%	0%	0%	0%	0%	75%	9.45	26.99	0	0	0	0
	CI-321-1-01	10	Stripper #3	HAP; VOC	6.61	15.55	8%	0%	0%	76%	0%	0%	0%	0%	16%	0%	0%	0%	0%	67%	0.39	0.92	0	0	0.19	0.46
Unit 500 Non-Tank Vents	SP-508-1-01	1	Inlet to Bleach Column - Train 1	HAP	8.00	35.04	0%	3%	0%	0%	0%	0%	0%	0%	0%	3%	0%	95%	0%	99%	0	0	0	0	0.084	0.37
	SP-513-1-01	2	Inlet to Bleach Column - Train 2	HAP	8.00	35.04	0%	3%	0%	0%	0%	0%	0%	0%	0%	3%	0%	95%	0%	99%	0	0	0	0	0.084	0.37
Unit 600 Non-Tank Vents	TBD	1	Nutsche Filter Vent	HAP	1.51E-08	6.64E-08	0%	100%	0%	0%	0%	0.030%	0%	0%	0%	0%	0%	0%	0%	0%	0	0	0	0	5.00E-12	2.19E-11
	TBD	2	Dryer Vent	Water	NA	NA	0%	50%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%	0	0	0	0	0	0
Unit 950 Non-Tank Vents	TBD	1	Main Vent Header	HAP	0.019	0.083	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0	0	0	0	0.021	0.091

Total[3]	Unit 100,150 & 300 Non-Tank Vents	24.42	34.50	0	0	1.54	1.22
	Unit 500 Non-Tank Vents	0	0	0	0	0.17	0.73
	Unit 600 Non-Tank Vents	0	0	0	0	5.00E-12	2.19E-11
	Unit 950 Non-Tank Vents	0	0	0	0	0.021	0.091

Notes:

[1] Column reductions are taken based chemical properties and information provided by Kairos.

[2] Hourly emissions (lb/hr) = Mass rate (lb/hr) * Total Pollutant wt. (%) * (1 - Column Reduction (%)) * (1 + SF (%))

[3] Annual emissions (10% was applied to the calculated emission rates.

[4] A safety factor of

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Emission Point 1: Unit Vent-300 Stack Emissions

EP No. / Unit ID	EP-1: Vent-300
Description:	Unit 100, 150, 300, and 400 vent stack

Uncontrolled Emissions [1]

Unit	NO_X		CO		VOC		SO_2		PM		PM_{10}		$PM_{2.5}$		Total HAPs		Chloroform		Hydrogen Chloride	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
Tanks [2]	-	-	-	-	61.56	1.92	-	-	1.37E-03	2.28E-04	1.37E-03	2.28E-04	1.37E-03	2.28E-04	44.83	0.91	44.83	0.91	7.78E-05	1.06E-04
Non-Tank Vents [3]	-	-	-	-	24.42	34.50	-	-	-	-	-	-	-	-	1.54	1.22	1.54	1.22	-	-
Total	**-**	**-**	**-**	**-**	**85.98**	**36.41**	**-**	**-**	**1.37E-03**	**2.28E-04**	**1.37E-03**	**2.28E-04**	**1.37E-03**	**2.28E-04**	**46.37**	**2.13**	**46.37**	**2.13**	**7.78E-05**	**1.06E-04**

Controlled Emissions

Unit	NO_X		CO		VOC		SO_2		PM		PM_{10}		$PM_{2.5}$		Total HAPs		Chloroform		Hydrogen Chloride [5]	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
Tanks [2]	-	-	-	-	61.56	1.92	-	-	1.37E-03	2.28E-04	1.37E-03	2.28E-04	1.37E-03	2.28E-04	44.83	0.91	44.83	0.91	7.78E-05	1.06E-04
Non-Tank Vents [3]	-	-	-	-	24.42	34.50	-	-	-	-	-	-	-	-	1.54	1.22	1.54	1.22	-	-
Total	**-**	**-**	**-**	**-**	**85.98**	**36.41**	**-**	**-**	**1.37E-03**	**2.28E-04**	**1.37E-03**	**2.28E-04**	**1.37E-03**	**2.28E-04**	**46.37**	**2.13**	**46.37**	**2.13**	**7.78E-05**	**1.06E-04**

Notes:

[1] Uncontrolled VOC, SO_2, and HAP emissions are comprised of tank and non-tank emissions. Refer to the appropriate calculation for speciated unit emissions.

[2] The following tanks are sent to the Vent-300 stack: TK-100, TK-101, TK-105, TK-107, TK-108, TK-150, TK-151, TK-156, TK-157, TK-158, TK-159, TK-160, TK-307, TK-308, TK-309, TK-311, TK-312, TK-323, TK-341-1-01, KP-340, TK-301, TK-302, TK-304, TK-306, TK-345, and TK-341-1-02.

[3] The following are non-tank vents sent to the Vent-300 stack: RX 2 IPA Dist OVHD Receiver (KP-340-1-01), Chloroform Recovery & Neutralization Column (CI-301-1-01), Flash Evaporator OVHD Receiver, WFE OVHD Receiver (KP-305-1-01), ML Evaporator OVHD Receiver (KP-320-1-01), and DMF Distillation OVHD Receiver (TK-303-1-02).

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Emission Point 2: Unit 500 Bleach Synthesis Column Emissions

EP No. / Unit ID	EP-2: Unit 500
Description:	Bleach Synthesis Column

Uncontrolled Emissions

Unit	NO$_X$		CO		VOC		SO$_2$		PM		PM$_{10}$		PM$_{2.5}$		H$_2$S		Total HAPs		Chlorine	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
Inlet to Bleach Column - Train 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.084	0.37	0.084	0.37
Inlet to Bleach Column - Train 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.084	0.37	0.084	0.37
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.17**	**0.73**	**0.17**	**0.73**

Controlled Emissions [1]

Unit	NO$_X$		CO		VOC		SO$_2$		PM		PM$_{10}$		PM$_{2.5}$		H$_2$S		Total HAPs		Chlorine	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
Inlet to Bleach Column - Train 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.084	0.37	0.084	0.37
Inlet to Bleach Column - Train 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.084	0.37	0.084	0.37
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.17**	**0.73**	**0.17**	**0.73**

Notes:

[1] Unit 500 does not have a control device. Therefore, controlled emissions are the same as uncontrolled emissions.

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Emission Point 3: Unit Vent-600 Stack Emissions

EP No. / Unit ID	EP-3: Vent-600
Description:	Unit 600 and 950 vent stack

Uncontrolled Emissions [1]

Unit	NO_X		CO		VOC		SO_2		PM		PM_{10}		$PM_{2.5}$		H_2S		Total HAPs		Hydrogen Fluoride	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
Unit 600 Tanks [2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11	0.50	0.11	0.50
Unit 600 Non-Tanks [3]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00E-12	2.19E-11	5.00E-12	2.19E-11
Unit 950 Main Vent Header	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.021	0.091	0.021	0.091
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.13**	**0.59**	**0.13**	**0.59**

Controlled Emissions [4]

Unit	NO_X		CO		VOC		SO_2		PM		PM_{10}		$PM_{2.5}$		H_2S		Total HAPs		Hydrogen Fluoride	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
Unit 600 Tanks [2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11	0.50	0.11	0.50
Unit 600 Non-Tanks [3]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00E-12	2.19E-11	5.00E-12	2.19E-11
Unit 950 Main Vent Header	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.021	0.091	0.021	0.091
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.13**	**0.59**	**0.13**	**0.59**

Notes:

[1] Uncontrolled HAP emissions are comprised of tank and non-tank emissions. Refer to the appropriate calculation for speciated unit emissions.

[2] The following tank emissions are sent to Vent-600: TK-1-01, TK-1-02, RR-1-01, TK-1-03, TK-1-05, TK-1-06, and TK-1-07.

[3] The following non-tank vents are sent to Vent-600: Nutsche Filter Vent and Paddle Dryer Vent

[4] Unit areas 600 and 950 main vent header contain neutralization columns, but Kairos is not taking credit for their reductions.

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Emission Point 4: Cooling Tower Emission Calculation

EP-4: Cooling Tower-1 Design Specifications

Parameter	Units	Cooling Tower 1
Water Circulation Rate	gpm	6,174
Operating Hours per Year	hrs/yr	8,760
Drift Rate	%	0.05
Water Authority Max TDS [1]	ppmw	314
Maximum TDS [2]	ppmw	500

[1] Max TDS value taken from 2023 Consumer Confidence Report – Zone 3, Albuquerque Bernalillo County Water Utility Authority (Water Authority).

[2] The Water Authority Max TDS value was rounded up to 500 ppmw to incorporate a conservative safety factor.

Potential Emissions

Source Name	EPN	FIN	Hourly Emissions (lb/hr) [1]			Annual Emissions (tpy) [2]		
			PM	PM_{10}	$PM_{2.5}$	PM	PM_{10}	$PM_{2.5}$
Cooling Tower 1			0.77	0.70	0.014	3.38	3.08	0.061
Total Cooling Tower Emissions			**0.77**	**0.70**	**0.014**	**3.38**	**3.08**	**0.061**

[1] Maximum hourly emissions calculated for TDS values ranging from 0 to 12,000 ppm. Detailed calculations provided in the tables below.

[2] Annual Emissions (tpy) = Hourly Emissions * Annual Operating Hours (hrs/yr) * 1/2,000 (ton/lb)

$$\text{Annual Emissions of PM (tpy)} = \frac{0.7723674\ \text{lb}}{\text{hr}} \Bigg| \frac{8760\ \text{hr}}{\text{yr}} \Bigg| \frac{1\ \text{ton}}{2{,}000\ \text{lb}} = 3.38\ \text{tpy}$$

Particle Size Distribution of PM Emissions from Cooling Towers

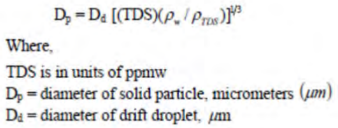
Particle Size Distribution Based on TDS [1]

TDS (ppm)	0	500	1000	1500	3000	4500	6000	7500	9000	10500	12000	EPRI % Mass Smaller [2]
EPRI Droplet Diameter (mm) [2]	Solid Particle Diameter (mm) [3]											
10	0.00	0.61	0.77	0.88	1.11	1.27	1.40	1.51	1.60	1.68	1.76	0.000
20	0.00	1.22	1.54	1.76	2.22	2.54	2.79	3.01	3.20	3.37	3.52	0.196
30	0.00	1.83	2.31	2.64	3.33	3.81	4.19	4.52	4.80	5.05	5.28	0.226
40	0.00	2.44	3.08	3.52	4.44	5.08	5.59	6.02	6.40	6.73	7.04	0.514
50	0.00	3.05	3.84	4.40	5.54	6.35	6.99	7.53	8.00	8.42	8.80	1.816
60	0.00	3.66	4.61	5.28	6.65	7.62	8.38	9.03	9.60	10.10	10.56	5.702
70	0.00	4.27	5.38	6.16	7.76	8.89	9.78	10.54	11.20	11.79	12.32	21.348
90	0.00	5.49	6.92	7.92	9.98	11.42	12.57	13.55	14.39	15.15	15.84	49.812
110	0.00	6.71	8.46	9.68	12.20	13.96	15.37	16.56	17.59	18.52	19.36	70.509
130	0.00	7.93	10.00	11.44	14.42	16.50	18.16	19.57	20.79	21.89	22.88	82.023
150	0.00	9.15	11.53	13.20	16.63	19.04	20.96	22.58	23.99	25.25	26.40	88.012
180	0.00	10.98	13.84	15.84	19.96	22.85	25.15	27.09	28.79	30.31	31.69	91.032
210	0.00	12.82	16.15	18.48	23.29	26.66	29.34	31.61	33.59	35.36	36.97	92.468
240	0.00	14.65	18.45	21.12	26.61	30.47	33.53	36.12	38.38	40.41	42.25	94.091
270	0.00	16.48	20.76	23.76	29.94	34.27	37.72	40.64	43.18	45.46	47.53	94.689
300	0.00	18.31	23.07	26.40	33.27	38.08	41.91	45.15	47.98	50.51	52.81	96.288
350	0.00	21.36	26.91	30.81	38.81	44.43	48.90	52.68	55.98	58.93	61.61	97.011
400	0.00	24.41	30.76	35.21	44.36	50.78	55.89	60.20	63.97	67.35	70.41	98.340
450	0.00	27.46	34.60	39.61	49.90	57.12	62.87	67.73	71.97	75.76	79.21	99.071
500	0.00	30.51	38.44	44.01	55.45	63.47	69.86	75.25	79.97	84.18	88.01	99.071
600	0.00	36.62	46.13	52.81	66.54	76.16	83.83	90.30	95.96	101.02	105.62	100.000

[1] Particle size distribution calculated based on emission calculations outlined in *Reisman, J. and G. Frisbie "Calculating Realistic PM10 Emissions from Cooling Towers", Greystone Environmental Consultants, Inc., 650 University Avenue, Suite 100, Sacramento, CA 95825.*

[2] The EPRI Droplet Diameter and the EPRI % Mass Smaller obtained from Table 1. Reisman, J. and G. Frisbie "Calculating Realistic PM10 Emissions from Cooling Towers", Greystone Environmental Consultants, Inc., 650 University Avenue, Suite 100, Sacramento, CA 95825.

[3] Solid particle diameter is calculated from EPRI droplet diameter assuming that each water droplet evaporates shortly after being emitted into a single, solid, spherical particle using the equation below.



$$D_p = D_d\,[(TDS)(\rho_w / \rho_{TDS})]^{1/3}$$

Where,

TDS is in units of ppmw
D_p = diameter of solid particle, micrometers (μm)
D_d = diameter of drift droplet, μm

Other assumptions include:

$\rho_{droplet}$	1	g/cm^3
ρ_{solid}	2.2	g/cm^3

Particle Size Distribution and Emission Rates for PM_{10} and $PM_{2.5}$

TDS (ppm)	Solid Particle Diameter used for PM_{10} (mm)	% of Particles where diameter < 10 mm	Solid Particle Diameter used for $PM_{2.5}$ (mm)	% of Particles where diameter < 2.5 mm	Hourly Emission Rate [1, 2, 3]		
					Cooling Tower 1		
					PM	PM_{10}	$PM_{2.5}$
0					--	--	--
500	10.98	91.032	3.05	1.816	0.77	0.70	0.014
1000	10.00	82.023	3.08	0.514	1.54	1.27	0.0079
1500	11.44	82.023	2.64	0.226	2.32	1.90	0.0052
3000	12.20	70.509	3.33	0.226	4.63	3.27	0.0105
4500	11.42	49.812	2.54	0.196	6.95	3.46	0.014
6000	12.57	49.812	2.79	0.196	9.27	4.62	0.018
7500	10.54	21.348	3.01	0.196	11.59	2.47	0.023
9000	11.20	21.348	3.20	0.196	13.90	2.97	0.027
10500	10.10	5.702	3.37	0.196	16.22	0.92	0.032
12000	10.56	5.702	3.52	0.196	18.54	1.06	0.036
Maximum Emission Rate (lb/hr):					**18.54**	**4.62**	**0.04**

[1] Hourly Emissions of PM (lb/hr) = Water Circulation Rate (gpm) * Drift Rate (%) / 100 x TDS (ppmw) * 8.34 (lb water/gal) * 60 (min/hr)

$$\text{Hourly Emissions of PM (lb/hr) @ 12,000 ppm} = \frac{1600\ \text{gal}}{\text{min}} \; \frac{0.02}{100} \; \frac{12{,}000\ \text{parts solids}}{1{,}000{,}000\ \text{part water}} \; \frac{8.34\ \text{lb water}}{\text{gal}} \; \frac{60\ \text{min}}{\text{hr}} = 1.92\ \text{lb/hr}$$

[2] Hourly Emissions of PM_{10} (lb/hr) = Hourly Emissions of PM (lb/hr) * PM_{10} Portion of PM (%) / 100

$$\text{Hourly Emissions of } PM_{10} \text{ (lb/hr) @ 12,000 ppm} = \frac{1.92\ \text{lb}}{\text{hr}} \; \frac{5.702}{100} = 0.11\ \text{lb/hr}$$

[3] Hourly Emissions of $PM_{2.5}$ (lb/hr) = Hourly Emissions of PM (lb/hr) * $PM_{2.5}$ Portion of PM (%) / 100

$$\text{Hourly Emissions of } PM_{2.5} \text{ (lb/hr) @ 12,000 ppm} = \frac{1.92\ \text{lb}}{\text{hr}} \; \frac{0.196}{100} = 0.0038\ \text{lb/hr}$$

Emission Point 5A: Boiler Emission Calculation

EP No. / Unit ID	EP-5A: Boiler-1		
Site Rating:	24.525	MMBtu/hr	
Fuel Heating Value:	1020	Btu/scf	Pipeline quality natural gas
Hours of Operation:	8760	hr/yr	
Hourly Fuel Usage:	24044	scf/hr	
	0.024	MMscf/hr	
Annual Fuel Usage:	210.63	MMscf/yr	

Boiler Emissions

	NO$_x$[1]	CO[1]	VOC[1]	SO$_2$[2]	PM[3]	Formaldehyde[1]	Benzene[1]	n-Hexane[1]	Toluene[1]	Total HAPs [4]	
Emission Factor	50.00	84.00	5.50		7.60	7.5E-02	2.1E-03	1.8E+00	3.4E-03		lb/MMscf
				0.02							gr/scf
Hourly Totals	1.20	2.02	0.13	0.14	0.18	1.80E-03	5.05E-05	0.043	8.18E-05	0.045	lb/hr
Annual Totals	5.27	8.85	0.58	0.60	0.80	7.90E-03	2.21E-04	0.19	3.58E-04	0.20	ton/yr

Notes

[1] Emissions factors used from AP-42 Section 1.4 Natural Gas Combustion Table 1.4-1 & 1.4-2.

[2] SO$_2$ is calculated based on the 2 grains total sulfur per 100 scf natural gas.

[3] PM = PM$_{condensable}$ + PM$_{filterable}$ [based on AP 42 Table 1.4-2]

[4] Total HAPs include formaldehyde, Benzene, n-Hexane, and Toluene.

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Emission Point 5B: Boiler Emission Calculation

EP No. / Unit ID	EP-5B: Boiler-2		
Site Rating:	32.700	MMBtu/hr	
Fuel Heating Value:	1020	Btu/scf	Pipeline quality natural gas
Hours of Operation:	8760	hr/yr	
Hourly Fuel Usage:	32059	scf/hr	
	0.032	MMscf/hr	
Annual Fuel Usage:	280.84	MMscf/yr	

Boiler Emissions

	NO$_x$[1]	CO[1]	VOC[1]	SO$_2$[2]	PM[3]	Formaldehyde[1]	Benzene[1]	n-Hexane[1]	Toluene[1]	Total HAPs [4]	
Emission Factor	50.00	84.00	5.50		7.60	7.5E-02	2.1E-03	1.8E+00	3.4E-03		lb/MMscf
				0.02							gr/scf
Hourly Totals	1.60	2.69	0.18	0.18	0.24	2.40E-03	6.73E-05	0.058	1.09E-04	0.060	lb/hr
Annual Totals	7.02	11.80	0.77	0.80	1.07	0.011	2.95E-04	0.25	4.77E-04	0.26	ton/yr

Notes

[1] Emissions factors used from AP-42 Section 1.4 Natural Gas Combustion Table 1.4-1 & 1.4-2.

[2] SO_2 is calculated based on the 2 grains total sulfur per 100 scf natural gas.

[3] PM = PM$_{condensable}$ + PM$_{filterable}$ [based on AP 42 Table 1.4-2]

[4] Total HAPs include formaldehyde, Benzene, n-Hexane, and Toluene.

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Emission Point 6: Emergency Engine Emissions

EP No. / Unit ID	EP-6: GEN-1
Source Description:	Emergency diesel fired generator
Manufacturer:	Iveco/FPT
Engine Model:	F3AE9685A-E
Emission Standard Category:	Tier 3

Fuel Consumption

Rated Engine Power	449	hp	Manufacturer Rating
Fuel consumption	22.10	gal/hr	
Max operating hours	8760	hr	
Requested Operating hours	500	hr	
Diesel Heat Value [1]	137,000	Btu/gal	
Heat Input:	3.03	MMBtu/hr	

	Emissions Summary															
	NO_x[2,3]	**CO[2]**	**NMHC[2,3]**	**SO_2[5]**	**PM[2]**	**Formaldehyde[4]**	**Acetaldehyde[4]**	**Acrolein[4]**	**Benzene[4]**	**Toluene[4]**	**Xylene[4]**	**Propylene[4]**	**1,3-Butadiene[4]**	**Naphthalene[4]**	**Total HAP**	**Units**
Engine Emission Factors	2.66	1.00	0.14		0.10											g/hp-hr
				0.29		1.18E-03	7.67E-04	9.25E-05	9.33E-04	4.09E-04	2.85E-04	2.58E-03	3.91E-05	8.48E-05		lb/MMBtu
																ppm
Hourly Totals	2.63	0.99	0.14	0.88	0.099	3.57E-03	2.32E-03	2.80E-04	2.82E-03	1.24E-03	8.63E-04	7.81E-03	1.18E-04	2.57E-04	0.019	lb/hr
Annual Totals	11.53	4.34	0.61	3.85	0.43	0.016	0.010	1.23E-03	0.012	5.42E-03	3.78E-03	0.034	5.19E-04	1.12E-03	0.084	ton/yr
Requested Emissions (lb/hr)	**2.63**	**0.99**	**0.14**	**0.88**	**0.099**	**3.57E-03**	**2.32E-03**	**2.80E-04**	**2.82E-03**	**1.24E-03**	**8.63E-04**	**7.81E-03**	**1.18E-04**	**2.57E-04**	**0.019**	**lb/hr**
Requested Emissions (500 hr/yr)	**0.66**	**0.25**	**0.035**	**0.22**	**0.025**	**8.93E-04**	**5.81E-04**	**7.00E-05**	**7.06E-04**	**3.10E-04**	**2.16E-04**	**1.95E-03**	**2.96E-05**	**6.42E-05**	**4.82E-03**	**ton/yr**

Notes

[1] Diesel heat value from Appendix A, AP 42

[2] Emissions factors are taken from the manufacturer specification sheet.

[3] NO_X and NMHC are derived from NO_X+NMHC based on the assumption of 95% NO_X and 5% NMHC according to Table D-25 on California Environmental Protection Agency (CARB, Revised date: Dec 18, 2011)

[4] HAPs emissions factors are referenced from AP-42 Table 3.3-1 & 3.3-2. HAPs include: Formaldehyde, Acetaldehyde, Acrolein, Benzene, Toluene, Xylene, Propylene, 1,3-Butadiene, and Naphthalene.

[5] SO_2 is calculated based on AP 42 Table 3.3-1.

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Emission Point 7: Facility Fugitives

EP No. / Unit ID	EP-7: FUG-1
Source description:	Facility-wide Fugitive Emissions
Total Operating Hours:	8,760
Safety Factor	10%

Component	Service	Emission factor[1] (lb/hr/source)	Subcomponent Count[2]	VOC Content[3] (wt%)	HAP Content[3] (wt%)	Chloroform[3] (wt%)
Valves	Gas/Vapor	0.0089	35	61.46%	57.90%	57.90%
	Light Liquid	0.0035	313	61.46%	57.90%	57.90%
	Heavy Liquid	0.0007	-	-	-	-
Pump seals	Light Liquid	0.0386	-	-	-	-
	Heavy Liquid	0.0161	-	-	-	-
Flanges/Connectors	Gas/Vapor	0.0029	236	53.09%	51.44%	51.44%
	Light Liquid	0.0005	2123	53.09%	51.44%	51.44%
	Heavy Liquid	0.00007	-	-	-	-
Compressors	All	0.5027	-	-	-	-
Relief Valves	Gas/Vapor	0.2293	-	-	-	-
Open-ended Lines	All	0.004	-	-	-	-
Sampling Connections	All	0.033	-	-	-	-
Agitator Seals	Light Liquid	-	-	-	-	-
Liquid Relief Valves	Light Liquid	-	-	-	-	-
			Total (lb/hr)[4]:	**1.97**	**1.88**	**1.88**
			Total (tpy)[5]:	**8.63**	**8.25**	**8.25**
			LDAR Annual Monitoring (75% Reduction) Total (lb/hr):	**0.49**	**0.47**	**0.47**
			LDAR Annual Monitoring (75% Reduction) Total (tpy):	**2.16**	**2.06**	**2.06**

Notes

[1] Emission factors were taken from Table I: "Uncontrolled SOCMI Fugitive Emission Factors," in Appendix A of the TCEQ Guidance Document "Air Permit Technical Guidance for Chemical Sources - Fugitive Guidance" (APDG 6422v2, Revised 06/18). Specifically emission factors were taken for "SOCMI Without Ethylene (C2)."

[2] Component counts are based on facility design.

[3] The VOC and HAP contents were determined as weighted averages based on the total composition for the equipment type and component counts. Additionally, it was assumed that 10% of the components were in gas/vapor service, with the remaining 90% in light liquid service.

[4] Hourly Emissions [lb/hr] = Emissions Factor [lb/hr/component] * Weight Content of Chemical Component [%] * Subcomponent Count. * (1 + SF (%))

[5] Annual Emissions [ton/yr] = Hourly Emissions [lb/hr] * Operating Hours [hr/yr] / [2000 lb/ton].

[6] Annual instrument monitorng of connectors/flanges at a 500 ppmv leak detection limit may receive a 75% reduction credit at SOCMI facilities per the "Air

2.5 Supporting Information

- Current version of AP-42 located online at: US EPA AP-42 Compilation of Air Emissions Factors
  - Specific sections used in this application:
    - AP-42 Chapter 1.4: Natural Gas Combustion – Tables 1.4-1 through 1.4-3
    - AP-42 Chapter 3.3: Gasoline And Diesel Industrial Engines – Tables 3.3-1 and 3.3-2
    - Ap-42 Chapter 7.1: Organic Liquid Storage Tanks
    - AP-42 Appendix A: Typical Parameters for Various Fuels
- Generac manufacturer specification sheet
- Marley Cooling Tower Datasheet
- CARB The Carl Moyer Program Guidelines (Revised December 18, 2011) Table D-26
- Albuquerque Bernalillo County Water Utility Authority Water Quality Report 2023 – Zone 3
- Reisman, J. and G. Frisbie. "Calculating Realistic PM_{10} Emissions from Cooling Towers", Greystone Environmental Consultants, Inc., 650 University Avenue, Suite 100, Sacramento, CA 95825.
- TCEQ Guidance Document "Air Permit Technical Guidance for Chemical Sources - Fugitive Guidance" (APDG 6422v2, Revised 06/18). Table I: "Uncontrolled SOCMI Fugitive Emission Factors"
- Chemical Safety Data Sheets (SDS) can be found in Appendix F for the following:
  - Beryllium Fluoride
  - Chemical A
  - Chemical C
  - Chloroform
  - Dimethylformamide
  - Hydrochloric Acid
  - Hydrofluoric Acid
  - Hydrogen Peroxide
  - Isopropanol
  - Flibe
  - Lithium Hydroxide Monohydrate
  - Sodium Hydroxide
  - Thionyl Chloride

1.4 Natural Gas Combustion

1.4.1 General[1-2]

Natural gas is one of the major combustion fuels used throughout the country. It is mainly used to generate industrial and utility electric power, produce industrial process steam and heat, and heat residential and commercial space. Natural gas consists of a high percentage of methane (generally above 85 percent) and varying amounts of ethane, propane, butane, and inerts (typically nitrogen, carbon dioxide, and helium). The average gross heating value of natural gas is approximately 1,020 British thermal units per standard cubic foot (Btu/scf), usually varying from 950 to 1,050 Btu/scf.

1.4.2 Firing Practices[3-5]

There are three major types of boilers used for natural gas combustion in commercial, industrial, and utility applications: watertube, firetube, and cast iron. Watertube boilers are designed to pass water through the inside of heat transfer tubes while the outside of the tubes is heated by direct contact with the hot combustion gases and through radiant heat transfer. The watertube design is the most common in utility and large industrial boilers. Watertube boilers are used for a variety of applications, ranging from providing large amounts of process steam, to providing hot water or steam for space heating, to generating high-temperature, high-pressure steam for producing electricity. Furthermore, watertube boilers can be distinguished either as field erected units or packaged units.

Field erected boilers are boilers that are constructed on site and comprise the larger sized watertube boilers. Generally, boilers with heat input levels greater than 100 MMBtu/hr, are field erected. Field erected units usually have multiple burners and, given the customized nature of their construction, also have greater operational flexibility and NO_x control options. Field erected units can also be further categorized as wall-fired or tangential-fired. Wall-fired units are characterized by multiple individual burners located on a single wall or on opposing walls of the furnace while tangential units have several rows of air and fuel nozzles located in each of the four corners of the boiler.

Package units are constructed off-site and shipped to the location where they are needed. While the heat input levels of packaged units may range up to 250 MMBtu/hr, the physical size of these units are constrained by shipping considerations and generally have heat input levels less than 100 MMBtu/hr. Packaged units are always wall-fired units with one or more individual burners. Given the size limitations imposed on packaged boilers, they have limited operational flexibility and cannot feasibly incorporate some NO_x control options.

Firetube boilers are designed such that the hot combustion gases flow through tubes, which heat the water circulating outside of the tubes. These boilers are used primarily for space heating systems, industrial process steam, and portable power boilers. Firetube boilers are almost exclusively packaged units. The two major types of firetube units are Scotch Marine boilers and the older firebox boilers. In cast iron boilers, as in firetube boilers, the hot gases are contained inside the tubes and the water being heated circulates outside the tubes. However, the units are constructed of cast iron rather than steel. Virtually all cast iron boilers are constructed as package boilers. These boilers are used to produce either low-pressure steam or hot water, and are most commonly used in small commercial applications.

Natural gas is also combusted in residential boilers and furnaces. Residential boilers and furnaces generally resemble firetube boilers with flue gas traveling through several channels or tubes with water or air circulated outside the channels or tubes.

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION[a]

CAS No.	Pollutant	Emission Factor (lb/10^6 scf)	Emission Factor Rating
91-57-6	2-Methylnaphthalene[b, c]	2.4E-05	D
56-49-5	3-Methylcholanthrene[b, c]	<1.8E-06	E
	7,12-Dimethylbenz(a)anthracene[b,c]	<1.6E-05	E
83-32-9	Acenaphthene[b,c]	<1.8E-06	E
203-96-8	Acenaphthylene[b,c]	<1.8E-06	E
120-12-7	Anthracene[b,c]	<2.4E-06	E
56-55-3	Benz(a)anthracene[b,c]	<1.8E-06	E
71-43-2	Benzene[b]	2.1E-03	B
50-32-8	Benzo(a)pyrene[b,c]	<1.2E-06	E
205-99-2	Benzo(b)fluoranthene[b,c]	<1.8E-06	E
191-24-2	Benzo(g,h,i)perylene[b,c]	<1.2E-06	E
207-08-9	Benzo(k)fluoranthene[b,c]	<1.8E-06	E
106-97-8	Butane	2.1E+00	E
218-01-9	Chrysene[b,c]	<1.8E-06	E
53-70-3	Dibenzo(a,h)anthracene[b,c]	<1.2E-06	E
25321-22-6	Dichlorobenzene[b]	1.2E-03	E
74-84-0	Ethane	3.1E+00	E
206-44-0	Fluoranthene[b,c]	3.0E-06	E
86-73-7	Fluorene[b,c]	2.8E-06	E
50-00-0	Formaldehyde[b]	7.5E-02	B
110-54-3	Hexane[b]	1.8E+00	E
193-39-5	Indeno(1,2,3-cd)pyrene[b,c]	<1.8E-06	E
91-20-3	Naphthalene[b]	6.1E-04	E
109-66-0	Pentane	2.6E+00	E
85-01-8	Phenanathrene[b,c]	1.7E-05	D
74-98-6	Propane	1.6E+00	E

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION (Continued)

CAS No.	Pollutant	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating
129-00-0	Pyrene[b, c]	5.0E-06	E
108-88-3	Toluene[b]	3.4E-03	C

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from $lb/10^6$ scf to $kg/10^6$ m^3, multiply by 16. To convert from $1b/10^6$ scf to lb/MMBtu, divide by 1,020. Emission Factors preceeded with a less-than symbol are based on method detection limits.

[b] Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act.

[c] HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.

[d] The sum of individual organic compounds may exceed the VOC and TOC emission factors due to differences in test methods and the availability of test data for each pollutant.

3.3 Gasoline And Diesel Industrial Engines

3.3.1 General

The engine category addressed by this section covers a wide variety of industrial applications of both gasoline and diesel internal combustion (IC) engines such as aerial lifts, fork lifts, mobile refrigeration units, generators, pumps, industrial sweepers/scrubbers, material handling equipment (such as conveyors), and portable well-drilling equipment. The three primary fuels for reciprocating IC engines are gasoline, diesel fuel oil (No.2), and natural gas. Gasoline is used primarily for mobile and portable engines. Diesel fuel oil is the most versatile fuel and is used in IC engines of all sizes. The rated power of these engines covers a rather substantial range, up to 250 horsepower (hp) for gasoline engines and up to 600 hp for diesel engines. (Diesel engines greater than 600 hp are covered in Section 3.4, "Large Stationary Diesel And All Stationary Dual-fuel Engines".) Understandably, substantial differences in engine duty cycles exist. It was necessary, therefore, to make reasonable assumptions concerning usage in order to formulate some of the emission factors.

3.3.2 Process Description

All reciprocating IC engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated.

There are 2 methods used for stationary reciprocating IC engines: compression ignition (CI) and spark ignition (SI). This section deals with both types of reciprocating IC engines. All diesel-fueled engines are compression ignited, and all gasoline-fueled engines are spark ignited.

In CI engines, combustion air is first compression heated in the cylinder, and diesel fuel oil is then injected into the hot air. Ignition is spontaneous because the air temperature is above the autoignition temperature of the fuel. SI engines initiate combustion by the spark of an electrical discharge. Usually the fuel is mixed with the air in a carburetor (for gasoline) or at the intake valve (for natural gas), but occasionally the fuel is injected into the compressed air in the cylinder.

CI engines usually operate at a higher compression ratio (ratio of cylinder volume when the piston is at the bottom of its stroke to the volume when it is at the top) than SI engines because fuel is not present during compression; hence there is no danger of premature autoignition. Since engine thermal efficiency rises with increasing pressure ratio (and pressure ratio varies directly with compression ratio), CI engines are more efficient than SI engines. This increased efficiency is gained at the expense of poorer response to load changes and a heavier structure to withstand the higher pressures.[1]

3.3.3 Emissions

Most of the pollutants from IC engines are emitted through the exhaust. However, some total organic compounds (TOC) escape from the crankcase as a result of blowby (gases that are vented from the oil pan after they have escaped from the cylinder past the piston rings) and from the fuel tank and carburetor because of evaporation. Nearly all of the TOCs from diesel CI engines enter the

Table 3.3-1. EMISSION FACTORS FOR UNCONTROLLED GASOLINE AND DIESEL INDUSTRIAL ENGINES[a]

Pollutant	Gasoline Fuel (SCC 2-02-003-01, 2-03-003-01)		Diesel Fuel (SCC 2-02-001-02, 2-03-001-01)		EMISSION FACTOR RATING
	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	
NO$_x$	0.011	1.63	0.031	4.41	D
CO	6.96 E-03[d]	0.99[d]	6.68 E-03	0.95	D
SO$_x$	5.91 E-04	0.084	2.05 E-03	0.29	D
PM-10[b]	7.21 E-04	0.10	2.20 E-03	0.31	D
CO$_2$[c]	1.08	154	1.15	164	B
Aldehydes	4.85 E-04	0.07	4.63 E-04	0.07	D
TOC					
Exhaust	0.015	2.10	2.47 E-03	0.35	D
Evaporative	6.61 E-04	0.09	0.00	0.00	E
Crankcase	4.85 E-03	0.69	4.41 E-05	0.01	E
Refueling	1.08 E-03	0.15	0.00	0.00	E

[a] References 2,5-6,9-14. When necessary, an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr was used to convert from lb/MMBtu to lb/hp-hr. To convert from lb/hp-hr to kg/kw-hr, multiply by 0.608. To convert from lb/MMBtu to ng/J, multiply by 430. SCC = Source Classification Code. TOC = total organic compounds.

[b] PM-10 = particulate matter less than or equal to 10 µm aerodynamic diameter. All particulate is assumed to be ≤ 1 µm in size.

[c] Assumes 99% conversion of carbon in fuel to CO$_2$ with 87 weight % carbon in diesel, 86 weight % carbon in gasoline, average BSFC of 7,000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and gasoline heating value of 20,300 Btu/lb.

[d] Instead of 0.439 lb/hp-hr (power output) and 62.7 lb/mmBtu (fuel input), the correct emissions factors values are 6.96 E-03 lb/hp-hr (power output) and 0.99 lb/mmBtu (fuel input), respectively. This is an editorial correction. March 24, 2009

Table 3.3-2. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR UNCONTROLLED DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (Fuel Input) (lb/MMBtu)
Benzene[b]	9.33 E-04
Toluene[b]	4.09 E-04
Xylenes[b]	2.85 E-04
Propylene	2.58 E-03
1,3-Butadiene[b,c]	<3.91 E-05
Formaldehyde[b]	1.18 E-03
Acetaldehyde[b]	7.67 E-04
Acrolein[b]	<9.25 E-05
Polycyclic aromatic hydrocarbons (PAH)	
Naphthalene[b]	8.48 E-05
Acenaphthylene	<5.06 E-06
Acenaphthene	<1.42 E-06
Fluorene	2.92 E-05
Phenanthrene	2.94 E-05
Anthracene	1.87 E-06
Fluoranthene	7.61 E-06
Pyrene	4.78 E-06
Benzo(a)anthracene	1.68 E-06
Chrysene	3.53 E-07
Benzo(b)fluoranthene	<9.91 E-08
Benzo(k)fluoranthene	<1.55 E-07
Benzo(a)pyrene	<1.88 E-07
Indeno(1,2,3-cd)pyrene	<3.75 E-07
Dibenz(a,h)anthracene	<5.83 E-07
Benzo(g,h,l)perylene	<4.89 E-07
TOTAL PAH	1.68 E-04

[a] Based on the uncontrolled levels of 2 diesel engines from References 6-7. Source Classification Codes 2-02-001-02, 2-03-001-01. To convert from lb/MMBtu to ng/J, multiply by 430.

[b] Hazardous air pollutant listed in the *Clean Air Act*.

[c] Based on data from 1 engine.

7.1 Organic Liquid Storage Tanks

Disclaimer: Emission factors in AP-42 are neither EPA-recommended emission limits (e.g., best available control technology or BACT, or lowest achievable emission rate or LAER) nor standards (e.g., National Emission Standard for Hazardous Air Pollutants or NESHAP, or New Source Performance Standards or NSPS). Use of these factors as source-specific permit limits and/or as emission regulation compliance determinations is NOT recommended by EPA. Because emission factors essentially represent an average of a range of emission rates, approximately half of the subject sources are expected to have emission rates greater than the emission factor, and the other half are expected to have emission rates less than the emission factor. As such, EPA does not recommend using emission factors as limits or standards. This could cause, for example, a permit limit using an AP-42 emission factor resulting in approximately half of the sources being in noncompliance. We recommend source testing be done for the best possible emission values. For more information on the use of emission factors, please refer to the AP-42 Introduction.

7.1.1 General

7.1.1.1 Scope

Section 7.1 presents emissions estimating methodologies for storage tanks of various types and operating conditions. The methodologies are intended for storage tanks that are properly maintained and in normal working condition. The methodologies do not address conditions of deteriorated or otherwise damaged materials of construction, nor do they address operating conditions that differ significantly from the scenarios described herein. To estimate losses that occur from underground gasoline storage tanks at service stations, please see AP-42 Section 5.2, “Transportation and Marketing of Petroleum Liquids.”

Sections 7.1.3.1 and 7.1.3.2 present emissions estimating methodologies for routine emissions from fixed roof tanks and floating roof tanks. Use of the terminology “routine emissions” to refer to standing and working losses applies only for the purposes of this document, and not for any other air quality purposes such as New Source Review (NSR) permitting. The equations for routine emissions were developed to estimate average annual losses for storage tanks, but provisions for applying the equations to shorter periods of time are addressed in Section 7.1.3.8.1. The equations for routine emissions are a function of temperatures that are derived from a theoretical energy transfer model. In order to simplify the calculations, default values were assigned to certain parameters in the energy transfer equations. The accuracy of the resultant equations for an individual tank depends upon how closely that tank fits the assumptions inherent to these default values. The associated uncertainty may be mitigated by using measured values for the liquid bulk temperature. The equations for routine emissions are not intended to include emissions from the following events (these are addressed separately):

a) To estimate losses that result from the landing of a floating roof. A separate methodology is presented for floating roof landing losses in Section 7.1.3.3.

b) To estimate losses that result from cleaning a tank. A separate methodology is presented for tank cleaning losses in Section 7.1.3.4.

The columns pass through deck openings via peripheral vertical wells. With noncontact decks, the well should extend down into the liquid stock. Generally, a closure device exists between the top of the well and the column. Several proprietary designs exist for this closure, including sliding covers and fabric sleeves, which must accommodate the movements of the deck relative to the column as the liquid level changes. A sliding cover rests on the upper rim of the column well (which is normally fixed to the deck) and bridges the gap or space between the column well and the column. The cover, which has a cutout, or opening, around the column slides vertically relative to the column as the deck raises and lowers. At the same time, the cover may slide horizontally relative to the rim of the well to accommodate out-of-plumbness of the column. A gasket around the rim of the well reduces emissions from this fitting. A flexible fabric sleeve seal between the rim of the well and the column (with a cutout or opening, to allow vertical motion of the seal relative to the columns) similarly accommodates limited horizontal motion of the deck relative to the column.

2. Ladders and wells. Some tanks are equipped with internal ladders that extend from a manhole in the fixed roof to the tank bottom. The deck opening through which the ladder passes is constructed with similar design details and considerations to deck openings for column wells, as previously discussed. A typical ladder well is shown in Figure 7.1-12.

Tanks are sometimes equipped with a ladder-slotted guidepole combination, in which one or both legs of the ladder is a slotted pipe that serves as a guidepole for purposes such as level gauging and sampling. A ladder-slotted guidepole combination is shown in Figure 7.1-21 with a ladder sleeve to reduce emissions.

3. Stub drains. Bolted internal floating roof decks are typically equipped with stub drains to allow any stored product that may be on the deck surface to drain back to the underside of the deck. The drains are attached so that they are flush with the upper deck. Stub drains are approximately 1 inch in diameter and extend down into the product on noncontact decks. A typical flush stub drain is shown in Figure 7.1-10. Stub drains may be equipped with floating balls to reduce emissions. The floating ball acts as a check valve, in that it remains covering the stub drain unless liquid is present to lift it.

Deck seams in internal floating roof tanks are a source of emissions to the extent that these seams may not be completely vapor tight if the deck is not welded. A weld sealing a deck seam does not have to be structural (i.e., may be a seal weld) to constitute a welded deck seam for purposes of estimating emissions, but a deck seam that is bolted or otherwise mechanically fastened and sealed with elastomeric materials or chemical adhesives is not a welded seam. Generally, the same loss mechanisms for deck fittings apply to deck seams. The predominant mechanism depends on whether or not the deck is in contact with the stored liquid. The deck seam loss equation accounts for the effects of all contributing loss mechanisms.

7.1.3 Emission Estimation Procedures

The following section presents the emission estimation procedures for vertical and horizontal fixed roof, external floating roof, domed external floating roof, and internal floating roof tanks. These procedures are valid for all volatile organic liquids and chemical mixtures. It is important to note that in all the emission estimation procedures the physical properties of the vapor do not include the noncondensibles in the atmosphere but only refer to the volatile components of the stored liquid. For example, the vapor-phase molecular weight is determined from the weighted average of the evaporated components of the stored liquid and does not include the contribution of atmospheric gases such as nitrogen and oxygen. To aid in the emission estimation procedures, a list of variables with their corresponding definitions was developed and is presented in Table 7.1-1.

The factors presented in AP-42 are those that are currently available and have been reviewed and approved by the U. S. Environmental Protection Agency. As storage tank equipment vendors design new floating decks and equipment, new emission factors may be developed based on that equipment. If the new emission factors are reviewed and approved, the emission factors will be added to AP-42 during the next update.

The emission estimation procedures outlined in this chapter have been used as the basis for the development of a software program to estimate emissions from storage tanks. The software program entitled "TANKS" is available through the U. S. Environmental Protection Agency website. While this software does not address all of the scenarios described in this chapter, known errors have been corrected and a new version, TANKS 5.1, is now available.

There are also commercially available storage tank emissions estimation software programs. Users of these programs are advised to understand the extent of agreement with AP-42 Chapter 7 calculation methodology and assume responsibility for the accuracy of the output as they have not been reviewed or approved by the EPA.

7.1.3.1 Routine Losses From Fixed Roof Tanks [8-14,22]

The following equations, provided to estimate standing and working loss emissions, apply to tanks with vertical cylindrical shells and fixed roofs and to tanks with horizontal cylindrical shells. These tanks must be substantially liquid- and vapor-tight. The equations are not intended to be used in estimating losses from tanks which have air or other gases injected into the liquid, or which store unstable or boiling stocks or mixtures of hydrocarbons or petrochemicals for which the vapor pressure is not known or cannot be readily predicted. Tanks containing aqueous mixtures in which phase separation has occurred, resulting in a free layer of oil or other volatile materials floating on top of the water, should have emissions estimated on the basis of properties of the free top layer.

Total routine losses from fixed roof tanks are equal to the sum of the standing loss and working loss:

$$L_T = L_S + L_W \tag{1-1}$$

where:

L_T = total routine losses, lb/yr
L_S = standing losses, lb/yr, see Equation 1-2
L_W = working losses, lb/yr, see Equation 1-37

7.1.3.1.1 Standing Loss

The standing loss, L_S, for a fixed roof tank refers to the loss of stock vapors as a result of tank vapor space breathing. Fixed roof tank standing losses can be estimated from Equation 1-2.

$$L_S = 365\ V_V\ W_V\ K_E\ K_S \tag{1-2}$$

where:

L_S = standing loss, lb/yr
V_V = vapor space volume, ft^3, see Equation 1-3
W_V = stock vapor density, lb/ft^3
K_E = vapor space expansion factor, per day
K_S = vented vapor saturation factor, dimensionless
365 = constant, the number of daily events in a year, (days/year)

Tank Vapor Space Volume, V_V - The tank vapor space volume is calculated using the following equation:

$$V_V = \left(\frac{\pi}{4}D^2\right)H_{VO} \tag{1-3}$$

where:

V_V = vapor space volume, ft^3
D = tank diameter, ft, see Equation 1-14 for horizontal tanks
H_{VO} = vapor space outage, ft, see Equation 1-18

The standing loss equation can be simplified by combining Equation 1-2 with Equation 1-3. The result is Equation 1-4.

$$L_S = 365K_E\left(\frac{\pi}{4}D^2\right)H_{VO}K_SW_V \tag{1-4}$$

where:

L_S = standing loss, lb/yr
K_E = vapor space expansion factor, per day, see Equation 1-5, 1-12, or 1-13
D = diameter, ft, see Equation 1-14 for horizontal tanks
H_{VO} = vapor space outage, ft, see Equation 1-18; use $H_E/2$ from Equation 1-15 for horizontal tanks
K_S = vented vapor saturation factor, dimensionless, see Equation 1-23
W_V = stock vapor density, lb/ft^3, see Equation 1-24
365 = constant, the number of daily events in a year, (days/year)

Vapor Space Expansion Factor, K_E

The calculation of the vapor space expansion factor, K_E, depends upon the properties of the liquid in the tank and the breather vent settings, as shown in Equation 1-5. As shown in the equation, K_E is greater than zero. If K_E is less than zero, standing losses will not occur. In that K_E represents the fraction of vapors in the vapor space that are expelled by a given increase in temperature, a value of 1 would indicate that the entire vapor space has been expelled. Thus the value of K_E must be less than 1, in that it is not physically possible to expel more than 100% of what is present to begin with.

$$0 < K_E \leq 1$$

$$K_E = \frac{\Delta T_V}{T_{LA}} + \frac{\Delta P_V - \Delta P_B}{P_A - P_{VA}} \tag{1-5}$$

where:

ΔT_V = average daily vapor temperature range, °R; see Note 1 to Equation 1-5
ΔP_V = average daily vapor pressure range, psi; see Note 2 to Equation 1-5
ΔP_B = breather vent pressure setting range, psi; see Note 3 to Equation 1-5
P_A = atmospheric pressure, psia
P_{VA} = vapor pressure at average daily liquid surface temperature, psia; see Note 1 to Equation 1-24 and Note 2 to Equation 1-24
T_{LA} = average daily liquid surface temperature, °R; see Note 3 to Equation 1-24

Notes on Equation 1-5:

Note 1 to Equation 1-5. The average daily vapor temperature range, ΔT_V, refers to the daily temperature range of the tank vapor space averaged over all the days in the given period of time, such as one year, and should not be construed as being applicable to an individual day. The average daily vapor temperature range is calculated for an uninsulated tank using Equation 1-6.

$$\Delta T_V = \left(1 - \frac{0.8}{2.2\,(H_S/D) + 1.9}\right)\Delta T_A + \frac{0.042 \alpha_R I + 0.026 (H_S/D) \alpha_S I}{2.2\,(H_S/D) + 1.9} \tag{1-6}$$

where:

ΔT_V = average daily vapor temperature range, °R
H_S = tank shell height, ft
D = tank diameter, ft,
ΔT_A = average daily ambient temperature range, °R; see Note 4 to Equation 1-5
α_R = tank roof surface solar absorptance, dimensionless; see Table 7.1-6
α_S = tank shell surface solar absorptance, dimensionless; see Table 7.1-6
I = average daily total insolation factor, Btu/ft^2 d; see Table 7.1-7.

API assigns a default value of $H_s/D = 0.5$ and an assumption of $\alpha_R = \alpha_S$, resulting in the simplified equation shown below for an uninsulated tank:[22]

$$\Delta T_V = 0.7\ \Delta T_A + 0.02\ \alpha\ I \tag{1-7}$$

where:

α = average tank surface solar absorptance, dimensionless

For purposes of estimating emissions, a storage tank should be deemed insulated only if the roof and shell are both sufficiently insulated so as to minimize heat exchange with ambient air. If only the shell is insulated, and not the roof, the temperature equations are independent of H_s/D. Also, there likely will be sufficient heat exchange through the roof such that Equation 1-7 would be applicable.

A more accurate method of accounting for the average daily vapor temperature range, ΔT_V, in partially insulated scenarios is given below. When the tank shell is insulated but the tank roof is not, heat gain to the tank from insolation is almost entirely through the tank roof and thus the liquid surface temperature is not sensitive to H_S/D.

$$\Delta T_V = 0.6\ \Delta T_A + 0.02\ \alpha_R\ I \tag{1-8}$$

In the case of a fully insulated tank maintained at constant temperature, the average daily vapor temperature range, ΔT_V, should be taken as zero. This assumption that ΔT_V is equal to zero addresses only temperature differentials resulting from the diurnal ambient temperature cycle. In the case of cyclic heating of the bulk liquid, see Section 7.1.3.8.4.

Note 2 on Equation 1-5. The average daily vapor pressure range, ΔP_V, refers to the daily vapor pressure range at the liquid surface temperature averaged over all the days in the given period of time, such as one year, and should not be construed as being applicable to an individual day. The average daily vapor pressure range can be calculated using the following equation:

$$\Delta P_V = P_{VX} - P_{VN} \tag{1-9}$$

where:

ΔP_V = average daily vapor pressure range, psia
P_{VX} = vapor pressure at the average daily maximum liquid surface temperature, psia; see Note 5 to Equation 1-5
P_{VN} = vapor pressure at the average daily minimum liquid surface temperature, psia; see Note 5 to Equation 1-5

See Section 7.1.6.1 for a more approximate equation for ΔP_V that was used historically, but which is no longer recommended.

In the case of a fully insulated tank maintained at constant temperature, the average daily vapor pressure range, ΔP_V, should be taken as zero, as discussed for the vapor temperature range in Note 1 to Equation 1-5.

Note 3 on Equation 1-5. The breather vent pressure setting range, ΔP_B, is calculated using the following equation:

$$\Delta P_B = P_{BP} - P_{BV} \tag{1-10}$$

where:

ΔP_B = breather vent pressure setting range, psig

P_{BP} = breather vent pressure setting, psig
P_{BV} = breather vent vacuum setting, psig

If specific information on the breather vent pressure setting and vacuum setting is not available, assume 0.03 psig for P_{BP} and -0.03 psig for P_{BV} as typical values. If the fixed roof tank is of bolted or riveted construction in which the roof or shell plates are not vapor tight, assume that $\Delta P_B = 0$, even if a breather vent is used.

Note 4 on Equation 1-5. The average daily ambient temperature range, ΔT_A, refers to the daily ambient temperature range averaged over all of the days in the given period of time, such as one year, and should not be construed as being applicable to an individual day. The average daily ambient temperature range is calculated using the following equation:

$$\Delta T_A = T_{AX} - T_{AN} \tag{1-11}$$

where:

ΔT_A = average daily ambient temperature range, °R
T_{AX} = average daily maximum ambient temperature, °R
T_{AN} = average daily minimum ambient temperature, °R

Table 7.1-7 gives historical values of T_{AX} and T_{AN} in degrees Fahrenheit for selected cities in the United States. These values are converted to degrees Rankine by adding 459.67.

Note 5 on Equation 1-5. The vapor pressures associated with the average daily maximum and minimum liquid surface temperatures, P_{VX} and P_{VN}, respectively, are calculated by substituting the corresponding temperatures, T_{LX} and T_{LN}, into Equation 1-27 or 1-28 after converting the temperatures to the units indicated for the respective equation. If T_{LX} and T_{LN} are unknown, Figure 7.1-17 can be used to calculate their values. In the case of a fully insulated tank maintained at constant temperature, the average daily vapor pressure range, ΔP_V, should be taken as zero.

If the liquid stored in the fixed roof tank has a true vapor pressure less than 0.1 psia and the tank breather vent settings are not greater than ±0.03 psig, Equation 1-12 or Equation 1-13 may be used with an acceptable loss in accuracy.

If the tank location and tank color and condition are known, K_E may be calculated using the following equation in lieu of Equation 1-5:

$$K_E = 0.0018\ \Delta T_V = 0.0018\ [0.7\ (T_{AX} - T_{AN}) + 0.02\ \alpha\ I] \tag{1-12}$$

where:

K_E = vapor space expansion factor, per day
ΔT_V = average daily vapor temperature range, °R
T_{AX} = average daily maximum ambient temperature, °R
T_{AN} = average daily minimum ambient temperature, °R
α = tank surface solar absorptance, dimensionless
I = average daily total insolation on a horizontal surface, Btu/(ft^2 day)

0.0018 = constant, $(°R)^{-1}$
0.7 = constant, dimensionless
0.02 = constant, $(°R\ ft^2\ day)/Btu$

Average daily maximum and minimum ambient temperatures and average daily total insolation can be determined from historical meteorological data for the location or may be obtained from historical meteorological data for a nearby location. Historical meteorological data for selected locations are given in Table 7.1-7, where values of T_{AX} and T_{AN} are given in degrees Fahrenheit. These values are converted to degrees Rankine by adding 459.67.

If the tank location is unknown, a value of K_E can be calculated using typical meteorological conditions for the lower 48 states. The typical value for daily insolation is 1,370 Btu/(ft^2 day), the average daily range of ambient temperature is 21°R, and the tank surface solar absorptance is 0.25 for white paint in average condition. Substituting these values into Equation 1-12 results in a value of 0.04, as shown in Equation 1-13.

$$K_E = 0.04 \tag{1-13}$$

Diameter

For vertical tanks, the diameter is straightforward. If a user needs to estimate emissions from a horizontal fixed roof tank, some of the tank parameters can be modified before using the vertical tank emission estimating equations. First, by assuming that the tank is one-half filled, the surface area of the liquid in the tank is approximately equal to the length of the tank times the diameter of the tank. Next, assume that this area represents a circle, i.e., that the liquid is an upright cylinder. Therefore, the effective diameter, D_{Eh}, is then equal to:

$$D_{Eh} = \sqrt{\frac{L\,D}{\frac{\pi}{4}}} \tag{1-14}$$

where:

D_{Eh} = effective tank diameter of the horizontal tank, ft
L = length of the horizontal tank, ft (for tanks with rounded ends, use the overall length)
D = diameter of a vertical cross-section of the horizontal tank, ft

By assuming the volume of the horizontal tank to be approximately equal to the cross-sectional area of the tank times the length of the tank, an effective height, H_{Eh}, of an equivalent upright cylinder may be calculated as:

$$H_{Eh} = \frac{\pi}{4}\,D \tag{1-15}$$

where:

H_{Eh} = effective height of the horizontal tank, ft
D = diameter of a vertical cross-section of the horizontal tank, ft

D_{Eh} should be used in place of D in Equation 1-4 for calculating the standing loss (or in Equation 1-3, if calculating the tank vapor space volume). One-half of the effective height, H_E, should be used as the vapor space outage, H_{VO}, in these equations. This method yields only a very approximate value for emissions from horizontal storage tanks. For underground horizontal tanks, assume that no breathing or standing losses occur ($L_S = 0$) because the insulating nature of the earth limits the diurnal temperature change. No modifications to the working loss equation are necessary for either aboveground or underground horizontal tanks. However, standing losses from underground gasoline tanks, which can experience relatively fast vapor growth after the ingestion of air and dilution of the headspace, are addressed in Section 5.2 of AP-42.

For rectangular tanks, effective diameter is calculated as:

$$D_{Er} = \sqrt{\frac{L_1 L_2}{\frac{\pi}{4}}} \tag{1-16}$$

where:

D_{Er} = effective tank diameter for a rectangular tank, ft
L_1 = length of side 1 of rectangular tank, ft
L_2 = length of side 2 of rectangular tank, ft

For square tanks, effective diameter is calculated as:

$$D_{Es} = \sqrt{\frac{L^2}{\frac{\pi}{4}}} \tag{1-17}$$

where:

D_{Es} = effective tank diameter for a square tank, ft
L = length of side of square tank, ft

D_{Er} or D_{Es} should be used in place of D in Equation 1-4 for calculating the standing loss (or in Equation 1-3, if calculating the tank vapor space volume) from rectangular or square tanks, respectively.

<u>Vapor Space Outage</u>

The vapor space outage, H_{VO} is the height of a cylinder of tank diameter, D, whose volume is equivalent to the vapor space volume of a fixed roof tank, including the volume under the cone or dome roof. The vapor space outage, H_{VO}, is estimated from:

$$H_{VO} = H_S - H_L + H_{RO} \tag{1-18}$$

where:

H_{VO} = vapor space outage, ft; use $H_{Eh}/2$ from Equation 1-15 for horizontal tanks
H_S = tank shell height, ft

H_L = liquid height, ft; typically assumed to be at the half-full level, unless known to be maintained at some other level

H_{RO} = roof outage, ft; see Note 1 to Equation 1-18 for a cone roof, Note 2 to Equation 1-18 for a dome roof, or Note 3 to Equation 1-18 for a flat roof

<u>Notes on Equation 1-18:</u>

<u>Note 1 to Equation 1-18</u>. For a cone roof, the roof outage, H_{RO}, is calculated as follows:

$$H_{RO} = (1/3)\ H_R \tag{1-19}$$

where:

H_{RO} = roof outage (or shell height equivalent to the volume contained under the roof), ft

H_R = tank roof height, ft

$$H_R = S_R\ R_S \tag{1-20}$$

where:

` S_R = tank cone roof slope, ft/ft; if unknown, a standard value of 0.0625 is used

RS = tank shell radius, ft

<u>Note 2 to Equation 1-18</u>. For a dome roof, the roof outage, H_{RO}, is calculated as follows:

$$H_{RO} = H_R \left[\frac{1}{2} + \frac{1}{6} \left[\frac{H_R}{R_S} \right]^2 \right] \tag{1-21}$$

where:

H_{RO} = roof outage, ft

R_S = tank shell radius, ft

H_R = tank roof height, ft

$$H_R = R_R - \left(R_R^2 - R_S^2 \right)^{0.5} \tag{1-22}$$

where:

H_R = tank roof height, ft

R_R = tank dome roof radius, ft

R_S = tank shell radius, ft

The value of R_R usually ranges from 0.8D - 1.2D, where D = 2 R_S. If R_R is unknown, the tank diameter is used in its place. If the tank diameter is used as the value for R_R, Equations 1-21 and 1-22 reduce to
$H_{RO} = 0.137\ R_S$ and $H_R = 0.268\ R_S$.

Note 3 to Equation 1-18. For a flat roof, the roof outage, H_{RO} is calculated using Equation 1-19 and Equation 1-20, except S_R = tank flat roof slope, ft/ft = 0. Therefore, H_{RO} equals zero.

Vented Vapor Saturation Factor

The vented vapor saturation factor, K_S, is calculated using the following equation:

$$K_S = \frac{1}{1 + 0.053 P_{VA} H_{VO}} \tag{1-23}$$

where:

K_S = vented vapor saturation factor, dimensionless

P_{VA} = vapor pressure at average daily liquid surface temperature, psia; see Note 1 to Equation 1-24 and Note 2 to Equation 1-24

H_{VO} = vapor space outage, ft, see Equation 1-18

0.053 = constant, $(\text{psia-ft})^{-1}$

Stock Vapor Density, W_V - The density of the vapor is calculated using the following equation:

$$W_V = \frac{M_V P_{VA}}{R T_V} \tag{1-24}$$

where:

W_V = vapor density, lb/ft^3

M_V = vapor molecular weight, lb/lb-mole; see Note 1 to Equation 1-24

R = the ideal gas constant, 10.731 psia ft^3/lb-mole °R

P_{VA} = vapor pressure at average daily liquid surface temperature, psia; see Note 1 to Equation 1-24 and Note 2 to Equation 1-24

T_V = average vapor temperature, °R; see Note 6 to Equation 1-24

Notes on Equation 1-24:

Note 1 to Equation 1-24. The molecular weight of the vapor, M_V, can be determined from Table 7.1-2 and 7.1-3 for selected petroleum liquids and selected organic chemicals, respectively, or by analyzing vapor samples. Where mixtures of organic liquids are stored in a tank, M_V can be calculated from the liquid composition. The molecular weight of the vapor, M_V, is equal to the sum of the molecular weight, M_i, multiplied by the vapor mole fraction, y_i, for each component. The vapor mole fraction is equal to the partial pressure of component I divided by the total vapor pressure. The partial pressure of component I is equal to the true vapor pressure of component I (P) multiplied by the liquid mole fraction, (x_i). Therefore,

$$M_V = \sum M_i y_i = \sum M_i \left(\frac{P x_i}{P_{VA}} \right) \tag{1-25}$$

where:

P_{VA}, total vapor pressure of the stored liquid, by Raoult's Law[30], is:

$$P_{VA} = \sum P x_i \tag{1-26}$$

where:

P_{VA} = total vapor pressure of the stored liquid, psia
P = vapor pressure of pure component i at the average daily liquid surface temperature, psia
x_i = liquid mole fraction, lb-mole/lb-mole

For more detailed information on Raoult's Law, please refer to Section 7.1.4. Frequently, 'however, the vapor pressure is not known for each component in a mixture. For more guidance on determining the total vapor pressure at a given temperature (*i.e.*, the true vapor pressure), see Note 2 to Equation 1-24 below.

Note 2 to Equation 1-24. True vapor pressure is defined in various ways for different purposes within the industry, such as "bubble point" for transportation specifications, but for purposes of these emissions estimating methodologies it is the sum of the equilibrium partial pressures exerted by the components of a volatile organic liquid, as shown in Equation 1-26. True vapor pressure may be determined by ASTM D2879 (or ASTM D6377 for crude oils with a true vapor pressure greater than 3.6 psia or ASTM D6378 for petroleum products with a true vapor pressure greater than 1.0 psia) or obtained from standard reference texts. For certain petroleum liquids, true vapor pressure may be predicted from Reid vapor pressure, which is the absolute vapor pressure of volatile crude oil and volatile non-viscous petroleum liquids, as determined by ASTM D323. ASTM D 5191 may be used as an alternative method for determining Reid vapor pressure for petroleum products, however, it should not be used for crude oils.

Caution should be exercised when considering ASTM D2879 for determining the true vapor pressure of certain types of mixtures. Vapor pressure is sensitive to the lightest components in a mixture, and the de-gassing step in ASTM D2879 can remove lighter fractions from mixtures such as No. 6 fuel oil if it is not done with care (*i.e.* at an appropriately low pressure and temperature). In addition, any dewatering of a sample prior to measuring its vapor pressure must be done using a technique that has been demonstrated to not remove the lightest organic compounds in the mixture. Alternatives to the method may be developed after publication of this chapter.

True vapor pressure can be determined for crude oils from Reid vapor pressure using Figures 7.1-13a and 7.1-13b. However, the nomograph in Figure 7.1-13a and the correlation equation in Figure 7.1-13b for crude oil are known to have an upward bias, and thus use of ASTM D6377 is more accurate for crude oils with a true vapor pressure greater than 3.6 psia. ASTM D6377 may be used to directly measure true vapor pressure at a given temperature. In order to utilize ASTM D6377 to predict true vapor pressure values over a range of temperatures, the method should be applied at multiple temperatures. A regression of the log-transformed temperature versus vapor pressure data thus obtained may be performed to obtain A and B constants for use in Equation 1-27. In order to determine true vapor pressure for purposes of estimating emissions of volatile organic compounds, ASTM D6377 should be performed using a vapor-to-liquid ratio of 4:1, which is expressed in the method as $VPCR_4$.

For light refined stocks (gasolines and naphthas) for which the Reid vapor pressure and distillation slope are known, Figures 7.1-14a and 7.1-14b can be used. For refined stocks with Reid vapor pressure below the 1 psi applicability limit of Figures 7.1-14a and 7.1-14b, true vapor pressure can be determined using ASTM D2879. In order to use Figures 7.1-13a, 7.1-13b, 7.1-14a, or 7.1-14b, the stored liquid surface temperature, T_{LA}, must be determined in degrees Fahrenheit. See Note 3 to Equation 1-24 to determine T_{LA}.

Alternatively, true vapor pressure for selected petroleum liquid stocks, at the stored liquid surface temperature, can be determined using the following equation:

$$P_{VA} = \exp\left[A - \left(\frac{B}{T_{LA}}\right)\right] \tag{1-27}$$

where:

exp = exponential function
A = constant in the vapor pressure equation, dimensionless
B = constant in the vapor pressure equation, °R
T_{LA} = average daily liquid surface temperature, °R; see Note 3 to Equation 1-24
P_{VA} = true vapor pressure, psia

For selected petroleum liquid stocks, physical property data including vapor pressure constants A and B for use in Equation 1-27 are presented in Table 7.1-2. For refined petroleum stocks with Reid vapor pressure within the limits specified in the scope of ASTM D 323, the constants A and B can be calculated from the equations presented in Figure 7.1-15 and the distillation slopes presented in Table 7.1-2. For crude oil stocks, the constants A and B can be calculated from Reid vapor pressure using the equations presented in Figure 7.1-16. However, the equations in Figure 7.1-16 are known to have an upward bias[29], and thus use of ASTM D 6377 is more accurate. Note that in Equation 1-27, T_{LA} is determined in degrees Rankine instead of degrees Fahrenheit.

The true vapor pressure of organic liquids at the stored liquid temperature can also be estimated by Antoine's equation:

$$\log\ P_{VA} = A - \left(\frac{B}{T_{LA} + C}\right) \tag{1-28}$$

where:

log = log 10
A = constant in vapor pressure equation, dimensionless

B = constant in vapor pressure equation, °C
C = constant in vapor pressure equation, °C
T_{LA} = average daily liquid surface temperature, °C
P_{VA} = vapor pressure at average daily liquid surface temperature, mm Hg

For selected pure chemicals, the values for the constants A, B, and C are listed in Table 7.1-3. Note that in Equation 1-28, T_{LA} is determined in degrees Celsius instead of degrees Rankine. Also, in Equation 1-28, P_{VA} is determined in mm of Hg rather than psia (760 mm Hg = 14.7 psia).

More rigorous thermodynamic equations of state are available in process simulation software packages. The use of such programs may be preferable in determining the true vapor pressure of mixtures that are not adequately characterized by Raoult's Law.

Note 3 to Equation 1-24. The average daily liquid surface temperature, T_{LA}, refers to the liquid surface temperature averaged over all of the days in the given period of time, such as one year, and should not be construed as being applicable to an individual day. While the accepted methodology is to use the average temperature, this approach introduces a bias in that the true vapor pressure, P_{VA}, is a non-linear function of temperature. However, the greater accuracy that would be achieved by accounting for this logarithmic function is not warranted, given the associated computational burden. The average daily liquid surface temperature is calculated for an uninsulated fixed roof tank using Equation 1-29.

$$T_{LA} = \left(0.5 - \frac{0.8}{4.4(H_S/D) + 3.8}\right) T_{AA} + \left(0.5 + \frac{0.8}{4.4(H_S/D) + 3.8}\right) T_B + \frac{0.021\,\alpha_R\, I + 0.013(H_S/D)\,\alpha_S\, I}{4.4(H_S/D) + 3.8} \tag{1-29}$$

where:

T_{LA} = average daily liquid surface temperature, °R
H_S = tank shell height, ft
D = tank diameter, ft,
T_{AA} = average daily ambient temperature, °R; see Note 4 to Equation 1-24
T_B = liquid bulk temperature, °R; see Note 5 to Equation 1-24
α_R = tank roof surface solar absorptance, dimensionless; see Table 7.1-6
α_S = tank shell surface solar absorptance, dimensionless; see Table 7.1-6
I = average daily total insolation factor, Btu/(ft^2 day); see Table 7.1-7

API assigns a default value of $H_s/D = 0.5$ and an assumption of $\alpha_R = \alpha_S$, resulting in the simplified equation shown below for an uninsulated fixed roof tank:[22]

$$T_{LA} = 0.4T_{AA} + 0.6T_B + 0.005\,\alpha\, I \tag{1-30}$$

where:

α = average tank surface solar absorptance, dimensionless

Equation 1-29 and Equation 1-30 should not be used to estimate liquid surface temperature for insulated tanks. In the case of fully insulated tanks, the average liquid surface temperature should be assumed to equal the average liquid bulk temperature (see Note 5 to Equation 1-24). For purposes of estimating emissions, a storage tank should be deemed insulated only if the roof and shell are both fully insulated so as to minimize heat exchange with ambient air. If only the shell is insulated, and not the roof, there likely will be sufficient heat exchange through the roof such that Equation 1-30 would be applicable.

A more accurate method of estimating the average liquid surface temperature, T_{LA}, in partially insulated fixed roof tanks is given below. When the tank shell is insulated but the tank roof is not, heat gain to the tank from insolation is almost entirely through the tank roof and thus the liquid surface temperature is not sensitive to H_S/D.

$$T_{LA} = 0.3\ T_{AA} + 0.7\ T_B + 0.005\ \alpha_R\ I \tag{1-31}$$

If T_{LA} is used to calculate P_{VA} from Figures 7.1-13a, 7.1-13b, 7.1-14a, or 7.1-14b, T_{LA} must be converted from degrees Rankine to degrees Fahrenheit (°F = °R – 459.67). If T_{LA} is used to calculate P_{VA} from Equation 1-28, T_{LA} must be converted from degrees Rankine to degrees Celsius (°C = [°R – 491.67]/1.8).

<u>Note 4 to Equation 1-24</u>. The average daily ambient temperature, T_{AA}, is calculated using the following equation:

$$T_{AA} = \left(\frac{T_{AX} + T_{AN}}{2}\right) \tag{1-32}$$

where:

T_{AA} = average daily ambient temperature, °R
T_{AX} = average daily maximum ambient temperature, °R
T_{AN} = average daily minimum ambient temperature, °R

Table 7.1-7 gives historical values of T_{AX} and T_{AN} in degrees Fahrenheit for selected U.S. cities. These values are converted to degrees Rankine by adding 459.67.

<u>Note 5 to Equation 1-24</u>. The liquid bulk temperature, T_B, should preferably be based on measurements or estimated from process knowledge. For uninsulated fixed roof tanks known to be in approximate equilibrium with ambient air, heat gain to the bulk liquid from insolation is almost entirely through the tank shell; thus the liquid bulk temperature is not sensitive to H_S/D and may be calculated using the following equation:

$$T_B = T_{AA} + 0.003\ \alpha_S\ I \tag{1-33}$$

where:

T_B = liquid bulk temperature, °R

T_{AA} = average daily ambient temperature, °R, as calculated in Note 4 to Equation 1-24
α_S = tank shell surface solar absorptance, dimensionless; see Table 7.1-6
I = average daily total insolation factor, Btu/(ft^2 day); see Table 7.1-7.

Note 6 to Equation 1-24. The average vapor temperature, T_V, for an uninsulated tank may be calculated using the following equation:

$$T_V = \frac{[2.2\,(H_S/D)+1.1]\,T_{AA} + 0.8\,T_B + 0.021\alpha_R I + 0.013(H_S/D)\alpha_S I}{2.2\,(H_S/D) + 1.9} \quad (1\text{-}34)$$

where:

H_S = tank shell height, ft
D = tank diameter, ft,
T_{AA} = average daily ambient temperature, °R
T_B = liquid bulk temperature, °R
α_R = tank roof surface solar absorptance, dimensionless
α_S = tank shell surface solar absorptance, dimensionless
I = average daily total insolation factor, Btu/(ft^2 day).

API assigns a default value of $H_s/D = 0.5$ and an assumption of $\alpha_R = \alpha_S$, resulting in the simplified equation shown below for an uninsulated tank:[22]

$$T_V = 0.7T_{AA} + 0.3T_B + 0.009\,\alpha I \quad (1\text{-}35)$$

where:

α = average tank surface solar absorptance, dimensionless

When the shell is insulated, but not the roof, the temperature equations are independent of H_s/D.

$$T_V = 0.6T_{AA} + 0.4T_B + 0.01\,\alpha_R I \quad (1\text{-}36)$$

When the tank shell and roof are fully insulated, the temperatures of the vapor space and the liquid surface are taken as equal to the temperature of the bulk liquid.

7.1.3.1.2 Working Loss

The fixed roof tank working loss, L_W, refers to the loss of stock vapors as a result of tank filling operations. Fixed roof tank working losses can be estimated from:

$$L_W = V_Q K_N K_P W_V K_B \quad (1\text{-}37)$$

where:

L_W = working loss, lb/yr

V_Q = net working loss throughput, ft^3/yr, see Note 1 to Equation 1-37

K_N = working loss turnover (saturation) factor, dimensionless
for turnovers > 36, $K_N = (180 + N)/6N$
for turnovers ≤ 36, $K_N = 1$
for tanks that are vapor balanced and tanks in which flashing occurs, $K_N = 1$ regardless of the number of turnovers; further adjustment of K_N may be appropriate in the case of splash loading into a tank.

N = number of turnovers per year, dimensionless:

$$N = \Sigma H_{QI} / (H_{LX} - H_{LN}) \quad (1\text{-}38)$$

ΣH_{QI} = the annual sum of the increases in liquid level, ft/yr
If ΣH_{QI} is unknown, it can be estimated from pump utilization records. Over the course of a year, the sum of increases in liquid level, ΣH_{QI}, and the sum of decreases in liquid level, ΣH_{QD}, will be approximately the same. Alternatively, ΣH_{QI} may be approximated as follows:

$$\Sigma H_{QI} = (5.614\ Q) / ((\pi/4)\ D^2) \quad (1\text{-}39)$$

5.614 = the conversion of barrels to cubic feet, ft^3/bbl

Q = annual net throughput, bbl/yr [Note that 1 bbl = 42 gallons]
For horizontal tanks, use D_{Eh} (Equation 1-14) in place of D in Equation 1-39
For rectangular tanks, use D_{Er} (Equation 1-16) in place of D in Equation 1-39
For square tanks, use D_{Es} (Equation 1-17) in place of D in Equation 1-39

H_{LX} = maximum liquid height, ft

If the maximum liquid height is unknown, for vertical tanks use one foot less than the shell height and for horizontal tanks use (π/4) D where D is the diameter of a vertical cross-section of the horizontal tank

H_{LN} = minimum liquid height, ft
If the minimum liquid height is unknown, for vertical tanks use 1 and for horizontal tanks use 0

K_P = working loss product factor, dimensionless
for crude oils, $K_P = 0.75$;
adjustment of K_P may be appropriate in the case of splash loading into a tank;
for all other organic liquids, $K_P = 1$

W_V = vapor density, lb/ft^3, see Equation 1-24

K_B = vent setting correction factor, dimensionless, see Note 2 to Equation 1-37 for open vents and for a vent setting range up to ± 0.03 psig, $K_B = 1$

<u>Notes on Equation 1-37:</u>

<u>Note 1 to Equation 1-37</u>. Net Working Loss Throughput.

The net working loss throughput, V_Q, is the volume associated with increases in the liquid level, and is calculated as follows:

$$V_Q = (\Sigma H_{QI})(\pi/4)\, D^2 \qquad (1\text{-}40)$$

where:

ΣH_{QI} = the annual sum of the increases in liquid level, ft/yr

D_{Eh} should be used for horizontal tanks in place of D in Equation 1-40. See Equation 1-14.

D_{Er} should be used for rectangular tanks in place of D in Equation 1-40. See Equation 1-16.

D_{Es} should be used for square tanks in place of D in Equation 1-40. See Equation 1-17.

If ΣH_{QI} is unknown, ΣH_{QI} can be estimated from pump utilization records. Over the course of a year, the sum of increases in liquid level, ΣH_{QI}, and the sum of decreases in liquid level, ΣH_{QD}, will be approximately the same. Alternatively, V_Q may be approximated as follows:

$$V_Q = 5.614\, Q \qquad (1\text{-}41)$$

where:

5.614 = the conversion of barrels to cubic feet, ft^3/bbl

Q = annual net throughput, bbl/yr

Note: Use of gross throughput to approximate the sum of increases in liquid level will significantly overstate emissions if pumping in and pumping out take place at the same time. However, use of gross throughput is still allowed, since it is clearly a conservative estimate of emissions.

Note 2 to Equation 1-37. Vent Setting Correction Factor

When the breather vent settings are greater than the typical values of ± 0.03 psig, and the condition expressed in Equation 1-42 is met, a vent setting correction factor, K_B, must be determined using Equation 1-42. This value of K_B will be used in Equation 1-37 to calculate working losses.

When:

$$K_N \left[\frac{P_{BP} + P_A}{P_I + P_A} \right] > 1.0 \qquad (1\text{-}42)$$

Then:

$$K_B = \left[\frac{\dfrac{P_I + P_A}{K_N} - P_{VA}}{P_{BP} + P_A - P_{VA}} \right] \qquad (1\text{-}43)$$

where:

K_B = vent setting correction factor, dimensionless

P_I = pressure of the vapor space at normal operating conditions, psig
P_I is an actual pressure reading (the gauge pressure). If the tank is held at atmospheric pressure (not held under a vacuum or at a steady pressure) P_I would be 0.

P_A = atmospheric pressure, psia

K_N = working loss turnover (saturation) factor (dimensionless), see Equation 1-37

P_{VA} = vapor pressure at the average daily liquid surface temperature, psia; see Note 1 to Equation 1-24 and Note 2 to Equation 1-24

P_{BP} = breather vent pressure setting, psig.

See Section 7.1.6.2 for a more approximate equation for fixed roof tank working loss that was used historically, but which is no longer recommended.

7.1.3.2 Routine Losses From Floating Roof Tanks [3-5,13-17]

Routine floating roof tank emissions are the sum of standing and working losses. Routine losses from floating roof tanks may be written as:

$$L_T = L_S + L_W \qquad (2\text{-}1)$$

where:

L_T = total routine loss, lb/yr

L_S = standing loss, lb/yr; see Equation 2-2

L_W = working (withdrawal) loss, lb/yr; see Equation 2-19

The equations presented in this subsection apply only to floating roof tanks. The equations are not intended to be used in the following applications:

1. To estimate losses from unstable or boiling stocks (see Section 7.1.3.5) or from mixtures of hydrocarbons or petrochemicals for which the vapor pressure is not known or cannot readily be predicted;

2. To estimate losses from floating roof tanks vented only through a pressure/vacuum vent in the fixed roof (*i.e.*, no open vents) (see Section 7.1.3.8.2);

3. To estimate losses from tanks in which the materials used in the rim seal and/or deck fittings are either deteriorated or significantly permeated by the stored liquid;

4. To estimate losses that result from the landing of a floating roof (see Section 7.1.3.3); or

5. To estimate losses that result from cleaning a tank (see Section 7.1.3.4).

7.1.3.2.1 Standing Loss

Standing losses from floating roof tanks are the sum of rim seal, deck fitting and deck seam losses, and may be written as:

Table 7.1-1. List Of Abbreviations Used In The Tank Equations

Variable	**Variable Description**
α	tank surface solar absorptance, dimensionless
π	constant, (3.14159)
A	constant in vapor pressure equation, dimensionless
A_{deck}	area of deck, ft^2
A_{fi}	liquid surface area within a particular type of deck fitting, in^2
B	constant in vapor pressure equation, °R or °C
C	constant in vapor pressure equation, °R or °C
C_S	shell clingage factor, bbl/1,000 ft^2
C_{sf}	filling saturation correction factor for wind, dimensionless
C_V	average vapor concentration by volume during continued forced ventilation, dimensionless
D	tank diameter, ft
D_E	effective tank diameter, ft
d_s	average depth of sludge, in.
F_C	effective column diameter, ft
F_E	fraction of sludge with potential to evaporate, dimensionless
F_F	total deck fitting loss factor, lb-mole/yr
h_d	deck leg height at the tank shell, ft
H_L	liquid height, ft
h_{le}	effective liquid height during roof landing, ft
H_{LN}	minimum liquid height, ft
H_{LX}	maximum liquid height, ft
ΣH_{QD}	the annual sum of the decreases in liquid level, ft/yr
ΣH_{QI}	the annual sum of the increases in liquid level, ft/yr
H_R	tank roof height, ft
H_{RO}	roof outage, ft
H_S	tank shell height, ft
h_v	vapor space height under landed floating roof, ft
H_{VO}	vapor space outage, ft
i	1,2,.....n, dimensionless
I	average daily total insolation factor, Btu/ft^2•d
K_C	product factor for floating roof tanks, dimensionless
K_D	deck seam loss per unit seam length factor, lb-mole/ft-yr
K_E	vapor space expansion factor, per day
K_{Fai}	zero wind speed loss factor for a particular type of deck fitting, lb-mole/yr
K_{Fbi}	wind speed dependent loss factor for a particular type of deck fitting, lb-mole/(mph)^{m}yr
K_{F_i}	loss factor for a particular type of deck fitting, lb-mole/yr
K_N	turnover factor, dimensionless
K_P	working loss product factor for fixed roof tanks, dimensionless
K_{Ra}	zero wind speed rim seal loss factor, lb-mole/ft•yr
K_{Rb}	wind speed dependent rim seal loss factor, lb-mole/ (mph)^{n}ft•yr
K_S	vented vapor saturation factor, dimensionless
K_v	fitting wind speed correction factor, dimensionless
L	length of tank, ft
L_C	clingage factor for drain dry tanks, lb
L_{CV}	continued forced ventilation emissions, lb/cleaning event
L_D	deck seam loss, lb/yr

Variable	Variable Description
L_F	deck fitting loss, lb/yr
L_{FV}	total tank cleaning emissions due to forced ventilation, lb/cleaning event
L_{FL}	filling loss during roof landing, lb/landing event
L_P	vapor space purge emissions due to first air change from forced ventilation, lb/cleaning event
L_R	rim seal loss, lb/yr
L_{RL}	rim seal loss during roof landing, lb/landing event
L_S	standing losses, lb/yr
L_{seam}	total length of deck seam, ft
L_{SL}	standing loss during roof landing, lb/landing event
L_T	total routine losses, lb/yr
L_{T_i}	emission rate of component i, lb/yr
L_{TL}	total loss during roof landing, lb/landing event
L_V	variable vapor space filling loss, lb/1,000 gal throughput
L_W	working losses, lb/yr
M_{CG}	molecular weight of calibration gas, lb/lb-mole
m_i	loss factor for a particular type of deck fitting, dimensionless
M_i	molecular weight of component i, lb/lb-mole
M_L	molecular weight of liquid mixture, lb/lb-mole
M_V	vapor molecular weight, lb/lb-mole
N	number of turnovers per year, dimensionless
n	seal-related wind speed exponent, dimensionless
n_d	number of days standing idle during roof landing or prior to forced ventilation, days
N_2	number of transfers into system, dimensionless
N_C	number of columns, dimensionless
n_{CV}	duration of continued forced ventilation, days
N_d	number of drains
n_f	total number of different types of fittings, dimensionless
N_{Fa_i}	zero wind speed loss factor for a particular type of deck fitting, lb-mole/yr
N_{Fb_i}	wind speed dependent loss factor for a particular type of fitting, lb-mole/ mph^m•yr
N_{F_i}	number of deck fittings of a particular type, dimensionless
N_l	number of deck legs
N_{TOTAL}	total number of moles in mixture, lb-mole
N_{vb}	number of vacuum breakers
P	true vapor pressure of component i, psia
P^*	vapor pressure function, dimensionless
P_A	atmospheric pressure, psi
ΔP_B	breather vent pressure setting range, psig
P_{BP}	breather vent pressure setting, psig
P_{BV}	breather vent vacuum setting, psig
P_I	gauge pressure within the vapor space, psig
P_i	partial pressure of component i, psia
ΔP_V	average daily vapor pressure range, psi
P_V	vapor pressure at average ambient temperature, psia
P_{VA}	vapor pressure at average daily liquid surface temperature, psia
P_{VN}	vapor pressure at the average daily minimum liquid surface temperature, psia
P_{VX}	vapor pressure at the average daily maximum liquid surface temperature, psia
Q	annual net throughput, bbl/yr
Q_V	average ventilation rate during tank cleaning, ft^3/min

Variable	Variable Description
R	ideal gas constant, (10.731 psia•ft^3/lb-mole•°R)
R_R	tank dome roof radius, ft
R_S	tank shell radius, ft
S	filling saturation factor, dimensionless
s	tank cone bottom slope, ft/ft
S_D	deck seam length factor, ft/ft^2
S_R	tank cone roof slope, ft/ft
ΔT_A	average daily ambient temperature range, °R
T_{AA}	average daily ambient temperature, °R
T_{AN}	average daily minimum ambient temperature, °R
T_{AX}	average daily maximum ambient temperature, °R
T_B	liquid bulk temperature, °R
T_{BN}	typical minimum liquid bulk temperature in heating cycles, °R
T_{BX}	typical maximum liquid bulk temperature in heating cycles, °R
T_{LA}	average daily liquid surface temperature, °R
T_V	average vapor temperature, °R
t_v	daily period of forced ventilation during tank cleaning, hr/day
ΔT_V	average daily vapor temperature range, °R
v	average wind speed, mph
V_1	volume of liquid pumped into system, bbl/yr
V_2	volume expansion capacity, bbl
V_Q	net working loss throughput, ft^3/yr
V_{LX}	tank maximum liquid volume, ft^3
V_V	vapor space volume, ft^3
W_i	liquid density of component i, lb/ft^3
W_L	average organic liquid density, lb/gal
W_V	vapor density, lb/ft^3
x_i	liquid mole fraction of component i, lb-mole/lb-mole
y_i	vapor mole fraction of component i, lb-mole/lb-mole
Z_{L_i}	liquid weight fraction of component i, lb/lb
Z_{V_i}	vapor weight fraction of component i, lb/lb

APPENDIX A

MISCELLANEOUS DATA AND CONVERSION FACTORS

TYPICAL PARAMETERS OF VARIOUS FUELS[a]

Type Of Fuel	Heating Value		Sulfur % (by weight)	Ash % (by weight)
	kcal	Btu		
Solid Fuels				
Bituminous Coal	7,200/kg	13,000/lb	0.6-5.4	4-20
Anthracite Coal	6,810/kg	12,300/lb	0.5-1.0	7.0-16.0
Lignite (@ 35% moisture)	3,990/kg	7,200/lb	0.7	6.2
Wood (@ 40% moisture)	2,880/kg	5,200/lb	N	1-3
Bagasse (@ 50% moisture)	2,220/kg	4,000/lb	N	1-2
Bark (@ 50% moisture)	2,492/kg	4,500/lb	N	1-3[b]
Coke, Byproduct	7,380/kg	13,300/lb	0.5-1.0	0.5-5.0
Liquid Fuels				
Residual Oil	9.98 x 10^6/m^3	150,000/gal	0.5-4.0	0.05-0.1
Distillate Oil	9.30 x 10^6/m^3	140,000/gal	0.2-1.0	N
Diesel	9.12 x 10^6/m^3	137,000/gal	0.4	N
Gasoline	8.62 x 10^6/m^3	130,000/gal	0.03-0.04	N
Kerosene	8.32 x 10^6/m^3	135,000/gal	0.02-0.05	N
Liquid Petroleum Gas	6.25 x 10^6/m^3	94,000/gal	N	N
Gaseous Fuels				
Natural Gas	9,341/m^3	1,050/SCF	N	N
Coke Oven Gas	5,249/m^3	590/SCF	0.5-2.0	N
Blast Furnace Gas	890/m^3	100/SCF	N	N

[a] N = negligible.

[b] Ash content may be considerably higher when sand, dirt, etc., are present.

APPLICATION AND ENGINEERING DATA

ENGINE SPECIFICATIONS

General

Make	Iveco/FPT
EPA Emissions Compliance	Stationary Emergency
EPA Emissions Reference	See Emission Data Sheet
Cylinder #	6
Type	In-Line
Displacement - L (cu. in)	10.3 (628.54)
Bore - mm (in)	125 (4.92)
Stroke - mm (in)	140 (5.51)
Compression Ratio	16.5:1
Intake Air Method	Turbocharged/Aftercooled
Cylinder Head	4-Valve
Piston Type	Aluminum
Crankshaft Type	Dropped Forged Steel

Engine Governing

Governor	Electronic Isochronous
Frequency Regulation (Steady State)	±0.25%

Lubrication System

Oil Pump Type	Gear
Oil Filter Type	Full Flow
Crankcase Capacity - L (qts)	30 (31.68)

Cooling System

Cooling System Type	Closed Recovery
Water Pump Type	Pre-Lubed, Self Sealing
Fan Type	Pusher
Fan Speed (rpm)	2250
Fan Diameter - mm (in)	762 (30.0)

Fuel System

Fuel Type	Ultra Low Sulfur Diesel Fuel
Fuel Specifications	ASTM
Fuel Filtering (microns)	5
Fuel Inject Pump Make	Electronic
Fuel Pump Type	Engine Driven Gear
Injector Type	Common Rail
Engine Type	Direct Injection
Fuel Supply Line - mm (in.)	12.7 (0.5) NPT
Fuel Return Line - mm (in.)	12.7 (0.5) NPT

Engine Electrical System

System Voltage	24 VDC
Battery Charger Alternator	Std
Battery Size	See Battery Index 0161970SBY
Battery Voltage	12 VDC
Ground Polarity	Negative

ALTERNATOR SPECIFICATIONS

Standard Model	520 mm Generac
Poles	4
Field Type	Revolving
Insulation Class - Rotor	H
Insulation Class - Stator	H
Total Harmonic Distortion	<5%
Telephone Interference Factor (TIF)	< 50

Standard Excitation	Permanent Magnet Excitation
Bearings	Single Sealed Cartridge
Coupling	Direct, Flexible Disc
Prototype Short Circuit Test	Yes
Voltage Regulator Type	Digital
Number of Sensed Phases	All
Regulation Accuracy (Steady State)	±0.25%

OPERATING DATA

POWER RATINGS

	Standby		Prime	
Three-Phase 120/208 VAC @0.8pf	300 kW	Amps: 1041	270 kW	Amps: 937
Three-Phase 120/240 VAC @0.8pf	300 kW	Amps: 902	270 kW	Amps: 812
Three-Phase 277/480 VAC @0.8pf	300 kW	Amps: 451	270 kW	Amps: 406
Three-Phase 346/600 VAC @0.8pf	300 kW	Amps: 361	270 kW	Amps: 325

STARTING CAPABILITIES (sKVA)

sKVA vs. Voltage Dip

480 VAC							
Alternator	kW	10%	15%	20%	25%	30%	35%
Standard	350	383	575	767	958	1150	1342
Upsize 1	400	387	581	775	968	1162	1356
Upsize 2	500	457	686	914	1143	1371	1600

208/240 VAC							
Alternator	kW	10%	15%	20%	25%	30%	35%
Standard	350	280	410	535	640	770	900
Upsize 1	400	210	350	500	680	875	1100
Upsize 2	450	345	570	835	1100	1460	1710

FUEL CONSUMPTION RATES*

Fuel Pump Lift- ft (m)
3 (1)

Total Fuel Pump Flow (Combustion + Return) - gal/hr (l/hr)
31 (117)

Diesel - gal/hr (l/hr)

Percent Load	Standby	Prime
25%	7.6 (28.7)	6.9 (26.1)
50%	12.6 (47.7)	11.6 (43.9)
75%	17.4 (65.9)	15.8 (59.8)
100%	22.1 (83.7)	19.9 (75.3)

* Fuel supply installation must accommodate fuel consumption rates at 100% load.

COOLING

		Standby	Prime
Coolant Flow per Minute	gal/min (l/min)	95 (360)	95 (360)
Coolant System Capacity	gal (l)	16.6 (63)	16.6 (63)
Heat Rejection to Coolant	BTU/hr	814,783	733,673
Inlet Air	cfm (m^3/hr)	14,505 (411)	14,505 (411)
Maximum Radiator Backpressure	in H_2O	0.5	0.5

COMBUSTION AIR REQUIREMENTS

	Standby	Prime
Flow at Rated Power cfm (m^3/min)	850 (24.07)	765 (21.67)

ENGINE

		Standby	Prime
Rated Engine Speed	rpm	1800	1800
Horsepower at Rated kW**	hp	480	432
Piston Speed	ft/min	1654	1654
BMEP	psi	336	302

EXHAUST

		Standby	Prime
Exhaust Flow (Rated Output)	cfm (m^3/min)	2240 (63.4)	2016 (57.1)
Max. Backpressure (Post Silencer)	in Hg (Kpa)	1.5 (5.1)	1.5 (5.1)
Exhaust Temp (Rated Output - Post Silencer)	°F (°C)	1020 (549)	918 (492)
Exhaust Outlet Size (Open Set)	mm (in)	101.6 (4)	101.6 (4)

** Refer to “Emissions Data Sheet” for maximum bHP for EPA and SCAQMD permitting purposes.

Deration – Operational characteristics consider maximum ambient conditions. Derate factors may apply under atypical site conditions.
Please consult a Generac Power Systems Industrial Dealer for additional details. All performance ratings in accordance with ISO3046, BS5514, ISO8528 and DIN6271 standards.

STATEMENT OF EXHAUST EMISSIONS
2024 FPT Diesel Fueled Generator

The measured emissions values provided here are proprietary to Generac and it's authorized dealers. This information may only be disseminated upon request to regulatory governmental bodies for emissions permitting purposes or to specifying organizations as submittal data when expressly required by project specifications, and shall remain confidential and not open to public viewing. This information is not intended for compilation or sales purposes and may not be used as such, nor may it be reproduced without the expressed written permission of Generac Power Systems, Inc.. The data provided shall not be meant to include information made public by Generac.

Generator Model:	**SD/MD300**	EPA Certificate Number:	**RFPXL10.3TR3-032**
kW_e Rating:	**300**	CARB Certificate Number:	**Not Applicable**
Engine Family:	**RFPXL10.3TR3**	SCAQMD CEP Number:	**511713**
Engine Model:	**F3AE9685A-E**	Emission Standard Category:	**Tier 3**
Rated Engine Power (BHP)*:	**449**	Certification Type:	**Stationary Emergency CI (40 CFR Part 60 Subpart IIII)**
Fuel Consumption (gal/hr)*:	**22.1**		
Aspiration:	**Turbocharged/Aftercooled**		
Rated RPM:	**1,800**		

*Engine power and fuel consumption are declared by the engine manufacturer of record and the U.S EPA.

Emissions Based on Engine Power of Specific Engine Model

These Values are Actual Composite Weighted Exhaust Emissions Results Over the EPA 5-Mode Test Cycle

CO	NOx + NMHC	PM	
1.3	3.80	0.11	Grams/kW-hr
1.0	2.80	0.1	Grams/bhp-hr

These Values are 100% Load Data Exhaust Emissions Results.

CO	NOx + NMHC	PM	
0.98	3.3	0.02	Grams/kW-hr
0.72	2.43	0.01	Grams/bhp-hr

- The stated values are actual exhaust emission test measurements obtained from an engine representative of the type described above.
- Values based on 5-Mode testing are official data of record as submitted to regulatory agencies for certification purposes. Testing was conducted in accordance with prevailing EPA protocol, which is typically accepted by SCAQMD and other regional authorities.
- No emissions values provided above are to be construed as guarantees of emission levels for any given Generac generator unit.
- Generac Power Systems, Inc. reserves the right to revise this information without prior notice.
- Consult state and local regulatory agencies for specific permitting requirements.
- The emission performance data supplied by the equipment manufacturer is only one element required toward completion of the permitting and installation process. State and local regulations may vary on a case-by-case basis and local agencies must be consulted by the permit application/equipment owner prior to equipment purchase or installation. The data supplied herein by Generac Power Systems Inc. cannot be construed as a guarantee of installability of the generating set.

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Open Cooling Tower Datasheet

Job Information

Selected by

Dyna-Tech Sales Corporation Northern New Jersey
55 Columbia Road
Branchburg, New Jersey 08876

Jonathan Kastner
908-698-1086
jkastner@dynatechsales.net

Marley NC8411WAN2

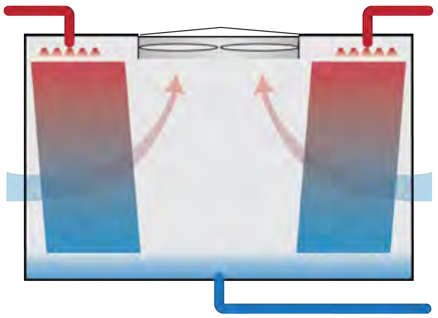
Marley NC Steel Crossflow Induced Draft Double-Flow Open Cooling Tower
Standard Low Sound (A)

https://spxcooling.com/cooling-towers/marley-nc/

Selection

Model	NC8411WAN2
Number of Cells	2
Capacity	103.1%
ASHRAE 90.1 Eff. (gpm/Hp)	47.3
Fill Type	MX75

This selection satisfies your design conditions.



Design Conditions

Fluid	Water
Total Flow (gpm)	6174
HWT (°F)	113
CWT (°F)	90
WBT (°F)	74
Total Heat Load (Btu/h)	70402000

Mechanical

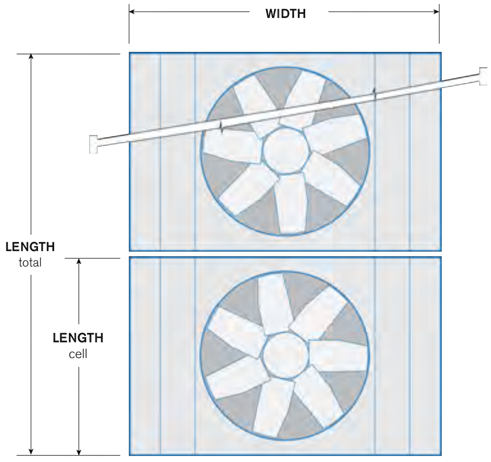
	Per Cell	Total
Fan Type	Low Sound	
Fans	1	2
Fan Speed (rpm)	323	
Fan Motor Speed (rpm)	1800	
Fan Motor Nameplate (Hp)	75	150
Fan Motor Rated (BHp)	75	150
Fan Motor Required (BHp)*	67.87	135.7
Airflow (cfm)	253660	507330

** Fan Motor Required power assumes variable speed operation.*

Weights / Dimensions (options NOT included, refer to drawings)

	Per Cell	Total
Width	22'-5"	22'-5"
Length	11'-10 ¾"	24'-1"
Height	18'-10 ⅛"	18'-10 ⅛"
Shipping Weight (lb)	17290	34580
Heaviest Section (lb)	9855	9855
Max Operating Weight (lb)	37020	74030
Clearance Solid Wall *	10'-8 ⅝"	
Clearance 50% Open Wall *	7'-2 ⅞"	

** Air inlet clearances with no performance impact; reduced if tower elevated*



Plan View

Other Data

Static Lift (ft)	19.2
Distribution Head Loss (ft)	NA
Evaporation, 50% RH (gpm)	124

Heater Sizing (to prevent collection basin freezing during shutdown)

kW/Cell	30	24	18	15	12	9
Ambient (°F)	-29.9	-15.1	-0.369	7	14.4	21.7

Version 8.2.0

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THE CARL MOYER PROGRAM GUIDELINES

Approved Revisions 2011

Approved by the Board: April 28,

2011 Revised Date: December 18,

California Environmental Protection Agency
Air Resources Board

APPENDIX D

TABLES FOR EMISSION REDUCTION AND COST-EFFECTIVENESS CALCULATIONS

REFERENCES

The information in these tables has already been incorporated into the preceding emission factor tables. These tables are included for informational purposes.

Table D-25
Pollutant Fractions
NOx+NMHC
Standards

Diesel Engines		Alternative Fuel Engines	
NOx	NMHC	NOx	NMHC
0.95	0.05	0.80	0.20

Table D-26
Fuel Correction Factors
On-Road Diesel Engines

Model Year	NOx	PM10	HC
Pre- 2007	0.93	0.72	0.72
2007+	0.93	0.80	0.72

Table D-27
Fuel Correction Factors
Off-Road Diesel Engines

Model Year	NOx	PM10
Pre-Tier 1	0.930	0.720
Tier 1+	0.948	0.800

Table D-28
Conversion Factors for NOx, ROG and PM10
Heavy-Duty Vehicle Projects (bhp-hr/mile)

Model Year	Medium Heavy-Duty 14,001-33,000 lbs	Heavy Heavy-Duty 33,000 lbs +	Urban Bus 33,000 lbs +
Pre-1989	1.9	3.1	4.0
1990 - 1993	1.8	3.0	4.0
1994 - 1995	1.8	2.9	4.0
1996+	1.8	2.9	4.0

Water Quality Report 2023

Distribution -Entry Points

Definitions & Terms   Notes & Sources of Substances

Zone 3

Metals	Sample Collection Years	Units	Zone Average	City Average	City Range	MCL	MCLG
Arsenic	2023	PPB	5	2	0 - 9	10	0
Barium	2023	PPM	0.122	0.071	0.046 - 0.18	2	2
Chromium	2020 - 2023	PPB	0.0	0.2	0 - 2	100	100

Minerals	Sample Collection Years	Units	Zone Average	City Average	City Range	MCL	MCLG
Fluoride	2023	PPM	0.54	0.59	0.36 - 0.73	4	4

Nutrients	Sample Collection Years	Units	Zone Average	City Average	City Range	MCL	MCLG
Nitrate + Nitrite as Nitrogen	2023	PPM	0.10	0.18	0 - 0.72	10	10

Radionuclides	Sample Collection Years	Units	Zone Average	City Average	City Range	MCL	MCLG
Combined Radium 226 and 228	2023	pCi/L	0.11	0.13	0.02 - 0.5	5	0
Gross Alpha Particle Activity	2023	pCi/L	0.4	0.7	0 - 1.6	15	0
Uranium, Mass Concentration	2023	PPB	3	2	0 - 6	30	0

Voluntary Comprehensive Monitoring in Distribution

(Samples taken every three months, 2023 results)

Zone 3

General Chemistry	Sample Collection Years	Units	Minimum	Average	Maximum	City Average	City Range	MCL
Alkalinity	2023	PPM as CaCO3	75	110	140	105	65 - 142	~
Bicarbonate	2023	PPM as CaCO3	75	110	140	105	65 - 142	~
Calcium	2023	PPM	40.00	49.43	62.00	48.64	12 - 68.00	~
Chloride	2023	PPM	23.65	33.12	39.89	31.44	9.27 - 42.56	250 a
Field Conductivity	2023	uS/cm	402	449	516	475	300 - 685	
Field Free Chlorine	2023	mg/L	0.8	1.0	1.2	0.9	0.3 - 1.4	
Field pH	2023	Std. unit	7.24	7.65	8	7.40	7.0 - 8.1	
Field Temperature	2023	Fahrenheit	42	64	81	64	42 - 86	
Hardness	2023	grains/ gallon	6.95	8.57	10.60	8.44	2.09 - 11.72	~
Magnesium	2023	PPM	4.60	5.61	7.00	5.55	1.4 - 9.90	~
Potassium	2023	PPM	3	3	3	4	2 - 8	~
Silica	2023	PPM as SiO2	18.6	26.2	34.3	32.4	15.6 - 68.5	~
Sodium	2023	PPM	17	29	38	29	13 - 77	~
Sulfate	2023	PPM	31	63	93	68	26 - 100	250 a
Total Dissolved Solids	2023	PPM	260	286	314	291	218 - 378	500 a

Metals	Sample Collection Years	Units	Minimum	Average	Maximum	City Average	City Range	MCL
Arsenic	2023	PPB	0	1	3	2	0 - 8	10
Barium	2023	PPM	0.050	0.091	0.140	0.072	0.04 - 0.140	2
Chromium	2023	PPB	0.0	0.1	1.0	0.3	0 - 5.0	100
Iron	2023	PPM	0.0	0.0	0.0	0.0	0 - 0.1	0.3 a

Minerals	Sample Collection Years	Units	Minimum	Average	Maximum	City Average	City Range	MCL
Fluoride	2023	PPM	0.36	0.64	0.87	0.59	0.34 - 0.90	4

Nutrients	Sample Collection Years	Units	Minimum	Average	Maximum	City Average	City Range	MCL
Nitrate	2023	PPM	0.09	0.56	1.62	0.39	0 - 3.47	10

a- Represents the USEPA Secondary Maximum Contaminant Level (SMCL). Secondary Drinking Water Standards are unenforceable federal guidelines regarding taste, odor, color and certain other non-aesthetic effects of drinking water. USEPA recommends them as reasonable goals, but federal law does not require water systems to comply with them.

Calculating Realistic PM_{10} Emissions from Cooling Towers

Abstract No. 216 Session No. AM-1b

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ABSTRACT

Particulate matter less than 10 micrometers in diameter (PM_{10}) emissions from wet cooling towers may be calculated using the methodology presented in EPA's AP-42[1] , which assumes that all total dissolved solids (TDS) emitted in "drift" particles (liquid water entrained in the air stream and carried out of the tower through the induced draft fan stack.) are PM_{10}. However, for wet cooling towers with medium to high TDS levels, this method is overly conservative, and predicts significantly higher PM_{10} emissions than would actually occur, even for towers equipped with very high efficiency drift eliminators (e.g., 0.0006% drift rate). Such over-prediction may result in unrealistically high PM_{10} modeled concentrations and/or the need to purchase expensive Emission Reduction Credits (ERCs) in PM_{10} non-attainment areas. Since these towers have fairly low emission points (10 to 15 m above ground), over-predicting PM_{10} emission rates can easily result in exceeding federal Prevention of Significant Deterioration (PSD) significance levels at a project's fenceline. This paper presents a method for computing realistic PM_{10} emissions from cooling towers with medium to high TDS levels.

INTRODUCTION

Cooling towers are heat exchangers that are used to dissipate large heat loads to the atmosphere. Wet, or evaporative, cooling towers rely on the latent heat of water evaporation to exchange heat between the process and the air passing through the cooling tower. The cooling water may be an integral part of the process or may provide cooling via heat exchangers, for example, steam condensers. Wet cooling towers provide direct contact between the cooling water and air passing through the tower, and as part of normal operation, a very small amount of the circulating water may be entrained in the air stream and be carried out of the tower as "drift" droplets. Because the drift droplets contain the same chemical impurities as the water circulating through the tower, the particulate matter constituent of the drift droplets may be classified as an emission. The magnitude of the drift loss is influenced by the number and size of droplets produced within the tower, which are determined by the tower fill design, tower design, the air and water patterns, and design of the drift eliminators.

AP-42 METHOD OF CALCULATING DRIFT PARTICULATE

EPA's AP-42[1] provides available particulate emission factors for wet cooling towers, however, these values only have an emission factor rating of "E" (the lowest level of confidence acceptable). They are also rather high, compared to typical present-day manufacturers' guaranteed drift rates, which are on the order of 0.0006%. (Drift emissions are typically expressed as a percentage of the cooling tower water circulation rate). AP-42 states that "a *conservatively high* PM_{10} emission factor can be obtained by (a) multiplying the total liquid drift factor by the TDS fraction in the circulating water, and (b) assuming that once the water evaporates, all remaining solid particles are within the PM_{10} range." (Italics per EPA).

If TDS data for the cooling tower are not available, a source-specific TDS content can be estimated by obtaining the TDS for the make-up water and multiplying it by the cooling tower cycles of concentration. [The cycles of concentration is the ratio of a measured parameter for the cooling tower water (such as conductivity, calcium, chlorides, or phosphate) to that parameter for the make-up water.]

Using AP-42 guidance, the total particulate emissions (PM) (after the pure water has evaporated) can be expressed as:

$$\text{PM} = \text{Water Circulation Rate x Drift Rate x TDS} \quad [1]$$

For example, for a typical power plant wet cooling tower with a water circulation rate of 146,000 gallons per minute (gpm), drift rate of 0.0006%, and TDS of 7,700 parts per million by weight (ppmw):

$$\text{PM} = 146{,}000 \text{ gpm x } 8.34 \text{ lb water/gal x } 0.0006/100 \text{ x } 7{,}700 \text{ lb solids}/10^6 \text{ lb water x } 60 \text{ min/hr} = \underline{3.38 \text{ lb/hr}}$$

On an annual basis, this is equivalent to almost 15 tons per year (tpy). Even for a state-of-the-art drift eliminator system, this is not a small number, especially if assumed to all be equal to PM_{10}, a regulated criteria pollutant. However, as the following analysis demonstrates, only a very small fraction is actually PM_{10}.

COMPUTING THE PM_{10} FRACTION

Based on a representative drift droplet size distribution and TDS in the water, the amount of solid mass in each drop size can be calculated. That is, for a given initial droplet size, assuming that the mass of dissolved solids condenses to a spherical particle after all the water evaporates, and assuming the density of the TDS is equivalent to a representative salt (e.g., sodium chloride), the diameter of the final solid particle can be calculated. Thus, using the drift droplet size distribution, the percentage of drift mass containing particles small enough to produce PM_{10} can be calculated. This method is conservative as the final particle is assumed to be perfectly spherical; hence as small a particle as can exist.

The droplet size distribution of the drift emitted from the tower is critical to performing the analysis. Brentwood Industries, a drift eliminator manufacturer, was contacted and agreed to provide drift eliminator test data from a test conducted by Environmental Systems Corporation (ESC) at the Electric Power Research Institute (EPRI) test facility in Houston, Texas in 1988 (Aull[2], 1999). The data consist of water droplet size distributions for a drift eliminator that achieved a tested drift rate of 0.0003 percent. As we are using a 0.0006 percent drift rate, it is reasonable to expect that the 0.0003 percent drift rate would produce smaller droplets, therefore, this size distribution data can be assumed to be <u>conservative</u> for predicting the fraction of PM_{10} in the total cooling tower PM emissions.

In calculating PM_{10} emissions the following assumptions were made:

- Each water droplet was assumed to evaporate shortly after being emitted into ambient air, into a single, solid, spherical particle.
- Drift water droplets have a density (ρ_w) of water; $1.0\ \text{g/cm}^3$ or $1.0 * 10^{-6}\ \mu g/\mu\text{m}^3$.
- The solid particles were assumed to have the same density (ρ_{TDS}) as sodium chloride, (i.e., $2.2\ \text{g/cm}^3$).

Using the formula for the volume of a sphere, $V = 4\pi r^3/3$, and the density of pure water, $\rho_w = 1.0\ \text{g/cm}^3$, the following equations can be used to derive the solid particulate diameter, D_p, as a function of the TDS, the density of the solids, and the initial drift droplet diameter, D_d :

$$\text{Volume of drift droplet} = (4/3)\pi(D_d/2)^3 \qquad [2]$$

$$\text{Mass of solids in drift droplet} = (\text{TDS})(\rho_w)(\text{Volume of drift droplet}) \qquad [3]$$

substituting,

$$\text{Mass of solids in drift} = (\text{TDS})(\rho_w)(4/3)\pi(D_d/2)^3 \qquad [4]$$

Assuming the solids remain and coalesce after the water evaporates, the mass of solids can also be expressed as:

$$\text{Mass of solids} = (\rho_{\text{TDS}})\ (\text{solid particle volume}) = (\rho_{\text{TDS}})(4/3)\pi(D_p/2)^3 \qquad [5]$$

Equations [4] and [5] are equivalent:

$$(\rho_{\text{TDS}})(4/3)\pi(D_p/2)^3 = (\text{TDS})(\rho_w)(4/3)\pi(D_d/2)^3 \qquad [6]$$

Solving for D_p:

$$D_p = D_d\ [(\text{TDS})(\rho_w/\rho_{TDS})]^{1/3} \qquad [7]$$

Where,

TDS is in units of ppmw
D_p = diameter of solid particle, micrometers (μm)
D_d = diameter of drift droplet, μm

Using formulas [2] – [7] and the particle size distribution test data, Table 1 can be constructed for drift from a wet cooling tower having the same characteristics as our example; 7,700 ppmw TDS and a 0.0006% drift rate. The first and last columns of this table are the particle size distribution derived from test results provided by Brentwood Industries. Using straight-line interpolation for a solid particle size 10 μm in diameter, we conclude that approximately <u>14.9 percent</u> of the mass emissions are equal to or smaller than PM_{10}. The balance of the solid particulate are particulate greater than 10 μm. Hence, PM_{10} emissions from this tower would be equal to PM emissions x 0.149, or 3.38 lb/hr x 0.149 = 0.50 lb/hr. The process is repeated in Table 2, with all parameters equal except that the TDS is 11,000 ppmw. The result is that approximately 5.11 percent are smaller at 11,000 ppm. Thus, while total PM emissions are larger by virtue of a higher TDS, overall PM_{10} emissions are actually lower, because more of the solid particles are larger than 10 μm.

Table 1. Resultant Solid Particulate Size Distribution (TDS = 7700 ppmw)

EPRI Droplet Diameter (μm)	Droplet Volume (μm^3) [2][1]	Droplet Mass (μg) [3]	Particle Mass (Solids) (μg) [4]	Solid Particle Volume (μm^3)	Solid Particle Diameter (μm) [7]	EPRI % Mass Smaller
10	524	5.24E-04	4.03E-06	1.83	1.518	0.000
20	4189	4.19E-03	3.23E-05	14.66	3.037	0.196
30	14137	1.41E-02	1.09E-04	49.48	4.555	0.226
40	33510	3.35E-02	2.58E-04	117.29	6.073	0.514
50	65450	6.54E-02	5.04E-04	229.07	7.591	1.816
60	113097	1.13E-01	8.71E-04	395.84	9.110	5.702
70	179594	1.80E-01	1.38E-03	628.58	10.628	21.348
90	381704	3.82E-01	2.94E-03	1335.96	13.665	49.812
110	696910	6.97E-01	5.37E-03	2439.18	16.701	70.509
130	1150347	1.15E+00	8.86E-03	4026.21	19.738	82.023
150	1767146	1.77E+00	1.36E-02	6185.01	22.774	88.012
180	3053628	3.05E+00	2.35E-02	10687.70	27.329	91.032
210	4849048	4.85E+00	3.73E-02	16971.67	31.884	92.468
240	7238229	7.24E+00	5.57E-02	25333.80	36.439	94.091
270	10305995	1.03E+01	7.94E-02	36070.98	40.994	94.689
300	14137167	1.41E+01	1.09E-01	49480.08	45.549	96.288
350	22449298	2.24E+01	1.73E-01	78572.54	53.140	97.011
400	33510322	3.35E+01	2.58E-01	117286.13	60.732	98.340
450	47712938	4.77E+01	3.67E-01	166995.28	68.323	99.071
500	65449847	6.54E+01	5.04E-01	229074.46	75.915	99.071
600	113097336	1.13E+02	8.71E-01	395840.67	91.098	100.000

[1] Bracketed numbers refer to equation number in text.

The percentage of PM_{10}/PM was calculated for cooling tower TDS values from 1000 to 12000 ppmw and the results are plotted in Figure 1. Using these data, Figure 2 presents predicted PM_{10} emission rates for the 146,000 gpm example tower. As shown in this figure, the PM emission rate increases in a straight line as TDS increases, however, the PM_{10} emission rate increases to a maximum at around a TDS of 4000 ppmw, and then begins to decline. The reason is that at higher TDS, the drift droplets contain more solids and therefore, upon evaporation, result in larger solid particles for any given initial droplet size.

CONCLUSION

The emission factors and methodology given in EPA's AP-42[1] Chapter 13.4 *Wet Cooling Towers*, do not account for the droplet size distribution of the drift exiting the tower. This is a critical factor, as more than 85% of the mass of particulate in the drift from most cooling towers will result in solid particles larger than PM_{10} once the water has evaporated. Particles larger than PM_{10} are no longer a regulated air pollutant, because their impact on human health has been shown to be insignificant. Using reasonable, conservative assumptions and a realistic drift droplet size distribution, a method is now available for calculating realistic PM_{10} emission rates from wet mechanical draft cooling towers equipped with modern, high-efficiency drift eliminators and operating at medium to high levels of TDS in the circulating water.

Table 2. Resultant Solid Particulate Size Distribution (TDS = 11000 ppmw)

EPRI Droplet Diameter (μm)	Droplet Volume (μm^3) [2][1]	Droplet Mass (μg) [3]	Particle Mass (Solids) (μg) [4]	Solid Particle Volume (μm^3)	Solid Particle Diameter (μm) [7]	EPRI % Mass Smaller
10	524	5.24E-04	5.76E-06	2.62	1.710	0.000
20	4189	4.19E-03	4.61E-05	20.94	3.420	0.196
30	14137	1.41E-02	1.56E-04	70.69	5.130	0.226
40	33510	3.35E-02	3.69E-04	167.55	6.840	0.514
50	65450	6.54E-02	7.20E-04	327.25	8.550	1.816
60	113097	1.13E-01	1.24E-03	565.49	10.260	5.702
70	179594	1.80E-01	1.98E-03	897.97	11.970	21.348
90	381704	3.82E-01	4.20E-03	1908.52	15.390	49.812
110	696910	6.97E-01	7.67E-03	3484.55	18.810	70.509
130	1150347	1.15E+00	1.27E-02	5751.73	22.230	82.023
150	1767146	1.77E+00	1.94E-02	8835.73	25.650	88.012
180	3053628	3.05E+00	3.36E-02	15268.14	30.780	91.032
210	4849048	4.85E+00	5.33E-02	24245.24	35.909	92.468
240	7238229	7.24E+00	7.96E-02	36191.15	41.039	94.091
270	10305995	1.03E+01	1.13E-01	51529.97	46.169	94.689
300	14137167	1.41E+01	1.56E-01	70685.83	51.299	96.288
350	22449298	2.24E+01	2.47E-01	112246.49	59.849	97.011
400	33510322	3.35E+01	3.69E-01	167551.61	68.399	98.340
450	47712938	4.77E+01	5.25E-01	238564.69	76.949	99.071
500	65449847	6.54E+01	7.20E-01	327249.23	85.499	99.071
600	113097336	1.13E+02	1.24E+00	565486.68	102.599	100.000

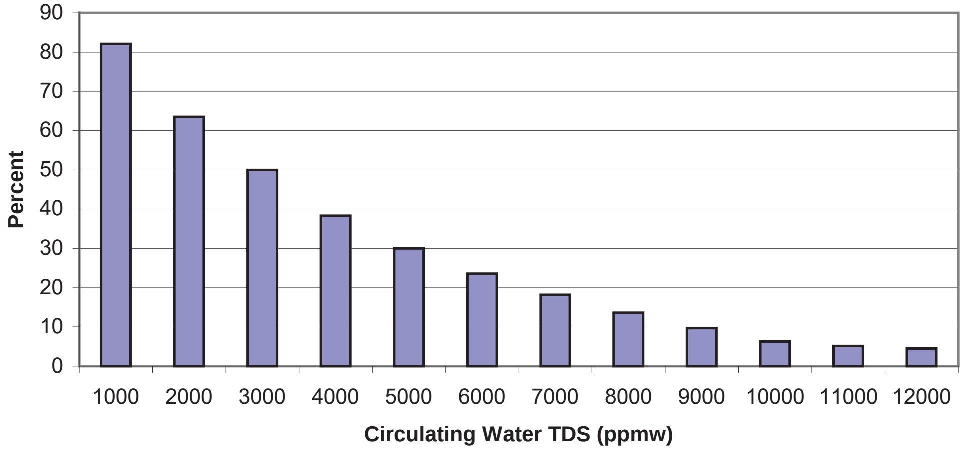
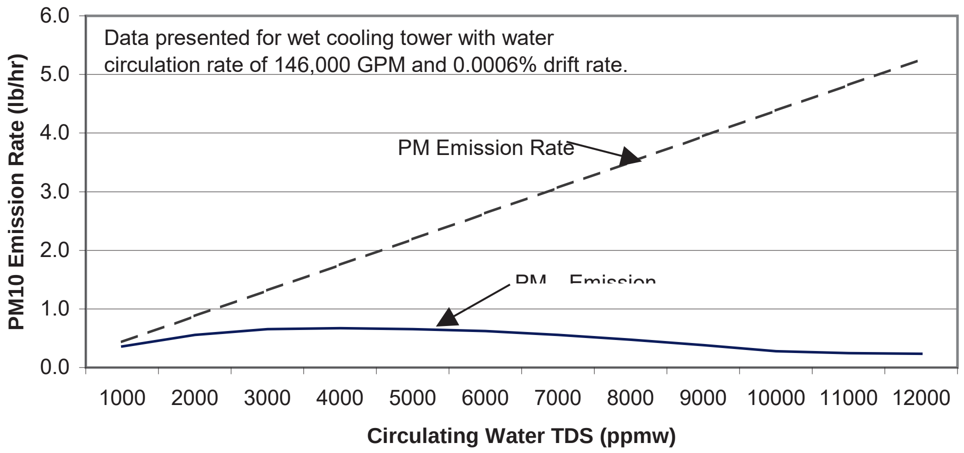


Figure 1: Percentage of Drift PM that Evaporates to PM10

Figure 2: PM$_{10}$ Emission Rate vs. TDS



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1. EPA, 1995. Compilation of Air pollutant Emission Factors, AP-42 Fifth edition, Volume I: *Stationary Point and Area Sources*, Chapter 13.4 Wet Cooling Towers, http://www.epa.gov/ttn/chief/ap42/, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, January.

2. Aull, 1999. Memorandum from R. Aull, Brentwood Industries to J. Reisman, Greystone, December 7, 1999.

KEY WORDS

Drift
Drift eliminators
Cooling tower
PM$_{10}$ emissions
TDS

Air Permit Technical Guidance for Chemical Sources

Fugitive Guidance

APDG 6422

Air Permits Division Texas Commission on Environmental Quality

June 2018

Section I: Quantifying Uncontrolled Emissions

Uncontrolled fugitive emissions are quantified by the number and type of components and an emission rate factor for each component type. Fugitive emission factors have been established by case studies of chemical plants, oil and gas facilities, refineries, gasoline marketing terminals, and other industries, as discussed later in this section. An average leak factor is used to determine what the fugitive emission rate is for an area, a facility, or an entire plant.

Estimates are based on the assumption that all piping components are leaking vapors into the atmosphere at all times. For purposes of permitting, the emission rate is based on the number of components of a specific type in a defined area multiplied by the appropriate fugitive emission factor. The emission rate for a component type must also be speciated for the compounds found within the process unit or area. All components must be included in the emission estimate, even components that are exempt from monitoring, unless they are excluded from emission calculations as described under Additional Information.

The specific factors currently approved for use by the TCEQ are located in Appendix A and can also be found in the web page for Equipment Leak Fugitives, www.tceq.texas.gov/permitting/air/guidance/newsourcereview/fugitives/nsr_fac_eqfug.html. Sets of factors have been established for several industries, as described below. Emission rate estimates must be calculated using the appropriate set of factors. If factors are not established for a particular industry, the SOCMI factors without ethylene may be used, or the TCEQ Air Permits Division (APD) can be contacted for guidance.

Fugitive Emission Factor

The Fugitive Emission Factor (FEF) is an average leak factor determined from data collected during industry case studies. The FEF is in units of pounds per hour per component (lb/hr/component). The following equation is used to estimate uncontrolled fugitive emissions for each type of component:

(FEF) × (# of components) = uncontrolled fugitive emission rate

There are three main criteria in choosing the correct FEF:

- Component type
- Service
- Industry or pollutant type

These criteria are explained in more detail in the sections that follow.

Component Type

The main component types considered are:

- Valves
- Pumps
- Flanges/connectors
- Compressors
- Relief valves
- Open-ended lines
- Process drains.

There may be other components found within a specific industry. For instance, in oil and gas production operations, other components may include diaphragms, dump arms, hatches, instruments, meters, and polished rods. For more information, please see Appendix A, Table II, footnote 10.

Some components are exempt from monitoring requirements based on size, physical location at a facility, VOC content, or low vapor pressure service. Emissions from these components must be calculated and included in the estimated fugitive emission rate regardless of any monitoring exemptions. In addition, certain difficult-to-monitor (DTM) and unsafe-to-monitor components, as defined in 30 Texas Administrative Code (TAC) Chapter 115, §115.352(7) and §115.354(1)(C) are exempt from monitoring requirements but the uncontrolled emissions must still be calculated.

Factors have not been developed for certain types of piping components. In order to ensure consistency, the TCEQ has reviewed factors for components with similar characteristics and designated the following guidelines for calculating emissions from these components:

- Emissions from screwed fittings should be estimated in the same manner as connectors.
- Emissions from liquid relief valves should be estimated in the same manner as light liquid valves. This addresses only the emissions resulting from the liquid relief valve reseating. It does not address the release itself which is an emission event.
- Emissions from agitators should be estimated in the same manner as light liquid pumps.
- Tubing size lines (flexible lines less than or equal to 0.5 inches in diameter) and equipment do not need to be quantified, unless the lines or equipment are subject to monitoring by any federal or state regulation.

A complete list of component types can be found in Tables I and II in Appendix A.

Service

The service designates the type of specific fluid handled by the component of concern. For most industries, these fluids include gas/vapor, light liquid, and heavy liquid. Oil and gas production operation factors include gas, water/light oil, light oil, and heavy oil. For industries other than oil and gas production sites, heavy liquids have vapor pressures of 0.044 pound per square inch absolute (psia) or less and light liquids have vapor pressures higher than 0.044 psia at 68°F. Gas/vapor factors are used for components in gas service at the operational conditions.

Industry or pollutant type

The fugitive factor type indicates a set of factors that have been defined and approved for a specific industry.

For Table I**,** the fugitive factor types are:

- Synthetic Organic Chemical Manufacturing Industry (SOCMI) Average
- SOCMI Without Ethylene (C_2)
- SOCMI With Ethylene (C_2)
- SOCMI Non-Leaker.

For Table II**,** the fugitive factor types are:

- Ethylene Oxide
- Phosgene
- Butadiene
- Petroleum Marketing Terminal
- Oil and Gas Production Operations
- Refinery.

Specialty FEFs

Specialty FEFs are industry or pollutant specific factors with specified Leak Detection and Repair (LDAR) program credits inherent within the factor. If an applicant uses Specialty FEFs, they are committed to using the associated LDAR program. Because LDAR program credits for those specialty factors are embedded within the specialty factors, the applicant cannot receive additional credits for using that LDAR program.

The SOCMI Non-Leaker FEFs in Table I, and the Ethylene Oxide, Phosgene, Butadiene, and Petroleum Marketing Terminal FEFs in Table II are considered Specialty FEFs. Applicants using the SOCMI Non-Leaker FEFs must employ LDAR program 28PI, endnote 3 in Table I. The ethylene oxide, phosgene, and butadiene factors can only be used with the specific LDAR programs defined in the associated footnotes in Table II. These factors will require additional permit conditions and can only be used for process lines that contain essentially pure compounds. Applicants using the Petroleum Marketing Terminal FEFs must employ LDAR program 28PET, endnote 5 and 6 in Table II. Refer to Section II for more detailed discussions on LDAR programs 28PI and 28PET.

Speciated Emissions

If the chemical composition in a process unit is not 100% pure, a speciation, or breakdown of the different compounds, is necessary to determine the off-property impact for each different compound emitted from a fugitive source. This includes compounds other than VOCs such as inorganic compounds, exempt solvents, and inerts.

For example, if a process unit contains 80% toluene and 20% ethylene, the emission rate would need to reflect the estimated quantity of emissions for each compound. Multiplying the emission rate by the weight percent of each compound yields the specific emission rate for that compound. If the weight percent of a particular compound varies from one process stream to another, then the fugitive emission rate for each area should be calculated separately, multiplied by the appropriate weight percent, and then totaled. The permit applicant may also group different streams together and determine the maximum percentage of each compound for that group. When using this method, the speciated emissions may exceed the total VOC emissions. The total emission rate of each individual chemical should be submitted with the permit application. Please see Table VII in Appendix A for an example of speciation calculations. Note that further speciation is not necessary for mixtures with defined ESLs, for example crude oil and gasoline. For complex mixtures with low volatility consult your permit reviewer for speciation requirements. In many cases, similar compounds can be grouped together with assignment of an appropriately conservative ESL.

Selecting Appropriate Factors for the Site

SOCMI Factors

The SOCMI factors are generally used in chemical plants and in chemical process units that are located in a refinery (e.g., cumene unit). The original SOCMI average factors were developed to represent fugitive emission rates from all chemical plants. The SOCMI average factors are found in the Environmental Protection Agency's (EPA) document EPA 453/R-95-017, "Protocol for Equipment Leak Emission Estimates," page 2-12, available at the EPA's Web site at www3.epa.gov/ttnchie1/efdocs/equiplks.pdf. From these factors, the TCEQ further derived two additional sets of factors: "SOCMI with ethylene" to be used for components where the ethylene concentration is greater than 85% by weight; and "SOCMI without ethylene" to be used where the ethylene concentration is less than 11%. For streams where the ethylene concentration is between 11% - 85%, the SOCMI average factors should be applied. For components in service where the material has a vapor pressure between 0.0147 psia and 0.147 psia, fugitives may be estimated with the SOCMI Non-Leaker factors. The SOCMI Non-Leaker factors were developed from test data where no leaking emissions occurred above 10,000 parts per million per volume (ppmv); therefore, using the Non-Leaker factors assumes that no leaks will occur over the 10,000 ppmv leak detection threshold.

Petroleum Marketing Terminal Factors

In February of 1995, TCEQ approved the use of the Petroleum Marketing Terminal Factors found in EPA document EPA-453/R-95-017, page 2-14. These factors are used to estimate fugitive emissions from components at gasoline distribution facilities that are "one-step removed" from local gasoline stations and other end-users. Although gasoline distribution facilities may also handle jet fuel and diesel, gasoline is their primary product. In a memorandum dated December 5, 2005, TCEQ approved the use of these factors for Pipeline Breakout Stations for crude oil and fuel service (gasoline, diesel, and jet fuel). For more information, please see www.tceq.texas.gov/assets/public/permitting/air/memos/petroleum_marketing.pdf.

The PMT factors were designed to be used only at distribution and pipeline breakout stations handling only fuels or fuel-related products at a facility consisting only of storage tanks and truck loading facilities. Loading racks at chemical plants, large terminals for hire, and refineries may not use these factors. Terminals for hire are generally larger, more complex facilities that store a variety of liquid compounds, and may have additional operations such as marine loading. Also, even though a terminal for hire may initially store only fuels and fuel-related products, they might later receive authorization through permit by rule (PBR) to store other products. In limited circumstances, small terminals for hire may be allowed to use the PMT factors if they meet all of the following criteria: the site has less than 25 tanks, it is limited by permit to only store fuels and fuel-related products and is prohibited by permit condition or physical constraints from using PBR authorization to authorize handling of other compounds, and it loads only tank trucks (no marine loading).

Use of the PMT factors is accompanied by a physical inspection LDAR program performed on a monthly basis as specified in the 28PET permit special conditions. The petroleum marketing terminal factors include the appropriate reduction credit for the physical inspection; therefore, no additional reductions to the factors are necessary. The decision to require a physical inspection program instead of instrument monitoring was based on the EPA/American Petroleum Institute (API) bagging study of various gasoline distribution facilities employing a variety of LDAR programs. The results of the study indicated that little or no improvement in fugitive emission control was achieved when an instrument was used to detect leaks at this type of facility.

Oil and Gas Production Operations Factors

The Oil and Gas Production Operations factors are based on equipment leak emissions data from the oil and gas production industry that was gathered by API and evaluated by the EPA. There are four equipment service categories covered by the Oil and Gas Production factors:

1. Gas Factors,
2. Heavy Oil (< 20° API gravity),
3. Light Oil (> 20° API gravity), and
4. Water/Light Oil (water streams in light oil service with a water content between 50% and 99% by weight).

The gas factors estimate total hydrocarbon emissions; therefore, the calculated emission rates must be multiplied by the VOC weight percent, (i.e., methane and ethane are excluded), in the gas stream to get a total VOC rate for permitting purposes. The Oil and Gas Production Operations gas factors replace the Gas Plant Fugitive Factors from the EPA protocol document (EPA-453/R-93-026).

Operators of crude oil pipeline facilities which handle weathered or “dead” crude may use the Oil and Gas Heavy Oil (< 20° API gravity) factors to estimate fugitive emissions. This decision was based upon studies at tank batteries and other upstream facilities that demonstrated weathered crude is free of the entrained gases and easily volatilized light ends.

Refinery Factors

Refinery factors are used when estimating fugitive emissions in a petroleum refinery process unit. A chemical process, such as a cumene production unit, may be located in a refining facility; however, because it is not considered a refinery process, the refinery factors should not be used to calculate that specific unit's fugitive emissions. Refinery factors are given in the EPA document, EPA 453/R-95-017, page 2-13, available at the EPA’s Web site at www3.epa.gov/ttnchie1/efdocs/equiplks.pdf.

Additional Information

This subsection discusses particular instances in regard to quantifying uncontrolled fugitive emissions including:

- When Fugitive Emissions Do Not Need to Be Quantified
- Fugitive Emissions from Select Odorous and Inorganic Compounds
- Operating Hours When Quantifying Fugitive Emissions
- Correlation Equations and Plant-Specific Factors
- Quantifying Fugitive Emissions from Process Drains
- Maximum Allowable Emission Rates Table (MAERT) Footnote Clarification

When Fugitive Emissions Do Not Need to Be Quantified

Emissions from certain components are expected to be so low that emissions from them do not need to be quantified. These include the following:

- Tubing size lines (flexible lines less than or equal to 0.5 inches in diameter) and equipment, unless the lines or equipment are subject to monitoring by any federal or state regulation. (As of August 2017, no current state regulations require that tubing less than 0.5 inches be monitored).
- Non-piping type fittings (swedge lock or ferrule fittings).
- Streams where the operating pressure is at least 0.7 psi below ambient pressure.
- VOC emissions from mixtures in streams where the VOC has an aggregate partial pressure of less than 0.002 psi at 68°Fahrenheit.

- Anything that is not considered an air contaminant (i.e. water vapor and nitrogen).
- Nitrogen lines (does not include lines with nitrogen that has been used as a sweep gas).
- Steam lines (non-contact).
- Components containing only noble gases, inerts such as CO_2 and water or air contaminants not typically listed on a MAERT such as methane, ethane, and Freon.
- Storage tank conservation vents.

In other cases, emissions must be quantified even though the components may be exempt from monitoring requirements or qualify for reduced monitoring. These include the following:

- Unsafe-to-monitor components that qualify for reduced monitoring.
- Difficult-to-monitor components that qualify for reduced monitoring.
- Equipment in VOC service only during startup and shutdown, excluding startup and shutdown between batches of the same campaign for a batch process.
- Any pressure relief device that is routed to a process or fuel gas system or equipped with a closed vent system capable of capturing and transporting leakage through the pressure relief device to a control device (quantify emissions from control device).
- Wastewater lines, pipeline quality sweet natural gas lines, and other lines that may be exempt from monitoring based on the weight percent VOC in the stream.
- Equipment that is exempt from monitoring under the applicable LDAR program (for example, where the VOC has an aggregate partial pressure or vapor pressure of less than 0.044 pounds per square inch, absolute (psia) at 68°F).

Fugitive Emissions from Inorganic Compounds

For inorganic compounds such as chlorine (Cl_2), ammonia (NH_3), hydrogen sulfide (H_2S), hydrogen fluoride (HF), and hydrogen cyanide (HCN), fugitive emissions are calculated in the same manner as VOC fugitive emissions. Although the VOC emission factors were not developed specifically for use with these compounds, they are presently recommended for estimating their fugitive emissions.

Operating Hours When Quantifying Fugitive Emissions

Fugitive emission factors are independent of process-unit throughput and therefore fugitives are assumed to occur if there is material in the line, regardless of the activity of the process. Therefore, the hours in service for all streams should always be 8,760 hours annually, regardless of process downtime. Any exception to this service time would result in a permit condition requiring the lines to be purged during process downtime.

Correlation Equations and Plant-Specific Factors

The use of various correlation equations developed by EPA for estimating fugitive emissions is not accepted for permitting purposes although they can be used for estimating actual emissions for emission inventory purposes.

Emission factors developed for individual facilities are also not accepted for permitting purposes, unless prior approval has been obtained before the application is submitted. TCEQ does not have the resources to evaluate studies for individual facilities or companies during application review. Emission factors developed for individual facilities require additional discussions, development of sampling protocols, and analysis of results prior to their use in a submitted permitting application.

Quantifying Fugitive Emissions from Process Drains

The refinery factor for fugitive emissions from process drains may be applied to any process drain regardless of facility or industry type.

MAERT Footnote Clarification

In the past, some permits were issued with a footnote on the MAERT indicating that “Fugitive emissions are an estimate only and should not be considered as a maximum allowable emission rate.” The footnote language has been revised to indicate that the “Emission rate is an estimate and is enforceable through compliance with the applicable special condition(s) and permit application representations.” The newer language more clearly states the intent of the earlier language. The intent of the “new” language is to ensure that the permit holder is in compliance with their permit representations and LDAR programs. Although fugitive emission rates are "estimates" they are used in determining applicability of Title V and major new source review. It is not likely that a regulated entity would have measured concentrations that would lead to emission rates calculated through correlation equations that would exceed the MAERT limits, unless the number of components was greater than the number on which the MAERT limit was based. In this case, the older footnote language could result in enforcement action against the regulated entity for exceeding the number of components represented.

Section II - Fugitive Emission Reduction Options

Fugitive emission rates can be reduced by two methods: leak detection and repair (LDAR) programs and equipment specification. Pollution prevention should be considered when designing a process unit to minimize the number of piping components. Certain types of equipment have lower emissions by design as outlined in the design options section.

LDAR Programs

LDAR programs are used to inspect fugitive components to identify leaks either by using instruments or in limited cases, by physical inspections. Leaks identified by the inspections are then repaired within a specified time period, thus reducing the emissions. When these programs are in place, estimated fugitive emissions can be reduced using the emission control credits according to Table V, in Appendix A. These credits can only be given in cases where the components are actually inspected and for components for which the LDAR program could result in emission reductions.

LDAR programs can be grouped into two categories:

- Instrument monitoring, and
- Physical inspection.

Instrument Monitoring LDAR programs can be differentiated by four key criteria as shown below and also in Appendix A Table III:

- *Leak definition:* The leak definition is the monitored concentration of an air contaminant, defined in parts per million by volume (ppmv), that identifies a leaking component needing repair. The most common levels used for pumps are 10,000 ppmv; 2,000 ppmv; and 500 ppmv and for other components are 10,000 ppmv and 500 ppmv.
- *Monitoring frequency:* The monitoring frequency varies depending on the component types and the LDAR program in place. Components typically must be monitored on a quarterly basis; however, some programs allow facilities to skip monitoring periods when the percentage of leaking components is maintained under a specified rate.
- *Properties of the monitored compounds:* Some LDAR programs define the components to be monitored by the vapor pressure of the material in the component or the weight percent of VOC in the stream. Compounds must have sufficient VOC vapor pressure to register as a leak when dripping to qualify for an emission reduction credit for monitoring.
- *Requirements for repair:* Program repair requirements may be either directed or non-directed maintenance. A directed maintenance program requires that a gas analyzer be used in conjunction with the repair or maintenance of leaking components to assure that a minimum leak concentration is achieved. A non-directed maintenance program does not require the use of a gas analyzer during repair or maintenance of a leaking component. In either case, if a replacement is required to fix a leaking component, the replaced component should be re-monitored within 15 days to confirm that the repair was successful.

Each of the instrument monitoring programs is outlined in Table III of Appendix A. LDAR credits can only be given in cases where the components are actually inspected and only for components for which the LDAR program could result in emission reductions. Control credits do not apply to components that are designated as difficult or unsafe-to-monitor, unless these components are monitored. For example, if difficult-to-monitor components are monitored annually at 500 ppmv, then a 75% reduction credit can be applied as it is for annual connector monitoring per 28 CNTA.

Some LDAR programs allow reduced monitoring frequency if the numbers of leaking components detected are below a specific percentage. In these cases the components using the skip options would continue to qualify for the same reduction credit.

The credits, or control efficiencies, associated with each program are listed in Table V of Appendix A. Summaries of the programs are shown below:

28M, 28RCT, 28VHP, 28MID and 28LAER

- These are the most common LDAR programs. These are differentiated by leak definition, vapor pressure, and directed versus non-directed maintenance as detailed in Table III.
- The 28LAER LDAR program is used to control fugitive emissions that are part of a nonattainment permit. For facilities that are not subject to a nonattainment permit, the same emission reductions may be attained by implementing the 28MID program in conjunction with the 28CNTQ LDAR program for connectors and 28PI for components in heavy liquid service.
- In an effort to keep the permit special conditions for LDAR programs as concise as possible, the procedures to calculate emissions from leaking components to justify delay of repair are not outlined in the 28 series LDAR programs; instead they reference 30 TAC Chapter 115, Subchapter H, Division 3. The 28 series LDAR programs also use the 30 TAC Chapter 115, Subchapter D, Division 3, §115.352 definition for difficult-to-monitor valves.
- When initial monitoring is required for existing components that have a change of service and are now required to be monitored quarterly, these components are normally associated with a specific portion of a process line or a plant. Most companies have an ongoing LDAR monitoring program in which a monitoring team works its way through the various sections of the plant by adhering to a schedule that will insure that every component is monitored once each quarter. It is conceivable that a component will re-enter service after the monitoring team has departed that portion of the plant. In that particular case, it is acceptable that this particular component is not monitored until the monitoring team is scheduled to monitor that portion of the plant again, as long as it is monitored within the next quarter.

28CNTQ and 28CNTA

- These are LDAR monitoring programs for connectors that can be added to weekly inspections to increase the reduction credit.

LDAR for Inorganic VOC Mixtures

For inorganics in VOC mixtures that are monitored according to an LDAR program, the calculated uncontrolled emission rates can be reduced according to the credit allowed by the monitoring program. The emission rates of the inorganic compounds are determined by multiplying the total emission rate by the weight-percent of each individual compound present in the stream. Please see Table VII for an example.

Reduction Credit for Annual and Quarterly Connector Monitoring

Annual instrument monitoring of connectors/flanges at a 500 ppmv leak detection limit may receive a 75% reduction credit at petroleum refineries and SOCMI facilities. This determination is based on information contained in the 1993 EPA document "Protocol for Equipment Leak Fugitives" and the results from monitoring data. The control effectiveness percentages given in the protocol document are based on the type of facility, monitored data, and the corresponding reduction in the percentage of leaking flanges. The lowest percent reduction was used to establish the appropriate reduction credit as it is preferable to allow a single reduction credit for both chemical facilities and refineries. Thus, the 75% reduction credit is suitable for use at both petroleum refineries and SOCMI facilities where the connectors/flanges are monitored annually at 500 ppmv. The 28CNTA LDAR program specifies the monitoring and recordkeeping necessary to receive the 75% reduction credit. This program may be used in conjunction with any of the other 28 series LDAR programs, except 28LAER, which already includes connector monitoring.

Quarterly instrument monitoring of connectors at a 500 ppmv leak detection limit may receive a 97% reduction credit. This credit is equivalent to that received by valves monitored at the same leak detection limit and frequency. The 28CNTQ LDAR program specifies the monitoring and recordkeeping necessary to receive the 97% reduction credit. This program may be used in conjunction with any of the other 28 series LDAR programs, except 28LAER, which already includes connector monitoring.

Low Vapor Pressure Compounds

Compounds with low vapor pressures can present a problem with instrument monitoring. No reduction credits are allowed for valves and pumps in heavy liquid service under any of the five 28 Series LDAR programs or 30 TAC Chapter 115 because components in heavy liquid service are not required to be monitored. An applicant may propose to monitor these components and take the appropriate reduction credits as noted in Table V, in Appendix A; however, the applicant must demonstrate that leaking components can be detected by implementing an instrument assisted fugitive monitoring program. For materials with vapor pressures below 0.147 psia, implementing a LDAR program with a 10,000 ppmv leak detection definition would be useless as leaking components may never be detected. For example, a component in heavy liquid service (vapor pressure < 0.044 psia) which is subject to a LDAR program with a leak definition of 10,000 ppmv would have a theoretical saturation concentration of 0.044/14.7 = 2990 ppmv. Depending on the instrument lower detection limit for the compounds being measured, this concentration may not be a measurable quantity; thus, it may not be possible to demonstrate an actual emission reduction via instrumental monitoring. These components would not get increased maintenance or reduced emission rates as a result of a LDAR Program with a 10,000-ppmv leak definition; therefore, these components cannot receive any reduction credit. To reduce these emissions, the applicant would have to commit to a 500 ppmv leak definition program.

For ultra-heavy liquids with vapor pressure less than 0.0147 psia at ambient temperature, emissions are calculated using the SOCMI without ethylene factors and the application of the 28 audio, visual and olfactory (28AVO) LDAR program reduction credits. Because the vapor pressure is so low, a dripping liquid leak found by visual inspection would have a similar concentration as the 500 ppmv leak rate that the 28AVO reduction credits are based upon. This estimate is more representative than the SOCMI factor alone because the SOCMI heavy liquid factor is overly conservative for these ultra-heavy liquids. Use of this estimation method requires the implementation of the 28 physical inspection (28PI) LDAR program as a minimum requirement. The weekly physical inspection for the dripping liquids is sufficient to control the air emissions and prevent the build-up of a liquid puddle which could become a wastewater permitting issue due to rain water runoff.

Phosgene, Butadiene, and Ethylene Oxide LDAR programs

Specific factors have been developed for use with components in phosgene, butadiene, and ethylene oxide production facilities. These factors are used to estimate fugitive emissions from components in phosgene, butadiene, and ethylene oxide production facilities when monitored with the 28MID LDAR Program at the following leak definitions:

Phosgene	50 ppmv
Butadiene	100 ppmv
Ethylene Oxide	500 ppmv

Note: the ethylene oxide connector factor does not include instrument monitoring. An additional reduction credit can be taken if connector monitoring is required.

Physical Inspection Programs

Physical inspections are available for those compounds for which instrument monitoring is not appropriate and for heavy liquids below the vapor pressure thresholds of the various LDAR programs. Physical inspections rely primarily on the visual detection of dripping liquids. A few highly odorous compounds with extreme odor nuisance potential may utilize an audio, visual and olfactory program (28AVO) to reduce leaks; however, use of this program is restricted to the following approved compounds: chlorine, ammonia, hydrogen sulfide, hydrogen cyanide and mercaptans. Hydrogen fluoride fugitives are controlled visually by the use of HF detection paint and are also subject to the 28AVO LDAR program.

28PI

Weekly physical inspection of all components for dripping liquids may be used when all components are in heavy liquid service for a 30% reduction credit. When components are in ultra-heavy liquid service (VP<0.0147-psia), 28PI may be used but the 28AVO credits may be employed. This program may also be used for insulated components that cannot be monitored with an instrument as long as a visual indication of a leak can be pin-pointed to the appropriate component and the insulation can be removed to repair the leak.

28PET

Monthly physical inspection for dripping liquids may only be used in conjunction with the Petroleum Marketing Terminal factors for bulk gasoline terminals and pipeline breakout stations.

28 Audio, Visual and Olfactory (AVO) Inspection

The 28AVO inspection program is a physical walk-through inspection every four hours with repair or containment of leak within one hour of detection and identification. This may only be used with certain compounds for which instrument monitoring is not available and which have sufficient odors to allow ready detection of leaks. It is approved for chlorine, ammonia, hydrogen sulfide, hydrogen fluoride, hydrogen cyanide, and mercaptans. Other odorous compounds may be considered with TCEQ management approval. If the predicted off-property impact of an inorganic/odorous compound is unacceptable, the applicant will be required to implement the 28AVO walk-through inspection. The inspection frequency given in the 28AVO condition may be reduced on a case-by-case basis, but may not be reduced to less than once a shift.

The 28AVO credit is based on type of component, not vapor pressure or service type. Fugitive emission rates controlled through the 28AVO inspection are determined as follows:

The total number of components in service of the compound in question should be multiplied by the appropriate “SOCMI without ethylene” emission factor regardless of industry type, as described in Section I. The 28AVO reduction credits found in Appendix A, Table V should then be applied to the uncontrolled inorganic, odorous compound emission rates.

If inorganic compounds are present in VOC mixtures and their maximum predicted off-property impacts are acceptable based on reduction credits from the VOC monitoring, separate 28AVO monitoring may not be required.

Equipment Credits

There are certain options that may be implemented in the design of a facility to reduce fugitive emissions. When calculating emission rates, various control credits may be applied to components in service as described below. Also, LDAR program monitoring for identified types of equipment is not required if 100% reduction credit is given. Remember that all fugitive components must be included in component counts, even if they are given 100% credit.

Relief Valves

100% control may be taken if one of the following conditions is met:

1. Relief valve vents are routed to an operating control device; or
2. Relief valves are equipped with a rupture disc and pressure sensing device (between the valve and disc) to monitor for disc integrity.

For new facilities, BACT guidelines generally require that all relief valves vent to a control device in order to control the releases. Releases may be vented to atmosphere if required for safety purposes and justified by applicant. If the relief valve is vented to the atmosphere it must be monitored regardless of accessibility unless each valve is equipped with a rupture disc upstream. A pressure gauge must also be installed between the relief valve and rupture disc to monitor disc integrity, and all leaking discs must be replaced at the earliest opportunity but no later than the next process shutdown.

Pumps

Certain types of pumps are designed to be "leakless" and can be given 100% control credit. Any of the following designs are accepted as leakless pumps:

1. Canned Pumps,
2. Magnetic Drive Pumps,
3. Diaphragm Pumps,
4. Double mechanical seals and the use of a barrier fluid at a higher pressure than the process, and
5. Double mechanical seals and venting the barrier fluid seal pot to a control device.

Valves

100% control credit may be taken if one of the following conditions is met:

1. Use of bellows valves with bellows welded to both the bonnet and stem,
2. Use of diaphragm-type valves, or
3. Use of seal-welded, magnetically actuated, packless, hermetically sealed control valves.

Open-ended lines

If an open-ended line is equipped with a cap, blind flange, plug, or a second valve, then a 100% control credit can be taken. The connector count is increased by the number of open-ended lines to account for the credit. Valves used in this manner are counted as connectors.

Connectors

Connectors may receive 100% control credit if the connections are welded together around the circumference of the connection such that the flanges are no longer capable of being disassembled by simply removing the bolts.

Compressors

Compressors must be designed to be entirely enclosed and must have the crankcase vented to a control device to be given 100% control.

Double Mechanical Seals

Any component employing double mechanical seals may be given a 75% credit. If the seals are monitored, then use the appropriate monitoring credit. One hundred percent credit can be given if the barrier fluid seal pot is controlled or the barrier fluid is at a higher pressure than process pressure.

Process Drains

Facilities subject to fugitive emission monitoring under 30 TAC §§115.324(1)(C) and 354(1)(A) are required to monitor process drains on an annual basis. A 75% reduction credit may be applied for annual monitoring of process drains at a leak threshold of 500 ppmv provided the drain is designed in such a manner that repairs to leaking drains can be achieved. For example, flushing a water seal on a leaking process drain would constitute repair, so a 75% reduction credit may be applied. Similarly, a 95% reduction credit can be applied for quarterly monitoring of drains if repairs to the leaking drains can be completed.

Design Options

There are certain options that may be incorporated into the design of a facility to minimize piping components, improve maintenance and/or reduce susceptibility to leaks. While some of these options may not result in reduction credits for fugitive emissions, they can result in lower maintenance costs and improved performance in some cases.

Overall

1. Design equipment layout to minimize pipe run lengths and associated connectors.
2. Minimize the use of valves and other components.
3. Minimize the use of relief valves whenever possible.
4. Optimize piping and component metallurgy for compatibility with process streams and/or physical environment to reduce corrosion potential.

Pumps

1. Use of pressure transfer to eliminate the need for pumps.
2. Use of submerged pumps which limit the exposure of potential leaks to the atmosphere.

Valves

1. Optimize length of time between leaks by using special packing sets and stringent adherence to packing procedures.
2. Use on-line direct injection repair equipment. However, this option may introduce an additional potential leak path for the valve if corrosion occurs around the tap.

Connectors

1. Use of new technologies which have been deemed by the TCEQ to be equivalent to flanges.
2. Eliminate the use of screwed fittings smaller than 2 inches in diameter.

   Note: BACT for fugitives does not allow the use of screwed connections on lines greater than 2 inches in diameter.

Compressors

1. Designs with lower leak potentials such as diaphragm compressors.
2. Shaft seal design such as carbon rings, double mechanical seals or buffered seals.
3. Design options such as internal balancing, double inlet or gland eductors.

Quantifying Fugitive Emission Reductions

Here are several important points to remember when calculating fugitive emission rates:

1. All components must be accounted for when estimating emission rates regardless of exemptions from monitoring requirements except for the fugitive components that meet the one or more of the exclusions specified in “When Fugitive Emissions Do Not Need to Be Quantified,”.
2. Taking an emission reduction for monitoring implies that all of those components will be monitored regardless of exemptions.
3. Difficult-to-monitor components and other unmonitored components must be clearly identified and separated from monitored components when calculating emission rates.
4. All components given emission reduction credits for monitoring must be capable of having reduced emissions through the monitoring program, i.e., any components represented as being monitored must have sufficient vapor pressure to allow the reduction.
5. Representations of emission reductions in a permit application will result in permit special conditions requiring monitoring for certain components based on the emission estimates.
6. The following connector monitoring can be applied in order to reduce emissions:
   - For a weekly walk-through inspection as required by an LDAR program, a 30% credit can be taken.
   - The 28CNT LDAR programs are used in addition to the other 28 series LDAR programs if connector monitoring is required by special circumstances or to reduce emissions.
   - For annual instrument monitoring of connectors under the 28CNTA LDAR program, a 75% credit may be taken.
   - For quarterly instrument monitoring of connectors under the 28CNTQ LDAR program, the valve credit corresponding to the appropriate leak definition for the LDAR program may be applied instead of the 30% credit.
7. Emission calculations should include a component count for those components with 100% control efficiency with a footnote describing the specific method of control.

Please see Table VII in Appendix A for an example calculation of fugitive emissions from equipment leaks for a SOCMI facility using the 28VHP LDAR program.

Section III - Best Available Control Technology and Impacts Guidelines

An integral part of the permitting process is the determination of Best Available Control Technology (BACT) for all new and modified sources.. BACT guidelines are based on the fugitive emissions for the site, not the new emissions only. The project may have lower emissions than the tons per year at which an LDAR program is required but the total uncontrolled site emissions are used to determine which LDAR program meets BACT. For example: An existing site currently does not require the use of a monitoring program, based on current uncontrolled fugitive emission rates. An applicant proposes to install a new process unit, which by itself would not require monitoring. If the emissions from the new unit combined with emissions from the existing unit would trigger a requirement to apply a monitoring program as BACT, the new unit would be required to institute monitoring.

Please see the TCEQ website www.tceq.texas.gov/permitting/air/nav/air_bact_chemsource.html, for guidelines for determining BACT for process fugitive emissions when submitting a permit application.

The uncontrolled annual emission rate thresholds and corresponding LDAR programs given in the TCEQ website are guidelines only; a case-by-case review will be performed for all permit applications. Separate applicability determinations must also be made for 30 TAC Chapter 115, 40 CFR Part 60, 40 CFR Part 61, or 40 CFR Part 63 affected sources. A more stringent program may be required to reduce impacts.

The following practices are generally considered to be the minimum for BACT.

1. Construction of new and reworked piping, valves, pump systems, and compressor systems shall conform to applicable American National Standards Institute (ANSI), American Petroleum Institute (API), American Society of Mechanical Engineers (ASME), or equivalent codes based on the material.
2. New and reworked buried connectors shall be welded.
3. To the extent that good engineering practice will permit, new and reworked valves and piping connections shall be reasonably accessible for leak checking during plant operation.
4. Damaged, leaking, or severely rusted valves, connectors, compressor seals, agitator seals, and pump seals found by visual inspection to be leaking (e.g., process fluids) shall be tagged and replaced or repaired. All leaking components that cannot be repaired until a scheduled shutdown shall be identified for such repair by tagging.
5. Open-ended lines are required to be equipped with a cap, plug, blind flange, or second valve.
6. New relief valves are required to vent to a control device for any potential releases and as a result, any fugitive emissions are reduced. Exceptions may be made if venting relief valves to control will result in a safety concern, but this does not exempt the company from controls such as equipping the valve with a rupture disk and pressure-sensing device. If instrument monitoring is chosen for existing relief valves, monitoring must be performed quarterly regardless of the accessibility of the relief valves.

Off-Property Impacts Review

The control technology determination is separate from the off-property impacts assessment performed during the permit review process. A more stringent LDAR program than required for BACT may be necessary to reduce impacts if the TCEQ Toxicology division determines that the predicted off-property impact of fugitive emissions is unacceptable or if the permit reviewer/toxicologist determines that the hours of exceedance of the ESL are unacceptable. If the impacts evaluation indicates a concern for off-property impacts exists, the following additional steps may be required:

1. Switching to a more stringent fugitive monitoring program, if available.
2. Equipment specifications for leakless operation (See Section II.)
3. Addition of secondary fugitive programs such as 28PI, 28CNTQ, or 28CNTA.

Applicants may submit their own proposals to reduce fugitive emissions and their impacts, but the TCEQ will not give additional credit above the levels listed in Appendix A, Table V without additional monitoring.

To view the requirements of our fugitive monitoring programs www.tceq.texas.gov/permitting/air/guidance/newsourcereview/fugitives/nsr_fac_eqfug.html.

Section IV – Federal Applicability Considerations for Fugitive Emissions

Fugitive emissions are defined in 30 TAC §101.1(39) as "Any gaseous or particulate contaminant entering the atmosphere that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening designed to direct or control its flow." Fugitive emissions from sources that are in one of the federal "named source" categories or are in a source category which, as of August 7, 1980, is being regulated under Federal Clean Air Act (FCAA) §§ 111 (New Source Performance Standards) or 112 (National Emission Standards for Hazardous Air Pollutants) are considered in determining whether a source is considered "major" for purposes of Title V applicability and for purposes of major new source review applicability. According to 30 TAC 122.10(14) and 30 TAC 116.12(19), fugitive emissions from "unnamed sources" are not included when determining whether a source is considered to be "major." Most chemical plants and refineries are "named sources" and accordingly do need to include equipment leak fugitive emissions in their major source determinations. If fugitive components are within a building, there is a presumption that the emissions can be captured and would not be considered "fugitives" because they can be routed to a stack.

For netting purposes, fugitive emissions from equipment leaks are evaluated differently than other sources of emissions because they are independent of process throughputs and cannot be directly measured. The TCEQ Air Permits Division does not require the use of actual emissions as reported in the Emissions Inventory for the netting calculations or project increases in the contemporaneous period. Project increases should be determined based on the number of new components, the appropriate emission factors, and the reduction credits based on the LDAR program applied (if any).

Creditable increases or decreases during the contemporaneous window should be based on the difference between the newly authorized and previously authorized fugitive emissions as determined considering the change in the number of components, emission factors and control credits contained in each contemporaneous change. The previously authorized fugitive emissions may need to be adjusted downward to correct for changes in or promulgation of applicable regulatory requirements.

Additional Information

For more information about netting please review APDG 5881, "Major New Source Review - Applicability Determination" at the following link: www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/fnsr_app_determ.pdf.

Section V - Regulations Governing VOC Equipment Leaks

A number of state and federal regulations exist that address VOC equipment leaks. All permit applications must demonstrate that the facility will comply with all applicable rules and regulations. New Source Performance Standards (NSPS) in 40 CFR Part 60 , National Emission Standards for Hazardous Air Pollutants (NESHAPS in 40 CFR Part 61 and MACT in 40 CFR Part 63) and 30 TAC Chapter 115 have fugitive emission monitoring programs that vary depending on the specific industry, the material, and the county where the source is located. Each of the major fugitive emission monitoring programs required by state or federal regulation is listed below by industry type. For specific details, refer to the actual regulation.

A facility may be subject to more than one monitoring program. Meeting the requirements of one program does not exempt a facility from the requirements of another. When LDAR programs have conflicting requirements, the permit holder is expected to perform the most stringent aspects of both.

For instance if the regulations require monthly inspections at 10,000 ppmv and the permit requires quarterly inspections at a leak definition of 500 ppmv, the permit holder must perform monthly inspections at a leak definition of 10,000 ppmv and once per quarter at a leak definition of 500 ppmv.

New Source Performance Standards (NSPS) (40 CFR Part 60)

Subpart	Title
VV	Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After January 5, 1981, and on or Before November 7, 2006.
VVa	Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006.
XX	Standards of Performance for Bulk Gasoline Terminals.
DDD	Standards of Performance for Volatile Organic Compound (VOC) Emissions from the Polymer Manufacturing Industry.
GGG	Standards of Performance for Equipment Leaks of VOC in Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After January 4, 1983, and on or Before November 7, 2006 (Excluding Those Subject to Subparts VV or KKK).
GGGa	Standards of Performance for Equipment Leaks of VOC in Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006.
KKK	Standards of Performance for Equipment Leaks of VOC from Onshore Natural Gas Processing Plants for Which Construction, Reconstruction, or Modification Commenced After January 20, 1984, and on or Before August 23, 2011 (Excluding Those Covered Under Subparts VV or GGG). (Replaced by Subpart OOOO for facilities modified after August 23, 2011).
QQQ	Standards of Performance for VOC Emissions From Petroleum Refinery Wastewater Systems.
OOOO	Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution for which Construction, Modification or Reconstruction Commenced after August 23, 2011, and on or before September 18, 2015.
OOOOa	Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution for which Construction, Modification or Reconstruction Commenced After September 18, 2015.

National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61)

Subpart	Title
F	National Emission Standard for Vinyl Chloride.
J	National Emission Standard for Equipment Leaks (Fugitive Emission Sources) of Benzene.
L	National Emission Standard for Benzene Emissions from Coke By Product Recovery Plants.
V	National Emission Standard for Equipment Leaks (Fugitive Emission Sources).
BB	National Emission Standard for Benzene Emissions From Benzene Transfer Operations
FF	National Emission Standard for Benzene Waste Operations

National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Categories, Maximum Achievable Control Technology (MACT) (40 CFR Part 63)

Subpart	Title
H	National Emission Standards for Organic Hazardous Air Pollutants for Equipment Leaks.
I	National Emission Standards for Organic Hazardous Air Pollutants for Certain Processes Subject to the Negotiated Regulation for Equipment Leaks. Rubber Production, Agricultural Chemicals, Polymers/Resins.
J	National Emission Standards for Organic Hazardous Air Pollutants for Polyvinyl Chloride and Copolymers Production.
R	National Emission Standards for Gasoline Distribution Facilities (Bulk Gasoline Terminals and Pipeline Breakout Stations).
S	National Emission Standards for Hazardous Air Pollutants from the Pulp and Paper Industry
U	National Emission Standards for Hazardous Air Pollutants Emissions: Group I Polymers and Resins.
W	National Emission Standards for Hazardous Air Pollutants for Epoxy Resins Production and Non Nylon Polyamides Production.
Y	National Emission Standards for Marine Tank Vessel Loading Operations.
CC	National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries.
DD	National Emission Standards for Hazardous Air Pollutants from Off Site Waste and Recovery Operations
GG	National Emission Standards for Aerospace Manufacturing and Rework Facilities
HH	Oil and Natural Gas Production Facilities.
PP	National Emission Standards for Containers
QQ	National Emission Standards for Surface Impoundments
SS	National Emission Standards for Closed Vent Systems, Control Devices, Recovery Devices and Routing to a Fuel Gas System or a Process.
TT	National Emission Standards for Equipment Leaks Control Level 1.
UU	National Emission Standards for Equipment Leaks Control Level 2 Standards.
YY	National Emission Standards for Hazardous Air Pollutants for Source Categories: Generic Maximum Achievable Control Technology Standards.
III	National Emission Standards for Hazardous Air Pollutants for Flexible Polyurethane Foam Production.
JJJ	National Emission Standards for Hazardous Air Pollutant Emissions: Group IV Polymers and Resins.
MMM	National Emission Standards for Hazardous Air Pollutants for Pesticide Active Ingredient Production.
OOO	National Emission Standards for Hazardous Air Pollutant Emissions: Manufacture of Amino/Phenolic Resins.
PPP	National Emission Standards for Hazardous Air Pollutant Emissions for Polyether Polyols Production.

Subpart	Title
VVV	National Emission Standards for Hazardous Air Pollutants: Publicly Owned Treatment Works
EEEE	National Emission Standards for Hazardous Air Pollutants: Organic Liquids Distribution (Non Gasoline)
FFFF	National Emission Standards for Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing.
BBBBB	National Emission Standards for Hazardous Air Pollutants for Semiconductor Manufacturing
GGGGG	National Emission Standards for Hazardous Air Pollutants: Site Remediation
HHHHH	National Emission Standards for Hazardous Air Pollutants: Miscellaneous Coating Manufacturing.
BBBBBB	National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Distribution Bulk Terminals, Bulk Plants, and Pipeline Facilities.
VVVVVV	Hazardous Air Pollutants for Chemical Manufacturing Area Source
HHHHHH	National Emission Standards for Hazardous Air Pollutant Emissions for Polyvinyl Chloride and Copolymers Production.

Mandatory Greenhouse Gas Reporting Program (40 CFR Part 98)

- Subpart W – Petroleum and Natural Gas Systems

Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR Part 264)

- Subpart BB - Air Emission Standards for Equipment Leaks

30 TAC

TCEQ	Title
Chapter 115 Subpart D	For petroleum refineries, natural gas/gasoline processing, and petrochemical processes in Beaumont/Port Arthur, Dallas/Fort Worth, Houston/Galveston and El Paso Areas Leak definition of 10,000 ppmv for pump seals and compressors. Leak definition of 500 ppmv for all other components. 115.322 Gregg, Nueces and Victoria Counties Leak definition of 10,000 ppmv for all components. Control requirements for process drains.
Chapter 115 Subpart H	For fugitives from components in contact with highly reactive VOCs as applicable to petroleum refinery; synthetic organic chemical, polymer, resin, or methyl tert butyl ether manufacturing process; or natural gas/gasoline processing operation in the Houston/Galveston/Brazoria area.
Chapter 122 Subchapter G	Determines if fugitive emissions count towards Title V applicability.

The regulations listed above are not an exhaustive list. Additionally, new standards are being proposed and promulgated that contain LDAR requirements for specific industries. Refer to the current NSPS and MACT standards for the specific industry to determine which requirements apply to the facility. In addition, 30 TAC Chapter 115 may list fugitive emission inspection and monitoring requirements in sections other than those written specifically to address fugitive emissions. For example, fugitive inspection and maintenance requirements for marine terminals and gasoline terminals are contained in Section 115.214 of 30 TAC Chapter 115, Subchapter C, “Volatile Organic Compound Transfer Operations.”

Appendix A: Tables

Table I: Uncontrolled SOCMI Fugitive Emission Factors

Equipment/Service	SOCMI Average[1]	SOCMI Without Ethylene (C_2)[2]	SOCMI With Ethylene (C_2)[2]	SOCMI Non-Leaker[3]
Valves				
Gas/Vapor	0.0132	0.0089	0.0258	0.00029
Light Liquid	0.0089	0.0035	0.0459	0.00036
Heavy Liquid	0.0005	0.0007	0.0005	0.0005
Pumps				
Light Liquid	0.0439	0.0386	0.144	0.0041
Heavy Liquid	0.019	0.0161	0.0046	0.0046
Flanges/Connectors				
Gas/Vapor	0.0039	0.0029	0.0053	0.00018
Light Liquid	0.0005	0.0005	0.0052	0.00018
Heavy Liquid	0.00007	0.00007	0.00007	0.00018
Compressors	0.5027	0.5027	0.5027	0.1971
Relief Valve (Gas/Vapor)	0.2293	0.2293	0.2293	0.0986
Open-ended Lines[4]	0.0038	0.004	0.0075	0.0033
Sampling Connection[5]	0.033	0.033	0.033	0.033[6]
Agitators	No factors developed; use industry appropriate light liquid pump factors.			
Liquid Relief Valves	No factors developed; use industry appropriate light liquid valve factors for existing units. New units are expected to have no emissions if they meet BACT.			

Endnotes Table I

[1] Factors are taken from EPA document, EPA-453/R-95-017, November 1995, Page 2-12.

[2] Factors are TCEQ derived, “without Ethylene (C_2)” means components contain less than 11% C_2 and “with Ethylene (C_2)” means components contain greater than 85%C_2

[3] Applicable only for components with vapor pressures between 0.0147 psia and 0.147 psia. Control credit is included in factor; no additional control credit can be applied to these factors. 28PI LDAR program is required.

[4] The 28 series quarterly LDAR programs require open-ended lines to be equipped with a cap, blind flange, plug, or a second valve. If so equipped, open-ended lines may be given 100% control credit.

[5] Emission factor is in terms of pounds per hour per sample taken. Valves, connectors and open-ended lines should be quantified separately.

[6] No factors were developed. The SOCMI sampling connection factor is also used for Non-Leaker.

3. OPERATIONAL PLAN – AIR EMISSIONS DURING SSM

The Salt Production Facility is owned and operated by Kairos Power, LLC. A detailed startup, shutdown, and maintenance operational plan is described below for each unit at the facility. In general, as soon as a malfunction occurs, the facility will shut down applicable equipment as soon as possible to ensure no excess emissions or non-permitted emissions are released. The facility will only start up again once it has identified that the malfunction is addressed, and the facility will operate as normal and permitted.

Emission Point 1: VENT-300

- Unit is a Batch Operating Unit, running through Batches on a daily basis. Batch loading, emptying, and operating emissions are included in the Unit Emission Summary.
- There is no operating scenario separate from the Batch Schedule. The unit operations are readily blocked in and isolated in standby and upset scenarios, which is the design default.
- **Start up:** There are no expected increased emissions due to start up and the system is designed to operate in batch.
- **Shut down:** There are no expected increased emissions due to a shut down and the system is designed to operate in batch.
- **Maintenance:** There are no expected increased emissions from maintenance and the unit is designed to be a recycling operation where any materials removed from the unit for maintenance are collected and recycled in a closed-circuit fashion.
- **Malfunction:** If a malfunction occurs that would impact emissions, the system will be brought to an idle state for repairs. This consists of either the above-mentioned blocked-in scenario, or the above materials removal, collection, and recycle in the closed-circuit fashion.

Emission Point 2: BSC-500

- Unit is a Batch Operating Unit, running through Batches on a daily basis. Batch loading, emptying, and operating emissions are included in the Unit Emission Summary.
- There is no operating scenario separate from the Batch Schedule. The unit operations are readily blocked in and isolated in standby and upset scenarios, which is the design default.
- **Start up:** There are no expected increased emissions due to start up and the system is designed to operate in batch.
- **Shut down:** There are no expected increased emissions due to a shut down and the system is designed to operate in batch.
- **Maintenance:** There are no expected increased emissions from maintenance and the unit is designed to be a recycling operation where any materials removed from the unit for maintenance are collected and recycled in a closed-circuit fashion.
- **Malfunction:** If a malfunction occurs that would impact emissions, the system will be brought to an idle state for repairs. This consists of either the above-mentioned blocked-in scenario, or the above materials removal, collection, and recycle in the closed-circuit fashion.

Emission Point 3: SCBR-600

- Unit is a Batch Operating Unit, running through Batches on a daily basis. Batch loading, emptying, and operating emissions are included in the Unit Emission Summary.
- There is no operating scenario separate from the Batch Schedule. The unit operations are readily blocked in and isolated in standby and upset scenarios, which is the design default.
- **Start up:** There are no expected increased emissions due to start up and the system is designed to operate in batch.

- **Shut down:** There are no expected increased emissions due to a shut down and the system is designed to operate in batch.
- **Maintenance:** There are no expected increased emissions from maintenance and the unit is designed to be a recycling operation where any materials removed from the unit for maintenance are collected and recycled in a closed-circuit fashion.
- **Malfunction:** If a malfunction occurs that would impact emissions, the system will be brought to an idle state for repairs. This consists of either the above-mentioned blocked-in scenario, or the above materials removal, collection, and recycle in the closed-circuit fashion.

Emission Point 4: COOLING TOWER-1

- The unit is equipped with circulating water monitoring on a continuous basis with control systems in place to adjust as needed.
- The unit is monitored by operating staff 24/7.
- Individual systems using the circulating water are equipped with water monitoring on a continuous basis with control systems in place to adjust as needed.
- **Start up:** There are no expected increased emissions due to start up.
- **Shut down:** There are no expected increased emissions due to shut down.
- **Maintenance:** There are no expected increased emissions from maintenance.
- **Malfunction:** If a malfunction occurs that would impact emissions, the system will be brought to an idle state for repairs.

Emission Point 5A: BOILER-1

- Boiler Emissions are based on thermal load (steam) requirements of the facility and there are no incremental emissions from start-up or shutdown;
- The two boilers are operated jointly with a lead/lag philosophy based on thermal load (steam) requirements with a single unit capable of maintaining plant operations;
- **Start up:** There are no expected increased emissions due to start up and the system is designed to operate continuously based on thermal load (steam) requirements;
- **Shut down:** There are no expected increased emissions due to shut down and system is designed to operate in batch based on operating philosophy described above;
- **Maintenance:** There are no expected increased emissions from maintenance based on the operating philosophy described above;
- **Malfunction:** If Malfunction occurs this will be taken offline for repairs based on operating philosophy described above;

Emission Point 5B: BOILER-2

- Boiler Emissions are based on thermal load (steam) requirements of the facility and there are no incremental emissions from start-up or shutdown;
- The two boilers are operated jointly with a lead/lag philosophy based on thermal load (steam) requirements with a single unit capable of maintaining plant operations;
- **Start up:** There are no expected increased emissions due to start up and the system is designed to operate continuously based on thermal load (steam) requirements;
- **Shut down:** There are no expected increased emissions due to shut down and system is designed to operate in batch based on operating philosophy described above;
- **Maintenance:** There are no expected increased emissions from maintenance based on the operating philosophy described above;
- **Malfunction:** If Malfunction occurs this will be taken offline for repairs based on operating philosophy described above;

Emission Point 6: GEN-1

- This unit is a back-up service only and will be operated only in the event of power loss at the site, which is expected to be a very rare and short-lived event;
- **Start up:** Engine startup is completed following manufacturer's instructions, including pre-startup checklists. The exhaust is monitored, for an excess of white and/or black smoke. If this is observed the engine is shut down.
- **Shut down:** Engine shutdown is completed following manufacturer's instructions. The exhaust is monitored, for an excess of white and/or black smoke. If this is observed the engine is taken offline for repairs.
- **Maintenance:** There are no expected increased emissions from maintenance.
- **Malfunction:** If Malfunction occurs this will be taken offline for repairs

Emission Point 7: FUG-1

- **Maintenance:** Per the LDAR program, flanges and connectors will be monitored annually to determine if any repairs are needed to reduce fugitive emissions.

4. AIR DISPERSION MODELING ANALYSIS

The following pages contain the information below regarding air dispersion modeling analysis for the SPF:

- Air Dispersion Modeling Protocol
- Email from CABQ EHD of Approval of the Submitted Modeling Protocol (October 24, 2024)
- Air Dispersion Modeling Report

AIR DISPERSION MODELING PROTOCOL

Initial Permit Application

Salt Production Facility

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October 2024

Project 233201.0065

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1. FACILITY INFORMATION

Kairos Power (Kairos) is submitting this initial ATC permit application for the proposed Salt Production Facility (SPF) to the City of Albuquerque (CABQ) Environmental Health Department (EHD), Air Quality Program (AQP). This document includes all required components requested for Modeling Protocols pursuant to Attachment B of the CABQ EHD's Air Dispersion Modeling Guidelines (published May 2024).

1.1 Facility Description

The Kairos SPF will be located at 5201 Hawking Dr SE, Albuquerque, NM 87106 (13N UTM 352,781 m E and 3,874,820 m N). This facility will be located next to the existing Kairos Power Southwest (KPSW) facility. From the initial pre-permit application meeting Kairos had with CABQ EHD, it was discussed whether this new SPF facility would have a different SIC code than the existing KPSW facility. Michael McKinstry, EHD Environmental Health Supervisor, communicated on May 31, 2024:

> "… the Air Quality Program has made a determination on your request for the two Kairos facilities each having their own separate permit number … since the Chemicals and Chemical preparation NAICS is 325998 and the Nuclear Electric Power Generation NAICS is 221113, the Air Quality Program will allow Kairos to have separate permits for the two facilities."

This determination will allow the SPF to have a separate permit and model than the existing KPSW facility. The SPF will contain a variety of tank and non-tank units associated with unit areas 100, 150, 300, and 400 which vent to a shared vent stack (Unit Vent-300), a bleach synthesis column (Unit BSC-500), unit area 600 and 950 scrubbers with a shared vent stack (SCBR-600), a 7100 gpm water cooling tower (Unit Cooling Tower-1), a 24.525 MMBtu/hr boiler (Unit Boiler-1), and a 32.700 MMBtu/hr boiler (Unit Boiler-2).

The SPF will have four sources which emit criteria pollutants required for modeling: Vent-300, Cooling Tower-1, Boiler-1, and Boiler-2. BSC-500 and SCBR-600 do not emit pollutants for which a national Ambient Air Quality Standard (NAAQS) or New Mexico Ambient Air Quality Standard (NMAAQS) have been established and will therefore not require air dispersion modeling.

1.2 Facility Maps

The maps requested by Attachment B of CABQ's Modeling Guidelines are reported in Figures 1 through 3 of this section.

Figure 1 shows an aerial image from Google Earth of the proposed location of the SPF along with the proposed facility fenceline. The imagery in this image is dated April 18, 2023. Additionally, a complete plot plan of the facility which includes the locations of the proposed sources, building locations, and a facility fenceline can be found in Appendix A.

Figure 1 – An Aerial Image of the Proposed Location of the SPF Obtained from Google Earth

In Figure 2, an aerial image of the proposed location of the obtained from the City of Albuquerque's Advance Map Viewer. As can be seen in Figure 2, the location of the SPF will be within the city limits. From the Advanced Map Viewer, it was determined that the SPF is surrounded by industrial sites and unincorporated areas.

Figure 2 – An Aerial Image of the Proposed Location of the SPF Obtained from the City of Albuquerque's Advanced Map Viewer

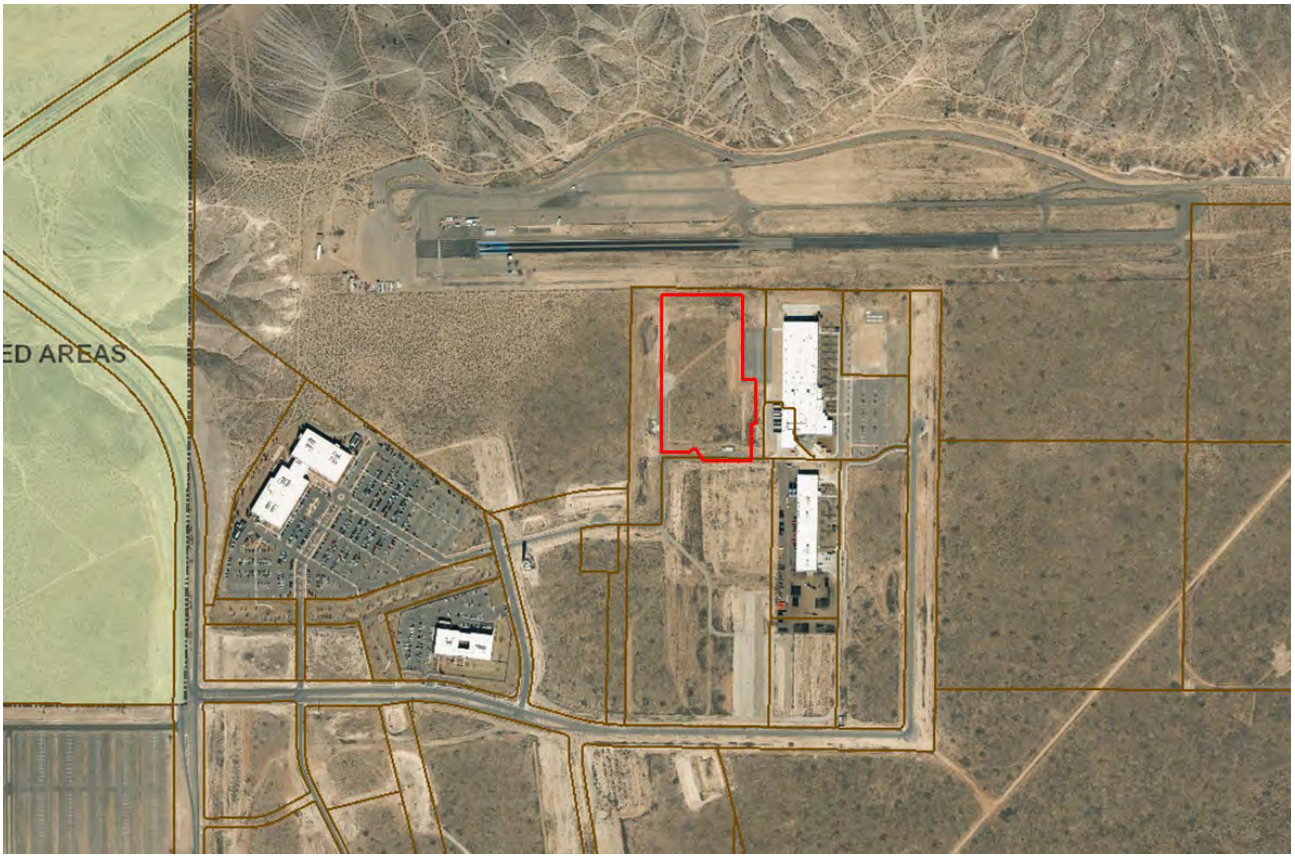

Figure 3 displays an aerial image obtained from Google Maps. The imagery in this image is dated October 10, 2022.

Figure 3 – An Aerial Image of the Proposed Location of the SPF and its Surroundings Obtained from Google Maps

1.3 Operating Hours

The SPF is requesting to be authorized to operate 24 hours a day, 7 days a week, and 52 weeks a year. All hours will be modeled.

2. EMISSIONS AND STANDARDS MODELED

2.1 Facility Emissions

Requested emission rates for all criteria pollutants can be found in Table 1. Please note that the requested emission may change slightly during development of the permit application.

Table 1 – Requested Total Facility Emissions

	NO_x (lb/hr)	CO (lb/hr)	SO_2 (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)
Requested Total	**2.81**	**4.71**	**3.42**	**1.15**	**0.46**

2.2 Standards Modeled

The pollutants and standards to be modeled are shown in Table 2. Note that some standards are surrogates that demonstrate compliance for other averaging periods. (e.g., SO_2 1-hr NAAQS is a surrogate that demonstrates compliance for SO_2 3-hr NAAQS and SO_2 24-hr and annual NMAAQS) per the NMED Air Dispersion Modeling Guidance.[1]

Table 2 – Proposed Pollutants and Averaging Periods to be Modeled

Pollutant	Averaging Period	Not Emitted	Surrogate Modeled	Modeled
CO	8-hr			☑
	1-hr			☑
H_2S	1-hr	☑		
Pb	Quarterly	☑		
NO_2	Annual			☑
	24-hr		☑	
	1-hr			☑
$PM_{2.5}$	Annual			☑
	24-hr			☑
PM_{10}	Annual			☑
	24-hr			☑
SO_2	Annual		☑	
	24-hr		☑	
	3-hr		☑	
	1-hr			☑

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[1] New Mexico Environment Department Air Quaility Bureau, New Mexico Air Quality Bureau Air Dispersion Modeling Guidelines. Revised March 2024, Table 18.

2.3 Impacts and Results

2.3.1 Significance Impact Level (SIL) Analysis

Kairos will conduct a screen analysis to determine if the High 1st High modeled impacts of each standard exceed the significance thresholds listed in Table 18 of the NMED Air Dispersion Modeling guidelines.[2] The significance levels for the modeled pollutants are reported in Table 3. The maximum potential hourly emission rate from the emission sources will be used to demonstrate compliance. All pollutants and standards shown in Table 3 will be modeled to assess significance.

Table 3 – Significant Impact Levels of Pollutants that Will be Modeled

Pollutant	Averaging Period	Significance Level (µg/m^3)
CO	8-hr	500
	1-hr	2,000
NO_2	Annual	1.0
	24-hr	5.0
	1-hr	7.52
$PM_{2.5}$	Annual	0.13
	24-hr	1.2
PM_{10}	Annual	1.0
	24-hr	5.0
SO_2	Annual	1.0
	24-hr	5.0
	3-hr	25.0
	1-hr	7.8

2.3.2 Cumulative Impact Analysis (CIA)

If the significance analysis predicts that modeled concentrations will exceed a SIL, a cumulative impact analysis (CIA) will be conducted. Kairos proposed to use the prescribed design value of each modeled standard as described in Table 18 and Table 20 of the NMED Air Dispersion Modeling guidelines[3]. Modeling will only be performed for receptors where the SIL is in exceedance based on the significant impacts modeling results.

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[2] Ibid, Table 18.

[3] Ibid, Table 18 & Table 20.

Table 4 – Cumulative Impact Analysis Design Values of Each Modeled Standard

Pollutant	Averaging Period	Modeled Concentration	Add Background Sources	Surrounding Sources Modeled	NAAQS Standard (µg/m³)	NMAAQS Standard (µg/m³)
CO	8-hr	High 1st High	☑	☑		9,960.1
	1-hr	High 1st High	☑	☑		14,997.5
NO_2	Annual	Annual Average*	☑	☑		94.02
	1-hr	High 8th High	☑	☑	188.03	
$PM_{2.5}$	Annual	Annual Average*	☑	☑	9	
	24-hr	High 8th High	☑	☑	35	
PM_{10}	Annual	Annual Average*	☑	☑		
	24-hr	High 2nd High	☑	☑	150	
SO_2	Annual	Annual Average*	☑	☑		52.4
	1-hr	High 4th High	☑	☑	196.4	

* The average of the three highest annual impacts from the five year met data set will be compared against the standard.

The proposed total NO_2 emission rate is 2.81 tpy and the proposed total SO_2 emission rate is 3.42 tpy. As the modeled emission rates for these pollutants do not exceed 40 tpy, secondary particulate formation will not be evaluated as part of modeling.[4]

---

[4] Ibid, Section 2.6.6.2

3. MODELING SET-UP

3.1 Proposed Sources Summary

As described in Section 1.1, this initial permit application will authorize the construction of the Kairos Salt Production Facility to produce coolant salt for industrial processes. This facility will contain a variety of tanks (Unit Tanks) vented to a shared stack associated with units 100, 150, and 300 (Unit 300), a bleach synthesis column (Unit Bleach Syn Col-500), two scrubbers with a shared vent stack (SCBR-600), a 7100 gpm water cooling tower (Unit Cooling Tower-1), a 24.525 MMBtu/hr boiler (Unit Boiler-1), and a 32.700 MMBtu/hr boiler (Unit Boiler-2). The center of the facility is located at 13N UTM 352,781 m E and 3,874,820 m N.

3.2 Sources and Emission Rates Modeled

The SPF will have four sources which emit criteria pollutants required for modeling: Vent-300, Cooling Tower-1, Boiler-1, and Boiler-2. BSC-500 and SCBR-600 do not emit pollutants for which a national Ambient Air Quality Standard (NAAQS) or New Mexico Ambient Air Quality Standard (NMAAQS) have been established and will therefore not require air dispersion modeling. Kairos has accurately represented the location of the modeled emission sources using an accurate plot plan and aerial imagery.

Table 5 reports the hourly emission rates that will be modeled for each unit. Please note that the requested emissions may change slightly during development of the permit application.

Table 5 – Modeled Emission Rates

Unit No.	Description	NO$_x$ (lb/hr)	CO (lb/hr	SO$_2$ (lb/hr)	PM$_{10}$ (lb/hr)	PM$_{2.5}$ (lb/hr)
Vent-300	Unit Areas 100, 150, 300, and 400 combined vent stack	-	-	3.10	0.016	0.016
Cooling Tower-1*	Cooling Tower	-	-	-	0.70	0.014
Boiler-1	Boiler	1.20	2.02	0.14	0.18	0.18
Boiler-2	Boiler	1.60	2.69	0.18	0.24	0.24

* Cooling Tower-1 has two cells and will therefore be modeled as two point sources. Emissions from Cooling Tower-1 will be split between the two point sources.

3.3 Source Types and Stack Parameters

All units will be modeled as point sources. The facility will run continuously. Table 6 contains the stack parameters for each point source at the facility.

Table 6 – Point Source Stack Parameters

Unit No.	UTM Coordinates	Exit Direction	Height Above Ground (ft)	Exhaust Temperature (°F)	Exhaust Velocity (ft/s)	Inside Diameter (ft)	Rain Cap?
Vent-300	352,819 m E 3,874,846 m N	Vertical	72	Ambient Temperature	0.17	0.67	No
Cooling Tower-1 Cell 1	352,817 m E 3,874,846 m N	Vertical	30.00	Ambient Temperature	44.49	11.00	No
Cooling Tower-1 Cell 2	352,821 m E 3,874,846 m N	Vertical	30.00	Ambient Temperature	44.49	11.00	No
Boiler-1	352,816 m E 3,874,763 m N	Vertical	50	600	99.85	2.00	No
Boiler-2	352,816 m E 3,874,754 m N	Vertical	50	600	133.14	2.00	No

3.4 Buildings, Tanks, and Downwash

There are several tanks and buildings located at the Kairos SPF. Building Profile Input Program for PRIME (BPIPPRM) will be run in all models to address building downwash associated with the tanks and structures at this facility. Kairos will determine the dimensions of all off site buildings and will run BPIPPRM if they are withing the Good Engineering Practice (GEP) 5L area of influence[5,6] of any proposed point source.

The GEP 5L area of influence for each structure is determined by measuring a distance of five times ‘L’ from each edge of the structure, where ‘L’ is the lesser of the building height or projected building width or length. Only those stacks within the area of influence are affected by building wake effects.

Tables 7 and 8 contain the building dimensions.

---

[5] EPA-454/R-93-038. User’s Guide to the Building Profile Input Program. Revised February 8, 1995.

[6] Electric Power Research Institute. Addendum to ISC3 User’s Guide: The prime Plume Rise and Building Downwash Model. November 1997.

Table 7 – Rectangular Building Dimensions

Bldg. ID	UTM Coordinates	Height (ft)	X Length (ft)	Y Length (ft)	Angle (deg.)
BLDG-1	352,838 m E 3,874,794 m N	25	160	60	90
BDLG-2	352,806 m E 3,874806 m N	16	44	54	90
BLDG-3	352,805 m E 3,874,786 m N	20	40	55	90
BLDG-4	352,806 m E 3,87,743 m N	26	100	81.17	90
BLDG-5	352,773 m E 3,874,752 m N	25	44	64	90
BLDG-6	352,773 m E 3,874,726 m N	28	64	64	90
BLDG-7	352,819 m E 3,874,846 m N	25	30	22	90
OSBLDG-1	352,849 m E 3,874,852 m N	20	~92.52	~54.46	90
OSBLDG-3	352,890 m E 3,874,907 m N	44	~293.64	~98.75	90
OSBLDG-4	352900 m E 3,874,940 m N	27	~50.85	~119.75	90

Table 8 – Polygon Building Dimensions

Bldg. ID	Height (ft)	Corner	X Coordinate (m)	Y Coordinate (m)	Corner	X Coordinate (m)	Y Coordinate (m)
OSBLDG-2	43	1	352878.1	3874797.8	8	352907.2	3874726
		2	352881.2	3874797.8	9	352907	3874733.5
		3	352881.1	3874794.9	10	352881	3874733.5
		4	352907.3	3874794.8	11	352880.8	3874726.2
		5	352907.3	3874797.5	12	352877.9	3874726.5
		6	352909.9	3874797.7	13	352878.1	3874797.8
		7	352909.6	3874725.8			
OSBLDG-5	65	1	352935.4	3874887.6	12	353052.5	3874734.4
		2	353028.4	3874887.2	13	353052.5	3874710.2
		3	353026.4	3874789.5	14	352988.1	3874709.8
		4	353029.2	3874789.5	15	352987.3	3874702.6
		5	353028.8	3874785.8	16	352993.8	3874696.1
		6	353035.6	3874785.8	17	352986.5	3874690.5
		7	353034.8	3874746.8	18	352966.8	3874690.1
		8	353040	3874746.8	19	352966	3874766.5
		9	353039.2	3874741.6	20	352933.8	3874766.5
		10	353044.1	3874741.2	21	352935.4	3874887.6
		11	353043.7	3874734.4			

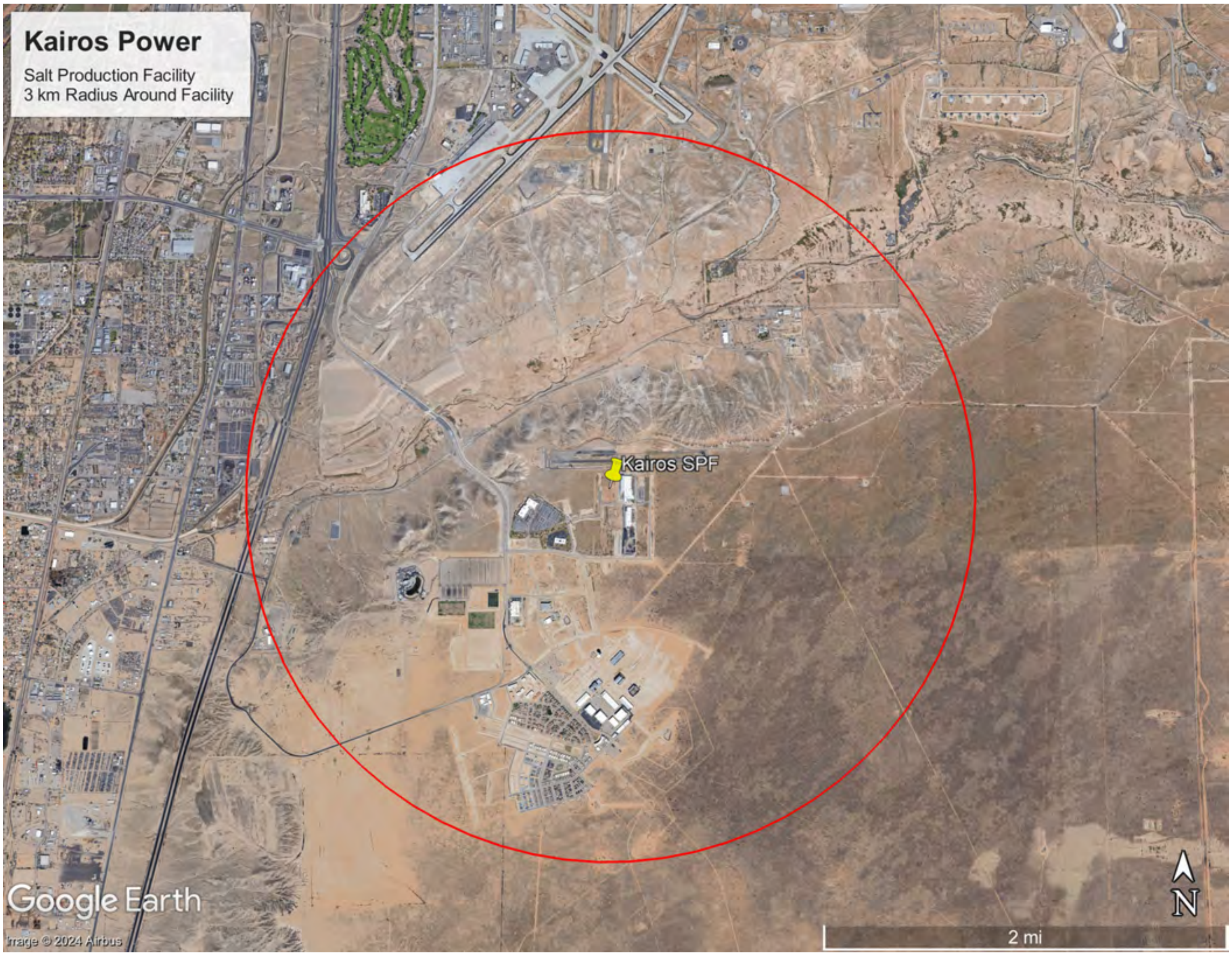
3.5 Model and Options Used

The most recent executable of AERMOD (v23132) will be used to perform air dispersion modeling. All regulatory default options will be used for air dispersion modeling at this facility. As seen in Figure 4, based on satellite imagery and the CABQ Advanced Map Viewer[7], the land use in a 3 km radius around the facility is less than 50% industrial, commercial, or compact residential, as defined in the CABQ EHD modeling guidance; therefore, rural dispersion coefficients will be used.

---

[7] City of Albuquerque Environmental Health Department Air Quality Program Permitting Division, Air Dispersion Modeling Guidelines for Air Quality Permitting, Revised May 2024, Attachment A.

Figure 4 - An Aerial Image of the Proposed Location of the SPF Circumscribed by a 3 km Radius



The Tier 2, Ambient Ratio Method 2 (ARM2) will be used to model ambient impact of NO_2. The national default minimum ambient ratio of 0.5 and maximum ambient ratio of 0.9 will be used.[8] Tier III methods (OLM or PVMRM) may be used if required. If Tier III methods are used, Kairos will Ambient Temperature apply the in-stack ratios provided in the CABQ EHD modeling guidelines. The South Valley 2014 to 2018 ozone date set would be used, if needed.

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[8] New Mexico Environment Department, New Mexico Air Quality Bureau, Air Dispersion Modeling Guidelines. Revised March 2024, Section 2.6.4.3.

Table 9 – Department-Approved In-Stack Ratios

Sources	In-Stack Ratio Value Accepted by the AQP
Diesel-fired RICE engines	0.15
Natural gas-fired boilers	0.2
Other sources at facility seeking permit	0.5
Other sources 1-3 km from fence of facility seeking permit	0.2
Other sources <1 km from fence of facility seeking permit	0.3

3.6 Meteorological Data

Meteorological data from the Albuquerque Airport from 2014 to 2018 provided by the CABQ EHD will be used for this air dispersion modeling. This meteorological data is assumed to be adequately representative of conditions at the Kairos SPF, based on the CABQ EHD modeling guidelines.[9]

3.7 Background Concentrations

Background concentrations were provided by the CABQ EHD on December 29, 2023 and will be used as applicable. This can be found in Appendix B.

In the memo titled “Background Values of Air Dispersion Modeling” found in Appendix C of the CABQ EHD modeling guidelines[10], it was stated that using data from the $PM_{2.5}$ in the South Valley (2ZV) results in a double counting of fine particulate emissions from industry. Using the $PM_{2.5}$ background values calculated from the Del Norte monitor data nearly eliminates double counting. This is also true for other pollutants, such as PM_{10} and NO_2, measured by the South Valley monitor. Like the South Valley monitor, the Jefferson, North Valley, and Foothills monitors are also not ideally located for calculating background values from monitored data. Additionally, the memo emphasized that background values for all pollutants should normally come from the Del Norte monitor and be used across the Albuquerque metro area within the jurisdiction of the Air Quality Program.

Table 10 shows the background concentrations proposed to be used from the Del Norte monitor.

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[9] City of Albuquerque Environmental Health Department Air Quality Program Permitting Division, Air Dispersion Modeling Guidelines for Air Quality Permitting, Revised May 2024, Page 12.

[10] City of Albuquerque Environmental Health Department Air Quality Program Permitting Division, Air Dispersion Modeling Guidelines for Air Quality Permitting, Revised May 2024, Page 12.

Table 10 – Background Concentrations of Pollutants Proposed for Modeling

Pollutant	Standard	Background Concentration (µg/m^3)
CO	8-hr	1,336
	1-hr	1,870
NO_2	Annual	18
	1-hr	83.1
$PM_{2.5}$	Annual	6.4
	24-hr	16.0
PM_{10}	24-hr	22.9
SO_2	1-hr	13.1

3.8 Receptor Grid and Elevation Data

AERMOD will be run using a rectangular grid receptor array. Spacing will follow CABQ EHD modeling guidelines:

- Fence line spacing: 25 meters
- Very fine grid spacing: 50 meters from the facility fenceline out to 250 meters
- Fine grid spacing: 100 meters from 250 meters to 1000 meters out from the facility fenceline
- Medium grid spacing: 250 meters from 1000 meters to 3000 meters out from the facility fenceline.
- Course grid spacing: 500 meters from 3000 meters to 5000 meters out from the facility fenceline.

This facility will use the USGS 1 arc-second national elevation data (NED) provided on the CABQ EHD website.[11] AERMAP, a terrain data preprocessor that incorporates complex terrain using USGS NED data, will be used to integrate all elevations and process the complex terrain in the model. All receptors will be used for Significant Impact Limits (SIL) modeling. Cumulative Impacts Analysis (CIA) modeling will only be performed for receptors where the SIL is exceeded based on the SIL modeling results.

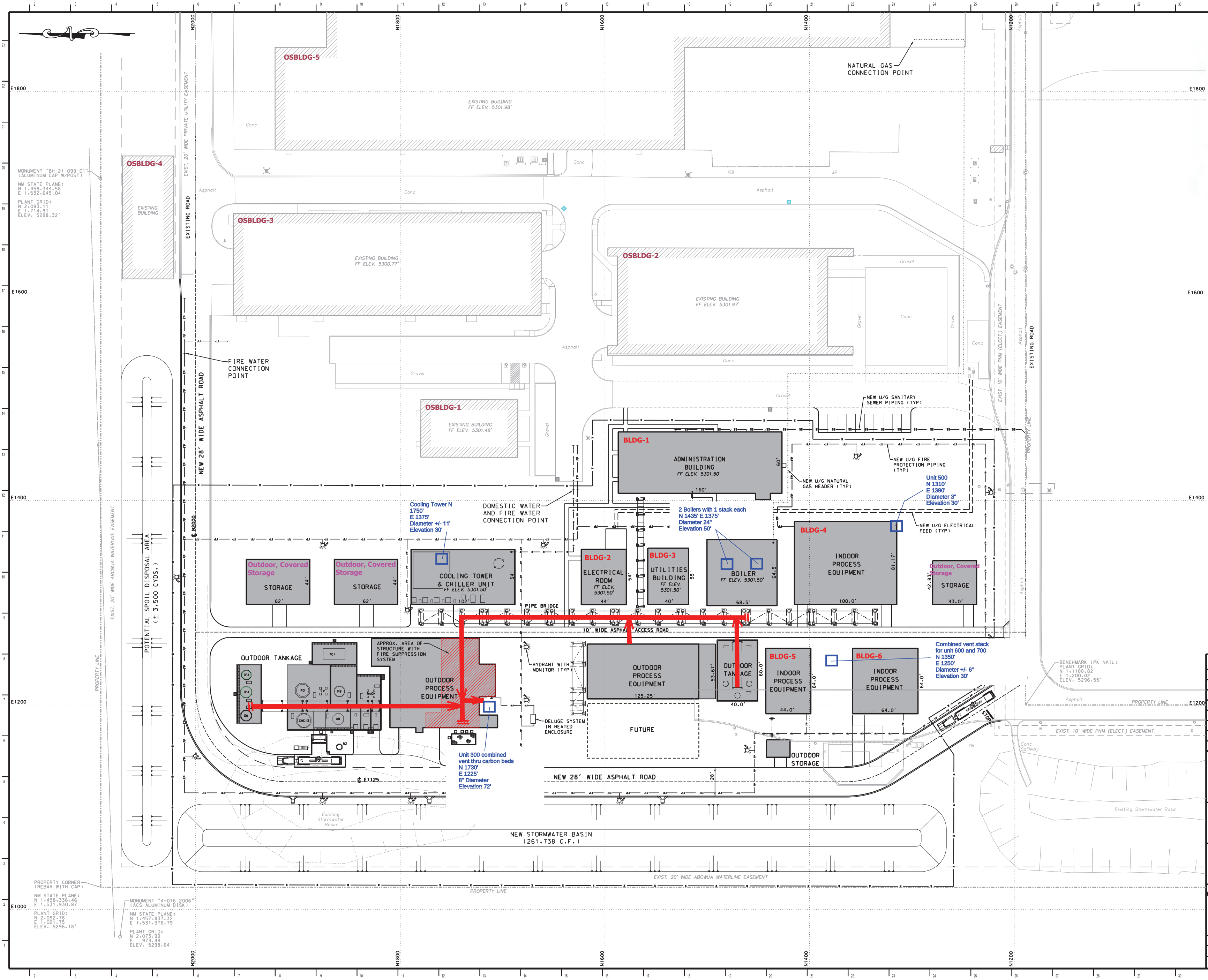
3.9 Nearby Permits and Surrounding Sources

Surrounding source data is requested from CABQ EHD for the Kairos Salt Production Facility at this time. The data provided will be included in the models as provided, unless specific approval to adjust the surrounding sources is granted.

---

[11] City of Albuquerque. Dispersion Modeling Guidelines. (n.d.) https://www.cabq.gov/airquality/air-quality-permits/dispersion-modeling-guidelines

APPENDIX A. FACILITY PLOT PLAN



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REVISION HISTORY

REV	DATE	DESCRIPTION	BY	CHK	APP

KBR

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COOLANT PRODUCTION FACILITY
EMISSION PLOT PLAN
SKETCH

DRAWN EJO	CHECKED	APPROVED	DATE
SCALE 1" = 40'	DRAWING NUMBER		REV. 5
PROJ 218356			

From:	Tumpane, Kyle <ktumpane@cabq.gov>
Sent:	Thursday, October 24, 2024 11:48 AM
To:	Daniel Dolce
Cc:	Adam Erenstein; kpkeckler@kpkeng.com; Elliott Hita; Warrick Smart; Alan Kruizenga; Stonesifer, Jeff W.; McKinstry, Michael W.
Subject:	Kairos Salt Production Facility Modeling Protocol Approval
Follow Up Flag:	Follow up
Flag Status:	Flagged

Mr. Dolce,

The City of Albuquerque Air Quality Program (AQP) has finished reviewing the 2nd modeling protocol submitted on October 17, 2024 on behalf of Kairos Power for the proposed new permit for their Salt Production Facility. The modeling protocol is approved with a few comments and questions.

- Can you confirm whether BLDG-7 in Table 7 is the structures for the cooling tower stacks that we discussed during the Zoom meeting on Oct. 17, 2024? I don't see this building on the plot plan but it is the correct height for the structures that we discussed. We also discussed that the structures should be modeled as two separate buildings because of the gap between the structures. Is this how they will be modeled?

- Can you confirm what the approximate proposed VOC emission rate (tpy) will be for this facility?

A follow-up email will be sent with the surrounding sources to be included in the modeling.

Please submit the application and modeling when you are ready. Let us know if you have any questions.

Thank you,

KYLE TUMPANE
senior environmental health scientist | environmental health department
o 505.768.2872
m 505.366.9985
cabq.gov/airquality

AIR DISPERSION MODELING REPORT

Initial Air Quality Construction Permit Application

Kairos Power, LLC
Salt Production Facility

Prepared By:

Adam Erenstein – Principal Consultant

TRINITY CONSULTANTS
9400 Holly Ave., Bldg. 3, Ste. B
Albuquerque, NM 87122
(505) 266-6611

February 2025

Project 233201.0065

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I. APPLICANT AND CONSULTANT INFORMATION

This modeling report is being submitted as part of an initial permit application submitted pursuant to 20.11.41.13 NMAC for the Salt Production Facility (SPF), which is owned and operated by Kairos Power, LLC (Kairos). This report and accompanying modeling files are being submitted to the City of Albuquerque (CABQ) Environmental Health Department (EHD), Air Quality Program (AQP) to satisfy the requirements of 20.11.41.13.E NMAC. This report includes all required components requested in the “Completeness Requirements” section of the CABQ’s Air Dispersion Modeling Guidelines (revised May 2024)[1].

a. Name of Facility and Company

Facility Name: Kairos Power Southwest
Company: Kairos Power, LLC

b. Permit Numbers Currently Registered for the Facility

This facility is newly established and currently does not hold any permits.

c. Contact Information for Modeling Questions

Contact Name: Adam Erenstein
Phone Number: (505) 266-6611
E-mail Address: AErenstein@trintiyconsultants.com

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[1] Air Quality Program. (2024, May). *Air Dispersion Modeling Guidelines for Air Quality Permitting*. City of Albuquerque, Environemntal Heatlh Department. https://www.cabq.gov/airquality/air-quality-permits/dispersion-modeling-guidelines

II. FACILITY AND OPERATIONS DESCRIPTION

a. Narrative Summary of Proposed Construction

This application is being submitted for the proposed construction of the Salt Production Facility (SPF) which will be owned and operated by Kairos Power, LLC (Kairos). The main purpose of the SPF is to manufacture a high purity heat transfer fluid, or coolant, that is a mixture of lithium fluoride (LiF) and beryllium fluoride (BeF_2) otherwise known as "Flibe." The location of the SPF will be located at UTM Zone 13, 352,786 meters East and 3,874,804 meters North.

The proposed construction of the SPF will consist of the following sources of emissions:

- One (1) vent stack associated with unit areas 100, 150, 300, and 400 tank groups (Unit Vent-300)
- One (1) bleach synthesis column (Unit BSC-500);
- One (1) vent stack associated with unit areas 600 and 950 (Unit Vent-600);
- One (1) cooling tower (Unit Cooling Tower-1);
- One (1) boiler (Unit Boiler-1);
- One (1) boiler (Unit Boiler-2);
- One (1) emergency generator (Unit GEN-1); and
- Facility fugitive emissions (Unit FUG-1)

Units Vent-300, Boiler-1, Boiler-2, and Cooling Tower-1 are sources of criteria pollutants and will be included in the air dispersion modeling. Cooling Tower-1 is a single unit that has two cell towers and will therefore be modeled as two units. Units BSC-500, Vent-600, and FUG-1 are sources of only VOC and HAP and will therefore not be included in the air dispersion modeling. Unit GEN-1 is an emergency generator which will operate less than 500 hours per year. Per the CABQ's Air Dispersion Modeling Guidelines, this unit is exempt from air dispersion modeling because emergency generators that have less than 500 hours of annual operations have minimal or intermittent emissions.

b. Brief Physical Description of the Location

The Salt Production Facility will be located at 5201 Hawking DR SE, Albuquerque, NM 87106 (UTM Zone 13, 352,781 meters E and 3,874,820 meters N).

c. Duration of Time that the Facility will be Located at This Location

The facility will be at this location for more than one (1) year.

d. Facility Maps – Google Earth Imagery Dated August 19, 2024

Figure 1. Location of the Facility

Figure 2. Location of On-Site Buildings

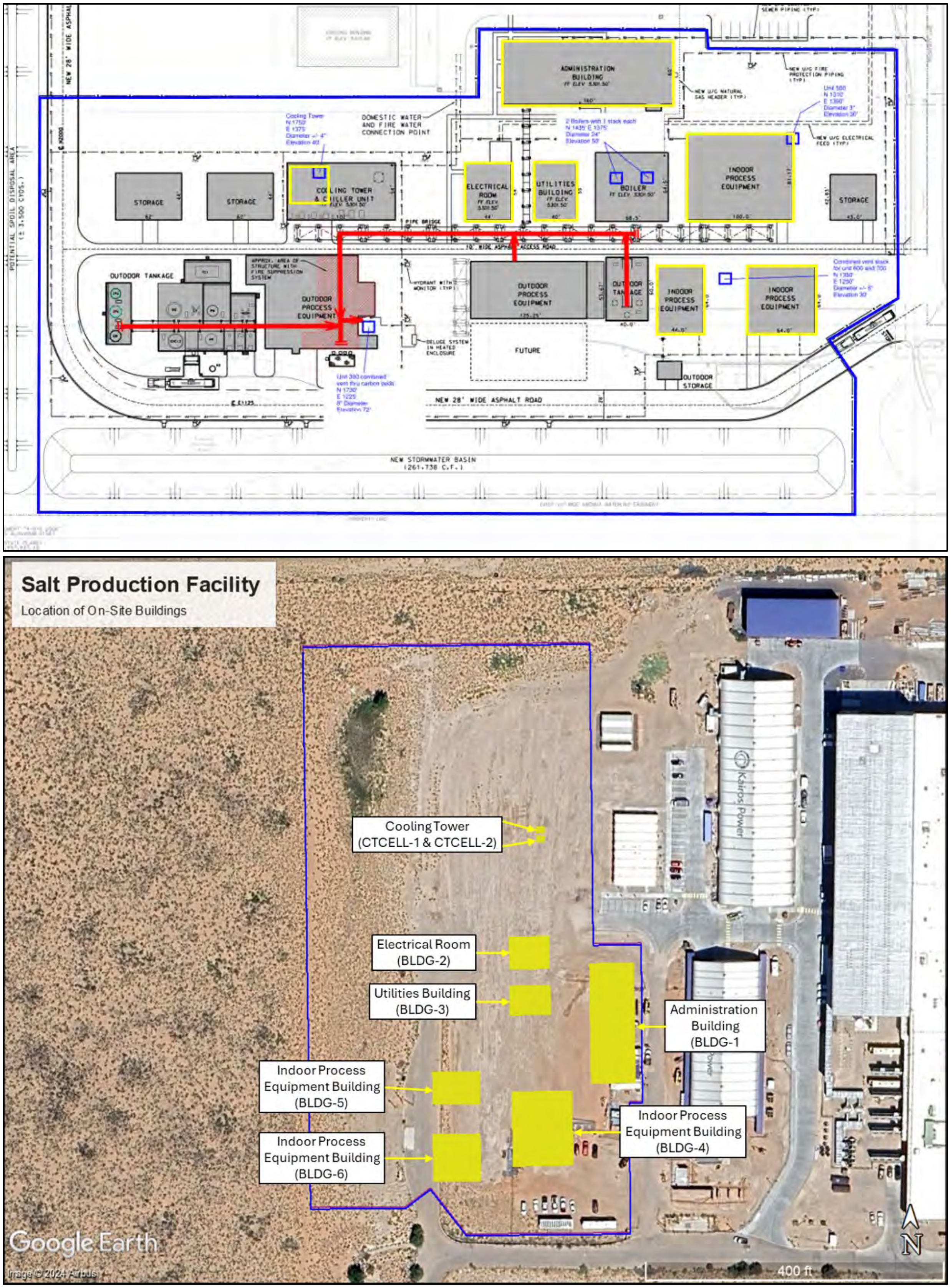


Figure 3. Location of Emission Points

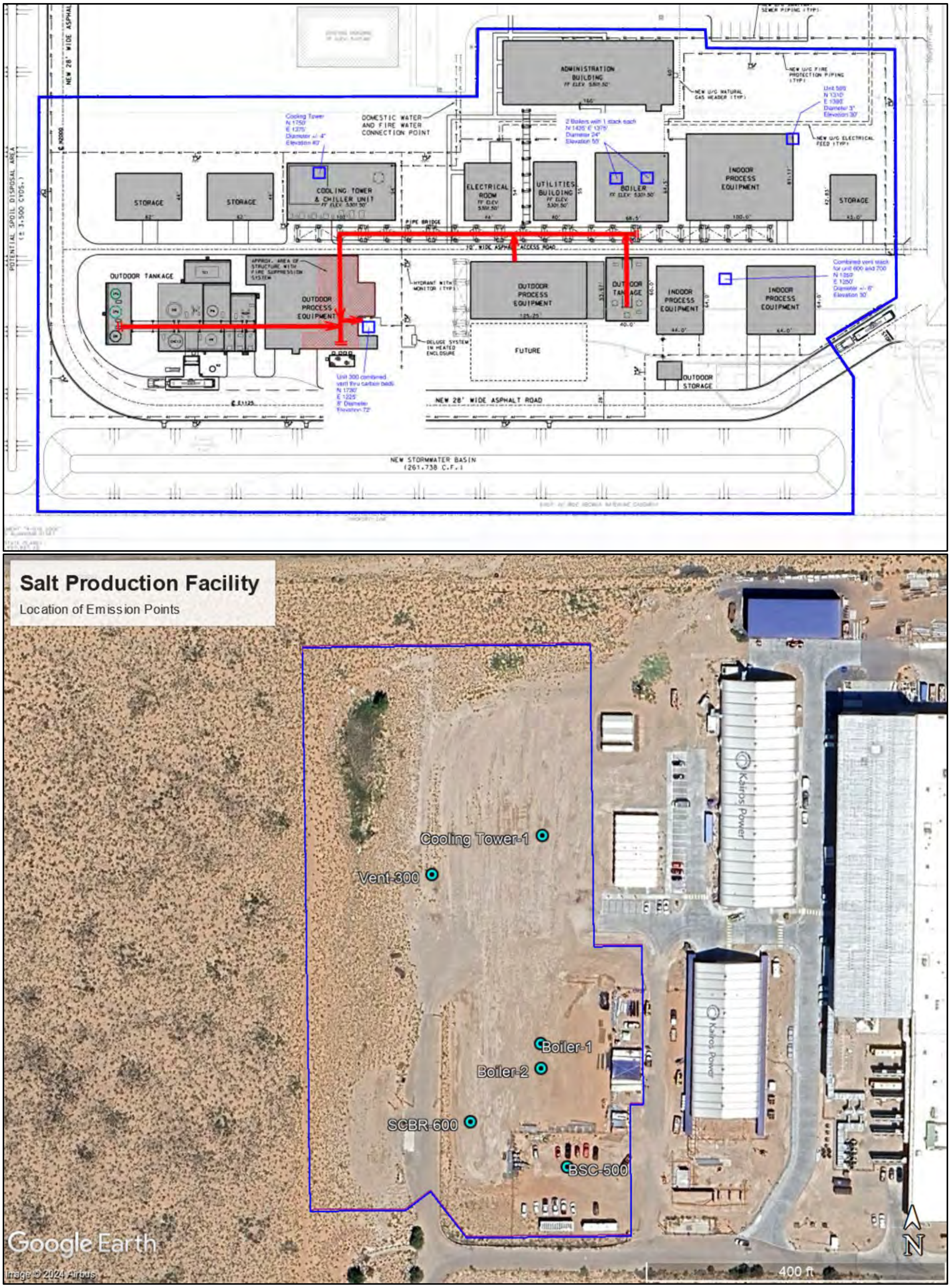


Figure 4. Location of Fence Line

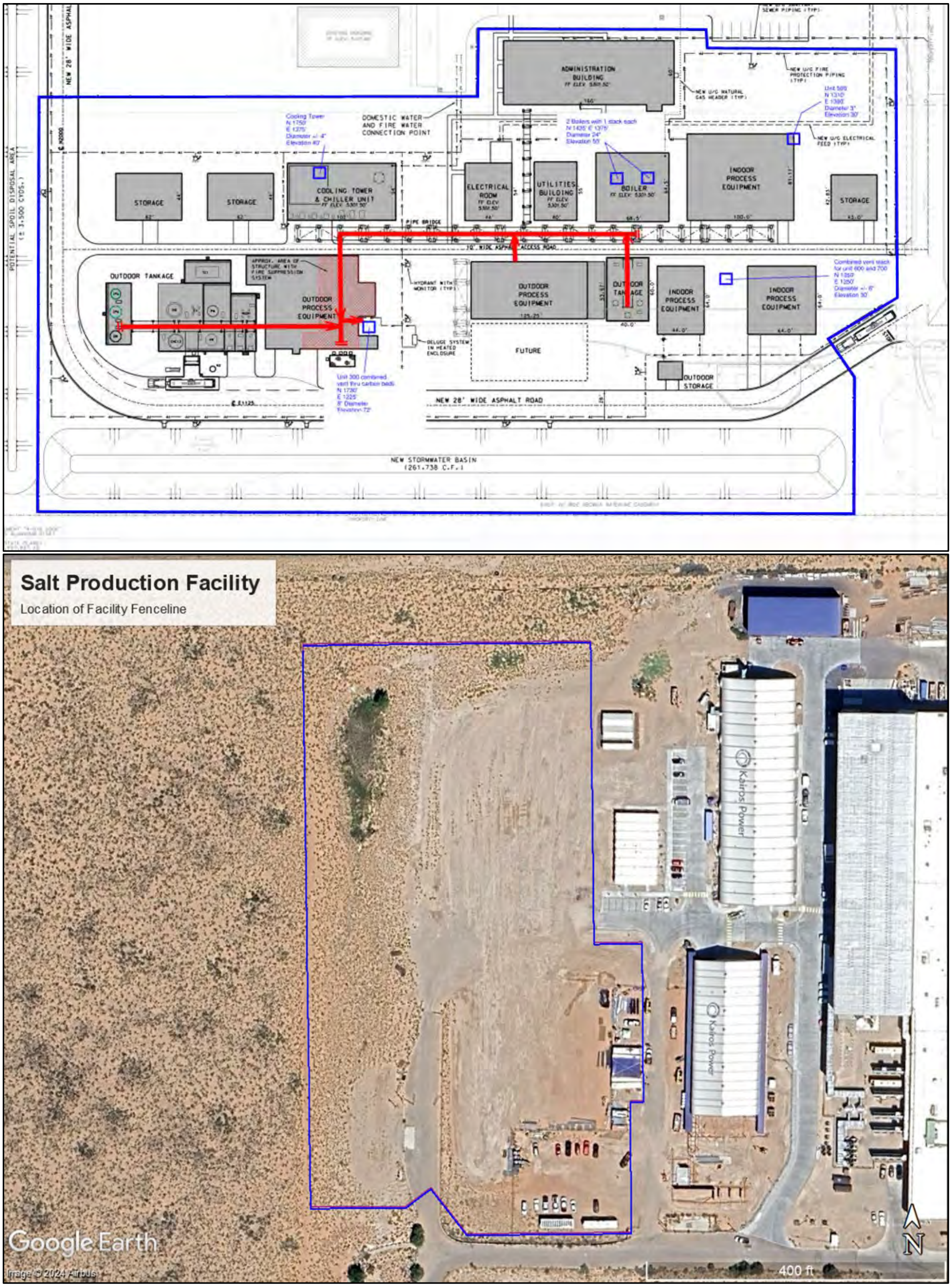
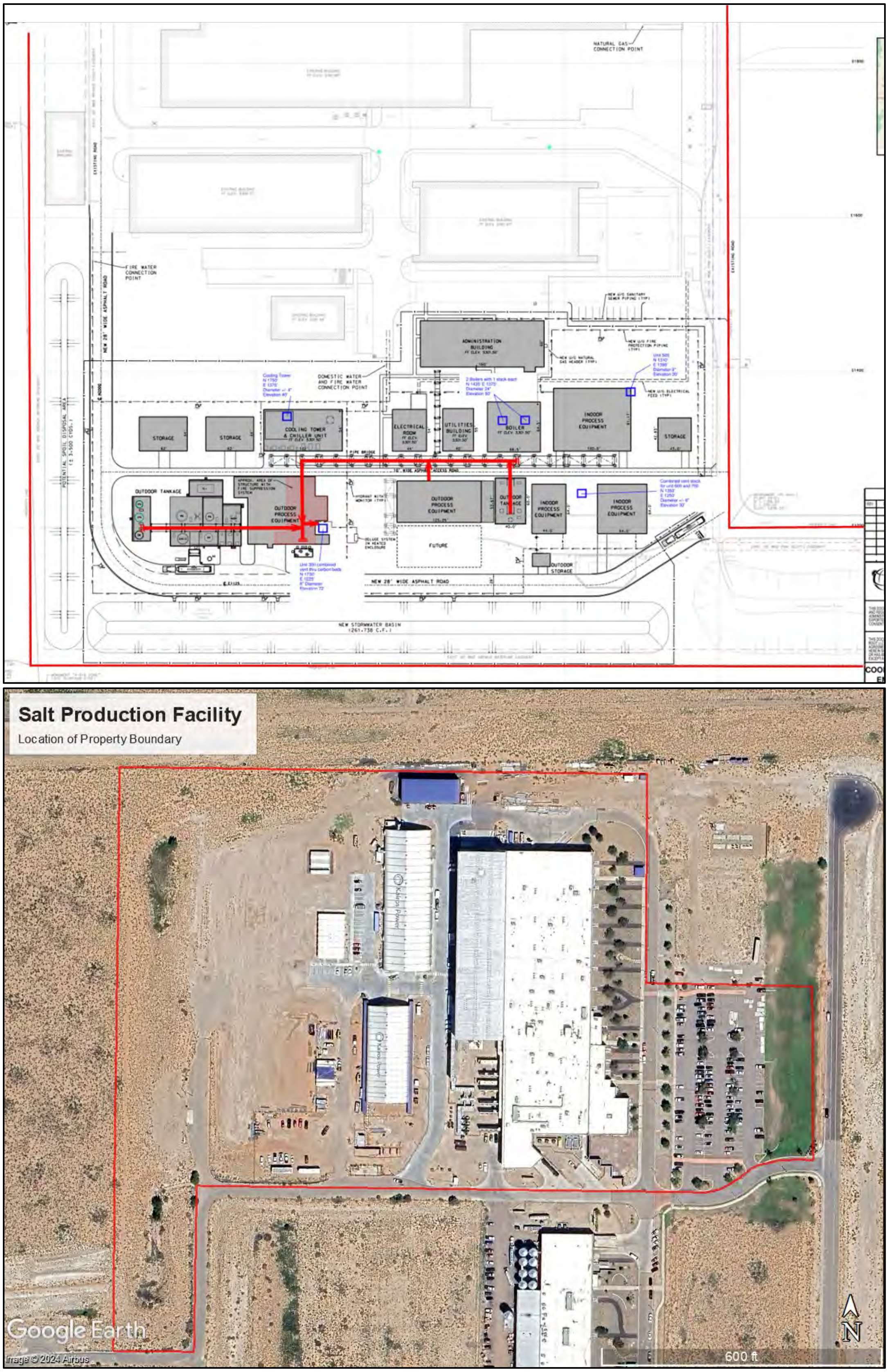


Figure 5. Location of Property Boundary



a. List of Pollutants Requiring NAAQS and/or NMAAQS Modeling

This air dispersion modeling evaluation is for a permit modification that will authorize the addition of a point source with combustion emissions. As such, averaging periods will be evaluated for CO, NO_2, PM_{10}, $PM_{2.5}$, and SO_2. There are no sources of lead or H_2S at this facility and therefore these pollutants will not be modeled.

Table 1. Modeled Pollutants and Averaging Periods to Show Compliance with the NAAQS and NMAAQS

Pollutant	Averaging Periods	Waiver Granted	Modeled
CO	8-hr		☑
	1-hr		☑
H_2S	1/2-hr		
Pb	Quarterly		
NO_2	Annual		☑
	1-hr		☑
$PM_{2.5}$	Annual		☑
	24-hr		☑
PM_{10}	24-hr		☑
SO_2	1-hr		☑

b. Additional Modeling Required

No additional New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), or Prevention of Significant Deterioration (PSD) modeling is required as part of this modification application. The SPF is located in an area that is classified by the EPA as in attainment with the National Ambient Air Quality Standard (NAAQS) for all regulated pollutants.

IV. MODELING INPUTS

a. General Modeling Approach

i. Models Used and Justification

The most recent executable of AERMOD (v24142) was used to perform all air dispersion modeling. All models were run in regulatory default mode and Building Profile Input Program (BPIP) Prime was used to address building downwash associated with the tanks and structures located at this facility as well as the surrounding area.

ii. Operational Flexibility

No operational flexibility is required for the modeling of the SPF.

iii. Source Groups

All source of criteria pollutants at the SPF were grouped together under the FACILITY source group. All surrounding source provided by the City of Albuquerque Modeling Department, as well as the current Kairos 1958-M2 sources, were grouped together under the SS source group. Both the facility and surrounding sources were grouped together under the NAAQS source group. The NAAQS source group was used for cumulative impacts analysis modeling along with the background concentration.

iv. Hourly Emission Factors

No hourly emission factors were used as part of the air dispersion modeling evaluation. All lb/hr values were calculated as the maximum and conservative concentration for each of the sources.

v. Gravitational Settling/Plume Depletion

Wet and dry depletion were not used to model ambient impacts of PM_{10} and $PM_{2.5}$.

vi. Reduction of NO_x to NO_2

The Tier 2, Ambient Ratio Method 2 (ARM2) was used to model ambient impacts of NO_2. The default minimum ambient ratio of 0.5 and maximum ambient ratio of 0.9 was used.

vii. Background Concentrations

Per *Attachment C: Background Values Memo* of the CABQ EHD modeling guidelines[2], it is stated "background values for all pollutants should normally come from the Del Norte monitor and be used across the Albuquerque metro area within the jurisdiction of the Air Quality Program."

Background concentrations shown in Table 2 have been added to the calculated facility and neighboring source impacts for each pollutant and averaging period. These background concentrations were provided by the Air Quality Program (AQP) via email on January 3, 2025 and have been preserved as provided.

---

[2] Air Quality Program. (2024, May). *Air Dispersion Modeling Guidelines for Air Quality Permitting*. City of Albuquerque, Environemntal Heatlh Department. https://www.cabq.gov/airquality/air-quality-permits/dispersion-modeling-guidelines

Table 2. Background Concentrations from the Del Norte Monitor

Pollutant	Averaging Periods	Value ($\mu g/m^3$)
CO	8-hr	1336
	1-hr	1870
NO_2	Annual	18
	1-hr	83.1
$PM_{2.5}$	Annual	5.4
	24-hr	14.3
PM_{10}	24-hr	22.3
SO_2	Annual	0
	24-hr	0
	1-hr	13.1

viii. Method for Demonstrating Compliance in Nearby Facilities

Discrete receptors were included in all surrounding sources and facilities. Receptors were only deleted inside the fenceline of the SPF.

b. Meteorological and Ozone Data

i. Discussion of Meteorological and Ozone Data

The most recent meteorological data set from the Albuquerque Airport from 2014 to 2018 provided by the CABQ was used for the air dispersion modeling. The airport is located nearby, and this meteorological data is assumed to be adequately representative of conditions at the Albuquerque Terminal.

ii. Actual Data

No further justification is required as the data was provided by the CABQ.

c. Receptor and Terrain Discussion

i. Spacing of Receptor Grids

The following spacing for the receptor array was used per CABQ EHD modeling guidelines:

- Fence line spacing: 25 meters
- Very fine grid spacing: 50 meters from facility fenceline to 250 meters
- Fine grid spacing: 100 meters from 250 meters to 1000 meters
- Course grid spacing: 250 meters from 1000 meters to 3000 meters
- Very course grid spacing: 500 meters from 3000 meters to 5000 meters

ii. Terrain Discussion

USGS National Elevation Dataset (NED) 1 arc-second data files were provided on the CABQ EHD dispersion modeling guidelines website[3]. These files were imported into AERMAP to determine elevations for sources, receptors, and buildings. There is no complex terrain requiring modifications to air dispersion modeling inputs.

iii. Reduction in Receptor Grid Size

The full receptor grid was utilized for all SIL models. Receptors not exceeding significance thresholds per Table 18 of the NMED Air Dispersion Modeling Guidelines[4] were removed for all CIA modeling.

d. Emission Sources

i. Description of Sources at Facility

1. Source Types

Table 3. Modeled Point Source Types

Model ID	Description	Vertical	Horizontal	Rain Capped
BOIL_1	Boiler	☑		
BOIL_2	Boiler	☑		
VENT300	Vent Stack	☑		
CTCELL_1	Cooling Tower	☑		
CTCELL_2				

There are no area or volume sources located at this facility.

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[3] City of Albuquerque, Environmental Health Department, Air Quality Bureau. (n.d.). *Dispersion Modeling Guidelines & Data*. https://www.cabq.gov/airquality/air-quality-permits/dispersion-modeling-guidelines

[4] New Mexico Air Quality Bureau. (July 2024). *Air Dispersion Modeling Guidelines*. New Mexico Environment Department. https://www.env.nm.gov/air-quality/modeling-publications/

2. Emission Rates and Stack Parameters

Table 4. Source Emission Rates and Stack Parameters

ID	NO_2 (lb/hr)	CO (lb/hr)	SO_2 (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	Height (ft)	Temp. (°F)	Velocity (ft/s)	Diameter (ft)
BOIL_1	1.20	2.02	0.14	0.18	0.18	50.00	600.00	99.85	2.00
BOIL_2	1.60	2.69	0.18	0.24	0.24	50.00	600.00	133.14	2.00
VENT300	0	0	1.71	0.13	0.13	72.00	-459.67	0.17	0.67
CTCELL_1	0	0	0	0.35	0.0070	30.00	-459.67	44.49	11.00
CTCELL_2	0	0	0	0.35	0.0070	30.00	-459.67	44.49	11.00

3. Summary of Actual and Modeled Dimensions of Volume Sources

There are no volume sourced located at the SPF.

4. Table of Proposed Changes

This application is for a new facility, not a modification.

5. Treatment of Operating Hours

No reductions were claimed to represent non-continuous annual operation for any of the emission sources located on site.

6. Particle Size Characteristics

No particle size distribution characteristics were included in the particulate matter modeling.

7. Discrepancies Between Modeled Parameters and Those in the Application

Modeled stack parameters and those represented in the application are identical.

8. Flare Calculations

There are no flares at the SPF.

9. Cross-Reference of Model Input Numbers and Names

The modeled units share the same names as the permit ID names.

e. Building Downwash

i. Dimension of Buildings

Table 5. Rectangular Building Dimensions and Locations

Model ID	Description	X Coordinate (m)	Y Coordinate (m)	Height (ft)	X Length (ft)	Y Length (ft)	Angle
BLDG1	Administration Building	352837.9	3874794.3	25.0	160.0	60.0	90

Model ID	Description	X Coordinate (m)	Y Coordinate (m)	Height (ft)	X Length (ft)	Y Length (ft)	Angle
BLDG2	Electrical Room	352805.5	3874805.6	16.0	44.0	54.0	90
BLDG3	Utilities Building	352805.4	3874785.8	20.0	40.0	55.0	90
BLDG4	Indoor Process Equipment	352805.6	3874743.0	26.0	100.0	81.2	90
BLDG5	Indoor Process Equipment	352773.4	3874751.5	25.0	44.0	64.0	90
BLDG6	Indoor Process Equipment	352773.2	3874726.3	28.0	64.0	64.0	90
CTCELL2	Cooling Tower Building	352817.2	3874843.3	25.0	12.0	9.0	0
CTCELL1	Cooling Tower Building	352817.2	3874847.2	25.0	12.0	9.0	0

Table 6. Polygon Building Dimensions and Locations

Model ID	Description	Height (ft)	X Coordinate (m)	Y Coordinate (m)
OSBLDG-1	Offsite Kairos Building	20.0	352848.3	3874826.1
			352866.1	3874825.7
			352867.1	3874854.1
			352849.4	3874854.8
			352848.3	3874826.1
OSBLDG-2	TDL	43.0	352875.7	3874725.4
			352878.7	3874725.3
			352878.7	3874732.5
			352905.7	3874731.8
			352905.4	3874724.5
			352907.8	3874724.4
			352910.2	3874797.3
			352907.9	3874797.3
			352907.6	3874794.5
			352881.1	3874795.2
			352881.1	3874798.2
			352878.2	3874798.3
			352875.7	3874725.4
OSBLDG-3	Offsite Kairos Building	44.0	352890.6	3874817.6
			352922.1	3874817.0
			352923.4	3874908.4
			352893.8	3874908.8
			352890.6	3874817.6
OSBLDG-4	Offsite Kairos Building	27.0	352904.7	3874925.8
			352941.9	3874925.4
			352942.1	3874940.8
			352904.9	3874941.4

Model ID	Description	Height (ft)	X Coordinate (m)	Y Coordinate (m)
			352904.7	3874925.8
OSBLDG-51	KPSW Main Bldg	32.5	352972.4	3874892.9
			352965.9	3874688.5
			352985.7	3874688.0
			352992.6	3874694.9
			352986.4	3874702.1
			352987	3874710.1
			353022.9	3874708.9
			353028.5	3874891.7
			352972.4	3874892.9
OSBLDG-52	KPSW_Lobby	18.0	353025.2	3874789.0
			353022.9	3874708.9
			353048.2	3874708.5
			353048.7	3874732.2
			353040.5	3874732.8
			353040.9	3874740.1
			353037.6	3874739.9
			353037.9	3874744.6
			353034.1	3874744.6
			353034.7	3874766.6
			353032.1	3874766.9
			353032.9	3874785.1
			353027.5	3874785.5
			353027.3	3874788.7
			353025.2	3874789.0
OSBLDG-53	KPSW_Warehouse	65.0	352936.6	3874772.4
			352968.2	3874771.2
			352972.4	3874892.9
			352940.7	3874893.8
			352936.6	3874772.4
OSBLDG-54	KPSW_Dipping Tower	45.0	352983.9	3874779.0
			352987.8	3874779.0
			352987.6	3874772.3
			352983.9	3874772.3
			352983.9	3874779.0
OSBLDG-55	KPSW_Dipping Tower	45.0	353008.6	3874778.3
			353012.4	3874778.3
			353012.3	3874771.7
			353008.6	3874771.7

ii. Discussion in Included and Excluded Buildings

The Salt Production Facility is located on the Kairos Power campus along with the existing Kairos Power Southwest facility and the new TRISO Development Laboratory facility. All three Kairos Power sites belong to the same address, but have/will have different permits based on SIC codes. Regardless, all Kairos Power buildings were included in the model to account for building downwash, regardless of the GEP 5L area of influence of any point source.

V. MODELING FILES DESCRIPTION

a. List of File Names

Table 7. Modeling Files and Description

Name	Description
SPF_CO SIL_v1.0_2025 0213	CO 1hr and 8hr SIL model
SPF_NO2 SIL_v1.0_2025 0213	NO_2 1hr, 24hr, and Annual SIL model
SPF_PM2.5 SIL_v1.0_2025 0213	$PM_{2.5}$ 24hr and Annual SIL model
SPF_PM10 SIL_v1.0_2025 0213	PM_{10} 24hr and Annual SIL model
SPF_SO2 SIL_v1.0_2025 0213	SO_2 1hr, 3hr, 24hr, and Annual SIL model
SPF_NO2 1-hr NAAQS_v1.0_2025 0213	NO_2 1-hr NAAQS CIA model
SPF_PM2.5 Ann NAAQS_v1.0_2025 0213	$PM_{2.5}$ Annual NAAQS CIA model
SPF_PM2.5 24-hr NAAQS_v1.0_2025 0213	$PM_{2.5}$ 24hr NAAQS CIA model
SPF_PM10 24-hr NAAQS_v1.0_2025 0213	PM_{10} 24hr NAAQS CIA model
SPF_SO2 1-hr NAAQS_v1.0_2025 0213	SO_2 1hr NAAQS CIA model

b. Description of Scenarios

All files labeled "SIL" correspond to the Significance Impact Level (SIL) analysis. As this facility is new, all sources of criteria pollutants have been included in the SIL modeling. The results indicate that the modeled concentrations are below the SIL thresholds for both the CO 1-hr and 8-hr averaging periods and the NO_2 annual averaging period. However, the modeled concentrations for the following averaging periods exceeded the SIL thresholds and therefore required a Cumulative Impacts Analysis (CIA): NO_2 1-hr, $PM_{2.5}$ annual, $PM_{2.5}$ 24-hr, PM_{10} 24-hr, and SO_2 1-hr.

All files labeled "CIA" correspond to the Cumulative Impacts Analysis. According to the NMED Modeling Guidelines, the following exceptions apply:

- The NO_2 24-hour NMAAQS does not need to be modeled, as compliance with the NO_2 1-hr NAAQS demonstrates compliance with this standard
- The SO_2 annual and 24-hr NMAAQS, as well as the 3-hour NAAQS, do not require modeling as compliance with the SO_2 1-hr NAAQS will demonstrate compliance with these standards
- There are no established NAAQS or NMAAQS standards for the PM_{10} annual averaging period, and the City of Albuquerque does not have a PSD Increment program in place. Therefore, modeling is not required.

a. Summary of Modeling Results

Table 8. Model Results, Maximum Concentration and Location, and Comparison to Significance Thresholds

Pollutant	Averaging Period	Significance Level (µg/m³)	Modeled Concentration (µg/m³)	Percent of Significance	Location of Maximum Concentration X	Location of Maximum Concentration Y	Elevation (m)
CO	8-hr	500	25.90	5.18%	352866	3874734	1613.22
	1-hr	2000	29.69	1.48%	352866	3874734	1613.22
NO_2	Annual	1.0	0.37	36.76%	352616	3874784	1613.83
	24-hr	5.0	8.65	Significant	352866	3874734	1613.22
	1-hr	7.52	15.88	Significant	352854	3874716	1613.22
$PM_{2.5}$	Annual	0.13	0.15	Significant	352841	3874924	1613.93
	24-hr	1.2	1.49	Significant	352866	3874734	1613.22
PM_{10}	Annual	1.0	2.18	Significant	352716	3874934	1614.14
	24-hr	5.0	14.00	Significant	352854	3874738	1613.22
SO_2	Annual	1.0	1.29	Significant	352823	3874924	1613.83
	24-hr	5.0	6.46	Significant	352859	3874786	1613.30
	3-hr	25	32.23	Significant	352823	3874924	1613.83
	1-hr	7.8	88.28	Significant	352723	3874873	1614.14

Table 9. Cumulative Impact Analysis Comparison to NAAQS/NMAAQS Thresholds

Pollutant	Averaging Period and Standard	NAAQS / NMAAQS (µg/m³)	Facility Modeled Concentration (µg/m³)	Facility and Surrounding Sources (µg/m³)	Background Concentration (µg/m³)	Cumulative Total	Percent of Standard
NO_2	24-hr NMAAQS	Standard was not modeled as the NO_2 1-hr NAAQS demonstrates compliance.					
	1-hr NAAQS	15.21	29.54	83.1	Both	112.64	59.90%
$PM_{2.5}$	Annual NAAQS	0.15	0.28	5.4	Both	5.68	63.09%
	24-hr NAAQS	0.73	0.76	14.3	Both	15.06	43.03%
PM_{10}	Annual	The average period was not modeled as there is no NAAQS or NMAAQS standards.					
	24-hr NAAQS	10.08	10.20	22.3	Both	32.50	21.66%
SO_2	Annual NMAAQS	The standards were not modeled as the SO_2 1-hr NAAQS demonstrates compliance.					
	24-hr NMAAQS						
	3-hr NAAQA						
	1-hr	69.28	69.29	13.1	Both	82.39	41.95%

VII. SUMMARY/CONCLUSIONS

a. Modeling Statement

The submitted air dispersion modeling and report demonstrate compliance with the National and New Mexico Ambient Air Quality Standards. All requirements have been satisfied. There are no exceedances which would prohibit approval of the permit modification.

b. Expected Permit Conditions

The facility will be allowed to operate its sources continuously.

5. APPLICABLE REGULATIONS

Table 1 is a summary of all City of Albuquerque and Federal regulations applicable to the SPF. Justifications are provided below detailing why or why a regulation is subject.

Table 1 – Applicable Requirements for the Facility

Applicable Requirements	Federally Enforceable	Entire Facility	Emission Unit
20.11.2 NMAC Fees	X	X	
20.11.5 NMAC Visible Air Contaminants	X	X	
20.11.8 NMAC Ambient Air Quality Standards		X	
20.11.41 NMAC Construction Permits	X	X	
20.11.43 NMAC Stack Heights	X	X	
20.11.47 NMAC Emission Inventory Requirements		X	
20.11.49 NMAC Excess Emissions		X	
20.11.63 NMAC New Source Performance Standards for Stationary Sources	X	X	
20.11.64 NMAC Emission Standards for Hazardous Air Pollutants for Stationary Sources	X	X	
20.11.65 NMAC Volatile Organic Compounds	X	X	
20.11.66 NMAC Process Equipment	X	X	
20.11.67 NMAC Equipment, Emissions, Limitations	X	X	
20.11.90 NMAC Source Surveillance; Administration and Enforcement	X	X	
40 CFR 50 - National Primary and Secondary Ambient Air Quality Standards	X	X	
40 CFR 60 Subpart Dc - Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units	X		Boiler-1 Boiler-2
40 CFR 60 Subpart IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engines	X		GEN-1
40 CFR 61 Subpart V - National Emission Standard for Equipment Leaks (Fugitive Emission Sources)	X	X	
40 CFR 63 Subpart ZZZZ National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines	X		GEN-1

5.1 Applicable City of Albuquerque Regulations

20.11.2 NMAC – Fees

This Part applies to every person required to submit a permit application pursuant to 20.11.41 NMAC, Construction Permits

20.11.5 NMAC – Visible Air Contaminants

This Part applies to stationary sources and visible emissions and operational limitations shall be applicable to the sources listed in this Part.

20.11.8 NMAC – Ambient Air Quality Standards

This Part adopts state and federal ambient air quality standards and are applicable to any sources located within Bernalillo county.

20.11.41 NMAC – Construction Permits

This proposed facility will be a new stationary source that will emit one or more regulated air contaminants for which a federal, state or board ambient air quality standard exists and if the source will emit, when calculated at the contaminant's potential emission rate, +10 lb/hr or +25 tpy of any single regulated air contaminant. Therefore, a construction permit is required by 20.11.41 NMAC before the person commences construction or operation of the source.

20.11.43 NMAC – Stack Heights

This Part adopts local requirements that are identical to those required by federal new source review regulations assuring uniform procedures and formulae in determining, on a case-by-case basis, what stack heights or other dispersion techniques are creditable under the term "good engineering practice."

20.11.47 NMAC – Emission Inventory Requirements

This Part applies to each person who owns or operates a source or who intends to construct or modify a source within Bernalillo county.

20.11.49 NMAC – Excess Emissions

This Part implements requirements for the reporting of excess emissions for facility owners and operators within Bernalillo County.

20.11.63 NMAC – New Source Performance Standards for Stationary Sources

This Part establishes requirements for all stationary sources of air pollutants located within Bernalillo county, which are subject to the requirements of 40 CFR Part 60, as amended in the Federal Register through November 15, 2024.

20.11.64 NMAC – Emission Standards for Hazardous Air Pollutants for Stationary Sources

This Part establishes requirements for all stationary sources of air pollutants located within Bernalillo county, which are subject to the requirements of 40 CFR Part 61 or Part 63, as amended in the Federal Register through November 15, 2024.

20.11.65 NMAC – Volatile Organic Compounds

This Part establishes standards for any source located within Bernalillo county to prevent or reduce emission of hydrocarbon vapors from facilities and sources not otherwise regulated or exempted by 40 CFR Part 60; including volatile organic compounds and petroleum liquids, in order to prevent the formation of photochemical oxidants in the atmosphere.

20.11.66 NMAC – Process Equipment

This Part is applicable to owners or operators of any equipment capable of emitting pollution emissions into the atmosphere within Bernalillo County.

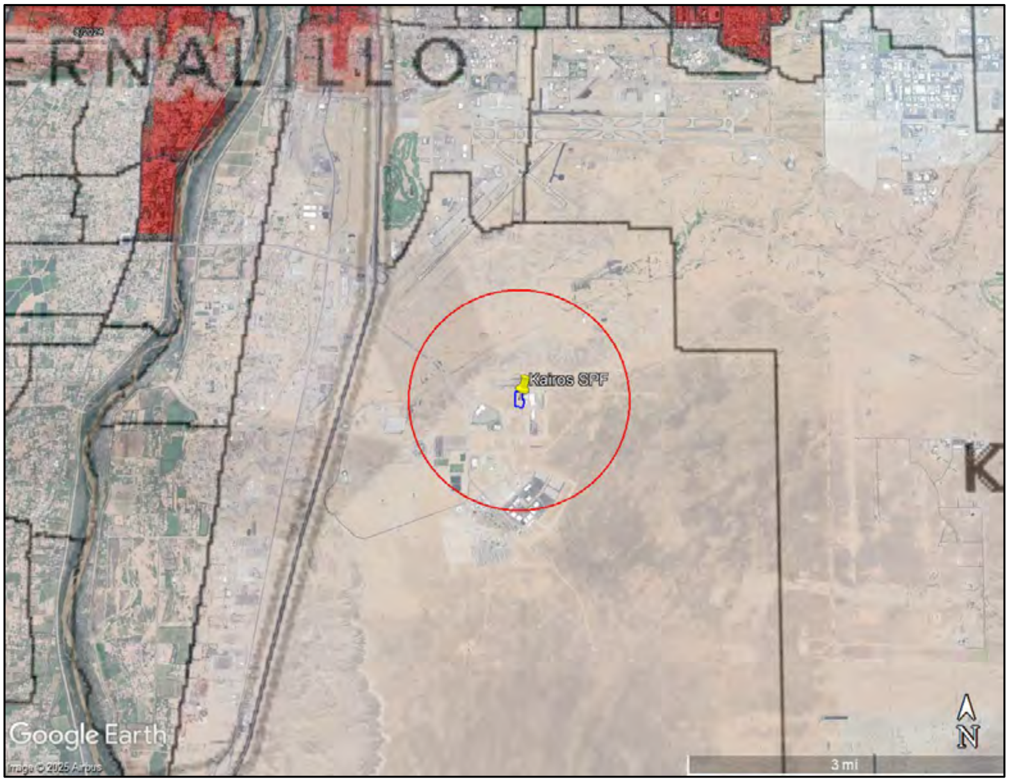
20.11.67 NMAC – Equipment, Emissions, Limitations

This Part is applicable to any stationary source located in Bernalillo County containing, constructing or modifying the following: Orchard Heaters; Kraft Mills; Coal, Oil, or Gas Burning Equipment.

20.11.72 NMAC – Health, Environment and Equity Impacts

This Part establishes additional permitting requirements for new or modified stationary sources of air pollution that are located, or proposed to be located, in or within a one-mile radius of an overburdened area as determined by the CABQ EHD Overburdened Areas Map published January 1, 2025. As can be seen by Figure 5-1, the SPF does not fall within a 1-mile radius of any overburdened areas and is therefore not subject to the requirements of this rule.

Figure 5-1 SPF in Relation to Overburdened Areas



20.11.90 NMAC – Source Surveillance; Administration and Enforcement

This Part minimizes emissions from sources through inspection, enforcement, and good operating procedures and is applicable to any source within Bernalillo County

5.2 Applicable Federal Regulations

40 CFR 50 National Primary and Secondary Ambient Air Quality Standards

This regulation establishes national primary and secondary ambient air quality standards under section 109 of the Clean Air Act and are applicable to this facility.

40 CFR 60 Subpart Dc - Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

This regulation establishes standards of performance for steam generating units for which construction, modification, or reconstruction was commenced after June 9, 1989 with a maximum design heat input capacity between 10 and 100 MMBtu/hr. Boiler-1 and Boiler-2 have heat input capacities of 24.53 and 32.70 MMBtu/hr, respectively; therefore, this regulation applies.

40 CFR 60 Subpart Kc - Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced After October 4, 2023

This regulation establishes performance standards for storage vessels with a capacity ≥ 20,000 gallons that is used to store volatile organic liquids (VOL) for which construction, reconstruction, or modification is commenced after October 4, 2023. All of the tanks at the SPF have a capacity < 20,000 gallons; therefore, this regulation does not apply.

40 CFR 60 Subpart IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

This regulation establishes standards of performance for stationary compression ignition (CI) internal combustion engines (ICE) that commenced construction after July 11, 2005. GEN-1 is an emergency CI ICE unit constructed after July 11, 2005; therefore, this regulation applies.

40 CFR 61 Subpart C - National Emission Standard for Beryllium

This regulation establishes emission standards for beryllium for extraction plants, ceramic plants, foundries, incinerators, propellant plants which process beryllium ore, beryllium, beryllium oxide, beryllium alloys, or beryllium-containing waste, and machine shops which process beryllium, beryllium oxides, or any alloy when such alloy contains more than 5 percent beryllium by weight. This facility does not meet the definitions of any of the applicable facilities; therefore, this regulation does not apply.

40 CFR 61 Subpart V - National Emission Standard for Equipment Leaks (Fugitive Emission Sources)

This regulation establishes emission standards for each of the following sources that are intended to operate in volatile hazardous air pollutant (VHAP) service: pumps, compressors, pressure relief devices, sampling connection systems, open-ended valves or lines, valves, connectors, surge control vessels, bottoms receivers, and control devices or systems required by this subpart. This facility operates chloroform in valve and connector services; therefore, this regulation applies.

Subpart Q – National Emission Standards for Hazardous Air Pollutants for Industrial Process Cooling Towers

This regulation establishes national emission standards for hazardous air pollutants for all new and existing industrial process cooling towers that are operated with chromium-based water treatment chemicals d are either major sources or integral parts of facilities that are major sources. This facility does not use chromium-based water treatment chemicals and is not a major source; therefore, this regulation does not apply.

40 CFR 63 Subpart FFFF - National Emission Standards for Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing

This subpart establishes national emission standards for hazardous air pollutants for miscellaneous organic chemical manufacturing processing units (MCPU) that are located at or part of a major source of hazardous air pollutants. This facility is not a major source of HAPs; therefore, this regulation does not apply.

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

This regulation establishes standards of performance for stationary compression ignition (CI) internal combustion engines (ICE) that commenced construction after July 11, 2005. GEN-1 is an emergency CI ICE unit constructed after July 11, 2005; therefore, this regulation applies.

Subpart JJJJJJ—National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources

This regulation establishes national emission standards for hazardous air pollutants for industrial, commercial, or institutional boilers that are located at an area source of HAPs. This facility does not meet the definitions of an affected facility as listed in § 63.11200 in this Part; therefore, this regulation does not apply.

Analysis received on May 15, 2025

6. 20.11.72 NMAC BACT ANALYSIS

Pursuant to 20.11.72.8 of the Health, Environment and Equity Impacts rule (20.11.72 NMAC), the CABQ EHD AQP department shall require BACT for new or modified stationary sources throughout Bernalillo County that emit any one, or combination of, the following fifteen hazardous air pollutants (HAPs): acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, ethyl benzene, ethylene oxide, formaldehyde, hydrochloric acid, methyl bromide, methylene chloride, naphthalene, toluene, vinyl chloride, and xylenes.

6.1 Definition of BACT

Pursuant to 20.11.72.7.A NMAC, "Best Available Control Technology" (BACT) means the same in 20.11.72 NMAC as it is defined in Subsection M of 20.11.61.7.M NMAC:

> ***"Best available control technology (BACT)"*** *means an emissions limitation … based on the maximum degree of reduction for each regulated [New Source Review] NSR pollutant which would be emitted from any proposed major stationary source or major modification, which the director on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant.*

This definition is consistent with federal regulations as codified in 40 CFR 52.21(b)(12) which goes on to define an NSR pollutant to be any pollutant for which a National Ambient Air Quality Standard (NAAQS) has been established, including Volatile Organic Compounds (VOC) as a precursor to ozone emissions.[1] In order to appropriately apply federal guidance and national resources, this facility has used VOC emissions as a surrogate for the HAPs listed within the regulation. VOC is an appropriate surrogate because the listed HAPs also meet the definition of a VOC:

> ***Volatile organic compounds (VOC)*** *means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.*[2]

The BACT definition goes on to add the following baseline:

> *In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR Parts 60 and 61.*

Control technologies for VOC specific to natural gas boilers and diesel generators, similar to those at the facility, are listed within the Federal Regulations (40 CFR Parts 60, 61, and 63), Reasonably Available (RACT)/BACT/Lowest Available Emission Rate (LAER) Clearinghouse (RBLC) and EPA published guidance. These resources establish national BACT standards and were reviewed in preparation of this report.

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[1] 40 CFR 52.21(b)(50)(i)(B)

[2] 40 CFR 51.100(s)

6.2 Process Area Ventilation (EP-1) BACT

Total HAP emissions from the ventilation systems in process areas 100, 150, and 300 include hydrochloric acid (HCl) among the listed HAPs. To ensure that the best available control technology is used to minimize HCl emissions, the facility employs a closed loop system. A closed loop system is designed to keep chemicals like HCl fully contained during use, preventing them from escaping into the atmosphere.

At this facility, HCl is stored in various tanks at different concentrations, depending on the needs of the process. The primary use of HCl is within reactors, where it is consumed or chemically transformed into other compounds. Additionally, all purchased HCl solutions are considered non-fuming (i.e., 20% concentration with a vapor pressure below 3 psia at 20°C), which further minimizes the potential for vaporization and atmospheric emissions.

Emissions from HCl storage tanks were estimated using EPA's AP-42 Chapter 7 methodology, which provides a conservative approach for calculating emissions from storage tanks. Even using this conservative method, HCl emissions are shown to be minimal, confirming that the closed loop system is effective in preventing significant releases of HCl to the atmosphere.

6.3 Natural Gas Boilers (EP-5A & 5B) BACT

Total HAP emissions from the boilers were calculated using AP-42 Table 1.4-3 emission factors, which lists benzene and formaldehyde among the HAPs. According to the RPLC database, the best control technologies to reduce HAPs from natural gas boilers (with a rated heat input between 20 and 40 MMBtu/hr) are:

- Good Combustion Practices and Design
- Operations and Maintenance Plan
- Use of Natural Gas

Good Combustion Practices and Design

Good combustion practices and design are essential for reducing emissions of pollutants including VOCs and HAPs which can contribute to smog and impact air quality. VOCs and HAPs can be released when fuel doesn't burn completely, so the goal of good combustion is to ensure efficient, complete burning of natural gas. For these natural gas boilers, the equipment has been designed to achieve high combustion efficiency, which minimizes the release of VOCs and HAPs. The burner system ensures proper mixing of air and fuel to support complete combustion. The unit operates at optimal temperatures and airflow conditions to avoid incomplete burning, which can lead to excess VOC and HAP emissions. In addition, the boilers are equipped with controls that automatically adjust combustion settings to maintain ideal conditions during operation. Regular maintenance, inspections, and operator training ensure the system stays clean and operates reliably over time. These design and operational elements work together to ensure the boilers emit very low levels of VOCs and HAPs and meet environmental standards.

Operations and Maintenance Plan

An operation and maintenance plan is required per 20.11.41.E.(5) NMAC to obtain an air quality construction permit with the CABQ EHD AQP. This plan is a structured document that outlines how a facility, system, or piece of equipment will be operated and maintained to ensure safe, efficient, and compliant performance over its lifetime and includes the steps the applicant will take if a malfunction occurs that may cause emission of a regulated air contaminant to exceed a limit that is included in the permit; the nature of emissions during routine startup or shutdown of the source and the source's air pollution control equipment;

and the steps the applicant will take to minimize emissions during routine startup or shutdown. Finally, the boilers will be under the supervision of a First Grade Stationary Engineer who is responsible for proper maintenance and operating efficiency.

Use of Natural Gas

Natural gas combustion is a widely used process in various industries due to its efficiency and relatively lower emissions compared to other fossil fuels. Natural gas with a higher methane content and lower carbon levels minimizes incomplete combustion which is a common source of VOC and HAP emissions. Additionally, natural gas allows for precise control over combustion conditions, allowing for optimized air-to-fuel ratios and temperature management. At this facility, the boilers are designed to operate exclusively on pipeline quality natural gas supplied by the local utility.

6.4 Emergency Diesel Generator (EP-6)

Total HAP emissions from the generator were calculated using AP-42 Table 3.3-2 emission factors, which lists acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, naphthalene, toluene, and xylenes among the HAPs. According to the RBLC database, the best control technologies to reduce VOCs from diesel generators (with a rated heat input between 400 and 500 hp) are:

- Good Combustion Practices and Design
- Compliance with 40 CFR 60 Subpart IIII

Good Combustion Practices and Design

Good combustion practices and design are essential for reducing emissions of pollutants including VOCs and HAPs which can contribute to smog and impact air quality. VOCs and HAPs can be released when fuel doesn’t burn completely, so the goal of good combustion is to ensure efficient, complete burning of natural gas. For this diesel generator, the equipment has been designed to achieve high combustion efficiency, which minimizes the release of VOCs and HAPs. The burner system ensures proper mixing of air and fuel to support complete combustion. The unit operates at optimal temperatures and airflow conditions to avoid incomplete burning, which can lead to excess VOC and HAP emissions. In addition, the generator is equipped with controls that automatically adjust combustion settings to maintain ideal conditions during operation. Regular maintenance, inspections, and operator training ensure the system stays clean and operates reliably over time. These design and operational elements work together to ensure the generator emits very low levels of VOCs and HAPs and meets environmental standards.

Compliance with 40 CFR 60 Subpart IIII

This regulation establishes performance standards for stationary compression ignition (CI) internal combustion engines (ICE) that commenced construction after July 11, 2005. Subpart IIII establishes stringent performance standards for these engines, focusing on reducing emissions of VOCs. The regulations require the use of advanced emission control technologies, such as closed crankcase ventilation, selective catalytic reduction (SCR), and diesel oxidation catalysts (DOCs), which significantly reduce the formation of VOCs during combustion. Additionally, engines that meet these standards are designed to operate with greater combustion efficiency, ensuring that fuel is burned more completely and producing fewer unburned hydrocarbons that contribute to VOC emissions.

Compliance with 40 CFR 63 Subpart ZZZZ

Compliance with 40 CFR 63 Subpart ZZZZ, the MACT (Maximum Achievable Control Technology) standards for stationary engines, is a highly effective way to reduce HAPs emissions, especially from diesel and gasoline engines. This regulation sets strict limits on emissions of HAPs and requires the use of control technologies to minimize these emissions.

Under MACT ZZZZ, engines must follow best practices for maintenance, use cleaner fuels, and install emission control devices like oxidation catalysts and crankcase ventilation systems. These measures help ensure that the engines burn fuel more completely, releasing fewer unburned hydrocarbons and HAPs. Regular monitoring and testing also ensure compliance with the standards.

APPENDIX A. APPLICATION FORMS

The following pages contain:

- Air Quality Permit Application (updated February 2022)
- Permit Application Review Fee Checklist (Updated Review Fees for January 1, 2025 through December 31, 2025)
- Permit Application Checklist (Updated November 2023)
- Compliance History Disclosure Form (Updated March 1, 2024)

City of Albuquerque – Environmental Health Department
Air Quality Program

Please mail this application to **P.O. Box 1293, Albuquerque, NM 87103**
or hand deliver between 8:00 am – 5:00 pm Monday – Friday to:
3rd Floor, Suite 3023 – One Civic Plaza NW, Albuquerque, NM 87102
(505) 768-1972 aqd@cabq.gov

Application for Air Pollutant Sources in Bernalillo County
Source Registration (20.11.40 NMAC) and Construction Permits (20.11.41 NMAC)

Submittal Date: April 18, 2025

Owner/Corporate Information ☐ **Check here and leave this section blank if information is exactly the same as Facility Information below.**

Company Name: **Kairos Power, LLC**			
Mailing Address: **707 W. Tower Ave, Ste. A**	City: **Alamdeda**	State: **CA**	Zip: **95401**
Company Phone: **(510) 808-5265**	Company Contact: **Terrence Williams**		
Company Contact Title: **Director of Environmental Health and Safety**	Phone: **(510) 775-1822**	E-mail: **wiliams@kairospower.com**	

Stationary Source (Facility) Information: Provide a plot plan (legal description/drawing of the facility property) with overlay sketch of facility processes, location of emission points, pollutant type, and distances to property boundaries.

Facility Name: **Salt Production Facility**			
Facility Physical Address: **5201 Hawking Dr. SE**	City: **Albuquerque**	State: **NM**	Zip: **87106**
Facility Mailing Address (if different): **N/A**	City: **N/A**	State: **N/A**	Zip: **N/A**
Facility Contact: **Terrence Williams**	Title: **Director of Environmental Health and Safety**		
Phone: **(510) 775-1822**	E-mail: **wiliams@kairospower.com**		
Authorized Representative Name[1]: **N/A**	Authorized Representative Title: **N/A**		

Billing Information ☐ **Check here if same contact and mailing address as corporate** ☐ **Check here if same as facility**

Billing Company Name: **Kairos Power, LLC**			
Mailing Address: **707 W. Tower Ave, Ste. A**	City: **Alameda**	State: **CA**	Zip: **95401**
Billing Contact: **Max Schellhorn**	Title: **Accounts Payable Manager**		
Phone: **(510) 761-0724**	E-mail: **schellhorn@kairospower.com**		

Preparer/Consultant(s) Information ☐ **Check here and leave section blank if no Consultant used or Preparer is same as Facility Contact.**

Name: **Adam Erenstein**	Title: **Principal Consultant**		
Mailing Address: **9400 Holly Ave, Bldg. 3, Ste. B**	City: **Albuquerque**	State: **NM**	Zip: **87122**
Phone: **(505) 266-6611**	Email: **AErenstein@trinityconsultants.com**		

1. See 20.11.41.13(E)(13) NMAC.

Application for Air Pollutant Sources in Bernalillo County
Source Registration (20.11.40 NMAC) and Construction Permits (20.11.41 NMAC)

General Operation Information (if any question does not pertain to your facility, type N/A on the line or in the box)

Permitting action being requested (please refer to the definitions in 20.11.40 NMAC or 20.11.41 NMAC):			
☒ New Permit	☐ Permit Modification Current Permit #: **N/A**	☐ Technical Permit Revision Current Permit #: **N/A**	☐ Administrative Permit Revision Current Permit #: **N/A**
☐ New Registration Certificate	☐ Modification Current Reg. #: **N/A**	☐ Technical Revision Current Reg. #: **N/A**	☐ Administrative Revision Current Reg. #: **N/A**
UTM coordinates of facility (Zone 13, NAD 83): **352,786 m E and 3,874,804 m N**			
Facility type (*i.e.*, a description of your facility operations): **Specialized chemical processing plant**			
Standard Industrial Classification (SIC Code #): **2899**		North American Industry Classification System (NAICS Code #): **325998**	
Is this facility currently operating in Bernalillo County? **No**		If **YES**, list date of original construction: **N/A** If **NO**, list date of planned startup: **February 1, 2025**	
Is the facility permanent? **Yes**		If **NO**, list dates for requested temporary operation: From **N/A** Through **N/A**	
Is the facility a portable stationary source? **No**		If **YES**, is the facility address listed above the main permitted location for this source? **N/A**	
Is the application for a physical or operational change, expansion, or reconstruction (*e.g.*, altering process, or adding, or replacing process or control equipment, etc.) to an existing facility? **No**			
Provide a description of the requested changes: **N/A**			
What is the facility's operation? ☒ Continuous ☐ Intermittent ☐ Batch			

Estimated percent of production/operation:	Jan-Mar: **25%**	Apr-Jun: **25%**	Jul-Sep: **25%**	Oct-Dec: **25%**
Requested operating times of facility:	**24** hours/day	**7** days/week	**4** weeks/month	**52** months/year
Will there be special or seasonal operating times other than shown above? This includes monthly- or seasonally-varying hours. **No**				
If **YES**, please explain: **N/A**				
List raw materials processed: **Chloroform, Dimethylformamide, Thlionyl Chlroide, Chemical A, Chemical B, Sodium Hydrocide, Isopropyl Alcohol**				
List saleable item(s) produced: **Purified Flibe, Lithium Hydroxide Monohydrate, Bleach**				

USE INSTRUCTIONS: For the forms on the following pages, please do not alter or delete the existing footnotes or page breaks. If additional footnotes are needed then add them to the end of the existing footnote list for a given table. Only update the rows and cells within tables as necessary for your project. Unused rows can be deleted from tables. If multiple scenarios will be represented then the Uncontrolled and Controlled Emission Tables, and other tables as needed, can be duplicated and adjusted to indicate the different scenarios.

Regulated Emission Sources Table

(*E.g.*, Generator-Crusher-Screen-Conveyor-Boiler-Mixer-Spray Guns-Saws-Sander-Oven-Dryer-Furnace-Incinerator-Haul Road-Storage Pile, etc.) Match the Units listed on this Table to the same numbered line if also listed on Emissions Tables & Stack Table.

Unit Number and Description[1]		Manufacturer	Model #	Serial #	Manufacture Date	Installation Date	Modification Date[2]	Process Rate or Capacity (Hp, kW, Btu, ft^3, lbs, tons, yd^3, etc.)[3]	Fuel Type
EP-1: Vent-300	Ventalation for process areas 100, 150, 300	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A
EP-2: BSC-500	Unit 500 Bleach Synthesis Column Emissions	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A
EP-3: Vent-600	Ventalation for process areas 600 and 950	TBD	TBD	TBD	TBD	TBD	N/A	N/A	N/A
EP-4: Cooling Tower-1	Cooling Tower 1	TBD	TBD	TBD	TBD	TBD	N/A	7,100 gpm	N/A
EP-5A: Boiler-1	Boiler 1	Cleaver Brooks	TBD	TBD	TBD	TBD	N/A	24.525 MMBtu/hr	Natural Gas
EP-5B: Boiler-2	Boiler 2	Cleaver Brooks	TBD	TBD	TBD	TBD	N/A	32.700 MMBtu/hr	Natural Gas
EP-6: GEN-1	Emergency Diesel Fired Generator	Iveco/FPT	F3AE9685A-E	TBD	TBD	TBD	N/A	449 hp	Diesel
EP-7: FUG-1	Facility fugitives	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTE: To add extra rows in Word, click anywhere in the last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

1. Unit numbers must correspond to unit numbers in the previous permit unless a complete cross reference table of all units in both permits is provided.
2. To determine whether a unit has been modified, evaluate if changes have been made to the unit that impact emissions or that trigger modification as defined in 20.11.41.7(U) NMAC. If not, put N/A.
3. Basis for Equipment Process Rate or Capacity (*e.g.*, Manufacturer's Data, Field Observation/Test, etc.) **Manufacturer's Data**
   Submit information for each unit as an attachment.

Emissions Control Equipment Table

Control Equipment Units listed on this Table should either match up to the same Unit number as listed on the Regulated Emission Sources, Controlled Emissions and Stack Parameters Tables (if the control equipment is integrated with the emission unit) or should have a distinct Control Equipment Unit Number and that number should then also be listed on the Stack Parameters Table.

Control Equipment Unit Number and Description	Controlling Emissions for Unit Number(s)	Manufacturer	Model # | Serial #	Date Installed	Controlled Pollutant(s)	% Control Efficiency[1]	Method Used to Estimate Efficiency	Rated Process Rate or Capacity or Flow
Kairos is Not Taking Credit for Any Control Devices at this Facility.								

NOTE: To add extra rows in Word, click anywhere in the last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

1. Basis for Control Equipment % Efficiency (*e.g.*, Manufacturer's Data, Field Observation/Test, AP-42, etc.). **N/A**
   Submit information for each unit as an attachment.

Exempted Sources and Exempted Activities Table

See 20.11.41 NMAC for exemptions.

Unit Number and Description	Manufacturer	Model #	Serial #	Manufacture Date	Installation Date	Modification Date[1]	Process Rate or Capacity (Hp, kW, Btu, ft^3, lbs, tons, yd^3, etc.)[2]	Fuel Type
N/A - There are No Exempted Sources at this Facility								

NOTE: To add extra rows in Word, click anywhere in the last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

1. To determine whether a unit has been modified, evaluate if changes have been made to the unit that impact emissions or that trigger modification as defined in 20.11.41.7(U) NMAC. Also, consider if any changes that were made alter the status from exempt to non-exempt. If not, put N/A.
2. Basis for Equipment Process Rate or Capacity (*e.g.*, Manufacturer's Data, Field Observation/Test, etc.) **N/A**
   Submit information for each unit as an attachment.

Uncontrolled Emissions Table

(Process potential under physical/operational limitations during a 24 hr/day and 365 day/year = 8760 hrs)

Regulated Emission Units listed on this Table should match up to the same numbered line and Unit as listed on the Regulated Emissions and Controlled Tables. List total HAP values per Emission Unit if overall HAP total for the facility is ≥ 1 ton/yr.

Unit Number*	Nitrogen Oxides (NO_X)		Carbon Monoxide (CO)		Nonmethane Hydrocarbons/Volatile Organic Compounds (NMHC/VOCs)		Sulfur Dioxide (SO_2)		Particulate Matter ≤ 10 Microns (PM_{10})		Particulate Matter ≤ 2.5 Microns ($PM_{2.5}$)		Hazardous Air Pollutants (HAPs)		Method(s) used for Determination of Emissions (AP-42, Material Balance, Field Tests, etc.)
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	
EP-1: Vent-300	-	-	-	-	85.98	36.41	-	-	1.37E-03	2.28E-04	1.37E-03	2.28E-04	46.37	2.13	Process Design
EP-2: BSC-500	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.73	Process Design
EP-3: Vent-600	-	-	-	-	-	-	-	-	-	-	-	-	0.13	0.59	Process Design
EP-4: Cooling Tower-1	-	-	-	-	-	-	-	-	0.70	3.08	0.014	0.061	-	-	AP-42 Section 13.4-1 Table 13.4-1
E_5A: Boiler-1	1.20	5.27	2.02	8.85	0.13	0.58	0.14	0.60	0.18	0.80	0.18	0.80	0.045	0.20	AP-42 Section 1.4 Table 1.4-1 & 1.4-2
EP-5B: Boiler-2	1.60	7.02	2.69	11.80	0.18	0.77	0.18	0.80	0.24	1.07	0.24	1.07	0.060	0.26	AP-42 Section 1.4 Table 1.4-1 & 1.4-2
EP-6: GEN-1	2.63	11.53	0.99	4.34	0.14	0.61	0.88	3.85	0.099	0.43	0.099	0.43	0.019	0.084	EPA Emission Standards for Nonroad Engines and Vehicles
EP-7: FUG-1	-	-	-	-	1.97	8.63	-	-	-	-	-	-	1.88	8.25	TCEQ "Air Permit Technical Gidance for Chemical Sources - Fugitve Guidance" - Table I
Totals of Uncontrolled Emissions	**5.44**	**23.82**	**5.70**	**24.98**	**88.40**	**47.00**	**1.20**	**5.25**	**1.23**	**5.38**	**0.54**	**2.36**	**48.68**	**12.25**	

NOTE: To add extra rows in Word, click anywhere in the second-to-last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

*A permit is required and this application along with the additional checklist information requested on the Permit Application checklist must be provided if:

(1) any one of these process units or combination of units, has an uncontrolled emission rate greater than or equal to (≥) 10 lbs/hr or 25 tons/yr for any of the above pollutants, excluding HAPs, based on 8,760 hours of operation; or

(2) any one of these process units or combination of units, has an uncontrolled emission rate ≥ 2 tons/yr for any single HAP or ≥ 5 tons/yr for any combination of HAPs based on 8,760 hours of operation; or

(3) any one of these process units or combination of units, has an uncontrolled emission rate ≥ 5 tons/yr for lead (Pb) or any combination of lead and its compounds based on 8,760 hours of operation; or

(4) any one of the process units or combination of units is subject to an Air Board or federal emission limit or standard.

* If all of these process units, individually and in combination, have an uncontrolled emission rate less than (<) 10 lbs/hr or 25 tons/yr for all of the above pollutants (based on 8,760 hours of operation), but > 1 ton/yr for any of the above pollutants, then a source registration is required. A Registration is required, at minimum, for any amount of HAP emissions. Please complete the remainder of this form.

Controlled Emissions Table

(Based on current operations with emission controls OR requested operations with emission controls)

Regulated Emission Units listed on this Table should match up to the same numbered line and Unit as listed on the Regulated Emissions and Uncontrolled Tables. List total HAP values per Emission Unit if overall HAP total for the facility is ≥ 1 ton/yr.

Unit Number	Nitrogen Oxides (NO_X)		Carbon Monoxide (CO)		Nonmethane Hydrocarbons/Volatile Organic Compounds (NMHC/VOCs)		Sulfur Dioxide (SO_2)		Particulate Matter ≤ 10 Microns (PM_{10})		Particulate Matter ≤ 2.5 Microns ($PM_{2.5}$)		Hazardous Air Pollutants (HAPs)		Control Method	% Efficiency[1]
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr		
EP-1: Vent-300	-	-	-	-	85.98	36.41	-	-	1.37E-03	2.28E-04	1.37E-03	2.28E-04	46.37	2.13	N/A	N/A
EP-2: BSC-500	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.73	N/A	N/A
EP-3: Vent-600	-	-	-	-	-	-	-	-	-	-	-	-	0.13	0.59	N/A	N/A
EP-4: Cooling Tower-1	-	-	-	-	-	-	-	-	0.70	3.08	0.014	0.061	-	-	N/A	N/A
E_5A: Boiler-1	1.20	5.27	2.02	8.85	0.13	0.58	0.14	0.60	0.18	0.80	0.18	0.80	0.045	0.20	N/A	N/A
EP-5B: Boiler-2	1.60	7.02	2.69	11.80	0.18	0.77	0.18	0.80	0.24	1.07	0.24	1.07	0.060	0.26	N/A	N/A
EP-6: GEN-1	2.63	0.66	0.99	0.25	0.14	0.035	0.88	0.22	0.099	0.025	0.099	0.025	0.019	4.82E-03	Reduction of Hours	N/A
EP-7: FUG-1	-	-	-	-	0.49	2.16	-	-	-	-	-	-	0.47	2.06	LDAR Program	N/A
Totals of Controlled Emissions	**5.44**	**12.94**	**5.70**	**20.89**	**86.92**	**39.96**	**1.20**	**1.62**	**1.23**	**4.97**	**0.54**	**1.95**	**47.27**	**5.98**		

NOTE: To add extra rows in Word, click anywhere in the second-to-last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

1. Basis for Control Method % Efficiency (*e.g.*, Manufacturer's Data, Field Observation/Test, AP-42, etc.). **Process Design; Field Observation**
   Submit information for each unit as an attachment.

Hazardous Air Pollutants (HAPs) Emissions Table

Report the Potential Emission Rate for each HAP from each source on the Regulated Emission Sources Table that emits a given HAP. Report individual HAPs with ≥ 1 ton/yr total emissions for the facility on this table. Otherwise, report total HAP emissions for each source that emits HAPs and report individual HAPs in the accompanying application package in association with emission calculations. If this application is for a Registration solely due to HAP emissions, report the largest HAP emissions on this table and the rest, if any, in the accompanying application package.

Unit Number	Total HAPs		Formaldehyde		n-Hexane		Hydrochloric Acid		Chloroform		Chlorine		Hydrogen Fluoride	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
EP-1: Vent-300	46.37	2.13	-	-	-	-	7.78E-05	1.06E-04	46.37	2.13	-	-	-	-
EP-2: BSC-500	0.17	0.73	-	-	-	-	-	-	-	-	0.17	0.73	-	-
EP-3: Vent-600	0.13	0.59	-	-	-	-	-	-	-	-	-	-	0.13	0.59
EP-4: Cooling Tower-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E_5A: Boiler-1	0.045	0.20	1.80E-03	7.90E-03	0.043	0.19	-	-	-	-	-	-	-	-
EP-5B: Boiler-2	0.060	0.26	2.40E-03	0.011	0.058	0.25	-	-	-	-	-	-	-	-
EP-6: GEN-1	0.019	4.82E-03	3.57E-03	8.93E-04	-	-	-	-	-	-	-	-	-	-
EP-7: FUG-1	0.47	2.06	-	-	-	-	-	-	0.47	2.06	-	-	-	-
Totals of HAPs for all units:	**47.27**	**5.98**	**7.78E-03**	**0.019**	**0.10**	**0.44**	**7.78E-05**	**1.06E-04**	**46.84**	**4.20**	**0.17**	**0.73**	**0.13**	**0.59**

NOTE: To add extra rows in Word, click anywhere in the second-to-last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

Use Instructions: Copy and paste the HAPs table here if need to list more individual HAPs.

Purchased Hazardous Air Pollutant Table*

Product Categories (Coatings, Solvents, Thinners, etc.)	Hazardous Air Pollutant (HAP), or Volatile Hazardous Air Pollutant (VHAP) Primary To The Representative As Purchased Product	Chemical Abstract Service (CAS) Number of HAP or VHAP from Representative As Purchased Product	HAP or VHAP Concentration of Representative As Purchased Product (pounds/gallon, or %)	Concentration Determination (CPDS, SDS, etc.)[1]	Total Product Purchases For Category	(-)	Quantity of Product Recovered & Disposed For Category	(=)	Total Product Usage For Category
1. Process Reactant	Beryllium Fluoride	7787-49-7	100%	SDS	100,000 lb/yr	(-)	0 lb/yr	(=)	100,000 lb/yr
2. Process Reactant	Chemical A	###-##-#	100%	SDS	324,710 lb/yr	(-)	0 lb/yr	(=)	324,710 lb/yr
3. Process	Chloroform	67-66-3	99%	SDS	238,002 lb/yr	(-)	216,582 lb/yr	(=)	21,420 lb/yr
					19,140 gal/yr		17,418 gal/yr		1,723 gal/yr
4. Process	Dimethylformamide	68-12-2	100%	SDS	58,921 lb/yr	(-)	58,921 lb/yr	(=)	0 lb/yr
					7,440 gal/yr		7,440 gal/yr		0 gal/yr
5. Process Reactant	Hydrochloric Acid	7647-01-0	21%	SDS	1,110,741 lb/yr	(-)	0 lb/yr	(=)	1,110,741 lb/yr
					119,906 gal/yr		0 gal/yr		119,906 gal/yr
6. Process Reactant	Hydrofluoric Acid	7664-39-3	49%	SDS	247,620 lb/yr	(-)	0 lb/yr	(=)	247,620 lb/yr
					25,360 gal/yr		0 gal/yr		25,360 gal/yr
TOTALS					**2,079,993 lb/yr**	(-)	**275,503 lb/yr**	(=)	**1,804,490 lb/yr**
					171,846 gal/yr		**24,857 gal/yr**		**146,989 gal/yr**

NOTE: To add extra rows in Word, click anywhere in the second-to-last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

NOTE: Product purchases, recovery/disposal and usage should be converted to the units listed in this table. If units cannot be converted please contact the Air Quality Program prior to making changes to this table.

1. Submit, as an attachment, information on one (1) product from each Category listed above which best represents the average of all the products purchased in that Category. CPDS = Certified Product Data Sheet; SDS = Safety Data Sheet

*** A Registration is required, at minimum, for any amount of HAP or VHAP emission.**
Emissions from purchased HAP usage should be accounted for on previous tables as appropriate.
A permit may be required for these emissions if the source meets the requirements of 20.11.41 NMAC.

Material and Fuel Storage Table

(*E.g.*, Tanks, barrels, silos, stockpiles, etc.)

Storage Equipment		Product Stored	Capacity (bbls, tons, gals, acres, etc.)	Above or Below Ground	Construction (Welded, riveted) & Color	Installation Date	Loading Rate[1]	Offloading Rate[1]	True Vapor Pressure	Control Method	Seal Type	% Eff.[2]
TK-100-1-01	Tank	Chloroform Tank	6267 gal	Above	TBD	TBD	N/A	N/A	3.09 psia	N/A	N/A	0%
TK-101-1-01	Tank	Process Water Tank	6267 gal	Above	TBD	TBD	N/A	N/A	0.34 psia	N/A	N/A	0%
TK-105-1-01	Tank	Isopropanol Tank	8226 gal	Above	TBD	TBD	N/A	N/A	0.62 psia	N/A	N/A	0%
TK-105-1-02	Tank	Isopropanol Tank	6315 gal	Above	TBD	TBD	N/A	N/A	0.62 psia	N/A	N/A	0%
TK-107-1-01	Tank	Aqueous Waste Tank	8226 gal	Above	TBD	TBD	N/A	N/A	0.32 psia	N/A	N/A	0%
TK-108-1-01	Tank	Organic Waste Tank	7051 gal	Above	TBD	TBD	N/A	N/A	0.55 psia	N/A	N/A	0%
TK-TBD	Tank	Separation Feed Tank	15580 gal	Above	TBD	TBD	N/A	N/A	3.09 psia	N/A	N/A	0%
TK-TBD	Tank	Separation Feed Tank	15580 gal	Above	TBD	TBD	N/A	N/A	2.39 psia	N/A	N/A	0%
TK-150-1-01	Tank	In-Process Tank #1	5000 gal	Above	TBD	TBD	N/A	N/A	1.79 psia	N/A	N/A	0%
TK-151-1-01	Tank	In-Process Tank #2	5000 gal	Above	TBD	TBD	N/A	N/A	1.79 psia	N/A	N/A	0%
TK-156-1-01	Tank	LHM Buffer Tank #1	500 gal	Above	TBD	TBD	N/A	N/A	0.25 psia	N/A	N/A	0%
TK-157-1-01	Tank	LHM Buffer Tank #2	500 gal	Above	TBD	TBD	N/A	N/A	0.25 psia	N/A	N/A	0%
TK-158-1-01	Tank	Organic Phase Surge Tank	5000 gal	Above	TBD	TBD	N/A	N/A	1.79 psia	N/A	N/A	0%
TK-159-1-01	Tank	Brine Surge Tank	5000 gal	Above	TBD	TBD	N/A	N/A	0.33 psia	N/A	N/A	0%
TK-160-1-01	Tank	Fresh Brine Tank	1800 gal	Above	TBD	TBD	N/A	N/A	0.25 psia	N/A	N/A	0%
TK-165	Tank	In-Process Tank #3	15580 gal	Above	TBD	TBD	N/A	N/A	2.39 psia	N/A	N/A	0%
TK-TBD	Tank	Aqueous Hazardous Waste Tank	11000 gal	Above	TBD	TBD	N/A	N/A	0.32 psia	N/A	N/A	0%
TK-TBD	Tank	Chloroform Tank	200 gal	Above	TBD	TBD	N/A	N/A	3.06 psia	N/A	N/A	0%
TK-301-1-02	Tank	Neutralization Tank	2669 gal	Above	TBD	TBD	N/A	N/A	0.58 psia	N/A	N/A	0%
TK-304-1-03	Tank	Recycle Water Tank	2700 gal	Above	TBD	TBD	N/A	N/A	0.34 psia	N/A	N/A	0%
TK-306-1-01	Tank	Dissolving Vessel	603 gal	Above	TBD	TBD	N/A	N/A	0.46 psia	N/A	N/A	0%
TK-307-1-01	Tank	Intermediate Tank	458 gal	Above	TBD	TBD	N/A	N/A	0.06 psia	N/A	N/A	0%
TK-308-1-01	Tank	DMF Tank	458 gal	Above	TBD	TBD	N/A	N/A	0.06 psia	N/A	N/A	0%

Storage Equipment		Product Stored	Capacity (bbls, tons, gals, acres, etc.)	Above or Below Ground	Construction (Welded, riveted) & Color	Installation Date	Loading Rate[1]	Offloading Rate[1]	True Vapor Pressure	Control Method	Seal Type	% Eff.[2]
TK-309-1-01	Tank	Reactor 2	5000 gal	Above	TBD	TBD	N/A	N/A	0.56 psia	N/A	N/A	0%
TK-311-1-01	Tank	Isopropanol Tank	6315 gal	Above	TBD	TBD	N/A	N/A	0.56 psia	N/A	N/A	0%
TK-323-1-01	Tank	Chloroform Tank	2200 gal	Above	TBD	TBD	N/A	N/A	3.09 psia	N/A	N/A	0%
TK-341-1-01	Tank	Isopropanol Tank	2250 gal	Above	TBD	TBD	N/A	N/A	0.53 psia	N/A	N/A	0%
TK-341-1-02	Tank	Isopropanol Tank	2250 gal	Above	TBD	TBD	N/A	N/A	0.62 psia	N/A	N/A	0%
TK-342-1-01	Tank	Drain Tank 1	500 gal	Above	TBD	TBD	N/A	N/A	3.09 psia	N/A	N/A	0%
TK-344-1-01	Tank	Drain Tank 2	500 gal	Above	TBD	TBD	N/A	N/A	0.40 psia	N/A	N/A	0%
TK-345-1-01	Tank	Dissolving Tank	1104 gal	Above	TBD	TBD	N/A	N/A	2.39 psia	N/A	N/A	0%
TK-1-01	Tank	LiOH Feed Tank Vent to Stack	250 gal	Above	TBD	TBD	N/A	N/A	0.32 psia	N/A	N/A	0%
TK-1-02	Tank	HF Feed Tank Vent to Atmosphere	880 gal	Above	TBD	TBD	N/A	N/A	0.20 psia	N/A	N/A	0%
RR-1-01	Tank	LiOH HF Reactor Vent to Atmosphere	470 gal	Above	TBD	TBD	N/A	N/A	0.31 psia	N/A	N/A	0%
TK-1-03	Tank	Mother Liquor Hold Tank Vent to Atmosphere	520 gal	Above	TBD	TBD	N/A	N/A	0.34 psia	N/A	N/A	0%
TK-1-05	Tank	Evaporator Tank Vent to Condenser	520 gal	Above	TBD	TBD	N/A	N/A	0.34 psia	N/A	N/A	0%
TK-1-06	Tank	Waste Water Neutralization Tank Vent to Atmosphere	250 gal	Above	TBD	TBD	N/A	N/A	0.34 psia	N/A	N/A	0%
TK-1-07	Tank	Caustic Solution Tank Vent to Atmosphere	5250 gal	Above	TBD	TBD	N/A	N/A	0.34 psia	N/A	N/A	0%

NOTE: To add extra rows in Word, click anywhere in the last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

1. Basis for Loading/Offloading Rate (*e.g.*, Manufacturer's Data, Field Observation/Test, etc.). **N/A**
   Submit information for each unit as an attachment.
2. Basis for Control Method % Efficiency (*e.g.*, Manufacturer's Data, Field Observation/Test, AP-42, etc.). **Field Observation**

Application for Air Pollutant Sources in Bernalillo County
Source Registration (20.11.40 NMAC) and Construction Permits (20.11.41 NMAC)

Stack Parameters Table

If any equipment from the Regulated Emission Sources Table is also listed in this Stack Table, use the same numbered line for the emission unit on both tables to show the association between the Process Equipment and its stack.

Unit Number and Description		Pollutant (CO, NOx, PM$_{10}$, etc.)	UTM Easting (m)	UTM Northing (m)	Stack Height (ft)	Stack Exit Temp. (°F)	Stack Velocity (fps)	Stack Flow Rate (acfm)	Stack Inside Diameter (ft)	Stack Type
EP-1: Vent-300	Unit 300, 500, 600, and 950 stack vent	VOC, HSO$_2$	352775	3874832	72.00	Ambient	0.17	0.059	0.67	Vertical
EP-2: BSC-500	Bleach Synthesis Column	No Criteria Pollutants	352829	3874713	30.00	Ambient	N/A	N/A	0.25	Vertical
EP-3: Vent-600	Combined Unit SCBR-600 and Unit SCBR-950 vent stack	No Criteria Pollutants	352789	3874732	30.00	Ambient	N/A	N/A	0.50	Vertical
EP-4: Cooling Tower-1	Cooling Tower 1 - Fan 1	PM$_{10}$, PM$_{2.5}$	352819	3874846	18.33	Ambient	44.49	253660	11.00	Vertical
	Cooling Tower 1 - Fan 2	PM$_{10}$, PM$_{2.5}$	352819	3874846	18.33	Ambient	44.49	253660	11.00	Vertical
E_5A: Boiler-1	Boiler 1	NO$_x$, CO, SO$_2$, PM$_{10}$, PM$_{2.5}$	352818	3874763	50.00	600.00	99.85	18821.81	2.00	Vertical
EP-5B: Boiler-2	Boiler 2	NO$_x$, CO, SO$_2$, PM$_{10}$, PM$_{2.5}$	352818	3874754	50.00	600.00	133.14	25095.74	2.00	Vertical
EP-6: GEN-1	Emergency Generator	NO$_x$, CO, SO$_2$, PM$_{10}$, PM$_{2.5}$	352823	3874798	0.00	1020.00	427.81	2240.00	0.33	Vertical

NOTE: To add extra rows in Word, click anywhere in the last row. A plus (+) sign should appear on the bottom right corner of the row. Click the plus (+) sign to add a row. Repeat as needed.

Application for Air Pollutant Sources in Bernalillo County
Source Registration (20.11.40 NMAC) and Construction Permits (20.11.41 NMAC)

Certification

NOTICE REGARDING SCOPE OF A PERMIT: The Environmental Health Department's issuance of an air quality permit only authorizes the use of the specified equipment pursuant to the air quality control laws, regulations and conditions. Permits relate to air quality control only and are issued for the sole purpose of regulating the emission of air contaminants from said equipment. Air quality permits are not a general authorization for the location, construction and/or operation of a facility, nor does a permit authorize any particular land use or other form of land entitlement. It is the applicant's/permittee's responsibility to obtain all other necessary permits from the appropriate agencies, such as the City of Albuquerque Planning Department or Bernalillo County Department of Planning and Development Services, including but not limited to site plan approvals, building permits, fire department approvals and the like, as may be required by law for the location, construction and/or operation of a facility. For more information, please visit the City of Albuquerque Planning Department website at https://www.cabq.gov/planning and the Bernalillo County Department of Planning and Development Services website at https://www.bernco.gov/planning.

NOTICE REGARDING ACCURACY OF INFORMATION AND DATA SUBMITTED: Any misrepresentation of a material fact in this application and its attachments is cause for denial of a permit or revocation of part or all of the resulting registration or permit, and revocation of a permit for cause may limit the permitee's ability to obtain any subsequent air quality permit for ten (10) years. Any person who knowingly makes any false statement, representation, or certification in any application, record, report, plan or other document filed or required to be maintained under the Air Quality Control Act, NMSA 1978 §§ 74-2-1 to 74-2-17, is guilty of a misdemeanor and shall, upon conviction, be punished by a fine of not more than ten thousand dollars ($10,000) per day per violation or by imprisonment for not more than twelve months, or by both.

I, the undersigned, hereby certify that I have knowledge of the information and data represented and submitted in this application and that the same is true and accurate, including the information and date in any and all attachments, including without limitation associated forms, materials, drawings, specifications, and other data. I also certify that the information represented gives a true and complete portrayal of the existing, modified existing, or planned new stationary source with respect to air pollution sources and control equipment. I understand that there may be significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations. I also understand that the person who has applied for or has been issued an air quality permit by the Department is an obligatory party to a permit appeal filed pursuant to 20.11.81 NMAC. Further, I certify that I am qualified and authorized to file this application, to certify the truth and accuracy of the information herein, and bind the source. Moreover, I covenant and agree to comply with any requests by the Department for additional information necessary for the Department to evaluate or make a final decision regarding the application.

Signed this 16 day of April, 20 25

Terrence Williams
Print Name

Director, Environmental Health and Safety
Print Title

Signature

Role: ☐ Owner ☐ Operator

☒ Other Authorized Representative

City of Albuquerque
Environmental Health Department
Air Quality Program

Permit Application Review Fee Instructions

All source registration and construction permit applications for stationary or portable sources shall be charged an application review fee according to the fee schedule in 20.11.2 NMAC. These filing fees are required for both new construction, reconstruction, and permit modification/revision applications. Most air quality notification (AQN) applications shall be charged an application review fee according to 20.11.39 NMAC. Qualified small businesses as defined in 20.11.2 NMAC may be eligible to pay one-half of the application review fees and 100% of all applicable federal program review fees.

Please fill out the permit application review fee checklist completely and submit with a check or money order payable to the "City of Albuquerque Fund 242" and:

1. Deliver it in person to the Albuquerque Environmental Health Department, 3rd floor, Room 3023, Albuquerque-Bernalillo County Government Center, south building, One Civic Plaza NW, Albuquerque, NM 87102; or

2. Mail it to Albuquerque Environmental Health Department, Air Quality Program, Permitting Division, P.O. Box 1293, Albuquerque, NM 87103; or

3. Online fee payments are now accepted as well. Application must be submitted first, then Department will provide invoice for online payment. Fill out form completely and mark check box below fee amount due on last page to request an invoice to pay the fee online.

The Department will provide a receipt of payment to the applicant. The person delivering or filing a submittal shall attach a copy of the receipt of payment to the submittal as proof of payment. Application review fees shall not be refunded without the written approval of the manager. If a refund is requested, a reasonable professional service fee to cover the costs of staff time involved in processing such requests shall be assessed. Please refer to 20.11.2 NMAC (effective January 10, 2011) for more detail concerning the "Fees" regulation as this checklist does not relieve the applicant from any applicable requirement of the regulation.

City of Albuquerque
Environmental Health Department
Air Quality Program

Permit Application Review Fee Checklist Effective January 1, 2025 – December 31, 2025

Please completely fill out the information in each section. Incompleteness of this checklist may result in the Albuquerque Environmental Health Department not accepting the application review fees. If you should have any questions concerning this checklist, please call (505) 768-1972.

I. COMPANY INFORMATION:

Company Name	Kairos Power, LLC	
Company Address	707 W. Tower Ave, Ste. A, Alameda, CA 95401	
Facility Name	Salt Production Facility	
Facility Address	5201 Hawking Dr. SE, Albuquerque, NM 87106	
Contact Person	Terrence Williams	
Contact Person Phone Number/Email	(510) 775-1822	
Are these application review fees for an existing permitted source located within the City of Albuquerque or Bernalillo County?	**Yes** ☐	**No** ☒
If yes, what is the current permit number for this facility?	**Permit #** N/A	
Is this application review fee for a Qualified Small Business as defined in 20.11.2 NMAC? (See Definition of Qualified Small Business on Page 4)	**Yes** ☐	**No** ☒

II. STATIONARY SOURCE APPLICATION REVIEW FEES:

If the application is for a new stationary source facility, please check all that apply. If this application is for a modification to an existing permit please see Section III. For revisions or relocations please see Sections IV or V.

Check All That Apply	Stationary Sources	Review Fee	Program Element
	Air Quality Notifications		
☐	AQN New Application	$701.00	2801
☐	AQN Technical Amendment	$383.00	2802
☐	AQN Transfer of a Prior Authorization	$383.00	2803
☒	*Not Applicable*	*See Sections Below*	
	Stationary Source Review Fees (Not Based on Proposed Allowable Emission Rate)		
☐	Source Registration required by 20.11.40 NMAC	$715.00	2401
☒	A Stationary Source that requires a permit pursuant to 20.11.41 NMAC or other board regulations and are not subject to the below proposed allowable emission rates	$1,429.00	2301
☐	*Not Applicable*	*See Sections Below*	
	Stationary Source Review Fees (Based on the Proposed Allowable Emission Rate for the single highest fee pollutant)		
☐	Proposed Allowable Emission Rate equal to or greater than 1 tpy and less than 5 tpy	$1,072.00	2302
☐	Proposed Allowable Emission Rate equal to or greater than 5 tpy and less than 25 tpy	$2,144.00	2303
☒	Proposed Allowable Emission Rate equal to or greater than 25 tpy and less than 50 tpy	$4,288.00	2304
☐	Proposed Allowable Emission Rate equal to or greater than 50 tpy and less than 75 tpy	$6,432.00	2305
☐	Proposed Allowable Emission Rate equal to or greater than 75 tpy and less than 100 tpy	$8,577.00	2306
☐	Proposed Allowable Emission Rate equal to or greater than 100 tpy	$10,721.00	2307
☐	*Not Applicable*	*See Sections Below*	

Federal Program Review Fees for each subpart (In addition to the Stationary Source Application Review Fees above)			
☒	40 CFR 60 – "New Source Performance Standards" (NSPS)	$1,429.00	2308
☒	40 CFR 61 – "National Emission Standards for Hazardous Air Pollutants" (NESHAPs)	$1,429.00	2309
☒	40 CFR 63 – (NESHAPs) Promulgated Standards	$1,429.00	2310
☐	20.11.64 – (NESHAPs) Case-by-Case MACT Review (Major HAP sources)	$14,294.00	2311
☐	20.11.61 NMAC – Prevention of Significant Deterioration (PSD) Permit	$7,147.00	2312
☐	20.11.60 NMAC – Non-Attainment Area Permit	$7,147.00	2313
☐	*Not Applicable*	*Not Applicable*	

III. MODIFICATION TO EXISTING PERMIT APPLICATION REVIEW FEES:

If the application is for a modification to an existing permit, please check all that apply. If this application is for a new stationary source facility, please see Section II. For revisions or relocations please see Sections IV or V.

Check All That Apply	Modifications	Review Fee	Program Element
Modification Application Review Fees (Not Based on Proposed Allowable Emission Rate)			
☐	Proposed modification to an existing Source Registration required by 20.11.40 NMAC	$715	2401
☐	Proposed modification to an existing stationary source that requires a permit pursuant to 20.11.41 NMAC or other board regulations and are not subject to the below proposed allowable emission rates	$1,429	2321
☒	*Not Applicable*	*See Sections Below*	
Modification Application Review Fees (Based on the Proposed Allowable Emission Rate for the single highest fee pollutant)			
☐	Proposed Allowable Emission Rate equal to or greater than 1 tpy and less than 5 tpy	$1,072.00	2322
☐	Proposed Allowable Emission Rate equal to or greater than 5 tpy and less than 25 tpy	$2,144.00	2323
☐	Proposed Allowable Emission Rate equal to or greater than 25 tpy and less than 50 tpy	$4,288.00	2324
☐	Proposed Allowable Emission Rate equal to or greater than 50 tpy and less than 75 tpy	$6,432.00	2325
☐	Proposed Allowable Emission Rate equal to or greater than 75 tpy and less than 100 tpy	$8,577.00	2326
☐	Proposed Allowable Emission Rate equal to or greater than 100 tpy	$10,721.00	2327
☒	*Not Applicable*	*See Sections Below*	
Major Modifications Review Fees (In addition to the Modification Application Review Fees above)			
☐	20.11.60 NMAC – Permitting in Non-Attainment Areas	$7,147.00	2333
☐	20.11.61 NMAC – Prevention of Significant Deterioration	$7,147.00	2334
☒	*Not Applicable*	*Not Applicable*	
Federal Program Review Fees for each subpart (This section applies only if a Federal Program Review is triggered by the proposed modification) (These fees are in addition to the Modification and Major Modification Application Review Fees above)			
☐	40 CFR 60 – "New Source Performance Standards" (NSPS)	$1,429.00	2328
☐	40 CFR 61 – "National Emission Standards for Hazardous Air Pollutants" (NESHAPs)	$1,429.00	2329
☐	40 CFR 63 – (NESHAPs) Promulgated Standards	$1,429.00	2330
☐	20.11.64 – (NESHAPs) Case-by-Case MACT Review (Major HAP sources)	$14,294.00	2331
☐	20.11.61 NMAC – Prevention of Significant Deterioration (PSD) Permit	$7,147.00	2332
☐	20.11.60 NMAC – Non-Attainment Area Permit	$7,147.00	2333
☒	*Not Applicable*	*Not Applicable*	

IV. ADMINISTRATIVE AND TECHNICAL REVISION APPLICATION REVIEW FEES:

If the application is for an administrative or technical revision of an existing permit issued pursuant to 20.11.40 or 20.11.41 NMAC, please check one that applies.

Check One	Revision Type	Review Fee	Program Element
☐	Administrative Revisions	$250.00	2340
☐	Technical Revisions	$500.00	2341
☒	*Not Applicable*	*See Sections II, III or V*	

V. PORTABLE STATIONARY SOURCE RELOCATION FEES:

If the application is for a portable stationary source relocation of an existing permit, please check one that applies.

Check One	Portable Stationary Source Relocation Type	Review Fee	Program Element
☐	No New Air Dispersion Modeling Required	$500.00	2501
☐	New Air Dispersion Modeling Required	$750.00	2502
☒	*Not Applicable*	*See Sections II, III or IV*	

VI. Please submit payment in the amount shown for the total application review fee.

Section Totals	Review Fee Amount
Section II Total	$10,004.00
Section III Total	$0.00
Section IV Total	$0.00
Section V Total	$0.00
Total Application Review Fee	**$10,004.00**

☐ **Check here if an invoice is requested so Application Review Fee can be paid online.**

I, the undersigned, a responsible officer of the applicant company, certify that to the best of my knowledge, the information stated on this checklist gives a true and complete representation of the permit application review fees which are being submitted. I also understand that an incorrect submittal of permit application reviews may cause an incompleteness determination of the submitted permit application and that the balance of the appropriate permit application review fees shall be paid in full prior to further processing of the application.

Signed this 16 day of April , 2025

Terrence Williams
Print Name

Director, Environmental Health and Safety
Print Title

Signature

Definition of Qualified Small Business as defined in 20.11.2 NMAC:
“Qualified small business” means a business that meets all of the following requirements:

(1) a business that has 100 or fewer employees;
(2) a small business concern as defined by the federal Small Business Act;
(3) a source that emits less than 50 tons per year of any individual regulated air pollutant, or less than 75 tons per year of all regulated air pollutants combined; and
(4) a source that is not a major source or major stationary source.

<u>Note:</u> Beginning January 1, 2011, and every January 1 thereafter, an increase based on the consumer price index shall be added to the application review fees. The application review fees established in Subsection A through D of 20.11.2.18 NMAC shall be adjusted by an amount equal to the increase in the consumer price index for the immediately-preceding year. Application review fee adjustments equal to or greater than fifty cents ($0.50) shall be rounded up to the next highest whole dollar. Application review fee adjustments totaling less than fifty cents ($0.50) shall be rounded down to the next lowest whole dollar. The department shall post the application review fees on the city of Albuquerque environmental health department air quality program website.

City of Albuquerque
Environmental Health Department
Air Quality Program

Construction Permit (20.11.41 NMAC)
Application Checklist

This checklist must be returned with the application

Any person seeking a new air quality permit, a permit modification, or an emergency permit under 20.11.41 NMAC (Construction Permits) shall do so by filing a written application with the Albuquerque-Bernalillo County Joint Air Quality Program, which administers and enforces local air quality laws for the City of Albuquerque (“City”) and Bernalillo County (“County”), on behalf of the City Environmental Health Department (“Department”).

The Department will rule an application administratively incomplete if it is missing or has incorrect information. The Department may require additional information that is necessary to make a thorough review of an application, including but not limited to technical clarifications, emission calculations, emission factor usage, additional application review fees if any are required by 20.11.2 NMAC, and new or additional air dispersion modeling.

If the Department has ruled an application administratively incomplete three (3) times, the Department will deny the permit application. Any fees submitted for processing an application that has been denied will not be refunded. If the Department denies an application, a person may submit a new application and the fee required for a new application. The applicant has the burden of demonstrating that a permit should be issued.

The following are the minimum elements that shall be included in the permit application before the Department can determine whether an application is administratively complete and ready for technical review. It is not necessary to include an element if the Department has issued a written waiver regarding the element and the waiver accompanies the application. However, the Department shall not waive any federal requirements.

At all times before the Department has made a final decision regarding the application, an applicant has a duty to promptly supplement and correct information the applicant has submitted in an application to the Department. The applicant’s duty to supplement and correct the application includes but is not limited to relevant information acquired after the applicant has submitted the application and additional information the applicant otherwise determines is relevant to the application and the Department’s review and decision. While the Department is processing an application, regardless of whether the Department has determined the application is administratively complete, if the Department determines that additional information is necessary to evaluate or make a final decision regarding the application, the Department may request additional information and the applicant shall provide the requested additional information.

NOTICE REGARDING PERMIT APPEALS: A person who has applied for or has been issued an air quality permit by the Department shall be an obligatory party to a permit appeal filed pursuant to 20.11.81 NMAC.

NOTICE REGARDING SCOPE OF A PERMIT: The Department’s issuance of an air quality permit only authorizes the use of the specified equipment pursuant to the air quality control laws, regulations and conditions. Permits relate to air quality control only and are issued for the sole purpose of regulating the emission of air contaminants from said equipment. Air quality permits are not a general authorization for the location, construction and/or operation of a facility, nor does a permit authorize any particular land use or other form of land entitlement. It is the applicant’s/permittee’s responsibility to obtain all other necessary permits from the appropriate agencies, such as the City Planning Department or County Department of Planning and Development Services, including but not limited to site plan approvals, building permits, fire department approvals and the like, as may be required by law for the location, construction and/or operation of a facility. For more information, please visit the City Planning Department website at https://www.cabq.gov/planning and the County Department of Planning and Development Services website at https://www.bernco.gov/planning.

The Applicant shall:

20.11.41.13(A) NMAC – Pre-Application Requirements:

Item	Completed	N/A[1]	Waived[2]
(1) Request a pre-application meeting with the Department using the pre-application meeting request form. Include a copy of the request form submitted to the Department.	☒	☐	☐
(2) Attend the pre-application meeting. Date of pre-application meeting: **March 28, 2024**	☒	☐	☐
Pre-application meeting agenda and public notice sign checklists included with application?	☒	☐	☐

1. *Not Applicable*
2. *It is not necessary to include an element if the Department has issued a written waiver regarding the element and the waiver accompanies the application. However, the Department shall not waive any federal requirements.*

20.11.41.13(B) NMAC – Applicant's Public Notice Requirements:

Item	Included in Application	N/A[1]	Waived[2]
(1) Provide public notice in accordance with the regulation, including by certified mail or electronic copy to the designated representative(s) of the recognized neighborhood associations and recognized coalitions that are within one-half mile of the exterior boundaries of the property on which the source is or is proposed to be located.	☒	☐	☐
• Contact list of representative(s) of recognized neighborhood associations and recognized coalitions cannot be more than three months old from the application submittal date. • Include contact list provided by Department in application submittal.	☒	☐	☐
• Provide notice using the Notice of Intent to Construct form and Applicant Notice Cover Letter.	☒	☐	☐
(2) In accordance with the regulation, post and maintain in a visible location a weather proof sign provided by the Department. Include pictures in application.	☒	☐	☐
Documentary proof of all public notice requirements listed above and required by 20.11.41.13(E)(15) included with application?	☒	☐	☐

1. *Not Applicable; For emergency permits, the public notice requirements in 20.11.41.24 NMAC shall apply instead.*
2. *It is not necessary to include an element if the Department has issued a written waiver regarding the element and the waiver accompanies the application. However, the Department shall not waive any federal requirements.*

20.11.41.13(D) NMAC

Item	Included in Application
A person who is seeking a construction permit pursuant to 20.11.41 NMAC shall complete a permit application and file one complete original and one duplicate copy with the Department.	☒
• A high-quality electronic duplicate copy is required by the Department to speed up review and allow for the Department public notice to be posted online. The electronic copy must be an exact duplicate of the hardcopy original, including pages with signatures such as the application certification page. Note: Do not include financial information, such as a copy of a check, in the electronic PDF.	☒
The electronic submittal on thumb drive, unless alternate method is allowed by the Department, must also include modeling files, if applicable, and emission calculations file(s) in Microsoft Excel-compatible format.	☒

The Permit Application shall include:

20.11.41.13(E) NMAC – Application Contents

Item	Included in Application	N/A[1]	Waived[2]
(1) A complete permit application on the most recent form provided by the Department.	☒	☐	☐
(2) The application form includes:			
a. The applicant's name, street and post office address, and contact information;	☒	☐	☐
b. The facility owner/ operator's name, street address and mailing address, if different from the applicant;	☒	☐	☐
c. The consultant's name and contact information, if applicable;	☒	☐	☐
d. All information requested on the application form is included (*i.e.*, the form is complete).	☒	☐	☐
(3) The date the application was submitted to the Department.	☒	☐	☐
(4) Sufficient attachments for the following:			
a. Ambient impact analysis using an atmospheric dispersion model approved by the U.S. Environmental Protection Agency, and the Department to demonstrate compliance with the applicable National Ambient Air Quality Standards (NAAQS). *See* 20.11.1 NMAC. If you are modifying an existing source, the modeling must include the emissions of the entire source to demonstrate the impact the new or modified source(s) will have on existing plant emissions.	☒	☐	☐
b. The air dispersion model has been executed pursuant to a protocol that was approved in advance by the Department.	☒	☐	☐
c. Air dispersion modeling approved (or 2nd denied) protocol date: **October 24, 2024**	☒	☐	☐
d. Basis or source for each emission rate (including manufacturer's specification sheets, AP-42 section sheets, test data, or corresponding supporting documentation for any other source used).	☒	☐	☐
e. All calculations used to estimate potential emission rates and controlled/proposed emissions.	☒	☐	☐
f. Basis for the estimated control efficiencies and sufficient engineering data for verification of the control equipment operation, including if necessary, design, drawing, test report and factors which affect the normal operation.	☒	☐	☐
g. Fuel data for each existing and/or proposed piece of fuel burning equipment.	☒	☐	☐
h. Anticipated maximum production capacity of the entire facility and the requested production capacity after construction and/or modification.	☒	☐	☐
i. Stack and exhaust gas parameters for all existing and proposed emission stacks.	☒	☐	☐
(5) An operational and maintenance strategy detailing:	☒	☐	☐
a. the steps the applicant will take if a malfunction occurs that may cause emission of a regulated air contaminant to exceed a limit that is included in the permit;	☒	☐	☐
b. the nature of emissions during routine startup or shutdown of the source and the source's air pollution control equipment; and	☒	☐	☐
c. the steps the applicant will take to minimize emissions during routine startup or shutdown.	☒	☐	☐
(6) A map, such as a 7.5'-topographic quadrangle map published by the U.S. Geological Survey or a map of equivalent or greater scale, detail, and precision, including a City or County zone atlas map that shows the proposed location of each process equipment unit involved in the proposed construction, modification, or operation of the source, as applicable.	☒	☐	☐

Item	Included in Application	N/A[1]	Waived[2]
(7) An aerial photograph showing the proposed location of each process equipment unit involved in the proposed construction, modification, relocation or technical revision of the source except for federal agencies or departments involved in national defense or national security as confirmed and agreed to by the Department in writing.	☒	☐	☐
(8) A complete description of all sources of regulated air contaminants and a process flow diagram depicting the process equipment unit or units at the facility, both existing and proposed, that are proposed to be involved in routine operations and from which regulated air contaminant emissions are expected to be emitted.	☒	☐	☐
(9) A full description of air pollution control equipment, including all calculations and the basis for all control efficiencies presented, manufacturer's specifications sheets, and site layout and assembly drawings; UTM (universal transverse mercator) coordinates shall be used to identify the location of each emission unit.	☒	☐	☐
(10) A description of the equipment or methods proposed by the applicant to be used for emission measurement.	☒	☐	☐
(11) The maximum and normal operating time schedules of the source after completion of construction or modification, as applicable.	☒	☐	☐
(12) Any other relevant information as the Department may reasonably require, including without limitation:	☒	☐	☐
a. Provide an applicability determination for all potentially applicable federal regulations.	☒	☐	☐
b. Applicants shall provide documentary proof that the proposed air quality permitted use of the facility's subject property is allowed by the zoning designation of the City or County zoning laws, as applicable. Sufficient documentation includes: (i) a zoning certification from the City Planning Department or County Department of Planning and Development Services, as applicable, if the property is subject to City or County zoning jurisdiction; or (ii) a zoning verification from both planning departments if the property is not subject to City or County zoning jurisdiction.[3] A zone atlas map shall not be sufficient.	☒	☐	☐
c. Compliance History Disclosure Form[4]	☒	☐	☐
(13) The signature of the applicant, operator, owner or an authorized representative, certifying to the accuracy of all information as represented in the application and attachments, if any.	☒	☐	☐
(14) A check or money order for the appropriate application fee or fees required by 20.11.2 NMAC, *Fees*. (Online fee payments are now accepted as well. Application must be submitted first, then Department will provide invoice for online payment.)	☒	☐	☐

1. *Not Applicable*
2. *It is not necessary to include an element if the Department has issued a written waiver regarding the element and the waiver accompanies the application. However, the Department shall not waive any federal requirements.*
3. *Applicants are not required to submit documentation for the subject property's zoning designation when applying for a relocation of a portable stationary source, or a technical or administrative revision to an existing permit.*
4. *Required for applications filed pursuant to the following regulations: Construction Permits (20.11.41 NMAC); Operating Permits (20.11.42 NMAC); Nonattainment Areas (20.11.60 NMAC); Prevention of Significant Deterioration (20.11.61 NMAC); and Acid Rain (20.11.62 NMAC); except this Form shall not be required for asbestos notifications under 20.11.20.22 NMAC, and this Form shall only be required for administrative permit revision (20.11.41.28(A) NMAC) and administrative permit amendments (20.11.42.12(E)(1) NMAC) when the action requested is a transfer of ownership. Air Quality Program staff can answer basic questions about the Compliance History Disclosure Form but will not provide specific advice about which boxes to check or whether information must be disclosed. The decision about how to answer a question and whether there is information to disclose is the responsibility of applicants/permittees.*

City of Albuquerque
Environmental Health Department
Air Quality Program

Air Quality
Compliance History Disclosure Form

The Albuquerque-Bernalillo County Joint Air Quality Program ("Program") administers and enforces local air quality laws for the City of Albuquerque ("City") and Bernalillo County ("County") on behalf of the City Environmental Health Department, including the New Mexico Air Quality Control Act ("AQCA"), NMSA 1978, Sections 74-2-1 to -17. In accordance with Sections 74-2-7(P) and (S) of the AQCA, the Program may deny any permit application or revoke any permit issued pursuant to the AQCA if, within ten years immediately preceding the date of submission of the permit application, the applicant or permittee meets any one of the criteria outlined in the AQCA. The Program requires applicants to file this Compliance History Disclosure Form in order for the Program to deem an air permit application administratively complete, or issue an air permit for those permits without an initial administrative completeness determination process. Additionally, an existing permit holder (permits issued prior to the Effective Date of this Form) shall provide this Compliance History Disclosure Form to the Program upon the Program's request. Note: Program Staff can answer basic questions about this Compliance History Disclosure Form but cannot provide specific guidance or legal advice.

Instructions

1. Applications filed pursuant to the following regulations shall include this Compliance History Disclosure Form, in accordance with Section 74-2-7(S) of the AQCA: *Construction Permits* (20.11.41 NMAC); *Operating Permits* (20.11.42 NMAC); *Nonattainment Areas* (20.11.60 NMAC); *Prevention of Significant Deterioration* (20.11.61 NMAC); *Acid Rain* (20.11.62 NMAC); and *Fugitive Dust* (20.11.20 NMAC) except this Form shall not be required for asbestos notifications under 20.11.20.22 NMAC.
2. This Compliance History Disclosure Form is not site specific: responses shall be based on the applicant/permittee as an entity and not be limited to the application, site, facility or source.
3. The permittee identified on this Compliance History Disclosure Form shall match the permittee in the existing permit or new application. If the information in an existing permit needs to be changed, please contact the Program about revisions and ownership transfers.
4. Answer every question completely and truthfully, and do not leave any blank spaces. If there is nothing to disclose in answer to a particular question, check the box labeled "No" except for Question 5b. Failure to provide any of the information requested in this Compliance History Disclosure Form may constitute grounds for an incompleteness determination, application denial, or permit revocation.
5. Be especially careful not to leave out information in a way that might create an impression that you are trying to hide it. Omitting information, even unintentionally, may result in application denial or permit revocation.
6. For any required explanations, be sure to identify the question to which the explanation is responsive. If you submit any document in connection with your answer to any question, refer to it as, "Exhibit No.__", and attach it after the explanation(s) at the end of the Compliance History Disclosure Form, consecutively numbering each additional page at the top right corner.
7. The Program may require additional information to make a thorough review of an application. At all times before the Program has made a final decision regarding the application, an applicant has a duty to promptly supplement and correct information the applicant has submitted in an application to the Program. The applicant's duty to supplement and correct the application includes, but is not limited to, relevant information acquired after the applicant has submitted the application and additional information the applicant otherwise determines is relevant to the application and the Program's review and decision. While the Program is processing an application, regardless of whether the Program has determined the application is administratively complete, if the Program determines that additional information is necessary to evaluate or make a final decision regarding the application, the Program may request additional information and the applicant shall provide the requested additional information.
8. Supplementary information required by the Program may include responses to public comment received by the Program during the application review process.
9. Any fees submitted for processing an application that has been denied will not be refunded. If the Program denies an application, a person may submit a new application and the fee required for a new application. The applicant has the burden of demonstrating that a permit should be issued.

COMPLIANCE HISTORY		
A. Applicant/Permittee Name: **Kairos Power, LLC**		*Check Applicable Box*: ☒ Applicant ☐ Permittee
B. Time Period of Compliance Reporting (10 Years): April 1, 2015 to April 1, 2025 *Instructions: For applicants, answer the following questions with information from within the 10 years preceding the current application. For existing permit holders requested to submit this form by the Program outside of an application, answer the following questions with information from within the 10 years preceding the Program's issuance of each permit.*		
C. Questions		
1	Knowingly misrepresented a material fact in an application for a permit?	☐ Yes ☒ No
2	Refused to disclose information required by the provisions of the New Mexico Air Quality Control Act?	☐ Yes ☒ No
3	Been convicted in any court of any state or the United States of a felony related to environmental crime?	☐ Yes ☒ No
4	Been convicted in any court of any state or the United States of a crime defined by state or federal statute as involving or being in restraint of trade, price fixing, bribery, or fraud?	☐ Yes ☒ No
5a	Constructed or operated any facility for which a permit was sought, including the current application, without the required air quality permit(s) under 20.11.41 NMAC, 20.11.42 NMAC, 20.11.60 NMAC, 20.11.61 NMAC, or 20.11.62 NMAC?	☐ Yes ☒ No
5b	If "No" to question 5a, mark N/A and go to question 6. If "Yes" to question 5a, state whether each facility that was constructed or operated without the required air quality permit met at least one of the following exceptions: i. The unpermitted facility was discovered after acquisition during a timely environmental audit that was authorized by the Program or the New Mexico Environment Department; or ii. The operator of the facility, using good engineering practices and established approved calculation methodologies, estimated that the facility's emissions would not require an air permit, **and** the operator applied for an air permit within 30 calendar days of discovering that an air permit was required for the facility.	☐ Yes ☐ No ☒ N/A
6	Had any permit revoked or permanently suspended for cause under the environmental laws of any state or the United States?	☐ Yes ☒ No
7	For each "yes" answer, or "no" to 5b, please attach an explanation and supporting documentation.	

I, the undersigned, hereby certify under penalty of law that this Compliance History Disclosure Form (Form) and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. I have knowledge of the information in this Form and it is, to the best of my knowledge and belief, true, accurate, and complete. I understand that there are significant penalties for submitting false information, including denial of the application or revocation of a permit, as well as fines and imprisonment for knowing violations. If I filed an application, I covenant and agree to promptly supplement and correct information in this Form until the Program makes a final decision regarding the application. Further, I certify that I am qualified and authorized to file this Form, to certify to the truth and accuracy of the information herein, and bind the permittee and source.

Signed on April 16, 2025

Terrence Williams
Print Name

Director, Environmental Health and Safety
Print Title

Signature

Kairos Power LLC
Company Name

APPENDIX B. PRE-APPLICATION MEETING

The following pages contain:

- Pre-Permit Meeting Request Form (Updated November 2023)
- Pre-Permit Meeting Agenda & Public Notice Sign Checklists (Updated November 2023)

Pre-Permit Application Meeting Request Form

Air Quality Program- Environmental Health Department

Please complete appropriate boxes and email to aqd@cabq.gov or mail to:

Environmental Health Department
Air Quality Program
P.O. Box 1293
Room 3047
Albuquerque, NM 87103

Name:	**Kairos Power Southwest Facility**
Company/Organization:	Kairos Power 5201 Hawking Dr SE Albuquerque, NM 87106
Point of Contact: **(phone number and email):** **Preferred form of contact (circle one):** Phone E-mail ☑	Terrence Williams, Director, EH&S Phone: (510) 775-1822 Email: williams@kairospower.com Adam Erenstein, Principal Consultant Phone: (505) 266-6611 Email: aerenstein@trinityconsultants.com
Preferred meeting date/times:	As soon as practicable for the department.
Description of Project:	Kairos Power Southwest (Kairos) currently operates under air quality construction permit #1958-M1. This permit was previously issued to Nova Corporation and has been transferred to Kairos. A permit modification is currently proposed for the existing facility and Kairos already had a pre-application meeting with the EHD on 1/10 to discuss that facility. Kairos is also proposing an expansion at the current site consisting of the addition of another facility. The emission sources at this facility include various fixed roof chemical tanks, natural gas-fired boilers, cooling towers and various chemical processes that are routed to control devices such as a carbon bed or scrubber. Kairos is proposing to authorize this new facility under a separate permit from the existing facility as the operations are inherently different and under separate SIC codes.

City of Albuquerque
Environmental Health Department
Air Quality Program

Construction Permit (20.11.41 NMAC)
Pre-Permit Application Meeting Agenda Checklist & Public Notice Sign Guidelines Checklist

This entire document, including both completed checklists, must be included as part of the application package.

Any person seeking a new permit, a permit modification, or an emergency permit under 20.11.41 NMAC (Construction Permits) shall do so by filing a written application with the Albuquerque-Bernalillo County Joint Air Quality Program, which administers and enforces local air quality laws for the City of Albuquerque ("City") and Bernalillo County ("County"), on behalf of the City Environmental Health Department ("Department").

Prior to submitting an application, per 20.11.41.13(A) NMAC, the applicant (or their consultant) shall contact the Department in writing and submit a Pre-Permit Application Meeting Request Form to request a pre-application meeting. The Pre-Permit Application Meeting Request Form is available at https://www.cabq.gov/airquality/air-quality-permits/air-quality-application-forms. The purpose of the pre-application meeting is for the Department to provide the applicant with information regarding the contents of the application and the application process.

This pre-application meeting agenda checklist is provided to aid the Department and applicant in ensuring that in the pre-permit application meeting all information regarding the contents of the application and the application process are communicated to the applicant. This is because applications that are ruled incomplete because of missing information will delay any determination or the issuance of the permit. The Department reserves the right to request additional relevant information prior to ruling the application complete in accordance with 20.11.41 NMAC.

Also included in this document is the Public Notice Sign Guidelines Checklist, which contains requirements for how the applicant must display the required weather-proof sign.

The applicant should fill out and have this agenda checklist available at the pre-application meeting to be sure all items are covered. Check the boxes to acknowledge that each item from the agenda was discussed and that requirements for the weather-proof sign were followed.

Pre-Permit Application Meeting Agenda Checklist

Applicant Company Name: **Kairos Power**
Facility Name: **Salt Production Facility (SPF)**

☒ Fill out and submit a Pre-Permit Application Meeting Request form
Available online at https://www.cabq.gov/airquality/air-quality-permits/air-quality-application-forms/air-quality-application-forms

I. ☒ Discuss Project:
   a. Facility Location
   b. Facility Description
   c. Main Processes
   d. Equipment
   e. Proposed Schedule

II. ☒ Discuss the requirement for a zoning certification or verifications for new permits and permit modifications. The Zoning Requirement Cover Page form is a required component of this part of the submittal:
   a. For projects on property subject to City or County zoning laws (*i.e.*, **not** located on federal land, **not** located on State of New Mexico land, **not** located on Tribal land), a zoning certification from the appropriate planning department is required.
      i. City Planning Form: https://www.cabq.gov/planning/code-enforcement-zoning
      ii. County Planning Form: https://www.bernco.gov/planning/planning-and-land-use/applications-forms/
   b. If the project's property is not subject to City or County zoning jurisdiction, a zoning verification from both planning departments is required.
      i. City Planning Form: https://www.cabq.gov/planning/code-enforcement-zoning
      ii. County Planning Form: https://www.bernco.gov/planning/planning-and-land-use/applications-forms/
   c. The zoning certification or verifications **must** be obtained from the appropriate Planning Department, either City of Albuquerque or Bernalillo County. For more information, please visit the City's Planning Department website at https://www.cabq.gov/planning or Bernalillo County's Planning Department website at the https://www.bernco.gov/planning/.

III. ☒ Discuss the requirement for a Compliance History Disclosure Form as of Nov. 6, 2023 for permit application submittals except for Administrative Revisions that are not transfers of ownership.

IV. ☐ If permit modification or revision, review current permit:
   a. Review Process Equipment Table and Emissions Table and discuss changes
   b. Request information about the replacement or new equipment (for example, if it is an engine, we need to know if it is new, what year, fuel type, etc…) to give them an idea of the changes that will be needed
   c. Discuss possible changes in permit conditions

V. ☒ Air Dispersion modeling process, procedures and options:
   a. When modeling is required and possibility of waivers
   b. Protocol process, purpose, and time frame
   c. Preliminary review, purpose, and time frame
   d. Full review and time frame
   e. Peer reviews
   f. Assumptions in the modeling become permit conditions
   g. NED data should be used instead of DEM data for assigning elevations to receptors, sources, buildings, etc.

VI. ☒ Applicant’s public notice requirements

a. During the same month application package will be submitted, ask Department for memo of neighborhood associations/coalitions within ½ mile of facility
b. Fill out and send Notice of Intent to Construct form as attachment, with Applicant Notice Cover Letter as email body, to neighborhood associations/coalitions listed in memo: https://www.cabq.gov/airquality/air-quality-permits/air-quality-application-forms
c. Post and maintain a weather-proof sign. Signs are available in the downtown Program office. The Public Notice Sign Guidelines Checklist can be found on the next page of this document.

VII. ☒ Regulatory timelines

a. 30 days to rule application complete
b. 90 days after ruled complete for permitting decision
c. 30-day public comment period after application deemed complete
d. If public interest in application:
    i. 30-day review of technical analysis
    ii. 90-day extension for permitting decision
e. Request for Public Information Hearing - 90-day extension for permitting decision
f. Complex technical issues in application - 90-day extension for permitting decision
g. If application ruled incomplete it stops timeline and restarts at beginning with updated submittal

VIII. ☒ Department Policies

a. One original hard copy must be submitted along with a duplicate copy. The duplicate copy should be a high-quality electronic duplicate submitted on thumb drive as one complete PDF with all application contents found in the hardcopy, including pages with signatures. However, do not include financial information, such as a copy of a check, in the electronic PDF. The electronic submittal should also include emission calculations Excel-compatible file(s) and modeling files, if applicable.
b. Applications will be ruled incomplete if any parts from Permit Application Checklist are missing
c. Review fees paid in full are part of the application package (Except as noted above)
d. Discuss payment format (by check, credit card or online)
e. Use the most recent Permit Application Checklist, found under Part 41 Implementation on this page: https://www.cabq.gov/airquality/air-quality-permits/air-quality-application-forms
f. After three tries, permit application denied and application must start over including repayment of fees

IX. ☒ Additional Questions?

Q: Can this new site be a separate permit from the exisiting facility next door if the new site falls under a different SIC code?
A: CABQ EHD will determine if it can be a separte facility or not.
Q: Given the past history of cooling towers with CABQ EHD, will the cooling towers at this new facility need to be included on the permit/modeling or not?
A: Cooling towers will need to be included. Kairos will need to determine if the cooling towers will be separate units or all one unit.
Q: This facility will have proprietary/confidential processes. How will this affect the information disclosed to the public?
A: For application submittal, two documents may be submitted (one marked "public" and one marked "confidential". CABQ EHD will determine if the confidential information hinders the determination of emission rates from sources, in which

City of Albuquerque
Environmental Health Department
Air Quality Program

Public Notice Sign Guidelines

Any person seeking a permit under 20.11.41 NMAC, Construction Permits, shall do so by filing a written application with the Department. *Prior to submitting an application, the applicant shall post and maintain a weather-proof sign provided by the department. The applicant shall keep the sign posted until the department takes final action on the permit application; if an applicant can establish to the department's satisfaction that the applicant is prohibited by law from posting, at either location required, the department may waive the posting requirement and may impose different notification requirements.* **A copy of this form must be submitted with your application.**

Applications that are ruled incomplete because of missing information will delay any determination or the issuance of the permit. The Department reserves the right to request additional relevant information prior to ruling the application complete in accordance with 20.11.41 NMAC.

Applicant Company Name: **Kairos Power**
Facility Name: **Salt Production Facility (SPF)**

- ☒ The sign must be posted at the more visible of either the proposed or existing facility entrance (or, if approved in advance and in writing by the department, at another location on the property that is accessible to the public)
  - ☒ The sign shall be installed and maintained in a condition such that members of the public can easily view, access, and read the sign at all times.
  - ☒ The lower edge of the sign board should be mounted a minimum of 2 feet above the existing ground surface to facilitate ease of viewing
- ☒ Include at least two pictures of the completed, properly posted sign in the application package immediately following this document. One picture should show the location of the posted sign and the other should be close enough to the sign for the posted information to be legible in the picture.
- ☐ **Check here if the department has waived the sign posting requirement.**
  Alternative public notice details:

APPENDIX C. NOTICE OF INTENT TO CONSTRUCT

The following pages contain:

- Notice of Intent (NOI) to Construct Form
- Applicant Notice Cover Letter (Updated November 2023)
- Email and Certified Mail Documentation of NOI Sent to Neighborhood Associations and Coalitions
- Pictures of Posted Public Notice Sign

NOTICE FROM THE APPLICANT

Notice of Intent to Apply for Air Quality Construction Permit

You are receiving this notice because the New Mexico Air Quality Control Act (20.11.41.13B NMAC) requires any owner/operator proposing to construct or modify a facility subject to air quality regulations to provide public notice by certified mail or electronic mail to designated representatives of recognized neighborhood associations and coalitions within 0.5-mile of the property on which the source is or is proposed to be located.

This notice indicates that the owner/operator intends to apply for an Air Quality Construction Permit from the Albuquerque – Bernalillo County Joint Air Quality Program. Currently, no application for this proposed project has been submitted to the Air Quality Program. Applicants are required to include a copy of this form and documentation of mailed notices with their Air Quality Construction Permit Application.

Proposed Project Information

Applicant's name and address:
Nombre y domicilio del solicitante:
Salt Production Facility
5201 Hawking Dr. SE
Albuquerque, NM 87106

Owner / operator's name and address:
Nombre y domicilio del propietario u operador:
Kairos Power, LLC
707 W. Tower Ave, Ste. A
Alameda, CA 95401

Contact for comments and inquires:
Datos actuales para comentarios y preguntas:

Name *(Nombre):* Terrence Williams
Address *(Domicilio):* 707 W. Tower Ave, Ste. A
Phone Number *(Número Telefónico)*: (510) 775-1822
E-mail Address *(Correo Electrónico)*: williams@kairospower.com

Actual or estimated date the application will be submitted to the department:
Fecha actual o estimada en que se entregará la solicitud al departamento: February 21, 2025

Description of the source:
Descripción de la fuente: This facility will have chemical storage tanks, synthesis columns, vents, cooling towers, boilers, fugitives, and an emergency generator.

Exact location of the source or proposed source:
Ubicación exacta de la fuente o fuente propuesta: UTM Zone 13 352,786 meters E, 3,874,804 meters N

Nature of business:
Tipo de negocio: Specialized chemical processing plant for Flibe coolant

Process or change for which the permit is requested:
Proceso o cambio para el cuál de solicita el permiso: Kairos will construct a chemical processing plant to manufacture a proprietary coolant called "Flibe" which is a mixture of lithium fluoride and beryllium fluoride.

Maximum operating schedule:
Horario máximo de operaciones: 24 hours a day, 7 days a week, 52 weeks per year, 8760 hr/yr

Normal operating schedule:
Horario normal de operaciones: 24 hours a day, 7 days a week, 52 weeks per year, 8760 hr/yr

Preliminary estimate of the maximum quantities of each regulated air contaminant the source will emit:
Estimación preliminar de las cantidades máximas de cada contaminante de aire regulado que la fuente va a emitir:

Air Contaminant *Contaminante de aire*	**Proposed Construction Permit** *Permiso de Construcción Propuesto*		**Net Changes (for permit modification or technical revision)** *Cambio Neto de Emisiones (para modificación de permiso o revisión técnica)*	
	pounds per hour *libras por hora*	tons per year *toneladas por año*	pounds per hour *libras por hora*	tons per year *toneladas por año*
NO_x	5.44	12.94	-	-
CO	5.70	20.89	-	-
VOC	88.54	45.51	-	-
SO_2	2.90	3.91	-	-
PM_{10}	1.36	4.97	-	-
$PM_{2.5}$	0.67	1.95	-	-
HAP	58.90	19.66	-	-

NOTE: To add extra rows for H_2S or Pb in Word, click in a box in the last row. Click the plus (+) sign that appears on the right of the row to add a row.

Questions or comments regarding this Notice of Intent should be directed to the Applicant. Contact information is provided with the Proposed Project Information on the first page of this notice. To check the status of an Air Quality Construction Permit application, call 311 and provide the Applicant's information, or visit www.cabq.gov/airquality/air-quality-permits.

The Air Quality Program will issue a Public Notice announcing a 30-day public comment period on the permit application for the proposed project when the application is deemed complete. The Air Quality Program does not process or issue notices on applications that are deemed incomplete. More information about the air quality permitting process is attached to this notice.

Air Quality Construction Permitting Overview

This is the typical process to obtain an Air Quality Construction Permit for Synthetic Minor and Minor sources of air pollution from the Albuquerque – Bernalillo County Joint Air Quality Program.

Step 1: Pre-application Meeting: The Applicant and their consultant must request a meeting with the Air Quality Program to discuss the proposed action. If air dispersion modeling is required, Air Quality Program staff discuss the modeling protocol with the Applicant to ensure that all proposed emissions are considered.

> **Notice of Intent from the Applicant:** Before submitting their application, the Applicant is required to notify all nearby neighborhood associations and interested parties that they intend to apply for an air quality permit or modify an existing permit. The Applicant is also required to post a notice sign at the facility location.

Step 2: Administrative Completeness Review and Preliminary Technical Review: The Air Quality Program has 30 days from the day the permit is received to review the permit application to be sure that it is administratively complete. This means that all application forms must be signed and filled out properly, and that all relevant technical information needed to evaluate any proposed impacts is included. If the application is not complete, the permit reviewer will return the application and request more information from the Applicant. Applicants have three opportunities to submit an administratively complete application with all relevant technical information.

> **Public Notice from the Department:** When the application is deemed complete, the Department will issue a Public Notice announcing a 30-day public comment period on the permit application. This notice is distributed to the same nearby neighborhood associations and interested parties that the Applicant sent notices to, and published on the Air Quality Program's website.
>
> During this 30-day comment period, individuals have the opportunity to submit written comments expressing their concerns or support for the proposed project, and/or to request a Public Information Hearing. If approved by the Environmental Health Department Director, Public Information Hearings are held after the technical analysis is complete and the permit has been drafted.

Step 3: Technical Analysis and Draft Permit: Air Quality Program staff review all elements of the proposed operation related to air quality, and review outputs from advanced air dispersion modeling software that considers existing emission levels in the area surrounding the proposed project, emission levels from the proposed project, and meteorological data. The total calculated level of emissions is compared to state and federal air quality standards and informs the decision on whether to approve or deny the Applicant's permit.

Draft Permit: The permit will establish emission limits, standards, monitoring, recordkeeping, and reporting requirements. The draft permit undergoes an internal peer review process to determine if the emissions were properly evaluated, permit limits are appropriate and enforceable, and the permit is clear, concise, and consistent.

> **Public Notice from the Department:** When the technical analysis is complete and the permit has been drafted, the Department will issue a second Public Notice announcing a 30-day public comment period on the technical analysis and draft permit. This second Public Notice, along with the technical analysis documentation and draft permit, will be published on the Air Quality Program's website, and the public notice for availability of the technical analysis and draft permit will only be directly sent to those who requested further information during the first comment period.

During this second 30-day comment period, residents have another opportunity to submit written comments expressing their concerns or support for the proposed project, and/or to request a Public Information Hearing.

Possible Public Information Hearing: The Environmental Health Department Director may decide to hold a Public Information Hearing for a permit application if there is significant public interest and a significant air quality issue. If a Public Information Hearing is held, it will occur after the technical analysis is complete and the permit has been drafted.

Step 4: Public Comment Evaluation and Response: The Air Quality Program evaluates all public comments received during the two 30-day public comment periods and Public Information Hearing, if held, and updates the technical analysis and draft permit as appropriate. The Air Quality Program prepares a response document to address the public comments received, and when a final decision is made on the permit application, the comment response document is published on the Air Quality Program's website and distributed to the individuals who participated in the permit process. If no comments are received, a response document is not prepared.

Step 5: Final Decision on the Application: After public comments are addressed and the final technical review is completed, the Environmental Health Department makes a final decision on the application. If the permit application meets all applicable requirements set forth by the New Mexico Air Quality Control Act and the federal Clean Air Act, the permit is approved. If the permit application does not meet all applicable requirements, it is denied.

Notifications of the final decision on the permit application and the availability of the comment response document is published on the Air Quality Program's website and distributed to the individuals who participated in the permit process.

The Department must approve a permit application if the proposed action will meet all applicable requirements and if it demonstrates that it will not result in an exceedance of ambient air quality standards. Permit writers are very careful to ensure that estimated emissions have been appropriately identified or quantified and that the emission data used are acceptable.

The Department must deny a permit application if it is deemed incomplete three times, if the proposed action will not meet applicable requirements, if estimated emissions have not been appropriately identified or quantified, or if the emission data are not acceptable for technical reasons.

For more information about air quality permitting, visit www.cabq.gov/airquality/air-quality-permits

Fill out the required highlighted information below. Then use the Subject as the Subject line of the required public notice email(s) sent to nearby neighborhood associations/neighborhood coalitions. Copy and paste the rest of the completed information on this page into the body of the email(s) and attach the completed NOI form. If providing notice by certified mail, use this page as the cover letter and attach the NOI form.

SUBJECT: Public Notice of Proposed Air Quality Construction Permit Application Kairos Power, LLC – Salt Production Facility

Dear Neighborhood Association/Coalition Representative(s),

Why did I receive this public notice?

You are receiving this notice in accordance with New Mexico Administrative Code (NMAC) 20.11.41.13.B(1) which requires any applicant seeking an Air Quality Construction Permit pursuant to 20.11.41 NMAC to provide public notice by certified mail or electronic mail to the designated representative(s) of the recognized neighborhood associations and recognized coalitions that are within one-half mile of the exterior boundaries of the property on which the source is or is proposed to be located.

What is the Air Quality Permit application review process?

The City of Albuquerque, Environmental Health Department, Air Quality Program (Program) is responsible for the review and issuance of Air Quality Permits for any stationary source of air contaminants within Bernalillo County. Once the application is received, the Program reviews each application and rules it either complete or incomplete. Complete applications will then go through a 30-day public comment period. Within 90 days after the Program has ruled the application complete, the Program shall issue the permit, issue the permit subject to conditions, or deny the requested permit or permit modification. The Program shall hold a Public Information Hearing pursuant to 20.11.41.15 NMAC if the Director determines there is significant public interest and a significant air quality issue is involved.

What do I need to know about this proposed application?

Applicant Name	Kairos Power, LLC
Site or Facility Name	Salt Production Facility
Site or Facility Address	5201 Hawking Dr. SE, Albuquerque, NM 87106
New or Existing Source	NEW
Anticipated Date of Application Submittal	February 21, 2025
Summary of Proposed Source to Be Permitted	This application is for the authority to construct the proposed Salt Production Facility (SPF). This facility is a specialized chemical processing plant to manufacture a proprietary coolant called "Flibe" which is a mixture of lithium fluoride and beryllium fluoride. This facility will have chemical storage tanks, synthesis columns, vents, cooling towers, boilers, fugitives, and an emergency generator.

What emission limits and operating schedule are being requested?

See attached Notice of Intent to Construct form for this information.

How do I get additional information regarding this proposed application?

For inquiries regarding the proposed source, contact:

- Terrence Williams
- williams@kairospower.com
- (510) 775-1822

For inquiries regarding the air quality permitting process, contact:

- City of Albuquerque Environmental Health Department Air Quality Program
- aqd@cabq.gov
- (505) 768-1972

Daniel Dolce

From:	Daniel Dolce
Sent:	Monday, February 17, 2025 1:12 PM
To:	info@willsonstudio.com; m.ryankious@gmail.com
Cc:	Adam Erenstein; Alan Kruizenga; Terrence Williams
Subject:	Public Notice of Proposed Air Quality Construction Permit Application Kairos Power, LLC – Salt Production Facility
Attachments:	SPF_NOI Cover Letter_v1.0_2025 0217.pdf; SPF_NOI to Construct Request_v1.0_2025 0217.pdf

Dear Neighborhood Association/Coalition Representative(s),

Why did I receive this public notice?
You are receiving this notice in accordance with New Mexico Administrative Code (NMAC) 20.11.41.13.B(1) which requires any applicant seeking an Air Quality Construction Permit pursuant to 20.11.41 NMAC to provide public notice by certified mail or electronic mail to the designated representative(s) of the recognized neighborhood associations and recognized coalitions that are within one-half mile of the exterior boundaries of the property on which the source is or is proposed to be located.

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What do I need to know about this proposed application?

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How do I get additional information regarding this proposed application?
For inquiries regarding the proposed source, contact:

- Terrence Williams
- williams@kairospower.com
- (510) 775-1822

For inquiries regarding the air quality permitting process, contact:

- City of Albuquerque Environmental Health Department Air Quality Program

- aqd@cabq.gov
- (505) 768-1972

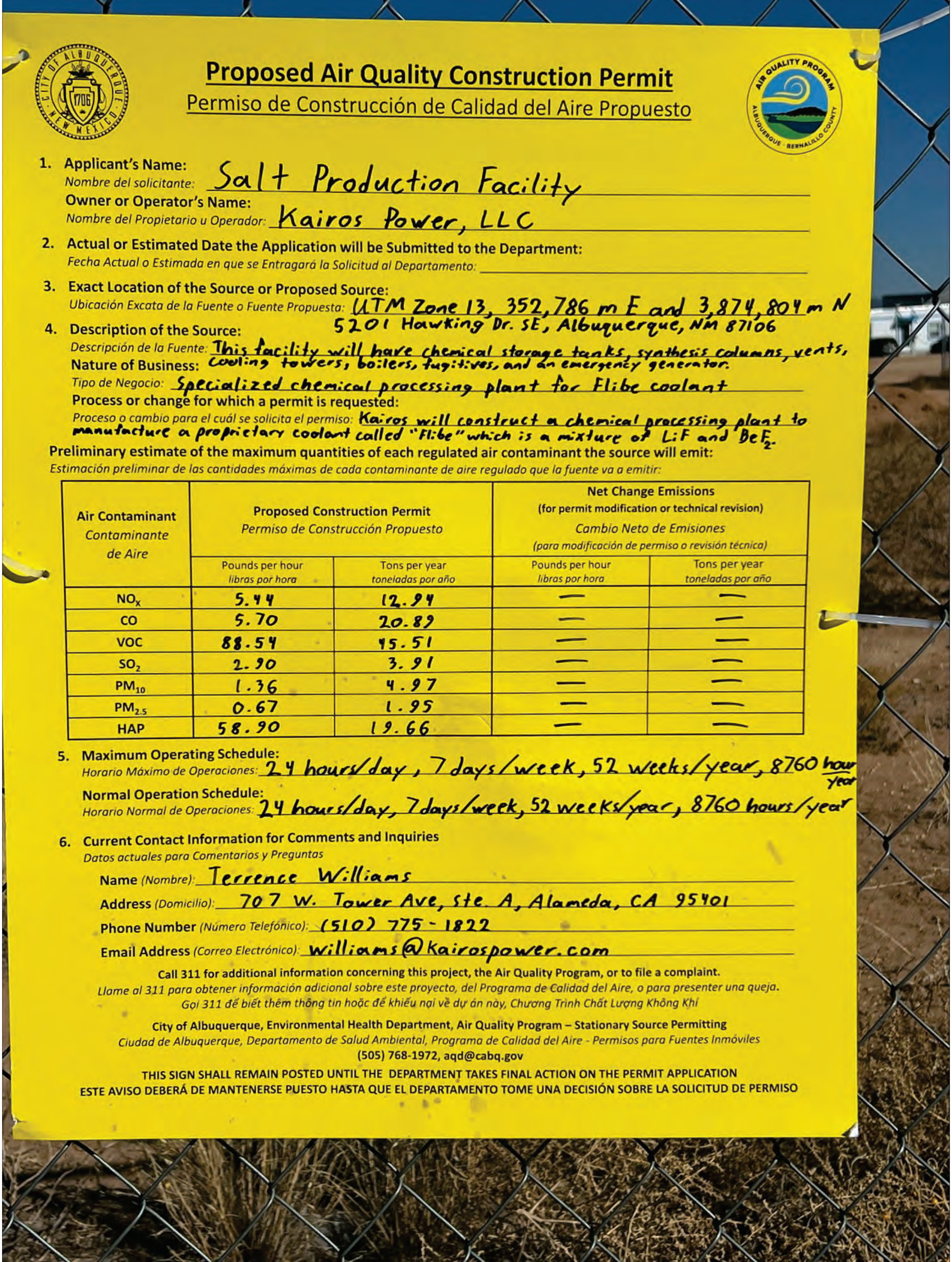
Thank you and regards,
Daniel Dolce

Daniel Dolce
Consultant

P 505.266.6611 x3208 M 505.818.8761
Email: Daniel.Dolce@trinityconsultants.com
9400 Holly Avenue NE, Building 3, Suite B, Albuquerque, NM 87122

Want to meet? Book a meeting with Daniel Dolce at Trinity Consultants.

Connect with us: LinkedIn / YouTube / trinityconsultants.com
View our capabilities in the Environmental Consulting, Built Environment, Life Sciences, and Water & Ecology markets.



Proposed Air Quality Construction Permit

Permiso de Construcción de Calidad del Aire Propuesto

1. **Applicant's Name:**
Nombre del solicitante: Salt Production Facility
Owner or Operator's Name:
Nombre del Propietario u Operador: Kairos Power, LLC

2. **Actual or Estimated Date the Application will be Submitted to the Department:**
Fecha Actual o Estimada en que se Entragará la Solicitud al Departamento:

3. **Exact Location of the Source or Proposed Source:**
Ubicación Excata de la Fuente o Fuente Propuesta: UTM Zone 13, 352,786 m E and 3,874,804 m N
5201 Hawking Dr. SE, Albuquerque, NM 87106

4. **Description of the Source:**
Descripción de la Fuente: This facility will have chemical storage tanks, synthesis columns, vents, cooling towers, boilers, fugitives, and an emergency generator.
Nature of Business:
Tipo de Negocio: Specialized chemical processing plant for Flibe coolant
Process or change for which a permit is requested:
Proceso o cambio para el cuál se solicita el permiso: Kairos will construct a chemical processing plant to manufacture a proprietary coolant called "Flibe" which is a mixture of LiF and BeF_2.

Preliminary estimate of the maximum quantities of each regulated air contaminant the source will emit:
Estimación preliminar de las cantidades máximas de cada contaminante de aire regulado que la fuente va a emitir:

Air Contaminant *Contaminante de Aire*	**Proposed Construction Permit** *Permiso de Construcción Propuesto*		**Net Change Emissions** (for permit modification or technical revision) *Cambio Neto de Emisiones (para modificación de permiso o revisión técnica)*	
	Pounds per hour *libras por hora*	Tons per year *toneladas por año*	Pounds per hour *libras por hora*	Tons per year *toneladas por año*
NO_X	5.44	12.94	—	—
CO	5.70	20.89	—	—
VOC	88.54	45.51	—	—
SO_2	2.90	3.91	—	—
PM_{10}	1.36	4.97	—	—
$PM_{2.5}$	0.67	1.95	—	—
HAP	58.90	19.66	—	—

5. **Maximum Operating Schedule:**
Horario Máximo de Operaciones: 24 hours/day, 7 days/week, 52 weeks/year, 8760 hour/year
Normal Operation Schedule:
Horario Normal de Operaciones: 24 hours/day, 7 days/week, 52 weeks/year, 8760 hours/year

6. **Current Contact Information for Comments and Inquiries**
Datos actuales para Comentarios y Preguntas

Name *(Nombre):* Terrence Williams
Address *(Domicilio):* 707 W. Tower Ave, Ste. A, Alameda, CA 95401
Phone Number *(Número Telefónico):* (510) 775-1822
Email Address *(Correo Electrónico):* williams@kairospower.com

Call 311 for additional information concerning this project, the Air Quality Program, or to file a complaint.
Llame al 311 para obtener información adicional sobre este proyecto, del Programa de Calidad del Aire, o para presenter una queja.
Gọi 311 để biết thêm thông tin hoặc để khiếu nại về dự án này, Chương Trình Chất Lượng Không Khí

City of Albuquerque, Environmental Health Department, Air Quality Program – Stationary Source Permitting
Ciudad de Albuquerque, Departamento de Salud Ambiental, Programa de Calidad del Aire - Permisos para Fuentes Inmóviles
(505) 768-1972, aqd@cabq.gov

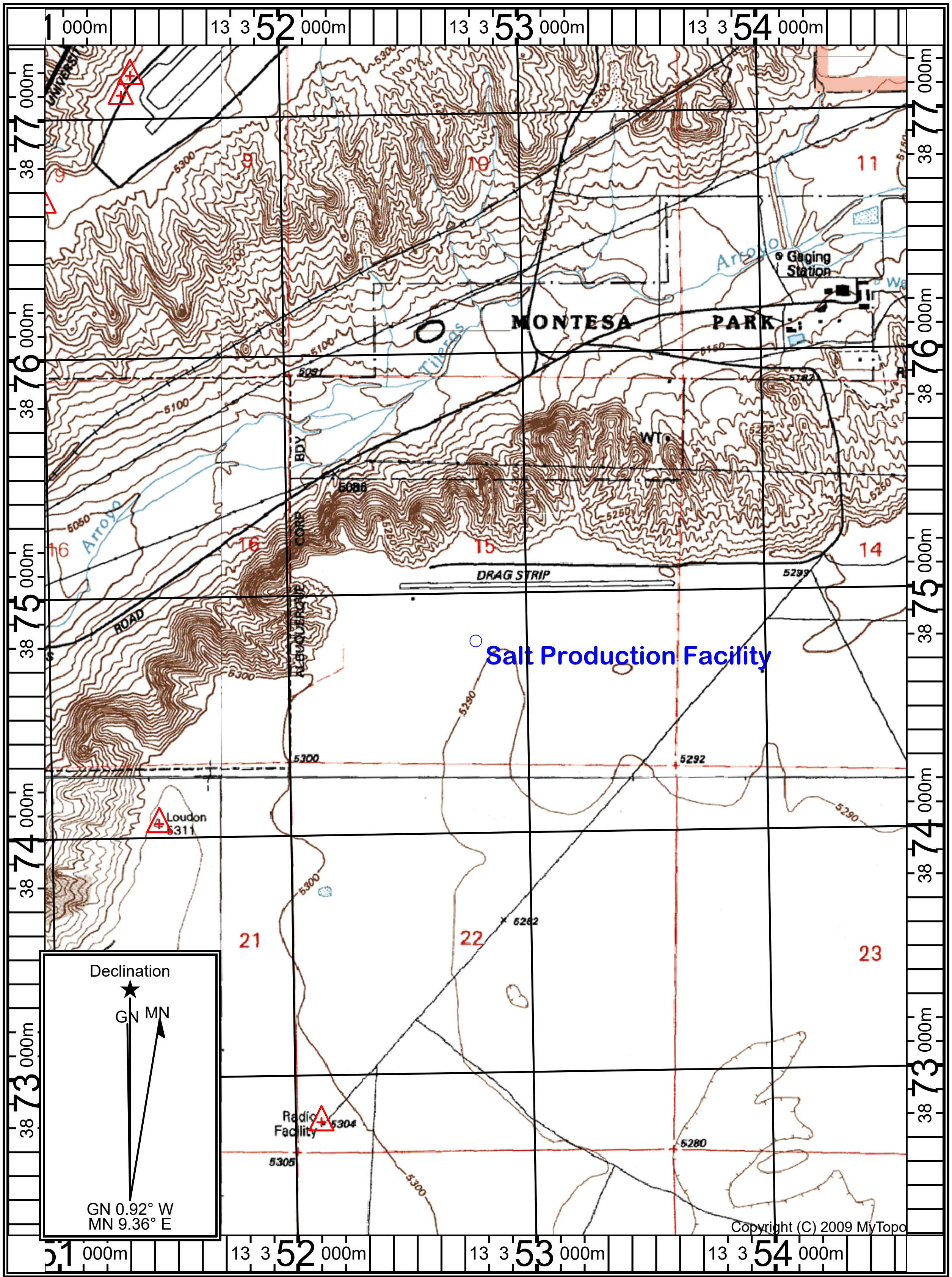
THIS SIGN SHALL REMAIN POSTED UNTIL THE DEPARTMENT TAKES FINAL ACTION ON THE PERMIT APPLICATION
ESTE AVISO DEBERÁ DE MANTENERSE PUESTO HASTA QUE EL DEPARTAMENTO TOME UNA DECISIÓN SOBRE LA SOLICITUD DE PERMISO


Kairos Power
Kairos Power
SPEED LIMIT 10

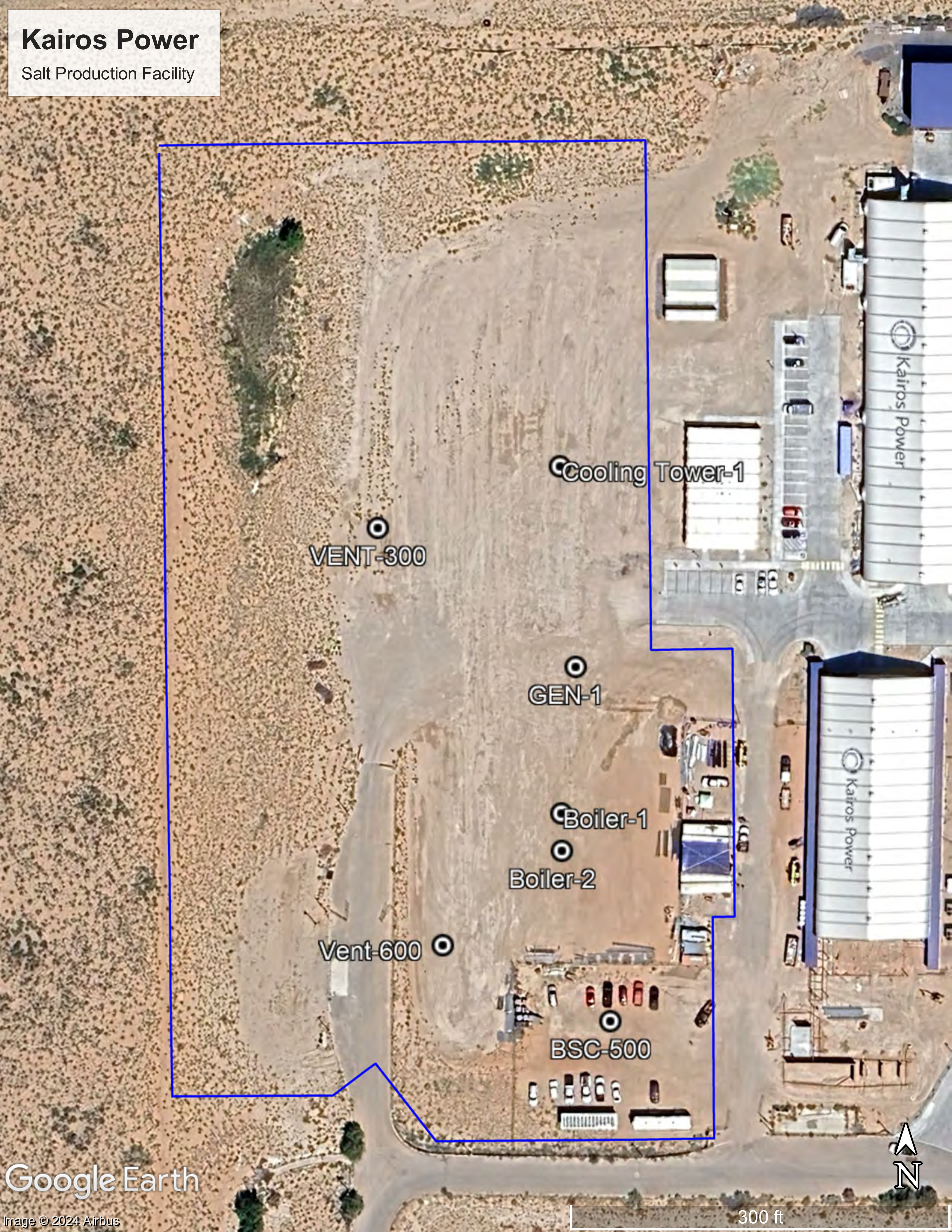
APPENDIX D. FACILITY LOCATION AND AERIAL PHOTOGRAPH

The following pages contain:

- A 7.5 minute topographic quadrangle map including a city of Albuquerque zone atlas map that shows the proposed location of each process equipment unit involved in the proposed modification
- An aerial photograph showing the proposed location of each process equipment unit involved in the proposed modification of the source (dated August 18, 2024)
- Facility plot plan showing the proposed construction and layout of the facility

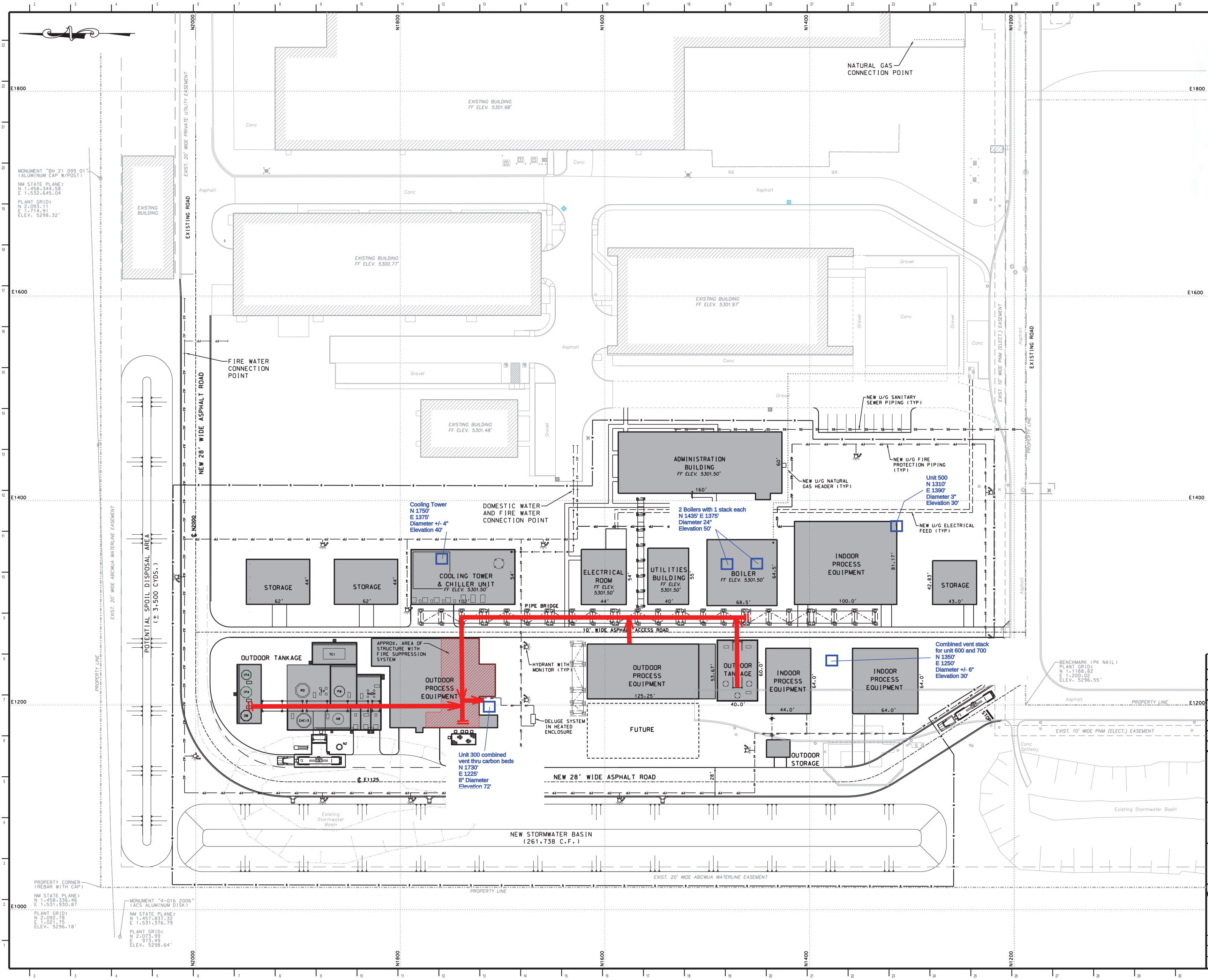


Map Name: ALBUQUERQUE EAS Scale: 1 inch = 2,000 ft. Horizontal Datum: WGS84
Print Date: 2/13/25 Map Center: 13 0352785 E 3874804



Kairos Power

Salt Production Facility




LOCATION PLAN

REVISION HISTORY

REV	DATE	DESCRIPTION	BY	CHK	APP

KBR

EXPORT COMPLIANCE STATEMENT

THIS DOCUMENT CONTAINS INFORMATION CONTROLLED BY U.S. EXPORT CONTROL LAWS AND REGULATIONS, INCLUDING BUT NOT LIMITED TO 10 C.F.R. PART 810 AND THE EXPORT ADMINISTRATION REGULATIONS. THIS EXPORT-CONTROLLED INFORMATION CANNOT BE EXPORTED OR REEXPORTED (INCLUDING DEEMED EXPORT) WITHOUT THE PRIOR WRITTEN CONSENT OF SAGUARO PROJECT AND, WHERE APPLICABLE, THE U.S. GOVERNMENT.

CONFIDENTIALITY STATEMENT

THIS DOCUMENT CONTAINS INFORMATION THAT IS PROPRIETARY TO KELLOGG BROWN & ROOT LLC. (KBR) AND IS TO BE HELD IN CONFIDENCE AS PER THE CONFIDENTIALITY AGREEMENT BETWEEN THE PARTIES. THIS DOCUMENT AND THE INFORMATION CONTAINED HEREIN SHALL NOT BE COPIED OR USED FOR OTHER THAN THE PURPOSES OF WHICH IT IS OR HAS BEEN PROVIDED OR DISCLOSED IN ANY FORM OR MEDIUM TO THIRD PARTIES EXCEPT AS EXPRESSLY PERMITTED BY KBR.

COOLANT PRODUCTION FACILITY
EMISSION PLOT PLAN
SKETCH

DRAWN EJO	CHECKED	APPROVED	DATE
SCALE 1" = 40'	DRAWING NUMBER		REV. 5
PROJ 218356			

ARCH D
24X36

APPENDIX E. ZONING REQUIREMENTS

The following page contains the following for zoning requirements of the SPF:

- Zoning Requirement Cover Letter (Revised November 3, 2023)
- Zone Designation Letter from the City of Albuquerque

City of Albuquerque
Environmental Health Department
Air Quality Program

Construction Permit (20.11.41 NMAC)
Zoning Requirement Cover Letter

This Cover Letter Must Be Returned With The Application Along With All Required Attachments

The Albuquerque-Bernalillo County Joint Air Quality Program, which administers and enforces local air quality laws for the City of Albuquerque ("City") and Bernalillo County ("County"), on behalf of the City Environmental Health Department ("Department").

Any person seeking a new air quality permit or a permit modification under 20.11.41 NMAC (Construction Permits) shall provide documentary proof that the proposed air quality permitted use of the facility's subject property is allowed by the zoning designation of the City or County zoning laws, as applicable. Sufficient documentation may include (i) a zoning certification from the City Planning Department or County Department of Planning and Development Services, as applicable, if the applicant is subject to City or County zoning jurisdiction; or (ii) a zoning verification from both planning departments if the applicant is not subject to City or County zoning jurisdiction. A zone atlas map shall not be sufficient. At this time, applicants are not required to submit documentation for the subject property's zoning designation when applying for a relocation of a portable stationary source, or a technical or administrative revision to an existing permit.

The Department will rule an application administratively incomplete if it is missing or has incorrect information. If the Department has ruled an application administratively incomplete three (3) times, the Department will deny the permit application. Any fees submitted for processing an application that has been denied will not be refunded. If the Department denies an application, a person may submit a new application and the fee required for a new application. The applicant has the burden of demonstrating that a permit should be issued.

The Department may require additional information that is necessary to make a thorough review of an application. At all times before the Department has made a final decision regarding the application, an applicant has a duty to promptly supplement and correct information the applicant has submitted in an application to the Department. The applicant's duty to supplement and correct the application includes, but is not limited to, relevant information acquired after the applicant has submitted the application and additional information the applicant otherwise determines is relevant to the application and the Department's review and decision. While the Department is processing an application, regardless of whether the Department has determined the application is administratively complete, if the Department determines that additional information is necessary to evaluate or make a final decision regarding the application, the Department may request additional information and the applicant shall provide the requested additional information.

NOTICE REGARDING SCOPE OF A PERMIT: The Department's issuance of an air quality permit only authorizes the use of the specified equipment pursuant to the air quality control laws, regulations and conditions. Permits relate to air quality control only and are issued for the sole purpose of regulating the emission of air contaminants from said equipment. Air quality permits are not a general authorization for the location, construction and/or operation of a facility, nor does a permit authorize any particular land use or other form of land entitlement. It is the applicant's/permittee's responsibility to obtain all other necessary permits from the appropriate agencies, such as the City Planning Department or County Department of Planning and Development Services, including but not limited to site plan approvals, building permits, fire department approvals and the like, as may be required by law for the location, construction and/or operation of a facility. For more information, please visit the City Planning Department website at https://www.cabq.gov/planning and the County Department of Planning and Development Services website at https://www.bernco.gov/planning.

Corporate and Facility Information: This information shall match the information in the permit application**.**

Air Quality Permit Applicant Company Name: **Kairos Power, LLC**			
Facility Name: **Salt Production Facility**			
Facility Physical Address: **5201 Hawking Dr. SE**	City: **Albuquerque**	State: **NM**	Zip: **87106**
Facility Legal Description: **Specialized chemical processing plant**			

General Operation Information: This information shall match the information in the permit application.

Permitting action being requested (please refer to the definitions in 20.11.41 NMAC):
☒ New Permit ☐ Permit Modification, Current Permit #:

Attachment Information: The location information provided to the City Planning Department or County Department of Planning and Development Services, as applicable, and reflected in the zoning certification or verifications, as applicable, shall be the same as the Facility location information provided to the Department in the air quality construction permit application.

☒ Zoning Certification Provided by: **City Planning** *This is a use-specific certification.* **City Planning Form**: https://www.cabq.gov/planning/code-enforcement-zoning **County Planning Form**: https://www.bernco.gov/planning/planning-and-land-use/applications-forms/	☐ City Zoning Verification ☐ County Zoning Verification **City Planning Form**: https://www.cabq.gov/planning/code-enforcement-zoning **County Planning Form**: https://www.bernco.gov/planning/planning-and-land-use/applications-forms/

CITY OF ALBUQUERQUE

CODE ENFORCEMENT
Plaza Del Sol Building, Suite 500
600 2nd Street NW
Albuquerque, NM 87102
Tel: (505) 924-3850 Fax: (505) 924-3847

Date: October 28, 2024

VIA Email, williams@kairospower.com
Kairos Power Southwest
Kairos Power LLC
5201 Hawking DR SE
Albuquerque, NM 87106

RE: 5201 HAWKING DR SE, ALBUQUERQUE 87105 the "property".
UPC: 101605230917540201

To Whom It May Concern:

This letter will certify that according to the map on file in this office on October 28, 2024, the referenced property, legally described as **TR D-1-A PLAT OF TRACT D-1-A MESA DEL SOL INNOVATION PARK II(BEING A REPLAT OF TRACT D-1 & D-3 MESA DEL SOL INNOVATIONPARK II) CONT 28.4377 AC** Albuquerque, Bernalillo County, New Mexico, is Zoned: **PLANNED COMMUNITY ZONE DISTRICT (PC.)**

The current uses of the property are Light manufacturing, Research or testing facility and Office all permissive uses in this Zone.

This property has been inspected and was found to be in compliance with the applicable provisions of the Integrated Development Ordinance. The site is within the Mesa del Sol Master Development Plan. The site is controlled by a site development plan, PR 2020-004448. The property is within the Kirtland Air Force Base (AFB) Military Influence Area and the Airport Protection Overlay Zone (Albuquerque International Sunport.) There are no special exceptions associated with this site.

If you have any questions, please contact me at (505) 924-3301 or by email at ametzgar@cabq.gov.

Sincerely:

Angelo Metzgar,
Code Compliance Manager, Code Enforcement, Planning Department

PO Box 1293

Albuquerque

NM 87103

www.cabq.gov

4-2 ALLOWABLE USES

Table 4-2-1: Allowable Uses

P = Permissive Primary C = Conditional Primary A = Permissive Accessory CA = Conditional Accessory CV = Conditional if Structure Vacant for 5+ years T = Temporary CT = Conditional Temporary Blank Cell = Not Allowed

Zone District >>	Residential						Mixed-use				Non-residential								Use-specific Standards
Land Uses	R-A	R-1	R-MC	R-T	R-ML	R-MH	MX-T	MX-L	MX-M	MX-H	NR-C	NR-BP	NR-LM	NR-GM	NR-SU	NR-PO A	NR-PO B	NR-PO C	
PRIMARY USES THAT MAY BE ACCESSORY IN SOME ZONE DISTRICTS																			
RESIDENTIAL USES																			
Household Living																			
Dwelling, single-family detached	P	P	P	P	P		P												4-3(B)(1)
Dwelling, mobile home			P																4-3(B)(2)
Dwelling, cluster development	P	P		P	P		P												4-3(B)(3)
Dwelling, cottage development	P	P	P	P	P		P												4-3(B)(4)
Dwelling, two-family detached (duplex)		P		P	P		P												4-3(B)(5)
Dwelling, townhouse				P	P	P	P	P	P	P									4-3(B)(6)
Dwelling, live-work				C	C	P	P	P	P	P	CA	CA							4-3(B)(7)
Dwelling, multi-family					P	P	P	P	P	P		CV							4-3(B)(8)
Group Living																			
Assisted living facility or nursing home				C	P	P	P	P	P	P									
Community residential facility, small	P	P		P	P	P	P	P	P	P									4-3(B)(9)
Community residential facility, large					P	P	P	P	P	P									4-3(B)(9)
Dormitory						P	C	P	P	P									
Group home, small					C	P	P	P	P										4-3(B)(10)
Group home, medium					C	C	C	P	P	P									4-3(B)(10)
Group home, large						C			C	C									4-3(B)(10)
CIVIC AND INSTITUTIONAL USES																			
Adult or child day care facility			C	C	C	P	P	P	P	P	P	P	A	A					
BioPark																P (in D)			4-3(C)(7)
Cemetery															P				
Community center or library	C	P		P	P	P	P	P	P	P	C	C	C	C		P		C	4-3(C)(1)
Correctional facility															P				
Elementary or middle school	C	C		C	P	P	P	P	P	P	P	P	CV			P		C	4-3(C)(2)
Fire station or police station									P	P	P	P	P	P					
High school	C	C		C	C	P	P	P	P	P	P	P	C			P			4-3(C)(3)
Hospital									P	P	P	P							4-3(C)(4)
Museum				CV	CV	C	P	P	P	P	P	P	P	P		P	A		4-3(C)(5)
Overnight shelter									C	C	C	C	C	C					4-3(C)(6)
Parks and open space	P	P		P	P	P	P	P	P	P	P	P	C	C	A	P	P	P	4-3(C)(7)
Religious institution	P	P		P	P	P	P	P	P	P	P	P	CV	CV					4-3(C)(8)
Sports field							CV	C	P	P	P	P	P	C		P		C	

Table 4-2-1: Allowable Uses
P = Permissive Primary C = Conditional Primary A = Permissive Accessory CA = Conditional Accessory
CV = Conditional if Structure Vacant for 5+ years T = Temporary CT = Conditional Temporary
Blank Cell = Not Allowed

Zone District >>	**Residential**						**Mixed-use**				**Non-residential**								**Use-specific Standards**
																NR-PO			
Land Uses	**R-A**	**R-1**	**R-MC**	**R-T**	**R-ML**	**R-MH**	**MX-T**	**MX-L**	**MX-M**	**MX-H**	**NR-C**	**NR-BP**	**NR-LM**	**NR-GM**	**NR-SU**	**A**	**B**	**C**	
University or college						CV	CV	C	P	P	P	P	CV	CV					
Vocational school						CV	P	P	P	P	P	P	P	P					
COMMERCIAL USES																			
Agriculture and Animal-related																			
Community garden	P	P	P	P	P	P	P	P	P	P	P	P	C	C		A	A	A	4-3(D)(1)
Equestrian facility	P																P	C	4-3(D)(2)
General agriculture	P											C	P	P			P	A	4-3(D)(3)
Kennel	C							C	C		P	P	P	P					4-3(D)(4)
Nursery	P								A		P	P	P	P		A	A		
Veterinary hospital	C						C	P	P	P	P	P	P	P					4-3(D)(5)
Other pet services	C						C	P	P	P	P	P	P	P					
Food, Beverage, and Indoor Entertainment																			
Adult entertainment												P	P	P					4-3(D)(6)
Auditorium or theater						A	A	A	P	P	P	P	P	P					4-3(D)(7)
Bar							C	C	P	P	P	P	P	P					4-3(D)(8)
Catering service									P	P	P	P	P	P					
Health club or gym			A		A	A	P	P	P	P	P	P	P	A					4-3(D)(9)
Mobile food truck court							C	P	P	P	P	P	P	C					4-3(D)(10)
Nightclub									P	P	P	P	P						4-3(D)(8)
Residential community amenity, indoor	P	P	P	P	P	P	P	P	P	P								C	4-3(D)(11)
Restaurant							C	P	P	P	P	P	P	P					4-3(D)(8)
Tap room or tasting room							C	C	P	P	P	P	P	P					4-3(D)(8)
Other indoor entertainment							C	P	P	P	P	P	P	P		P		C	4-3(D)(12)
Lodging																			
Bed and breakfast	A	CA		A	A	P	P												4-3(D)(13)
Campground or recreational vehicle park									C		P	P					A	C	4-3(D)(14)
Hotel or motel							P	P	P	P	P	P	P	P					4-3(D)(15)
Motor Vehicle-related																			
Car wash								P	P	P	P	P	P	P					4-3(D)(16)
Heavy vehicle and equipment sales, rental, fueling, and repair											P	C	P	P					4-3(D)(17)
Light vehicle fueling station								C	P	P	P	P	P	P					4-3(D)(18)
Light vehicle repair								P	P	P	P	P	P	P					4-3(D)(19)
Light vehicle sales and rental								C	P	P	P	P	P	P					4-3(D)(20)
Outdoor vehicle storage											C	C	P	P			A		4-3(D)(21)
Paid parking lot			A		A	A	C	P	P	A	P	P	P	P	A	A	A		4-3(D)(22)
Parking structure			A		A	A	CA	P	P	P	P	P	P	P	A				4-3(D)(22)
Offices and Services																			
Bank							P	P	P	P	P	P	P	CV					4-3(D)(23)

Table 4-2-1: Allowable Uses

P = Permissive Primary C = Conditional Primary A = Permissive Accessory CA = Conditional Accessory
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Zone District >>	Residential						Mixed-use				Non-residential								
																NR-PO			
Land Uses	R-A	R-1	R-MC	R-T	R-ML	R-MH	MX-T	MX-L	MX-M	MX-H	NR-C	NR-BP	NR-LM	NR-GM	NR-SU	A	B	C	Use-specific Standards
Blood services facility									C	C	C	P	P	P					
Club or event facility							C	P	P	P	P	P	P	CV		P	P	C	4-3(D)(24)
Commercial services								P	P	P	P	P	P	P					
Construction contractor facility and yard										C	P	P	P	P					4-3(D)(25)
Crematorium															P				
Medical or dental clinic							P	P	P	P	P	P	P	P					4-3(D)(26)
Mortuary								C	P	P	P	P	C		A				
Office							P	P	P	P	P	P	P	P					
Personal and business services, small							P	P	P	P	P	P	P	P					4-3(D)(27)
Personal and business services, large									P	P	P	P	P	P					4-3(D)(27)
Research or testing facility							P	P	P	P	P	P	P	P					4-3(D)(28)
Self-storage								C	C	P	P	P	P	P			A		4-3(D)(29)
Outdoor Recreation and Entertainment																			
Amphitheater										C	C	C	C	C	A	P	A	C	
Balloon Fiesta Park events and activities																P			4-3(D)(30)
Drive-in theater									C	C	C	C	C						4-3(D)(31)
Fairgrounds															P				
Residential community amenity, outdoor	P	P	P	P	P	P	P	P	P	P								A	
Stadium or racetrack															P	P			
Other outdoor entertainment	CA	CA	CA	CA	CA	CA	A	A	A	A	P	P	P	A		P		P	4-3(D)(32)
Retail Sales																			
Adult retail										P		P	P	P					4-3(D)(6)
Art gallery	CV	CV	C	P	P	P	P	P	P	P	P		P	A					4-3(D)(33)
Bakery goods or confectionery shop							C	P	P	P	P	P	P	P					
Building and home improvement materials store									C	C	P	P	P	C					4-3(D)(34)
Cannabis retail								P	P	P	P	P	A	A					4-3(D)(35)
Farmers' market	T		T	T	T	T	T	P	P	P	P	P	CV	CV		P	A	CA	4-3(D)(36)
General retail, small			A			A	P	P	P	P	P	P	P	P					4-3(D)(37)
General retail, medium									P	P	P	C	C						4-3(D)(37)
General retail, large									C	C	P	P							4-3(D)(37)
Grocery store								P	P	P	P		P	P					4-3(D)(38)
Liquor retail							C	A	C	C	C	C	C	C					4-3(D)(39)
Nicotine retail							CA	A	C	C	C	C	C	C					4-3(D)(40)
Pawn shop								C	P	P	P	P	P	P					4-3(D)(41)

Table 4-2-1: Allowable Uses

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Zone District >>	Residential						Mixed-use				Non-residential								Use-specific Standards
																NR-PO			
Land Uses	R-A	R-1	R-MC	R-T	R-ML	R-MH	MX-T	MX-L	MX-M	MX-H	NR-C	NR-BP	NR-LM	NR-GM	NR-SU	A	B	C	
Transportation																			
Airport															P				4-3(D)(42)
Freight terminal or dispatch center												C	P	P					4-3(D)(43)
Helipad									CA	CA	A	P	P	P	A				4-3(D)(44)
Park-and-ride lot						C	C	C	P	C	C	P	C	C	A	A			4-3(D)(45)
Railroad yard												C	P	P					4-3(D)(46)
Transit facility						C	C	C	P	P	P	P	P	P					4-3(D)(47)
INDUSTRIAL USES																			
Manufacturing, Fabrication, and Assembly																			
Artisan manufacturing							C	P	P	P	P	P	P	P					4-3(E)(1)
Cannabis cultivation							C	P	P	P	P	P	P	P					4-3(E)(2)
Cannabis-derived products manufacturing							C	P	P	P	P	P	P	P					4-3(E)(3)
Light manufacturing										A	P	P	P	P					4-3(E)(4)
Heavy manufacturing														P					4-3(E)(5)
Natural resource extraction															P				4-3(E)(6)
Special manufacturing														C					4-3(E)(7)
Telecommunications, Towers, and Utilities																			
Drainage facility	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	C	
Electric utility	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	4-3(E)(8)
Energy Storage System (ESS)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	4-3(E)(9)
Geothermal energy generation	A	A	A	A	A	A	A	A	A	A	A	P	P	P		A	A		4-3(E)(10)
Major utility, other	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	
Solar energy generation	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P	P	4-3(E)(11)
Wind energy generation							A	A	A	A	A	A	A	C	A	A	A		4-3(E)(12)
Wireless Telecommunications Facility (WTF)																			4-3(E)(13)
Architecturally integrated	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A			
Collocation	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A			
Freestanding							P	P	P	P	P	P	P	P	A				
Non-commercial or broadcasting antenna	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A			
Public utility collocation	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A			
Roof-mounted			A		A	A	A	A	A	A	A	A	A	A	A				
Small cell	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Waste and Recycling																			
Recycling drop-off bin facility						A	A	A	A	A	P	P	P	P					4-3(E)(14)
Salvage yard												C	C	P					4-3(E)(15)
Solid waste convenience center															P				4-3(E)(16)
Waste and/or recycling transfer station															P				4-3(E)(17)

Table 4-2-1: Allowable Uses

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Zone District >>	Residential						Mixed-use				Non-residential								Use-specific Standards
	R-A	R-1	R-MC	R-T	R-ML	R-MH	MX-T	MX-L	MX-M	MX-H	NR-C	NR-BP	NR-LM	NR-GM	NR-SU	NR-PO			
Land Uses																A	B	C	
Wholesaling and Storage																			
Above-ground storage of fuels or feed													C	P					
Outdoor storage								CA	C	C	C	A	P	P					4-3(E)(18)
Warehousing									C	C	P	P	P	P					4-3(E)(19)
Wholesaling and distribution center									C	C	P	P	P	P					4-3(E)(20)
ACCESSORY AND TEMPORARY USES																			
ACCESSORY USES																			**4-3(F)(1)**
Agriculture sales stand	A	A	A	A	A	A	A	A	A	A	A	A	CA	CA			A		4-3(F)(2)
Animal keeping	A	A	A	A	A	A	A	A	A	A	A	A	A	A				CA	4-3(F)(3)
Automated Teller Machine (ATM)			A		A	A	A	A	A	A	A	A	A	A		T	T		
Clean Room												CA	A	A					4-3(F)(4)
Drive-through or drive-up facility								A	A	CA	A	A	A						4-3(F)(5)
Dwelling unit, accessory	A	A		A	A		A	A	A		A	A	A	A	A		A		4-3(F)(6)
Family care facility	A	A	A	A	A	A	A	A	A	A									4-3(F)(7)
Family home day care	CA	CA	CA	CA	A	A	A												4-3(F)(8)
Garden	A	A	A	A	A	A	A	A	A	A	A	A	A				A		
Hobby breeder	A	A	A	A															4-3(F)(9)
Home occupation	A	A	A	A	A	A	A	A	A	A									4-3(F)(10)
Independent living facility				A	A	A	A	A	A	A									4-3(F)(11)
Mobile food truck	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A			4-3(F)(12)
Mobile vending cart							A	A	A	A	A	A	A	A		A		A	4-3(F)(13)
Outdoor animal run	A							CA	CA		CA		A	A					4-3(F)(14)
Outdoor dining area							CA	A	A	A	A	A	A	A	A				4-3(F)(15)
Second kitchen in a dwelling	A	A	A	A	A	A	A												4-3(F)(16)
Other use accessory to non-residential primary use							A	A	A	A	A	A	A	A	A			A	4-3(F)(17)
Other use accessory to residential primary use	A	A	A	A	A	A	A	A	A	A									4-3(F)(18)
TEMPORARY USES																			
Temporary Uses That Require A Permit																			
Circus									T		T	T	T						4-3(G)(1)
Construction staging area, trailer, or office	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T		4-3(G)(2)
Dwelling, temporary	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T		4-3(G)(3)
Fair, festival, or theatrical performance	T	T	T	T	T	T	T	T	T	T	T	T			T	T	T		4-3(G)(4)
Film production	T	T	T	T	T	T	T	T	T	T	T	T	T	T		T			4-3(G)(5)
Open air market							T	T	T	T	T						T		4-3(G)(6)

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Zone District >>	Residential						Mixed-use				Non-residential								Use-specific Standards
Land Uses	R-A	R-1	R-MC	R-T	R-ML	R-MH	MX-T	MX-L	MX-M	MX-H	NR-C	NR-BP	NR-LM	NR-GM	NR-SU	NR-PO A	NR-PO B	NR-PO C	
Park-and-ride facility, temporary						T	T	T	T	T	T	T	T	T	T		T		4-3(G)(7)
Real estate office or model home	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T				4-3(G)(8)
Safe outdoor space							CT	CT	CT	CT	T	T	T	T					4-3(G)(9)
Seasonal outdoor sales							T	T	T	T	T	T	T	T					4-3(G)(10)
Temporary use not listed			T			T	T	T	T	T	T	T	T	T	T		T		4-3(G)(11)
Temporary Uses That Do Not Require A Permit																			
Garage or yard sale	T	T	T	T	T	T	T												4-3(G)(12)
Hot air balloon takeoff/landing	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	4-3(G)(13)

APPENDIX F. SAFETY DATA SHEETS

The following pages contain the chemical safety data sheets for the following:

- Beryllium Fluoride
- Chemical A
- Chemical C
- Chloroform
- Dimethylformamide
- Hydrochloric Acid
- Hydrofluoric Acid
- Hydrogen Peroxide
- Isopropanol
- Flibe
- Lithium Hydroxide Monohydrate
- Sodium Hydroxide
- Thionyl Chloride

SAFETY DATA SHEET

1. Identification

Product identifier	Beryllium Fluoride
Other means of identification	
SDS number	M12
CAS number	7787-49-7

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name	Materion Brush Inc.
Address	6070 Parkland Boulevard Mayfield Heights, OH 44124 United States
Telephone	1.800.862.4118
Website	www.materion.com
E-mail	ehs@materion.com
Contact person	Theodore Knudson
Emergency phone number	1.800.862.4118

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Acute toxicity, oral	Category 3
	Acute toxicity, inhalation	Category 2
	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 2
	Sensitization, skin	Category 1
	Carcinogenicity (inhalation)	Category 1B
	Specific target organ toxicity, single exposure	Category 3 respiratory tract irritation
	Specific target organ toxicity, repeated exposure	Category 1 (Respiratory system)
Environmental hazards	Not classified.	
OSHA defined hazards	Not classified.	

Label elements

Signal word Danger

Hazard statement Toxic if swallowed. Fatal if inhaled. Causes skin irritation. Causes serious eye irritation. May cause an allergic skin reaction. May cause cancer. May cause respiratory irritation. Causes damage to organs (respiratory system) through prolonged or repeated exposure by inhalation.

Precautionary statement

Prevention Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Minimize dust generation and accumulation. Avoid breathing dust. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Contaminated work clothing must not be allowed out of the workplace. Wear protective gloves/protective clothing/eye protection/face protection. In case of inadequate ventilation wear respiratory protection.

Response If swallowed: Immediately call a poison center/doctor. If on skin: Wash with plenty of water. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If exposed or concerned: Get medical advice/attention. If skin irritation or rash occurs: Get medical advice/attention. If experiencing respiratory symptoms: Call a poison center/doctor. Wash contaminated clothing before reuse.

Storage Store locked up. Store in a well-ventilated place. Keep container tightly closed.

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

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information Exposure to the elements listed in Section 3 by inhalation, ingestion, and skin contact can occur when melting, casting, dross handling, pickling, chemical cleaning, heat treating, abrasive cutting, welding, grinding, sanding, polishing, milling, crushing, or otherwise heating or abrading the surface of this material in a manner which generates particulate.

For further information, please contact the Product Stewardship Department at +1.800.862.4118.

3. Composition/information on ingredients

Substances

Chemical name	Common name and synonyms	CAS number	%
Beryllium Fluoride		7787-49-7	100

4. First-aid measures

Inhalation If symptoms develop move victim to fresh air. For breathing difficulties, oxygen may be necessary. Breathing difficulty caused by inhalation of particulate requires immediate removal to fresh air. If breathing has stopped, perform artificial respiration and obtain medical help.

Skin contact Take off contaminated clothing and wash before reuse. Thoroughly wash skin cuts or wounds to remove all particulate debris from the wound. Seek medical attention for wounds that cannot be thoroughly cleansed. Treat skin cuts and wounds with standard first aid practices such as cleansing, disinfecting and covering to prevent wound infection and contamination before continuing work. Obtain medical help for persistent irritation. Material accidentally implanted or lodged under the skin must be removed.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention if symptoms persist.

Ingestion If swallowed, seek medical advice immediately and show this container or label. Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.

Most important symptoms/effects, acute and delayed May cause allergic skin reaction. May cause allergic respiratory reaction. Prolonged exposure may cause chronic effects.

Indication of immediate medical attention and special treatment needed Treatment of Chronic Beryllium Disease: There is no known treatment which will cure chronic beryllium disease. Prednisone or other corticosteroids are the most specific treatment currently available. They are directed at suppressing the immunological reaction and can be effective in diminishing signs and symptoms of chronic beryllium disease. In cases where steroid therapy has had only partial or minimal effectiveness, other immunosuppressive agents, such as cyclophosphamide, cyclosporine, or methotrexate, have been used. In view of the potential side effects of all the immunosuppressive medications, including steroids such as prednisone, they should be used only under the direct care of a physician. Other treatment, such as oxygen, inhaled steroids or bronchodilators, may be prescribed by some physicians and can be effective in selected cases. In general, treatment is reserved for cases with significant symptoms and/or significant loss of lung function. The decision about when and with what medication to treat is a judgment situation for individual physicians.

In their 2014 official statement on the Diagnosis and Management of Beryllium Sensitivity and Chronic Beryllium Disease, the American Thoracic Society states that “it seems prudent for workers with BeS to avoid all future occupational exposure to beryllium.”

General information	If exposed or concerned: get medical attention/advice. Get medical attention if symptoms occur. Wash contaminated clothing before reuse. As supplied, there is no immediate medical risk with beryllium products in article form. First aid measures provided are related to particulate containing beryllium.

5. Fire-fighting measures

Suitable extinguishing media	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. The product is non-combustible.
Unsuitable extinguishing media	Do not use water to extinguish fires around operations involving molten metal due to the potential for steam explosions.
Specific hazards arising from the chemical	Not applicable.
Special protective equipment and precautions for firefighters	Firefighters should wear full protective clothing including self contained breathing apparatus. Wear suitable protective equipment.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk. Use water spray to cool unopened containers. Water runoff can cause environmental damage.
Specific methods	Pressure-demand self-contained breathing apparatus must be worn by firefighters or any other persons potentially exposed to the particulate released during or after a fire.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Wear appropriate protective equipment and clothing during clean-up. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	This product is miscible in water. Clean up in accordance with all applicable regulations. Dike far ahead of spill for later disposal. Following product recovery, flush area with water. For waste disposal, see section 13 of the SDS.
Environmental precautions	In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. Avoid release to the environment. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Minimize dust generation and accumulation. Do not breathe dust/fume. Contaminated work clothing must not be allowed out of the workplace. Wear protective gloves/protective clothing/eye protection/face protection. Wear respiratory protection. When using, do not eat, drink or smoke. Wash thoroughly after handling.
Conditions for safe storage, including any incompatibilities	Keep locked-up. Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Avoid contact with acids and alkalies. Avoid contact with oxidizing agents.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Material	Type	Value
Beryllium Fluoride (CAS 7787-49-7)	STEL	0.002 mg/m3 (as beryllium)
	TWA	0.0002 mg/m3 (as beryllium)

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Material	Type	Value
Beryllium Fluoride (CAS 7787-49-7)	PEL	2.5 mg/m3 (as fluoride)

US. NIOSH: Pocket Guide to Chemical Hazards

Material	Type	Value
Beryllium Fluoride (CAS 7787-49-7)	Ceiling	0.0005 mg/m3 (as beryllium)
	TWA	2.5 mg/m3

US. California Code of Regulations, Title 8, Section 5155. Airborne Contaminants

Material	Type	Value
Beryllium Fluoride (CAS 7787-49-7)	Ceiling	0.025 mg/m3
		0.025 mg/m3 (as beryllium)
	PEL	0.0002 mg/m3

Biological limit values

ACGIH Biological Exposure Indices

Material	Value	Determinant	Specimen	Sampling Time
Beryllium Fluoride (CAS 7787-49-7)	3 mg/l	Fluoride	Urine	*
	2 mg/l	Fluoride	Urine	*

* - For sampling details, please see the source document.

Exposure guidelines

Based on joint research conducted with the National Institute for Occupational Safety and Health (NIOSH), Materion adopted an 8 element Beryllium Worker Protection Model (BWPM) which includes the use of a recommended exposure guideline (REG) for airborne beryllium of 0.2 µg/m3 as a time-weighted average (TWA) limit for an 8-hour work day. Subsequent NIOSH studies have shown that the BWPM has reduced but not eliminated the risk of beryllium sensitization and chronic beryllium disease (CBD) in workers. Information on the BWPM can be found at www.berylliumsafety.com or by contacting Materion at +1 800.862.4118. In January 2017, OSHA issued a comprehensive occupational health standard for beryllium which includes a Permissible Exposure Limit (PEL) of 0.2 µg/m3 as an 8-hour TWA. In its evaluation, OSHA concluded that “despite the reduction in risk expected with the new PEL, the risks of CBD and cancer to workers with average exposure levels of 0.2 µg/m3 are still clearly significant.” (Preamble to Final Rule, Occupational Exposure to Beryllium, Docket #OSHA-H005C-2006-0870, at 316.) Therefore, Materion recommends that beryllium users not only comply with the OSHA Beryllium Standard and carefully apply all elements of the BWPM, but reduce airborne exposures to the lowest feasible level.

The American Conference of Governmental Industrial Hygienists (ACGIH®) is a scientific body that has developed guidelines for all listed substances. In its development documents, the ACGIH® states that “Threshold Limit Values and Biological Exposure Indices represent conditions under which ACGIH® believes that nearly all workers may be repeatedly exposed without adverse health effects. They are not fine lines between safe and dangerous exposures, nor are they a relative index of toxicology.”

Specific genetic factors have been identified and shown to increase an individual’s susceptibility to CBD. Medical testing is available to detect those genetic factors in individuals.

Appropriate engineering controls

Ensure adequate ventilation, especially in confined areas.
Whenever possible, the use of local exhaust ventilation or other engineering controls is the preferred method of controlling exposure to airborne particulate. Where utilized, exhaust inlets to the ventilation system must be positioned as close as possible to the source of airborne generation. Avoid disruption of the airflow in the area of a local exhaust inlet by equipment such as a man-cooling fan. Check ventilation equipment regularly to ensure it is functioning properly. Provide training on the use and operation of ventilation to all users. Use qualified professionals to design and install ventilation systems.

Control parameters

VENTILATION: Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Whenever possible, the use of local exhaust ventilation or other engineering controls is the preferred method of controlling exposure to airborne particulate. Where utilized, exhaust inlets to the ventilation system must be positioned as close as possible to the source of airborne generation. Avoid disruption of the airflow in the area of a local exhaust inlet by equipment such as a man-cooling fan. Check ventilation equipment regularly to ensure it is functioning properly. Provide training on the use and operation of ventilation to all users. Use qualified professionals to design and install ventilation systems.

WET METHODS: Machining operations are usually performed under a liquid lubricant/coolant flood which assists in reducing airborne particulate. However, the cycling through of machine coolant containing finely divided particulate in suspension can result in the concentration building to a point where the particulate may become airborne during use. Certain processes such as sanding and grinding may require complete hooded containment and local exhaust ventilation. Prevent coolant from splashing onto floor areas, external structures or operators’ clothing. Utilize a coolant filtering system to remove particulate from the coolant.

WORK PRACTICES: Develop work practices and procedures that prevent particulate from coming in contact with worker skin, hair, or personal clothing. If work practices and/or procedures are ineffective in controlling airborne exposure or visual particulate from deposition on skin, hair, or clothing, provide appropriate cleaning/washing facilities. Procedures should be written that clearly communicate the facility’s requirements for protective clothing and personal hygiene. These clothing and personal hygiene requirements help keep particulate from being spread to non-production areas or from being taken home by the worker. Never use compressed air to clean work clothing or other surfaces.

Fabrication processes may leave a residue of particulate on the surface of parts, products or equipment that could result in employee exposure during subsequent material handling activities. As necessary, clean loose particulate from parts between processing steps. As a standard hygiene practice, wash hands before eating or smoking.

HOUSEKEEPING: Use vacuum and wet cleaning methods for particulate removal from surfaces. Be certain to de-energize electrical systems, as necessary, before beginning wet cleaning. Use vacuum cleaners with high efficiency particulate air (HEPA). Do not use compressed air, brooms, or conventional vacuum cleaners to remove particulate from surfaces as this activity can result in elevated exposures to airborne particulate. Follow the manufacturer’s instructions when performing maintenance on HEPA filtered vacuums used to clean hazardous materials.

Individual protection measures, such as personal protective equipment

Eye/face protection

Wear approved safety glasses, goggles, face shield and/or welder’s helmet when risk of eye injury is present, particularly during operations that generate dust, mist or fume.

Skin protection

Hand protection

Wear gloves to prevent contact with particulate or solutions. Wear gloves to prevent metal cuts and skin abrasions during handling.

Other

Protective overgarments or work clothing must be worn by persons who may become contaminated with particulate during activities. Skin contact with this material may cause, in some sensitive individuals, an allergic dermal response. Particulate that becomes lodged under the skin has the potential to induce sensitization and skin lesions.

Respiratory protection	When airborne exposures exceed or have the potential to exceed the occupational exposure limits, approved respirators must be used as specified by an Industrial Hygienist or other qualified professional. Respirator users must be medically evaluated to determine if they are physically capable of wearing a respirator. Quantitative and/or qualitative fit testing and respirator training must be satisfactorily completed by all personnel prior to respirator use. Users of tight fitting respirators must be clean shaven on those areas of the face where the respirator seal contacts the face. Use pressure-demand airline respirators when performing jobs with high potential exposures such as changing filters in a baghouse air cleaning device.
Thermal hazards	Not applicable.
General hygiene considerations	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Appearance	
Physical state	Solid.
Form	Solid.
Color	Clear. Off-white.
Odor	Not available.
Odor threshold	Not applicable.
pH	Not applicable.
Melting point/freezing point	1031 °F (555 °C)
Initial boiling point and boiling range	2120 °F (1160 °C)
Flash point	Not applicable.
Evaporation rate	Not applicable.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not applicable.
Flammability limit - upper (%)	Not applicable.
Explosive limit - lower (%)	Not applicable.
Explosive limit - upper (%)	Not applicable.
Vapor pressure	< 0.0000001 kPa at 25 °C
Vapor density	Not applicable.
Relative density	Not applicable.
Solubility(ies)	
Solubility (water)	Not applicable.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not applicable.
Decomposition temperature	Not applicable.
Viscosity	Not applicable.
Other information	
Density	1.99 g/cm3 estimated at 25 °C
Explosive properties	Not explosive.
Flash point class	Not applicable.
Molecular formula	Be-F2
Molecular weight	47.01 g/mol
Oxidizing properties	Not oxidizing.

Specific gravity	1.99 at 25 °C

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Contact with incompatible materials. Avoid dust formation. Contact with acids. Contact with alkalis.
Incompatible materials	Strong acids, alkalies and oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation	May cause sensitization by inhalation. May cause allergy or asthma symptoms or breathing difficulties if inhaled. May cause damage to organs (respiratory system) through prolonged or repeated exposure.
Skin contact	May cause an allergic skin reaction.
Eye contact	Not likely, due to the form of the product.
Ingestion	Not likely, due to the form of the product.
Symptoms related to the physical, chemical and toxicological characteristics	Respiratory disorder.

Information on toxicological effects

Acute toxicity	May cause allergy or asthma symptoms or breathing difficulties if inhaled. May cause allergic skin reaction.
Skin corrosion/irritation	Not likely, due to the form of the product.
Serious eye damage/eye irritation	Harmful in contact with eyes.

Respiratory or skin sensitization

ACGIH sensitization

BERYLLIUM AND COMPOUNDS, SOLUBLE AND INSOLUBLE COMPOUNDS, AS BE, INHALABLE FRACTION (CAS 7787-49-7)	Respiratory sensitization

Respiratory sensitization	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
Skin sensitization	May cause an allergic skin reaction.
Germ cell mutagenicity	Due to lack of data the classification is not possible.
Carcinogenicity	Cancer hazard.

IARC Monographs. Overall Evaluation of Carcinogenicity

Beryllium Fluoride (CAS 7787-49-7)	1 Carcinogenic to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

US. National Toxicology Program (NTP) Report on Carcinogens

Beryllium Fluoride (CAS 7787-49-7)	Known To Be Human Carcinogen.

Reproductive toxicity	Not classified.
Specific target organ toxicity - single exposure	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
Specific target organ toxicity - repeated exposure	May cause damage to organs (respiratory system) through prolonged or repeated exposure by inhalation.
Aspiration hazard	Due to lack of data the classification is not possible.

Chronic effects	Hazardous by OSHA criteria. May cause damage to organs through prolonged or repeated exposure. Prolonged exposure may cause chronic effects.
Further information	Symptoms may be delayed.

12. Ecological information

Ecotoxicity	No ecotoxicity data noted for the ingredient(s).
Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	Not available.
Mobility in soil	Not available.
Other adverse effects	Not available.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Material should be recycled if possible. Disposal recommendations are based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal. When this product as supplied is to be discarded as waste, it does not meet the definition of a RCRA waste under 40 CFR 261.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT	
UN number	UN1566
UN proper shipping name	Beryllium compounds, n.o.s.
Transport hazard class(es)	
Class	6.1(PGI, II)
Subsidiary risk	-
Label(s)	6.1
Packing group	II
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	IB8, IP2, IP4, T3, TP33
Packaging exceptions	153
Packaging non bulk	212
Packaging bulk	242
IATA	
UN number	UN1566
UN proper shipping name	Beryllium compound, n.o.s.
Transport hazard class(es)	
Class	6.1(PGI, II)
Subsidiary risk	-
Packing group	II
Environmental hazards	No.
ERG Code	6L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Other information	
Passenger and cargo aircraft	Allowed with restrictions.

Cargo aircraft only	Allowed with restrictions.

IMDG

UN number	UN1566
UN proper shipping name	BERYLLIUM COMPOUND, N.O.S.
Transport hazard class(es)	
Class	6.1(PGI, II)
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	No.
EmS	F-A, S-A
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

DOT

IATA; IMDG

15. Regulatory information

US federal regulations	This product is listed on the U.S. EPA TSCA Inventory. This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Beryllium Fluoride (CAS 7787-49-7)	Listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - Yes Delayed Hazard - Yes Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Beryllium Fluoride	7787-49-7	100

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Beryllium Fluoride (CAS 7787-49-7)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Clean Water Act (CWA) Section 112(r) (40 CFR 68.130)	Hazardous substance Priority pollutant Toxic pollutant
Safe Drinking Water Act (SDWA)	Not regulated.

US state regulations

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

Beryllium Fluoride (CAS 7787-49-7)	Listed: October 1, 1987

16. Other information, including date of preparation or last revision

Issue date	04-21-2016
Revision date	09-28-2017
Version #	02
Disclaimer	This document has been prepared using data from sources considered to be technically reliable and the information is believed to be correct. Materion makes no warranties, expressed or implied, as to the accuracy of the information contained herein. Materion cannot anticipate all conditions under which this information and its products may be used and the actual conditions of use are beyond its control. The user is responsible to evaluate all available information when using this product for any particular use and to comply with all Federal, State, Provincial and Local laws, statutes and regulations.
Other information	Revised information in Section 2. Revised information in Section 4. Revised information in Section 8.

SAFETY DATA SHEET

CHEMICAL A FLAKES

Revision Date 04/12/2023

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

- Trade name	Chemical A FLAKES

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

Uses of the Substance / Mixture

- Industrial uses: Uses of substances as such or in preparations at industrial sites
- Formulation
- Fuels and fuel additives
- Adhesives
- Intermediate
- Starting raw material for pharmaceutical industry

- Antioxidant
- Corrosion inhibitors
- Tanning agents
- Additive

Uses advised against

- Synthesis intermediate in organic chemistry of pharmaceutical compounds

1.3 Details of the supplier of the safety data sheet

Company

Solvay USA Inc.,
AROMA PERFORMANCE
504 CARNEGIE CENTER
PRINCETON NJ 08540, USA
Telephone number: 609-860-4000

1.4 Emergency telephone

FOR EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT, CONTACT CHEMTREC (24-Hour Number): +1-800-424-9300 within the United States and Canada, or +1-703-527-3887 for international collect calls.

SECTION 2: Hazards identification

Although OSHA has not adopted the environmental portion of the GHS regulations, this document may include information on environmental effects.

2.1 Classification of the substance or mixture

HCS 2012 (29 CFR 1910.1200)

Combustible dust	May form combustible dust concentrations in air.
Acute toxicity, Category 3	H301: Toxic if swallowed.
Acute toxicity, Category 3	H311: Toxic in contact with skin.
Skin irritation, Category 2	H315: Causes skin irritation.
Serious eye damage, Category 1	H318: Causes serious eye damage.
Skin sensitization, Category 1	H317: May cause an allergic skin reaction.
Germ cell mutagenicity, Category 2	H341: Suspected of causing genetic defects.
Carcinogenicity, Category 2	H351: Suspected of causing cancer.

2.2 Label elements

HCS 2012 (29 CFR 1910.1200)

Pictogram

Signal Word

- Danger

Hazard Statements

- May form combustible dust concentrations in air.

- H301 + H311	Toxic if swallowed or in contact with skin.
- H315	Causes skin irritation.
- H317	May cause an allergic skin reaction.
- H318	Causes serious eye damage.
- H341	Suspected of causing genetic defects.
- H351	Suspected of causing cancer.

Precautionary Statements

Prevention

- P201	Obtain special instructions before use.
- P202	Do not handle until all safety precautions have been read and understood.
- P261	Avoid breathing dust.
- P264	Wash skin thoroughly after handling.
- P270	Do not eat, drink or smoke when using this product.
- P272	Contaminated work clothing must not be allowed out of the workplace.
- P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response

- P301 + P310 + P330	IF SWALLOWED: Immediately call a POISON CENTER/ doctor. Rinse mouth.
- P302 + P352 + P312	IF ON SKIN: Wash with plenty of water.Call a POISON CENTER/ doctor if you feel unwell.
- P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/ doctor.
- P308 + P313	IF exposed or concerned: Get medical advice/ attention.
- P333 + P313	If skin irritation or rash occurs: Get medical advice/ attention.
- P362	Take off contaminated clothing and wash before reuse.

Storage

- P405 Store locked up.

Disposal

- P501 Dispose of contents/ container to an approved waste disposal plant.

2.3 Other hazards which do not result in classification

- H401: Toxic to aquatic life.

SECTION 3: Composition/information on ingredients

3.1 Substance

Hazardous Ingredients and Impurities

Chemical name	Identification number CAS-No.	Concentration [%]
Chemical A	[redacted]	>= 98.5 - <= 100

The specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret.

3.2 Mixture

- Not applicable, this product is a substance.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice

- Show this material safety data sheet to the doctor in attendance.
- First responder needs to protect himself.
- Place affected apparel in a sealed bag for subsequent decontamination.

In case of inhalation

- Move to fresh air.
- If breathing is difficult, give oxygen.
- Consult a physician if necessary.

In case of skin contact

- Take off contaminated clothing and shoes immediately.
- Wash off with plenty of water.
- Wash immediately and thoroughly for a prolonged period (at least 15 minutes).
- Call a physician if irritation develops or persists.

In case of eye contact

- Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
- Get immediate medical advice/ attention.
- If it is necessary to transport the patient to a physician and the eye needs to be bandaged, use a dry sterile cloth pad and cover both eyes.

In case of ingestion

- Do NOT induce vomiting.
- Rinse mouth with water.
- Do not give anything to drink.

- Consult a physician if necessary.

4.2 Most important symptoms and effects, both acute and delayed

Effects

- Skin contact may aggravate existing skin disease
- Inhalation of product may aggravate existing chronic respiratory problems such as asthma, emphysema or bronchitis

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician

- All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

- SKIN EXPOSURE: Immediately, wash all exposed skin with a large volume of water or isopropyl alcohol. The following polyvinylpyrrolidone treatment has been used successfully to minimize the effects of skin contact with and to reduce absorption through the skin of phenol-like materials. This recommendation is based on the ability of PVP to strongly complex phenol compounds. PVP can be applied directly as a water paste or as a neutralizing solution of 40 grams PVP, 1/2 gallon water and 1/2 gallon isopropyl alcohol. For contact over 10% of body, treat by removing clothes and shoes under a shower and then wrapping in PVP-soaked towels. Transport to hospital for observation and further treatment. Keep a supply of PVP solution on hand.

SECTION 5: Firefighting measures

Flash point	282 °F (139 °C) closed cup
Autoignition temperature	950 °F (510 °C)
Flammability / Explosive limit	No data available

5.1 Extinguishing media

Suitable extinguishing media

- Water spray
- Carbon dioxide (CO2)
- Foam
- Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media

- High volume water jet

5.2 Special hazards arising from the substance or mixture

- On combustion, toxic gases are released.
- Combustible solid.
- Risk of dust explosion.

5.3 Advice for firefighters

Special protective equipment for fire-fighters

- Firefighters should wear NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing.

Specific fire fighting methods

- Use appropriate means for fighting adjacent fires.
- Evacuate personnel to safe areas.
- Cool containers/tanks with water spray.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

- Avoid dust formation.
- Avoid contact with eyes, skin, and respiratory system.
- Use personal protective equipment.
- For personal protection see section 8.
- Do not allow uncontrolled discharge of product into the environment.
- Mark the contaminated area with signs and prevent access to unauthorized personnel.
- Only qualified personnel equipped with suitable protective equipment may intervene.
- Ventilate the area.

6.2 Environmental precautions

- Do not allow uncontrolled discharge of product into the environment.
- Dam up.
- Contain the spilled material by diking.

- Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies

6.3 Methods and materials for containment and cleaning up

Recovery

- Recover as much of the product as possible.
- Collect the product with suitable means.
- Use approved industrial vacuum cleaner for removal.
- Shovel into suitable container for disposal.
- Avoid dust formation.
- Non-sparking tools should be used.
- Keep in properly labeled containers.
- Plastic materials.
- Keep in suitable, closed containers for disposal.

Decontamination / cleaning

- Wash with caustic soda solution (2-5 % NaOH).
- Wash off with plenty of water.
- Recover the cleaning water for subsequent disposal.

Disposal

- Treat recovered material as described in the section "Disposal considerations".

Additional advice

- Equipment required for containment/clean-up

6.4 Reference to other sections

- 8. EXPOSURE CONTROLS/PERSONAL PROTECTION
- 13. DISPOSAL CONSIDERATIONS

SECTION 7: Handling and storage

7.1 Precautions for safe handling

- Avoid dust formation.
- Potential dust explosion hazard.
- Non-sparking tools should be used.
- Dry powders can build static electricity charges when subjected to the friction of transfer and mixing operations.
- It is recommended that all dust control equipment such as local exhaust ventilation and material transport systems involved in handling of this product contain explosion relief vents or an explosion suppression system or an oxygen deficient environment.
- Use only with adequate ventilation/personal protection.
- For personal protection see section 8.
- Avoid any direct contact with the product.
- The product must only be handled by specifically trained employees.

Hygiene measures

- Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this materials:
- 1) Do not store, use, and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored.
- 2) Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet.
- 3) Wash exposed skin promptly to remove accidental splashes or contact with material.

- Ensure that eyewash stations and safety showers are close to the workstation location.
- Use clean, well maintained personal protection equipment.
- Contaminated work clothing should not be allowed out of the workplace.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/Storage conditions

- Prevent unauthorized access.
- The floor of the depot should be impermeable and designed to form a watertight basin.
- Take all necessary measures to avoid accidental discharge of products into drains and waterways due to the rupture of containers or transfer systems.
- Do not allow contact with air.
- Protect against light.
- Keep in a well-ventilated place.
- Keep container tightly closed and dry.
- Keep away from open flames, hot surfaces and sources of ignition.
- Store in original container.

- Keep away from: Acids, Alkalis and caustic products.

Packaging material

Suitable material
- For the product as flakes
- Polyethylene
- Tinted glass.
- Molten form
- Stainless steel

Unsuitable material
- Aluminum and its alloys.

Remarks
- Keep only in the original container.
- Flexible container lined with a plastic film.

- Cardboard drum with a polyethylene bag.
- Paper bag lined with a plastic film.

7.3 Specific end use(s)

- Contact your supplier for additional information

SECTION 8: Exposure controls/personal protection

Introductory Remarks: These recommendations provide general guidance for handling this product. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Assistance with selection, use and maintenance of worker protection equipment is generally available from equipment manufacturers.

8.1 Control parameters

Components with workplace occupational exposure limits

Components	Value type	Value	Basis
Chemical A	TWA	5 ppm 20 mg/m3	National Institute for Occupational Safety and Health
	Potential for dermal absorption		
Chemical A	TWA	5 ppm	American Conference of Governmental Industrial Hygienists
	Danger of cutaneous absorption		
Chemical A	TWA	1.5 mg/m3	Solvay Acceptable Exposure Limit
	Skin		
Particulates not otherwise regulated	PEL	15 mg/m3	Occupational Safety and Health Administration - Table Z-1 Limits for Air Contaminants
	Form of exposure : Total dust		
Particulates not otherwise regulated	PEL	5 mg/m3	Occupational Safety and Health Administration - Table Z-1 Limits for Air Contaminants
	Form of exposure : Respirable fraction		
Chemical A	TWA	5 ppm 20 mg/m3	National Institute for Occupational Safety and Health
	Potential for dermal absorption		
Chemical A	TWA	5 ppm	American Conference of Governmental Industrial Hygienists
	Danger of cutaneous absorption		
Chemical A	TWA	1.5 mg/m3	Solvay Acceptable Exposure Limit
	Skin		

Biological Exposure Indices

Components	Value type	Value	Basis
Chemical A	BEI	5 % Hb Methemoglobin In blood During or at the end of the shift	American Conference of Governmental Industrial Hygienists
	Nonspecific Background		

8.2 Exposure controls

Control measures

Engineering measures

- Where engineering controls are indicated by use conditions or a potential for excessive exposure exists, the following traditional exposure control techniques may be used to effectively minimize employee exposures :

- Dust must be extracted directly at the point of origin.
- Apply technical measures to comply with the occupational exposure limits.

Individual protection measures

Respiratory protection

- When respirators are required, select NIOSH/MSHA approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or industrial recommendations.

Hand protection

- Where there is a risk of contact with hands, use appropriate gloves
- Gloves must be inspected prior to use.
- Gloves should be discarded and replaced if there is any indication of degradation or chemical breakthrough.

Suitable material

- Nitrile rubber
- PVC

Eye protection

- Eye and face protection requirements will vary dependent upon work environment conditions and material handling practices. Appropriate ANSI Z87 approved equipment should be selected for the particular use intended for this material.
- Eye contact should be prevented through the use of:

- Safety glasses with side-shields
- Goggles

Skin and body protection

- Choose body protection according to the amount and concentration of the dangerous substance at the work place.
- Remove and wash contaminated apparel.
- Wear suitable protective clothing, gloves and eye/face protection.

Hygiene measures

- Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this materials:
- 1) Do not store, use, and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored.
- 2) Wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics, or using the toilet.

- 3) Wash exposed skin promptly to remove accidental splashes or contact with material.

- Ensure that eyewash stations and safety showers are close to the workstation location.
- Use clean, well maintained personal protection equipment.
- Contaminated work clothing should not be allowed out of the workplace.

Protective measures
- The protective equipment must be selected in accordance with current local standards and in cooperation with the supplier of the protective equipment.
- Selection of appropriate personal protective equipment should be based on an evaluation of the performance characteristics of the protective equipment relative to the task(s) to be performed, conditions present, duration of use, and the potential hazards, and/or risks that may occur during use.
- Handle in accordance with good industrial hygiene and safety practice.

SECTION 9: Physical and chemical properties

Physical and Chemical properties here represent typical properties of this product. Contact the business area using the Product information phone number in Section 1 for its exact specifications.

9.1 Information on basic physical and chemical properties

Physical state	solid liquid (> 221 °F (> 105 °C))
Form	Flakes
Color	beige to brown.
Odor	slight, phenol-like
Odor Threshold	No data available
Melting point/freezing point	Melting point/range: 221 °F (105 °C) (759.81 mmHg (1,013 hPa))
Initial boiling point and boiling range	Boiling point/boiling range: 473.9 °F (245.5 °C) (759.81 mmHg (1,013 hPa)) Boiling point/boiling range: 349 °F (176 °C) (99.76 mmHg (133 hPa)) Boiling point/boiling range: 219 °F (104 °C) (5.03 mmHg (6.7 hPa))
Flammability (solid, gas)	Not highly flammable. Method: A10Flammability (solids) May form combustible dust concentrations in air.
Flammability (liquids)	No data available
Flammability / Explosive limit	No data available
Flash point	282 °F (139 °C) (750.81 mmHg (1,001 hPa)) closed cup
Autoignition temperature	No data available
Decomposition temperature	No data available
pH	3.2 (10 % (m/v)) Aqueous solution pKa: 9.2

	13.0
Viscosity	Viscosity, dynamic : Not applicable, solid Viscosity, kinematic : Not applicable, solid
Solubility	Water solubility: soluble 517.5 g/l (68 °F (20 °C)) 584 g/l (77 °F (25 °C)) Solubility in other solvents: Acetone: 660 g/l (68 °F (20 °C)) soluble Ethanol: 582 g/l (68 °F (20 °C)) soluble Chloroform: 19 g/l (68 °F (20 °C)) soluble carbon tetrachloride.: 1 g/l (68 °F (20 °C)) slightly soluble
Partition coefficient: n-octanol/water	log Pow: 0.93
Vapor pressure	0.04 mmHg (0.05 hPa) (77 °F (25 °C)) 5.00 mmHg (6.66 hPa) (219 °F (104 °C))
Density	Bulk density: 500 - 600 kg/m3 loose
Relative density	1.341 - 1.371 (59 °F (15 °C))
Relative vapor density	3.8
Particle characteristics	Particle size: 1,000 µm (90.3 % m/m) ca. 100 µm (1.05 % m/m)
Evaporation rate (Butylacetate = 1)	No data available

9.2 Other information

Oxidizing properties	Not considered as oxidizing., Structure-activity relationship (SAR)
Self-ignition	950 °F (510 °C) (759.81 mmHg (1,013 hPa)) Relative self-ignition temperature for solids
Impact sensitivity	Not explosive Structure-activity relationship (SAR)
Molecular weight	110.11 g/mol

SECTION 10: Stability and reactivity

10.1 Reactivity

- Not classified as a reactivity hazard.

10.2 Chemical stability

- Stable at room temperature.

10.3 Possibility of hazardous reactions

- Hazardous polymerization does not occur.

10.4 Conditions to avoid

- Heat, flames and sparks.
- Static electricity
- Avoid dust formation.

10.5 Incompatible materials

- Reacts with the following substances:
- Bases
- Oxidizing agents
- Acids

10.6 Hazardous decomposition products

Hazardous decomposition products

- On combustion or on thermal decomposition (pyrolysis), releases:
- Toxic Gas

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Acute oral toxicity	LD50 : 300 mg/kg - Rat , males This product is classified as acute toxicity category 3 Published data
Acute inhalation toxicity	
Chemical A	LC0 - 8 h : >= 2.8 mg/l - Rat , females Not classified as hazardous for acute inhalation toxicity according to GHS. Published data
Acute dermal toxicity	
Chemical A	LD50 : 600 mg/kg - Rat , male and female Method: OECD Test Guideline 402 This product is classified as acute toxicity category 3 Unpublished internal reports
Acute toxicity (other routes of administration)	No data available

Skin corrosion/irritation

Chemical A	Rabbit Skin irritation Published data

Serious eye damage/eye irritation

Rabbit
Risk of serious damage to eyes.
Published data

Respiratory or skin sensitization

Chemical A

Guinea pig
Classified as a skin sensitizer category 1 according to GHS criteria
Published data

Mutagenicity

Genotoxicity in vitro

Chemical A

Suspected of causing genetic defects.
internal evaluation
Published data
Unpublished internal reports

Genotoxicity in vivo

Chemical A

Suspected of causing genetic defects.
internal evaluation
Published data
Unpublished internal reports

Carcinogenicity

Chemical A

Rat , male
Oral exposure
Exposure time: two-year
NOAEL: 65mg/kg bw/day
LOAEL: 141mg/kg bw/dayTarget Organs: Stomach
Published data

Components	CAS-No.	Rating	Basis
Chemical A	[redacted]	Group 2B: Possibly carcinogenic to humans	IARC

This product does not contain any ingredient designated as probable or suspected human carcinogens by:
NTP
OSHA

Toxicity for reproduction and development

Toxicity to reproduction / fertility

Chemical A

Rat, male and female, Oral exposure
Fertility NOAEL Parent: 160 mg/kg
Method: OECD Test Guideline 422
no impairment of fertility has been observed, No embryotoxic effects have been observed in animal tests., Unpublished internal reports

Developmental Toxicity/Teratogenicity No data available

STOT

STOT-single exposure

Chemical A

The substance or mixture is not classified as specific target organ toxicant, single exposure according to GHS criteria.
internal evaluation

STOT-repeated exposure

Chemical A	The substance or mixture is not classified as specific target organ toxicant, repeated exposure according to GHS criteria. internal evaluation
Chemical A	Oral exposure 52 Days - Rat NOEL: 30 mg/kg Target Organs: Digestive organs Method: OECD Test Guideline 422 Symptoms: Local irritation No systemic toxicity observed. Unpublished internal reports

Experience with human exposure No data available

CMR effects

Carcinogenicity

Chemical A Sufficient evidence of carcinogenicity in animal experiments

Mutagenicity

Chemical A Classified as mutagen category 2 according to GHS criteria.

Aspiration toxicity

Chemical A Not applicable

SECTION 12: Ecological information

12.1 Toxicity

Aquatic Compartment

Acute toxicity to fish Chemical A

LC50 - 96 h : 9.2 mg/l - Pimephales promelas (fathead minnow)
flow-through test

Method: OECD Test Guideline 203
(nominal concentrations)
Toxic to fish.
Published data

Acute toxicity to daphnia and other aquatic invertebrates

Chemical A

EC50 - 48 h : 1.09 mg/l - Daphnia magna (Water flea)
semi-static test
Method: OECD Test Guideline 202
Toxic to aquatic invertebrates.
internal evaluation
Unpublished internal reports

Toxicity to aquatic plants Chemical A

EC50 - 96 h : 22 mg/l - Chlorella vulgaris (Fresh water algae)
Method: OECD Test Guideline 201
Growth rate
Harmful to algae.
Published data

Toxicity to microorganisms

Chemical A	IC50 - 48 h : 19.58 mg/l - Tetrahymena pyriformis Published data
Chronic toxicity to fish	No data available
Chronic toxicity to daphnia and other aquatic invertebrates	No data available

Terrestrial Compartment

Toxicity to soil dwelling organisms Chemical A	NOEC: ca. 500 mg/kg - 42 Days - Eisenia fetida (earthworms) (nominal concentrations) Published data

12.2 Persistence and degradability

Abiotic degradation

Stability in water

Chemical A	DT50: Half-life value: < 1 Days Published data
Physical- and photo-chemical elimination	No data available

Biodegradation

Biodegradability

Chemical A	Ready biodegradability study: Method: OECD Test Guideline 301C The substance fulfills the criteria for ultimate aerobic biodegradability and ready biodegradability Published data Inherent biodegradability study The substance fulfills the criteria for inherent ultimate biodegradability Published data

Degradability assessment

Chemical A	The product is considered to be rapidly degradable in the environment

12.3 Bioaccumulative potential

Partition coefficient: n-octanol/water

Chemical A	Not potentially bioaccumulable Published data
Bioconcentration factor (BCF)	No data available

12.4 Mobility in soil

Adsorption potential (Koc)

Chemical A	Koc: 118.44 Method: OECD Test Guideline 106 Not expected to adsorb on soil.

	Published data

Known distribution to environmental compartments

Chemical A	Ultimate destination of the product: Water Structure-activity relationship (SAR)

12.5 Results of PBT and vPvB assessment

Chemical A	This substance is not considered to be persistent, bioaccumulating, and toxic (PBT). This substance is not considered to be very persistent and very bioaccumulating (vPvB).

12.6 Other adverse effects

Ecotoxicity assessment

Short-term (acute) aquatic hazard

Chemical A	Toxic to aquatic life.

Long-term (chronic) aquatic hazard

Chemical A	Not classified due to data which are conclusive although insufficient for classification.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product Disposal

- Chemical additions, processing or otherwise altering this material may make the waste management information presented in this SDS incomplete, inaccurate or otherwise inappropriate. Please be advised that state and local requirements for waste disposal may be more restrictive or otherwise different from federal laws and regulations. Consult state and local regulations regarding the proper disposal of this material.

Prohibition

- Should not be released into the environment.
- Do not dispose of together with household waste.

Waste Code

- RCRA Hazardous Waste (40 CFR 302)
- Hazardous Waste – NO

Advice on cleaning and disposal of packaging

- Dispose of in accordance with local regulations.

Measure for waste avoidance or recovery

- Do not dispose of with domestic refuse.

SECTION 14: Transport information

Transportation status: IMPORTANT! Statements below provide additional data on listed transport classification.

The listed Transportation Classification does not address regulatory variations due to changes in package size, mode of shipment or other regulatory descriptors.

49 CFR

14.1 UN number	UN 2811
14.2 Proper shipping name	TOXIC SOLIDS, ORGANIC, N.O.S. (Chemical A)
14.3 Transport hazard class	6.1
Label(s)	6.1
14.4 Packing group	
Packing group	III
ERG No	154
14.5 Environmental hazards **Marine pollutant**	NO

14.6 Special precautions for user

This product contains one or more ingredients identified as a hazardous substance in Appendix A of 49 CFR 172.101.

Reportable quantities : RQ substance: Chemical A
RQ limit for substance: 100 lb
RQ limit for product: 100 lb

TDG

14.1 UN number	UN 2811
14.2 Proper shipping name	TOXIC SOLID, ORGANIC, N.O.S. (Chemical A)
14.3 Transport hazard class	6.1
Label(s)	6.1
14.4 Packing group	
Packing group	III
ERG No	154
14.5 Environmental hazards **Marine pollutant**	NO

NOM

No data available

IMDG

14.1 UN number	UN 2811
14.2 Proper shipping name	TOXIC SOLID, ORGANIC, N.O.S. (Chemical A)

14.3 Transport hazard class	6.1
Label(s)	6.1

14.4 Packing group

Packing group	III

14.5 Environmental hazards	NO
Marine pollutant	

14.6 Special precautions for user

EmS	F-A , S-A

For personal protection see section 8.

14.7 Transport in bulk vessels according to IMO instruments

No data available

IATA

14.1 UN number	UN 2811
14.2 Proper shipping name	TOXIC SOLID, ORGANIC, N.O.S. (Chemical A)
14.3 Transport hazard class	6.1
Label(s):	6.1

14.4 Packing group

Packing group	III
Packing instruction (cargo aircraft)	677
Max net qty / pkg	200.00 kg
Packing instruction (passenger aircraft)	670
Max net qty / pkg	100.00 kg
14.5 Environmental hazards	NO

14.6 Special precautions for user

For personal protection see section 8.

Note: The above regulatory prescriptions are those valid on the date of publication of this sheet. Given the possible evolution of transportation regulations for hazardous materials, it would be advisable to check their validity with your sales office.

SECTION 15: Regulatory information

15.1 Notification status

Inventory Information	Status
United States TSCA Inventory	- All substances listed as active on the TSCA inventory
Canadian Domestic Substances List (DSL)	- Listed on Inventory
Australian Inventory of Industrial Chemicals (AIIC)	- Listed on Inventory

Japan. CSCL - Inventory of Existing and New Chemical Substances	- Listed on Inventory
Korea. Korean Existing Chemicals Inventory (KECI)	- Listed on Inventory
China. Inventory of Existing Chemical Substances in China (IECSC)	- Listed on Inventory
Philippines Inventory of Chemicals and Chemical Substances (PICCS)	- Listed on Inventory
Taiwan Chemical Substance Inventory (TCSI)	- Listed on Inventory
Taiwan Chemical Substance Inventory (TCSI)	- Listed on Inventory
New Zealand. Inventory of Chemical Substances	- All components are listed on the NZIoC inventory. Additional HSNO obligations may apply. Please refer to Section 15 of SDS for New Zealand.
Mexico INSQ (INSQ)	- Listed on Inventory
EU. European Registration, Evaluation, Authorization and Restriction of Chemical (REACH)	- When purchased from a Solvay legal entity based in the EEA ("European Economic Area"), this product is compliant with the registration provisions of the REACH Regulation (EC) No. 1907/2006 as all its components are either excluded, exempt, and/or registered. When purchased from a legal entity outside of the EEA, please contact your local representative for additional information.

15.2 Federal Regulations

US. EPA EPCRA SARA Title III

SARA HAZARD DESIGNATION SECTIONS 311/312 (40 CFR 370)

Combustible dust	Yes
Acute toxicity (any route of exposure)	Yes
Skin corrosion or irritation	Yes
Serious eye damage or eye irritation	Yes
Respiratory or skin sensitization	Yes
Germ cell mutagenicity	Yes
Carcinogenicity	Yes

The categories not mentioned are not relevant for the product.

Section 313 Toxic Chemicals (40 CFR 372.65)
The following components are subject to reporting levels established by SARA Title III, Section 313:

Components	CAS-No.	Concentration
Chemical A	[redacted]	98.5- 100%

Section 302 Emergency Planning Extremely Hazardous Substance Threshold Planning Quantity (40 CFR 355)
This material does not contain any components with a section 302 EHS TPQ.

Section 302 Emergency Planning Extremely Hazardous Substance Reportable Quantity (40 CFR 355)

Components	CAS-No.	Reportable quantity
Hydroquinone	123-31-9	100 lb
Phenol	108-95-2	1000 lb

Section 304 Emergency Release Notification Reportable Quantity (40 CFR 355)

Components	CAS-No.	Reportable quantity
Hydroquinone	123-31-9	100 lb
Phenol	108-95-2	1000 lb

US. EPA CERCLA Hazardous Substances and Reportable Quantities (40 CFR 302.4)

Components	CAS-No.	Reportable quantity
Chemical A	[redacted]	100 lb
Hydroquinone	123-31-9	100 lb
Phenol	108-95-2	1000 lb
Benzoic acid	65-85-0	5000 lb

15.3 State Regulations

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)

This product can expose you to chemicals including Chemical A [redacted], which is/are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

SECTION 16: Other information

NFPA (National Fire Protection Association) - Classification

Health	3 serious
Flammability	3 serious
Instability or Reactivity	0 minimal

HMIS (Hazardous Materials Identification System (Paint & Coating)) - Classification

Health	3 serious
Flammability	3 serious
Reactivity	0 minimal
PPE	Determined by User; dependent on local conditions

Further information

- Distribute new edition to clients

Date Prepared: 04/12/2023

Key or legend to abbreviations and acronyms used in the safety data sheet

- PEL: Permissible exposure limit
- STEL: Short-term exposure limit
- TWA: Time weighted average
- SAEL: Solvay Acceptable Exposure Limit
- ACGIH: American Conference of Governmental Industrial Hygienists
- OSHA: Occupational Safety and Health Administration

- NTP: National Toxicology Program
- IARC: International Agency for Research on Cancer
- NIOSH: National Institute for Occupational Safety and Health
- ADR: European Agreement on International Carriage of Dangerous Goods by Road.
- ADN: European Agreement on the International Carriage of Dangerous Goods by Inland Waterways.
- RID: European Agreement concerning the International Carriage of Dangerous Goods by Rail.
- IATA: International Air Transport Association.
- ICAO-TI: Technical Specification for Safe Transport of Dangerous Goods by Air.
- IMDG: International Maritime Dangerous Goods.
- TWA: Time weighted average
- ATE: Estimated value of acute toxicity
- EC: European Community number
- CAS: Chemical Abstracts Service.
- LD50: Substance that causes 50% (half) death in the test animals group (Median Fatal Dose).
- LC50: Substance concentration causing 50% (half) death in the test animals group.
- EC50: Effective Concentration of the substance causing the maximum of 50%.
- PBT: Persistent, Bioaccumulative and Toxic substance.
- vPvB: Very Persistent and Very Bioaccumulative.
- SEA: Classification, labeling, packaging regulation
- DNEL: Derived No Effect Level
- PNEC: Predicted No Effect Concentration
- STOT: Specific Target Organ Toxicity

Not all acronyms listed above are referenced in this SDS.

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information, and belief at the date of its publication. Such information is only given as a guidance to help the user handle, use, process, store, transport, dispose, and release the product in satisfactory safety conditions and is not to be considered as a warranty or quality specification. It should be used in conjunction with technical sheets but do not replace them. Thus, the information only relates to the designated specific product and may not be applicable if such product is used in combination with other materials or in any other manufacturing process, unless otherwise specifically indicated. It does not release the user from ensuring he is in conformity with all regulations linked to its activity.

Safety Data Sheet
Chemical C

Version 1.0 Revision Date: 02/25/2020

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name Chemical C

Recommended use of the chemical and restrictions on use

Recommended use : Industrial chemical

Manufacturer or supplier's details

Company : Univar Solutions USA, Inc.
Address
3075 Highland Pkwy Suite 200
Downers Grove, IL 60515
United States of America (USA)

Emergency telephone number:
Transport North America: CHEMTREC (1-800-424-9300)
CHEMTREC INTERNATIONAL Tel # 703-527-3887

Additional Information: : Responsible Party: Product Compliance Department
E-mail: SDSNA@univarsolutions.com
SDS Requests: 1-855-429-2661
Website: www.univarsolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Not a hazardous substance or mixture.

GHS label elements

Not a hazardous substance or mixture.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Pure substance

Hazardous components

No hazardous ingredients

SECTION 4. FIRST AID MEASURES

General advice	: Do not leave the victim unattended.
If inhaled	: If unconscious, place in recovery position and seek medical advice. If symptoms persist, call a physician.
In case of skin contact	: Wash skin thoroughly with soap and water or use recognized skin cleanser. Get medical attention if irritation develops and persists.
In case of eye contact	: Remove contact lenses. Protect unharmed eye. If eye irritation persists, consult a specialist.
If swallowed	: Keep respiratory tract clear. Do not give milk or alcoholic beverages. Never give anything by mouth to an unconscious person.

If symptoms persist, call a physician.
DO NOT induce vomiting unless directed to do so by a physician or poison control center.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Carbon dioxide (CO2) Foam Dry powder Water mist
Unsuitable extinguishing media	:	High volume water jet
Hazardous combustion products	:	Carbon oxides
Further information	:	Standard procedure for chemical fires. Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Special protective equipment for firefighters	:	Wear self-contained breathing apparatus for firefighting if necessary.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Methods and materials for containment and cleaning up	:	Wipe up with absorbent material (e.g. cloth, fleece). Keep in suitable, closed containers for disposal.

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion	:	Normal measures for preventive fire protection.
Advice on safe handling	:	For personal protection see section 8. Smoking, eating and drinking should be prohibited in the application area.
Conditions for safe storage	:	Electrical installations / working materials must comply with the technological safety standards.
Materials to avoid	:	No materials to be especially mentioned.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection	:	General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and use NIOSH/MSHA approved respirators. Protection provided

	by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection. No personal respiratory protective equipment normally required.
Eye protection	: Safety glasses
Skin and body protection	: Protective suit
Hygiene measures	: General industrial hygiene practice.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: liquid
Colour	: No data available
Odour	: No data available
Odour Threshold	: No data available
pH	: 8
Freezing Point (Melting point/freezing point)	: -4 °C (25 °F)
Boiling Point (Boiling point/boiling range)	: 329 °C (624 °F)
Flash point	: 202 °C (396 °F)
Evaporation rate	: No data available
Flammability (solid, gas)	: No data available
Upper explosion limit	: No data available
Lower explosion limit	: No data available
Vapour pressure	: No data available
Relative vapour density	: No data available
Relative density	: No data available
Density	: 9.4100 lb/gal
Water solubility	: No data available
Solubility in other solvents	: No data available
Partition coefficient: n-octanol/water	: No data available
Auto-ignition temperature	: 358 °C
Thermal decomposition	: No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity	: No dangerous reaction known under conditions of normal use.
Chemical stability	: Stable under normal conditions.
Possibility of hazardous reactions	: Stable under recommended storage conditions. No hazards to be specially mentioned.
Conditions to avoid	: Keep away from heat, flame, sparks and other ignition sources.

Incompatible materials : Reducing agents
Strong acids
Strong bases
Strong oxidizing agents

SECTION 11. TOXICOLOGICAL INFORMATION

Carcinogenicity

IARC	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Further information

Product:

Remarks: No data available

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

No data available

Persistence and degradability

No data available

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential : Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances
Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).

Additional ecological information	:	No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	:	Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact Univar Solutions ChemCare: 1-800-909-4897
Contaminated packaging	:	Empty containers should be taken to an approved waste handling site for recycling or disposal.

SECTION 14. TRANSPORT INFORMATION

DOT (Department of Transportation): Not regulated as a dangerous good

UNRTDG
Not regulated as a dangerous good

IATA (International Air Transport Association): Not regulated as a dangerous good

IMDG-Code: Not regulated as a dangerous good

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Acetaldehyde	75-07-0	1000	*

*: Calculated RQ exceeds reasonably attainable upper limit.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards	:	No SARA Hazards
SARA 302	:	This material does not contain any components with a section 302 EHS TPQ.

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Clean Air Act

This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

The following Hazardous Substances are listed under the U.S. CleanWater Act, Section 311, Table 116.4A:
75-07-0 Acetaldehyde
The following Hazardous Chemicals are listed under the U.S. CleanWater Act, Section 311, Table 117.3:
75-07-0 Acetaldehyde
This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

Massachusetts Right To Know

75-07-0 Acetaldehyde

Pennsylvania Right To Know

[redacted] Chemical C

California Prop 65

⚠ **WARNING**: This product can expose you to chemicals including Acetaldehyde, which is/are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

The components of this product are reported in the following inventories:

TSCA : On TSCA Inventory

DSL : not determined

AICS : not determined

NZIoC : not determined

ENCS : not determined

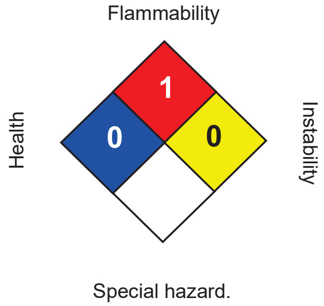
KECI : not determined

PICCS : not determined

IECSC : not determined

SECTION16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	**0/**
FLAMMABILITY	**1**
PHYSICAL HAZARD	**0**

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

The information accumulated is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made become available subsequently to the date hereof, we do not assume any responsibility for the results of its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by Univar Solutions Product Compliance Department (1-855-429-2661) SDSNA@univarsolutions.com.

Revision Date : 02/25/2020

Material number:
[redacted]

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program
CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level
EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philippines Inventory of Commercial Chemical Substances

MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Composition, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50	Lethal Concentration 50%		

SAFETY DATA SHEET

M47011 - North America - EN

CHLOROFORM (ALL GRADES)

SDS No.: M47011 **Rev. Date:** 29-Sep-2020

SECTION 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Company Identification:	Occidental Chemical Corporation 14555 Dallas Parkway, Suite 400 Dallas, Texas 75254-4300
24 Hour Emergency Telephone Number:	1-800-733-3665 (USA); CANUTEC (Canada): 1-613-996-6666; CHEMTREC (within USA and Canada): 1-800-424-9300; CHEMTREC (outside USA and Canada): +1 703-527-3887; CHEMTREC Contract No: CCN16186
To Request an SDS:	MSDS@oxy.com or 1-972-404-3245
Customer Service:	1-800-752-5151 or 1-972-404-3700
Product Identifier:	**CHLOROFORM; CHLOROFORM TECHNICAL GRADE; CHLOROFORM FLUOROCARBON GRADE; CHLOROFORM ALCOHOL STABILIZED GRADE**
Trade Name:	Chloroform; Chloroform Technical Grade; Chloroform Fluorocarbon Grade; Chloroform Alcohol Stabilized Grade
Synonyms:	METHYL TRICHLORIDE; FORMYL TRICHLORIDE; METHANE TRICHLORIDE; METHENYL TRICHLORIDE; TRICHLOROFORM; TRICHLOROMETHANE
Product Use:	This substance is used in the following products: laboratory chemicals. This substance has an industrial use resulting in manufacture of another substance (use as chemical intermediate). FOR USE IN INDUSTRIAL INSTALLATIONS ONLY. Used as a chemical intermediate in industrial facilities that manufacturer refrigerants, dyes, plastics, and resins.
Restrictions on Use (United States):	Chloroform may NOT be used as an ingredient in cosmetic products or food packaging. In addition, all drug products containing chloroform have been removed from the market, and a new drug application is required for approval. For

	cosmetic products, the regulation makes an exception for residual amounts, in certain cases, from its use as a processing solvent during manufacture, or as a byproduct from the synthesis of an ingredient (21 CFR 700.18).
Restrictions on Use (EU):	FOR INDUSTRIAL USE ONLY. Chloroform use is restricted in the EU and shall not be placed on the market, or used, as substances or as constituents of other substances, or in mixtures in concentrations equal to or greater than 0,1 % by weight, where the substance or mixture is intended for supply to the general public and/or is intended for diffusive applications such as in surface cleaning and cleaning of fabric.
Other Global Restrictions on Use:	FOR USE IN INDUSTRIAL INSTALLATIONS ONLY. Other restrictions on use based on local, regional, or national regulations may exist and must be determined on a case-by-case basis.
Chemical Family:	Chlorinated Organics
Note:	The Alcohol Stabilized Grade contains small amounts of ethanol as a stabilizer. The Technical and Fluorocarbon Grades do not.

SECTION 2. HAZARDS IDENTIFICATION

OSHA REGULATORY STATUS: This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

****

EMERGENCY OVERVIEW:

Color:	Colorless
Physical State:	Liquid
Appearance:	Clear
Odor:	Mildly sweet odor, Pleasant, etheric
Signal Word:	**DANGER**

MAJOR HEALTH HAZARDS: HARMFUL IF SWALLOWED. CAUSES SKIN IRRITATION. CAUSES SERIOUS EYE IRRITATION. MAY BE HARMFUL IF INHALED. MAY CAUSE DROWSINESS OR DIZZINESS. SUSPECTED OF CAUSING CANCER. SUSPECTED OF DAMAGING FERTILITY OR THE UNBORN CHILD. CAUSES DAMAGE TO LIVER, KIDNEYS, AND HEART. MAY CAUSE DAMAGE TO LIVER AND KIDNEYS THROUGH PROLONGED OR REPEATED EXPOSURE. THIS MATERIAL IS A POTENTIAL ENDOCRINE DISRUPTOR. IF INGESTED MAY BE AN ASPIRATION HAZARD.

AQUATIC TOXICITY: HARMFUL TO AQUATIC LIFE WITH LONG LASTING EFFECTS, FOR CHRONIC

EXPOSURES.

PRECAUTIONARY STATEMENTS: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe mist, vapors, or spray. Wash skin and contaminated clothing thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Wear protective gloves, protective clothing, eye, and face protection. Avoid release to the environment.

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HAZARD CLASSIFICATION:

GHS: CONTACT HAZARD - SKIN:	Category 2 - Causes skin irritation
GHS: CONTACT HAZARD - EYE:	Category 2A - Causes serious eye irritation
GHS: ACUTE TOXICITY - ORAL:	Category 4 - Harmful if swallowed
GHS: TARGET ORGAN TOXICITY (SINGLE EXPOSURE):	Category 1 - Causes damage to liver, kidney, and heart Category 3 - May cause drowsiness or dizziness
GHS: TARGET ORGAN TOXICITY (REPEATED EXPOSURE):	Category 2 - May cause damage to liver and kidney through prolonged or repeated exposure
GHS: CARCINOGENICITY:	Category 2 - Suspected of causing cancer
GHS: REPRODUCTION TOXIN:	Category 2 - Suspected of damaging fertility or the unborn child
HAZARDS NOT OTHERWISE CLASSIFIED (HNOC):	- ACUTE AQUATIC HAZARD - CATEGORY 3: Harmful to aquatic life - ACQUATIC TOXICITY - CHRONIC: Category 3 (Harmful to aquatic life with long lasting effects) - ACUTE TOXICITY - INHALATION (Vapor) Category 5: MAY BE HARMFUL IF INHALED

GHS SYMBOL: Exclamation mark, Health hazards

GHS SIGNAL WORD: DANGER

GHS HAZARD STATEMENTS:

GHS - Health Hazard Statement(s) -
- Harmful if swallowed
- Causes skin irritation
- Causes serious eye irritation
- May cause drowsiness or dizziness
- Suspected of causing cancer
- Suspected of damaging fertility or the unborn child
- Causes damage to liver, kidneys, and heart
- May cause damage to liver and kidneys through prolonged and repeated exposure

Additional Hazards - GHS Hazards Not Otherwise Classified (HNOC):
- ACUTE AQUATIC HAZARD - CATEGORY 3: Harmful to aquatic life
- CHRONIC AQUATIC HAZARD - CATEGORY 3: Harmful to aquatic life with long lasting effects
- ACUTE TOXICITY - INHALATION (Vapor) Category 5: MAY BE HARMFUL IF INHALED

GHS - Precautionary Statement(s) - Prevention
- Obtain special instructions before use
- Do not handle until all safety precautions have been read and understood
- Do not breathe mist, vapors, or spray
- Wash skin and contaminated clothing thoroughly after handling
- Do not eat, drink or smoke when using this product
- Use only outdoors or in a well-ventilated area
- Wear protective gloves, protective clothing, eye, and face protection
- Avoid release to the environment

GHS - Precautionary Statement(s) - Response
- IF SWALLOWED: Call a POISON CENTER OR LICENSED HEALTH CARE PROVIDER if you feel unwell
- Rinse mouth if ingested
- IF INHALED: Remove person to fresh air and keep at rest in a position comfortable for breathing
- IF INHALED: Call a POISON CENTER OR LICENSED HEALTH CARE PROVIDER if you feel unwell
- IF ON SKIN: Wash with plenty of soap and water
- If skin irritation occurs: Get medical advice/attention
- Take off immediately all contaminated clothing and wash it before reuse
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
- If eye irritation persists: Get medical advice/attention
- IF exposed: Call a POISON CENTER OR LICENSED HEALTH CARE PROVIDER

GHS - Precautionary Statement(s) - Storage
- Store in a well-ventilated place. Keep container tightly closed
- Store in a secure manner

GHS - Precautionary Statement(s) - Disposal
- Dispose of contents and container in accordance with applicable local, regional, national, and/or international regulations

Hazard Not Otherwise Classified (HNOC)-Health
- May be harmful if inhaled
- Potential endocrine disruptor
- ASPIRATION HAZARD IF SWALLOWED - CAN ENTER LUNGS AND CAUSE DAMAGE

See Section 11: TOXICOLOGICAL INFORMATION

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonym(s) for Product: METHYL TRICHLORIDE; FORMYL TRICHLORIDE; METHANE TRICHLORIDE; METHENYL TRICHLORIDE; TRICHLOROFORM; TRICHLOROMETHANE

Notes: *The Alcohol Stabilized Grade contains small amounts of ethanol as a stabilizer. The Technical and Fluorocarbon Grades do not.*

Component	CAS Number	Percent [%]
Chloroform	67-66-3	> 99
Ethyl Alcohol (Alcohol Stabilized Grade Only)	64-17-5	< 1

SECTION 4. FIRST AID MEASURES

INHALATION: IF INHALED: Remove person to fresh air and keep at rest in a position comfortable for breathing. IF INHALED: Call a POISON CENTER OR LICENSED HEALTH CARE PROVIDER if you feel unwell.

SKIN CONTACT: If on skin or hair, wash with plenty of soap and water. If skin irritation occurs: Get medical advice/ attention. Take off contaminated clothing and wash before reuse.

EYE CONTACT: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

INGESTION: Rinse mouth if ingested. Call a POISON CENTER OR LICENSED HEALTH CARE PROVIDER if you feel unwell.

Most Important Symptoms/Effects (Acute and Delayed):

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Acute Symptoms/Effects:
Inhalation (Breathing): Respiratory System Effects: Inhalation of this material may cause acute respiratory depression with central nervous system (CNS) depression, resulting in lightheadedness to possibly rapid loss of consciousness. High concentrations can cause cardiac arrhythmias and cardiac arrest due to sensitization of the myocardium to epinephrine.
Skin: Skin Irritation: Exposure to skin may cause redness, dryness, localized edema, ulcerations. This material may be absorbed across the skin causing systemic effects. Chloroform absorbed through the skin and into the blood is expected to be metabolized and to cause toxicity in much the same way as chloroform absorbed by other exposure routes.
Eye: Eye Irritation. Eye exposure may cause irritation, tearing, conjunctivitis, corneal edema, cornea epithelial damage.
Ingestion (Swallowing): Gastrointestinal System Effects: May be fatal if swallowed.

Delayed Symptoms/Effects:
- Respiratory System Effects: Chemical pneumonitis and delayed pulmonary edema
- Skin: Repeated and prolonged skin contact may cause a chronic dermatitis
- May cause delayed hepatotoxicity
- Specific treatment: See section 4 of the safety data sheet (SDS)
- Acute renal toxicity has been rarely reported
- Suspected of causing cancer

- Suspected of damaging fertility or the unborn child

Target Organ Effects: Heart. Liver. Kidney.

Protection of First-Aiders: Protect against vapor/gas exposure. Do not breathe gas, fumes, vapor, mist, or spray. Protect against liquid contamination/frostbite. Avoid contact with skin and eyes. Use personal protective equipment. Refer to Section 8 for specific personal protective equipment recommendations.

Notes to Physician: For ingestion, nasogastric aspiration is recommended if volume ingested is of sufficient volume to aspirate. Protect the airway, onset of respiratory depression may be rapid. Consider EKG monitoring to detect cardiac arrhythmias. Monitor blood pressure for hypotension. Avoid catecholamines, especially in the presence of arrhythmias. For very high exposures, (intentional, solvent abuse), oxygen, advanced cardiac life support, intubation and volume support may be required. For skin exposures, wash the area with soap and water, and treat any irritation symptomatically. Thorough decontamination of the eye is important. N-acetylcysteine has been used clinically in patients with chloroform-induced liver dysfunction, based upon the similarity between the mechanism of chloroform and acetaminophen hepatotoxicity. This is based upon 2 case reports, 1 dosed at 600 mg/day, while a second mirrored dosing recommended for acetaminophen toxicity: 150 mg/kg over 1 hour, 50 mg/kg over 4 hours, then an IV infusion of 6.25 mg/kg/h. The clinical efficacy and benefit of N-acetylcysteine for chloroform hepatotoxicity is currently unproven. See section 11 for additional toxicology information.

Interaction with Other Chemicals Which Enhance Toxicity: Alcohol may enhance toxic effects. May potentiate other agents that cause central nervous system (CNS) and respiratory system depression, such as alcohol, opiates. Liver toxicity may be enhanced by other agents that cause liver damage, such as alcohol, acetaminophen. Catechol amines may potentiate arrhythmias.

Medical Conditions Aggravated by Exposure: May increase potential for cardiac arrhythmia. Persons with alcoholism, kidney disorders, liver disorders, or central nervous system disorders may be more susceptible to toxicity.

SECTION 5. FIRE-FIGHTING MEASURES

Fire Hazard: Negligible fire hazard.

Explosive properties: This product does not contribute to the spreading of flames, nor is it combustible or explosive.

Extinguishing Media: Use media appropriate for surrounding fire.

Specific Hazards: Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes.

Unusual Hazards: Containers may explode when heated. Runoff may pollute waterways.

Fire Fighting: Wear NIOSH approved positive-pressure self-contained breathing apparatus operated in pressure demand mode. Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Flood with fine water spray. Do not scatter spilled material with high-pressure water streams. Avoid inhalation of material or combustion by-products. Stay upwind and keep out of low areas. Keep water runoff out of water supplies and sewers (see Section 6 of the SDS).

Component	Immediately Dangerous to Life/ Health (IDLH)
Chloroform 67-66-3	500 ppm IDLH
Ethyl Alcohol (Alcohol Stabilized Grade Only) 64-17-5	3300 ppm IDLH

Hazardous Combustion Products: Thermal decomposition or combustion products: hydrogen chloride, chlorine, phosgene, oxides of carbon

Sensitivity to Mechanical Impact: Not sensitive.

Sensitivity to Static Discharge: Not sensitive.

Lower Flammability Level (air):	Not flammable
Upper Flammability Level (air):	Not flammable
Flash point:	None
Auto-ignition Temperature:	>1832 °F (>1000 °C)

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Keep unnecessary and unprotected persons away. Isolate hazard area and deny entry. Evacuation of surrounding area may be necessary for large spills. Do not get in eyes, on skin or on clothing. Do not breathe dust, fume, gas, mist, vapors, or spray. Most vapors are heavier than air and will spread along ground and collect in low or confined areas (drains, basements, tanks). Ventilate closed spaces before entering. Wear appropriate personal protective equipment recommended in Section 8, Exposure Controls / Personal Protection, of the SDS.

Personal Protective Equipment: See section 8 for information on personal protective equipment.

Emergency Procedures: For other than minor leaks, immediately implement the facility's predetermined emergency response plan. Restrict access to the area until cleanup is complete. Prevent material and runoff from entering sewers and waterways if it can be done safely well ahead of the release. Ventilate confined area if possible, without placing personnel at risk. Cleanup personnel must wear proper protective equipment. Notify all downstream water users of possible contamination.

Environmental Precautions: Avoid discharge into drains, surface water or groundwater. Keep out of water supplies, sewers and soil. Releases should be reported, if required, to appropriate agencies.

Methods and Materials for Containment, Confinement, and/or Abatement: Stop leak if possible without personal risk. Shut off ventilation system if needed. Ventilate closed spaces before entering. Completely contain spilled materials with dikes, sandbags, etc. Remove contaminated soil or collect with appropriate absorbent and place into suitable container. Keep container tightly closed. Liquid material may be removed with a properly rated vacuum truck. Dispose of in accordance with all applicable regulations. See Section 13, Disposal considerations, for additional information.

Recovery: In case of spill or leak, stop the leak as soon as possible. Shut off ventilation systems to occupied areas where they can be impacted by vapors picked up by the intake systems. Ventilate closed spaces before entering. Liquid material may be removed with a properly rated vacuum truck. Small and large spills: Contain spilled material if possible. After containment, collect the spilled material and transfer to a chemical waste area. Spills must be surrounded by absorbent material in order to delimit its extension, then complete its absorption. The recovered material must be placed in a suitable container and labelled with corresponding identification.
Neutralization: No additional information available.
Final Disposal: For waste disposal, see section 13.

Additional Disaster Prevention Measures: No information available.

SECTION 7. HANDLING AND STORAGE

Handling:

Precautions for Safe Handling: Review and adhere to requirements in 49 CFR 177.834 for unloading product. Most vapors are heavier than air and will spread along ground and collect in low or confined areas (drains, basements, tanks). Before entering tanks or opening service lines that may have contained chlorinated organics, they should be completely emptied and checked for vapors before performing maintenance activities. Never enter a confined space (which includes tanks or pits) without following proper entry procedures such as 29 CFR 1910.146.

Technical measures/precautions: Chlorinated organics handling equipment must not be constructed of any reactive metals such as aluminum, zinc, brass or magnesium alloys. Neoprene and natural rubber parts cannot be used for chlorinated organic service. Gaskets used in the service of chlorinated organics may be constructed of PTFE or Teflon® envelope gasket material or graphite with stainless steel metal inserts. Rubber-based products such as neoprene or Buna N gasketing should not be used. If a composition differing from those mentioned above is to be used, it must first be tested with the specific chlorinated organic product to ensure compatibility.

Other precautions: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood.

Prevention of contact: Do not breathe mist, vapor, or spray. Wash skin and contaminated clothing thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Wear protective gloves, protective clothing, eye, and face protection.

Storage:

Safe Storage Conditions: Store and handle in accordance with all current regulations and standards. Keep container tightly closed and properly labeled. Store in a cool, dry area. Store in a well-ventilated area. Prevent water or moist air from entering storage tanks or containers. Do not enter confined spaces without following proper confined space entry procedures. Do not store in aluminum container or use aluminum fittings or transfer lines. Do not reuse drum without recycling or reconditioning in accordance with any applicable federal, state or local laws. Do not use cutting or welding torches, open flames or electric arcs on empty or full containers. Keep separated from incompatible substances (see Section 10 of SDS).

Technical measures: All storage facilities should be designed to protect the environment from contamination through the use of secondary containment. Typical secondary containment systems employ impermeable surfaces such as double-walled tanks, sumps, dikes (non-earth). All storage tanks should be diked to contain the tank contents in the event of a spill or tank rupture. They should be large enough to contain the tank‘s volume and an additional appropriate volume as a safety factor. Containment volumes and diking requirements are often defined and mandated by individual states and localities. Regulations must be reviewed prior to construction. Always store chlorinated organic drums in areas equipped with secondary containment systems. Containment systems should be adequate to hold 110% of the largest expected amount of drummed product to be stored, and should be impermeable to chlorinated organics.

Incompatible Substances: bases, reactive metals, metallic fines or powders, oxidizing materials, halogens, acetone, aluminum, disilane, magnesium, potassium, sodium.

Packaging Material: Bulk storage containers should be constructed of either carbon or stainless steel. Aluminum or fiberglass reinforced plastic storage tanks are prohibited for chlorinated organic service. Storage tanks should not be constructed of, nor contain, any non-compatible plastic components. The storage tanks exterior should be cleaned, primed and painted with a white or aluminum colored paint to aid in keeping the tank and its contents cool.

Additional Information: Keep containers tightly closed in a cool, well-ventilated place.
Keep containers tightly closed in a cool, well-ventilated place

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

REGULATORY EXPOSURE LIMIT(S):
Listed below for the product components that have regulatory occupational exposure limits (OEL's).

Component	OSHA Final PEL TWA	OSHA Final PEL STEL	OSHA Final PEL Ceiling
Chloroform 67-66-3 (> 99 %)	-----	-----	50 ppm 240 mg/m³
Ethyl Alcohol (Alcohol Stabilized Grade Only) 64-17-5 (< 1 %)	1000 ppm 1900 mg/m³	-----	-----

OEL: Occupational Exposure Limit; OSHA: United States Occupational Safety and Health Administration; PEL: Permissible Exposure Limit; TWA: Time Weighted Average; STEL: Short Term Exposure Limit OSHA Ceiling values indicate the exposure limit, which at no time shall be exceed. Instantaneous monitoring is the preferred method to determine compliance with OSHA Ceiling values. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time during the working day [29CFR1910.1000(a)(1)]

Component	Canada - TWAs	Canada - STELs	Canada - Ceilings
Chloroform 67-66-3	Ontario - 10 ppm (TWA) Alberta - 10 ppm (TWA) Alberta - 49 mg/m³ (TWA)	-----	-----

Component	Canada - TWAs	Canada - STELs	Canada - Ceilings
	British Columbia - 2 ppm (TWA)		
Ethyl Alcohol (Alcohol Stabilized Grade Only) 64-17-5	Alberta - 1000 ppm (TWA) Alberta - 1880 mg/m³ (TWA)	Ontario - 1000 ppm (STEL)	-----

NON-REGULATORY EXPOSURE LIMIT(S):
Listed below for the product components that have non-regulatory occupational exposure limits (OELs).

Component	ACGIH TWA	ACGIH STEL	ACGIH Ceiling	Skin Absorption - ACGIH	OSHA TWA (Vacated)	OSHA STEL (Vacated)	OSHA Ceiling (Vacated)
Chloroform	10 ppm	-----	-----	-----	2 ppm 9.78 mg/m³	-----	-----
Ethyl Alcohol (Alcohol Stabilized Grade Only)	-----	1000 ppm	-----	-----	1000 ppm 1900 mg/m³	-----	-----

- The Non-Regulatory United States Occupational Safety and Health Administration (OSHA) limits, if shown, are the Vacated 1989 PEL's (vacated by 58 FR 35338, June 30, 1993).

- The American Conference of Governmental Industrial Hygienists (ACGIH) is a voluntary organization of professional industrial hygiene personnel in government or educational institutions in the United States. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals, physical agents, and biological exposure indices.

Additional Advice: SEE SECTION 11 FOR ADDITIONAL TOXICOLOGICAL INFORMATION.

ENGINEERING CONTROLS: Provide local exhaust or process enclosure ventilation system. Ensure compliance with applicable exposure limits.

PERSONAL PROTECTIVE EQUIPMENT:

Eye Protection: Wear chemical safety goggles with a face shield to protect against eye and skin contact when appropriate. Provide an emergency eyewash fountain and quick drench shower in the immediate work area.

Skin and Body Protection: Wear chemical resistant clothing to prevent skin contact. Thoroughly clean and dry contaminated clothing before reuse. Discard contaminated leather goods.

Hand Protection: Wear appropriate chemical resistant gloves. Consult a glove supplier for assistance in selecting an appropriate chemical resistant glove.

Protective Material Types: Viton®, Polyvinyl alcohol (PVA), Polyethylene (PE)

Respiratory Protection: Where vapor concentration exceeds or is likely to exceed applicable exposure limits, a NIOSH approved respirator is required. A NIOSH approved self-contained positive pressure breathing apparatus with full-face piece or airline respirator is required for spills, emergencies and/or IDLH concentrations. A respiratory protection program that meets 29 CFR 1910.134 must be followed whenever workplace conditions warrant use of a respirator.

Component	Immediately Dangerous to Life/ Health (IDLH)
Chloroform 67-66-3	500 ppm IDLH
Ethyl Alcohol (Alcohol Stabilized Grade Only) 64-17-5	3300 ppm IDLH

HYGIENE MEASURES: An emergency eyewash fountain and quick drench shower should be provided in the immediate work area.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Color:	Colorless
Odor:	Mildly sweet odor Pleasant, etheric
Molecular Weight:	119.38
Molecular Formula:	$CHCl3$
Chemical Family:	Chlorinated Organics
pH:	Not applicable
Melting Point/Range:	-63.41°C
Freezing Point/Range:	-83 º F (-63.9 º C)
Boiling point °C	61.12 °C
Flash point:	None
Vapor Pressure:	160 mmHg @ 20º C 197 mmHg @ 25º C
Vapor Density (air=1):	4.1
Relative Density/Specific Gravity (water=1):	1.49 @ 25 º C
Density:	No data available
Water Solubility:	0.8% @ 25 ºC
Partition Coefficient (n-octanol/water):	log Kow = 1.97
Auto-ignition Temperature:	>1832 °F (>1000 °C)
Decomposition Temperature:	No data available
Odor Threshold [ppm]:	85 ppm (ACGIH 2007) 205-307 ppm (causes olfactory fatigue)
Evaporation Rate (ether=1):	0.56
Volatility:	100%
Flammability (solid, gas):	Not flammable
Lower Flammability Level (air):	Not flammable
Upper Flammability Level (air):	Not flammable
Viscosity:	5.63 mP (dynamic) @ 20 °C; 5.10 mP (dynamic) @ 30 °C

SECTION 10. STABILITY AND REACTIVITY

Chemical Stability: Stable at normal temperatures and pressures.

Reactivity: Not reactive under normal temperatures and pressures.

Possibility of Hazardous Reactions: Keep away from heat. Containers may rupture or explode if exposed to heat. Will attack some forms of plastics, rubber, and coatings. Avoid contact with incompatible substances and conditions due to generation of phosgene and other toxic and irritating substances.

Conditions to Avoid (e.g., static discharge, shock, or vibration): None known.

Incompatible Substances: bases, reactive metals, metallic fines or powders, oxidizing materials, halogens, acetone, aluminum, disilane, magnesium, potassium, sodium.

Hazardous Decomposition Products: Thermal decomposition or combustion products: hydrogen chloride, chlorine, phosgene, oxides of carbon.

Hazardous Polymerization: Will not occur.

SECTION 11. TOXICOLOGICAL INFORMATION

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POTENTIAL HEALTH EFFECTS:

TOXICITY:
Chloroform was used as an anesthetic for humans (10,000 - 22,500 ppm), but is no longer recommended for this use due to liver and kidney damage. Intentional abuse can result in significant toxicity. Respiratory depression, with central nervous system depression and delayed hepatotoxicity are indicative of chloroform poisoning. Symptoms of central nervous system depression have been reported in workers at concentrations of 80-240 ppm. Dizziness, vertigo, fatigue, and headache have been reported from exposure to 920 ppm for approximately 3 minutes. Exposure to levels of 1500-2000 ppm have been reported to cause slight anesthesia. Irregular heartbeat may occur from exposure to levels of 8000 ppm or higher. This material is likely to be fatal after 5-10 minutes of 25,000 ppm.

ACUTE TOXICITY:

Eye contact: Eye contact may cause irritation, conjunctivitis, tearing, swelling, eye pain, corneal edema, blurred vision, cornea epithelial damage.
Skin contact: Skin contact may cause irritation, redness, dryness, localized edema, ulcerations after significant long-term exposure.
Inhalation: Not a pulmonary irritant. May cause respiratory depression. May cause slightly sweet odor on breath. May cause central nervous system (CNS) depression resulting in lightheadedness to rapid loss of consciousness. Moderate to severe exposures may cause cardiac arrhythmias.
Ingestion: May cause gastrointestinal effects, liver damage, kidney damage, unconsciousness and death.

CHRONIC TOXICITY:

Chronic Effects: Increased irritability and decreased concentration was reported in female workers exposed to levels of 77 ppm or greater in the workplace. Deliberate abuse has been associated with depression, hallucinations, delirium and degenerative changes in central and peripheral nervous system tissues. May be excreted in breast milk. Repeated exposure has been associated with liver and kidney damage in animals. In addition, nasal cavity changes were observed in rats and mice exposed for 7 days. Long-term ingestion may cause liver damage, reproductive effects and cancer. Interstitial pneumonitis was observed in male rats and in rabbits exposed to this material for six months. This effect was not observed in other species.

SIGNS AND SYMPTOMS OF EXPOSURE:

Inhalation (Breathing): Respiratory System Effects: Inhalation of this material may cause acute respiratory depression with central nervous system (CNS) depression, resulting in lightheadedness to possibly rapid loss of consciousness. High concentrations can cause cardiac arrhythmias and cardiac arrest due to sensitization of the myocardium to epinephrine.
Skin: Skin Irritation: Exposure to skin may cause redness, dryness, localized edema, ulcerations. This material may be absorbed across the skin causing systemic effects. Chloroform absorbed through the skin and into the blood is expected to be metabolized and to cause toxicity in much the same way as chloroform absorbed by other exposure routes.
Eye: Eye Irritation. Eye exposure may cause irritation, tearing, conjunctivitis, corneal edema, cornea epithelial damage.
Ingestion (Swallowing): Gastrointestinal System Effects: May be fatal if swallowed.

Interaction with Other Chemicals Which Enhance Toxicity: Alcohol may enhance toxic effects. May potentiate other agents that cause central nervous system (CNS) and respiratory system depression, such as alcohol, opiates. Liver toxicity may be enhanced by other agents that cause liver damage, such as alcohol, acetaminophen. Catechol amines may potentiate arrhythmias.

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GHS HEALTH HAZARDS:

GHS: CONTACT HAZARD - SKIN: Category 2 - Causes skin irritation
GHS: CONTACT HAZARD - EYE: Category 2A - Causes serious eye irritation
GHS: ACUTE TOXICITY - ORAL: Category 4 - Harmful if swallowed
GHS: ACUTE TOXICITY - INHALATION: Category 5 - May be harmful if inhaled
GHS: TARGET ORGAN TOXICITY (SINGLE EXPOSURE): Category 1 - Causes damage to liver, kidney, and heart
Category 3 - May cause drowsiness or dizziness
GHS: CARCINOGENICITY: Category 2 - Suspected of causing cancer
GHS: REPRODUCTION TOXIN: Category 2 - Suspected of damaging fertility or the unborn child

TOXICITY DATA:

PRODUCT TOXICITY DATA: .

LD50 Oral:	LD50 Dermal:	LC50 Inhalation:
300-695 mg/kg oral-rat LD50	> 20 gm/kg skin-rabbit LD50	47,702 mg/m^3 (4 hr - Rat)

COMPONENT TOXICITY DATA: .

Component	Oral LD50	Dermal LD50	Inhalation LC50
Chloroform	450 mg/kg (Rat)	>20 g/kg (Rabbit)	47702 mg/m^3 (4-h Rat)
Ethyl Alcohol (Alcohol Stabilized Grade Only)	7060 mg/kg (Rat)		124.7 mg/L (4-h Rat)

Eye Irritation/Corrosion: This product is classified as causing serious eye irritation (Category 2) per GHS criteria.

Skin Irritation/Corrosion: The product is classified as cutaneous irritant (Category 2), according to GHS classification criteria.

Skin Absorbent / Dermal Route: NO.

CARCINOGENICITY: Studies have shown increases in kidney and liver cancer in rodents. Suspected of causing cancer to bladder, liver, and kidneys. Classified as Category 2 under GHS (suspected of causing cancer).

SPECIFIC TARGET ORGAN TOXICITY (Single Exposure): Category 1 - Causes damage to liver, kidney, and heart. Category 3 - Narcotic Effects.

SPECIFIC TARGET ORGAN TOXICITY (Repeated or Prolonged Exposure): Category 2 - Liver, Kidneys.

INHALATION HAZARD: MAY BE HARMFUL IF INHALED. Breathing this material may cause central nervous system depression with symptoms including nausea, headache, dizziness, fatigue, drowsiness, or unconsciousness.

GERM CELL/IN-VITRO MUTAGENICITY: Not classified as a mutagen per GHS criteria. This material has tested positive in one or more in vitro mutagenicity studies. However, the majority genotoxicity data have demonstrated a pattern of negative results.

REPRODUCTIVE TOXICITY: Classified as Category 2 under GHS (may cause damage to fertility or the unborn child).

DEVELOPMENTAL TOXICITY: Category 2 - Suspected of damaging fertility or the unborn child. This material may cause harm to the human fetus based on tests with laboratory animals. Studies of workers have not shown any association between exposure and adverse effects on reproduction or pregnancy outcome. This material crosses the placenta rapidly and enters fetal circulation. Developmental studies in experimental animals have produced a variety of results, some indicating fetotoxicity and weak teratogenicity. Animal studies indicate that inhalation exposure may cause reproductive effects in rodents. Miscarriages occurred in rats and mice that breathed air containing elevated levels (30 to 300 ppm) of chloroform during pregnancy and in rats that consumed chloroform during pregnancy. Abnormal sperm were found in mice that breathed air containing elevated levels (400 ppm) of chloroform for a few days. Offspring of rats and mice that breathed chloroform during pregnancy had birth defects.

ASPIRATION HAZARD: Aspiration of material into the lungs may cause chemical pneumonitis, which may be fatal. Possible aspiration hazard.

TOXICOKINETICS: The toxicokinetics of chloroform (CAS # 67-66-3, CHCl3) was systematically evaluated and interpreted in various species including B6C3F1 mice, Fischer 344 and male Osborne-Mendel rats, and male Syrian Golden hamsters for development and validation of a physiologically-based pharmacokinetic (PB-PK) model of prospective dose-, species- and route-specific disposition of CHCl3. This model assumes total chloroform metabolism within target organs, liver and kidney, solely by a mixed function oxidase (MFO) metabolic pathway following Michaelis-Menten kinetics.

METABOLISM: A large number of studies support the conclusion that metabolism of chloroform is required for toxicity.

PATHOGENICITY AND ACUTE INFECTIOUSNESS (ORAL, DERMAL, AND INHALATION): Not applicable.

ENDOCRINE DISRUPTOR: Chloroform is listed on The Endocrine Disruptors Exchange's (TEDX) List of Potential Endocrine Disruptors database of chemicals with the potential to affect the endocrine system. Every chemical on the TEDX List has one or more verified citations published, accessible, primary scientific research demonstrating effects on the endocrine system.

NEUROTOXICITY: Breathing this material may cause central nervous system depression with symptoms including nausea, headache, dizziness, fatigue, drowsiness, or unconsciousness. Long term exposure to concentrations of 20-200 ppm of chloroform produce mainly neurological effects, with increased incidence of symptoms such as fatigue, nausea, vomiting, lassitude, dry mouth, and anorexia.

IMMUNOTOXICITY: Chloroform administered via drinking water affects body weight and selected hematological parameters at high dose levels; however, overall immune responses, as measured in several tests for immune function, are not compromised.

Hazard Not Otherwise Classified (HNOC)-Health
- May be harmful if inhaled
- Potential endocrine disruptor
- ASPIRATION HAZARD IF SWALLOWED - CAN ENTER LUNGS AND CAUSE DAMAGE

SECTION 12. ECOLOGICAL INFORMATION

ECOTOXICITY (EC, IC, and LC):

Component:	***Freshwater Fish:***	***Invertebrate Toxicity:***	***Algae Toxicity:***	***Other Toxicity:***
Chloroform	*Oncornhyncus mykiss 96hr LC50: 18 mg/l *Lepomis macrochirus 96 hr LC50: 18 mg/l *Micropterus salmoides 96 hr LC50: 51 mg/l *Ictalurus punctatus 96 hr LC50: 75 mg/l	*Daphnia magna 48 hr EC50: 29-79 mg/l	*EC50 Desmodesmus subspicatus (48 h) =560 mg/L	No data available
Ethyl Alcohol (Alcohol Stabilized Grade Only)	*LC50 Oncorhynchus mykiss: 12.0 - 16.0 mL/L 96h static *LC50 Pimephales promelas: 100 mg/L 96h static *LC50 Pimephales promelas: 13400 - 15100 mg/L 96h flow-through	*LC50 Daphnia magna: 9268 - 14221 mg/L 48h *EC50 Daphnia magna: 2 mg/L 48h *EC50 Daphnia magna: 10800 mg/L 24h	No data available	*LC50 Eisenia foetida (48 h filter paper) 0.1 - 1 mg/cm2

Fish Toxicity:
Oncornhyncus mykiss 96hr LC50: 18 mg/l
Lepomis macrochirus 96 hr LC50: 18 mg/l
Micropterus salmoides 96 hr LC50: 51 mg/l
Ictalurus punctatus 96 hr LC50: 75 mg/l

Algae Toxicity:
Chlamydomonas rein. 72 hr ErC50: 3.6-13.3 mg/l

Invertebrate Toxicity:
Daphnia magna 48 hr EC50: 29-79 mg/l

FATE AND TRANSPORT:

PERSISTENCE: Chloroform has a negligible tropospheric ozone creation potential in the atmosphere. No effect of chloroform can be expected on stratospheric ozone depletion and global warming as half-life of at least one year is necessary to expect such effects. Chloroform is not listed in the substances concerned by the Montreal Protocol on substances affecting the ozone layer.

BIODEGRADATION: As indicated by the Henry’s lay constant, chloroform entering aquatic systems would be transferred to the atmosphere through volatilization. A half-life of 3.7 hours can be calculated from this constant using a water current of 1 m/sec a wind speed of 3 m/sec and 1 m depth. A field monitoring in the Rhine River gave a half-life of 1.2 days. In the atmosphere, indirect photolysis (reaction with OH radicals) occurs with half-life of approximately 15 to 23 weeks.

BIOCONCENTRATION: Bioconcentration Factor (BCF) values suggest bioconcentration in aquatic organisms is low.

BIOACCUMULATIVE POTENTIAL: Bioaccumulation of chloroform in aquatic species is unlikely in view of its physical, chemical and biological properties. The octanol water partition coefficient is small. Under these conditions the bioaccumulation through the food chain is highly unlikely. The following bioconcentration factors (BCF) have been reported for freshwater fish:. Cyprinus Carpio 4-13
Lepomis macrochirus 1.6 – 2.5
Oncornhyncus mykiss 3.34 – 10.34.

MOBILITY IN SOIL: Chloroform is expected to have high to moderate mobility in soil.

SECTION 13. DISPOSAL CONSIDERATIONS

Waste from material:
Reuse or reprocess, if possible. Keep out of water supplies, sewers and soil. Contact a licensed professional waste disposal service to dispose of surplus and non-recyclable solutions. Dispose in accordance with all applicable regulations. If the material is to be incinerated, the chemical incinerator must be equipped with an afterburner (to assure complete combustion to prevent the formation of phosgene) and an acid scrubber (to remove the halo acids produced). All disposal practices must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Report spills if applicable. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. AS YOUR SUPPLIER, WE HAVE NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN SDS SECTION: Composition Information (FOR UNUSED & UNCONTAMINATED PRODUCT).

Container Management:
Dispose of container in accordance with applicable local, regional, national, and/or international regulations. Container rinsate must be disposed of in compliance with applicable regulations. Puncture container to avoid re-use.

Contaminated Material:
Contaminated material must be disposed of in a permitted waste management facility. Contaminated packaging must be disposed of as unused product by a licensed / permitted waste disposal service.

SECTION 14. TRANSPORT INFORMATION

LAND TRANSPORT

U.S. DOT 49 CFR 172.101:

UN NUMBER:	UN1888
PROPER SHIPPING NAME:	Chloroform
HAZARD CLASS/ DIVISION:	6.1
PACKING GROUP:	III
LABELING REQUIREMENTS:	6.1
RQ (lbs.):	RQ 10 Lbs. (Chloroform)
Special provisions for transport:	IB3, N36, T7, TP2.
Packaging Exceptions	153.
Non-bulk Packaging:	203.
Bulk Packaging:	241.

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:

UN NUMBER:	UN1888
SHIPPING NAME:	Chloroform
CLASS OR DIVISION:	6.1
PACKING/RISK GROUP:	III
LABELING REQUIREMENTS:	6.1

MARITIME TRANSPORT (IMO / IMDG)

UN NUMBER:	UN1888
PROPER SHIPPING NAME:	Chloroform
HAZARD CLASS / DIVISION:	6.1
Packing Group:	III
LABELING REQUIREMENTS:	6.1

AIR TRANSPORT (ICAO / IATA)

Special Instructions CAO:	IATA Certificate for shipping personnel is required

SECTION 15. REGULATORY INFORMATION

U.S. REGULATIONS

OSHA REGULATORY STATUS:

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):

If a release is reportable under CERCLA section 103, notify the state emergency response commission and local emergency planning committee. In addition, notify the National Response Center at (800) 424-8802 or (202) 426-2675.

Component	U.S. DOT Hazardous Substances/ RQs	CERCLA Hazardous Substances / RQs	CERCLA Section 302 EHS EPCRA RQs	Section 302 Threshold Planning Quantity (TPQs)
Chloroform 67-66-3 (0 - 99)	10 lbs(RQ)	10 lb(final RQ)	10 lb(EPCRA RQ)	10000 lb TPQ

SARA EHS Chemical (40 CFR 355.30)

If a release is reportable under EPCRA, notify the state emergency response commission and local emergency planning committee. If the TPQ is met, facilities are subject to reporting requirements under EPCRA Sections 311 and 312.

EPCRA SECTIONS 311/312 HAZARD CATEGORIES (40 CFR 370.10):

Acute Health Hazard, Chronic Health Hazard, Extremely Hazardous

SARA HAZARD CATEGORIES ALIGNED WITH GHS (2018):

Health Hazard - Carcinogen
Health Hazard - Acute Toxin (any route of exposure)
Health Hazard - Reproductive Toxin
Health Hazard - Skin Corrosion or Irritation
Health Hazard - Serious eye damage or eye irritation
Health Hazard - Specific Target Organ Toxicity (STOT) Single Exposure (SE)
Health Hazard - Specific Target Organ Toxicity (STOT) Repeat Exposure (RE)
Health Hazard - Aspiration Hazard
Health Hazard - HNOC

EPCRA SECTION 313 (40 CFR 372.65):

The following chemicals are listed in 40 CFR 372.65 and may be subject to Community Right-to Know Reporting requirements.

Component	SARA 313 - Emission Reporting	SARA 313 PBT
Chloroform 67-66-3 (0 - 99)	0.1% (de minimis concentration)	Not Listed

DEPARTMENT OF HOMELAND SECURITY (DHS)- Chemical Facility Anti-Terrorism Standards (6 CFR 27):

The following components are regulated under DHS:

Component	DHS - Security Issues	DHS-Sabotage Screening Threshold Qnty.	DHS-Sabotage Min. Conc.	DHS-Theft Screening Threshold Qnty.	DHS-Theft Min. Conc.	DHS-Release Screening Threshold Qnty.	DHS-Release Min. Conc.	CWC Toxic Chemicals:
Chloroform 67-66-3 (0 - 99)	Release - Toxic	Not Listed	Not Listed	Not Listed	Not Listed	20000 lb STQ	1.0%Minimum Concentration	Not Listed

OSHA PROCESS SAFETY (PSM) (29 CFR 1910.119):

Regulated.

Component	EPA RMP Toxic or Flammable TPQ	PSM - Highly Hazardous Substances, Toxics and Reactives	Flash Point
Ethyl alcohol 64-17-5 (0 - 1)	Not Listed	Not Listed	13°C 17°C 20°C 21°C 22°C 24°C 26°C 29°C 36°C 49°C 62°C
Chloroform 67-66-3 (0 - 99)	Toxic (20000 lb threshold quantity)	Not Listed	

EPA'S CLEAN WATER AND CLEAN AIR ACTS:

Regulated as noted in table below.

Component	Clean Water Act - Priority Pollutants	CAA - ODS CLASS 1 AND CLASS 2	CAA - Volatile Organic Compounds (VOCs) in SOCMI	CAA - HON Rule - Organic HAPs	CAA - Hazard Air Pollutants	CAA - Urban HAPs List (Integrated Urban Strategy)	SNAP - Substitutes for ODS	EPA RMP Toxic or Flammable TPQ
Ethyl alcohol	Not Listed	Not Listed	Present	Not Listed	Not Listed	Not Listed	Not Listed	Not Listed
Chloroform	Present	Not Listed	Present	Present	Present	Present	Not Listed	Toxic (20000 lb threshold quantity)

NATIONAL INVENTORY STATUS

U.S. INVENTORY STATUS: Toxic Substance Control Act (TSCA):

Component	TSCA Inventory	TSCA ACTIVE LIST	TSCA 12(b)	TSCA - Section 4	TSCA - Section 5	TSCA - Section 6	TSCA - Section 8
Ethyl alcohol 64-17-5	Listed	ACTIVE	Not Listed	Not listed	Not Listed	Not listed	Not listed
Chloroform 67-66-3	Listed	ACTIVE	Not Listed	Not listed	Not Listed	Not listed	Listed

CANADIAN CHEMICAL INVENTORY: All components of this product are listed on either the DSL or the NDSL.

Component	DSL	NDSL
Ethyl alcohol 64-17-5 (0 - 1)	Listed	Not Listed
Chloroform 67-66-3 (0 - 99)	Listed	Not Listed

STATE REGULATIONS

California Proposition 65:
This product contains a chemical known to the State of California to cause cancer, and/or birth defects, and/or other reproductive harm as listed under Proposition 65 State Drinking Water and Toxic Enforcement Act. For additional information, contact OxyChem Technical Services.

Component	California Proposition 65 Cancer WARNING:	California Proposition 65 CRT List - Male reproductive toxin:	California Proposition 65 CRT List - Female reproductive toxin:	Massachusetts Right to Know Hazardous Substance List	Rhode Island Right to Know Hazardous Substance List
Ethyl alcohol	Listed developmental toxicity	Not Listed	Not Listed	Listed	Listed
Chloroform	Listed developmental toxicity	Not Listed	Not Listed	Listed	Listed

Component	New Jersey Right to Know Hazardous Substance List	New Jersey Special Health Hazards Substance List	New Jersey - Environmental Hazardous Substance List	Pennsylvania Right to Know Hazardous Substance List	Pennsylvania Right to Know Special Hazardous Substances	Pennsylvania Right to Know Special Hazardous Substances	Pennsylvania Right to Know Environmental Hazard List
Ethyl alcohol	0844	flammable - third degree	Not Listed	Listed	Not Listed	Not Listed	Not Listed
Chloroform	0388	carcinogen	Listed	Listed	Present	Present	Present

CANADIAN REGULATIONS

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.

Component	Canada - CEPA - Schedule I - List of Toxic Substances	Canada - NPRI	Canada - CEPA - 2010 Greenhouse Gases (GHG) Subject to Mandatory Reporting	CANADIAN CHEMICAL INVENTORY:	NDSL:
Ethyl alcohol 64-17-5 (0 - 1)	Present (065)	Part 5, Individual Substance Part 4 Substance	Not Listed	Listed	Not Listed
Chloroform 67-66-3 (0 - 99)	Present (065)	Part 1, Group 1 Substance Part 4 Substance	Not Listed	Listed	Not Listed

SECTION 16. OTHER INFORMATION

Prepared by: Occidental Chemical Corporation - HES&S Product Stewardship Department

Rev. Date: 29-Sep-2020

Reason for Revision:
- Scheduled review
- Updated Product Use information: SEE SECTION 1
- Updated Uses Advised Against information: SEE SECTION 1
- Emergency Overview was revised: SEE SECTION 2
- Revised Major Health Hazards: SEE SECTION 2
- Revised GHS Information: SEE SECTION 2

CHLOROFORM (ALL GRADES)

- Modified GHS Hazard and Precautionary Statements: SEE SECTION 2
- FIRE FIGHTING MEASURES (SECTION 5)
- Revised Accidental Release Measures: SEE SECTION 6
- Revised Handling and Storage Recommendations: SEE SECTION 7
- Added Hygiene Measures SEE SECTION 8
- Updated Physical and Chemical Properties. SEE SECTION 9
- Toxicological Information has been revised: SEE SECTION 11
- Ecological Information has been modified: SEE SECTION 12
- Updated Disposal Considerations. SEE SECTION 13
- Updated Transportation Information: SEE SECTION 14
- Added LOLI tables such as EPA'S Clean Water / Air Act, TSCA status, DHS, PSM, EPCRA, CERCLA, Federal Canadian: SEE SECTION 15
- Revised California Proposition 65 Statement: SEE SECTION 15

IMPORTANT:
The information presented herein, while not guaranteed, was prepared by technical personnel and is true and accurate to the best of our knowledge. NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTY OR GUARANTY OF ANY OTHER KIND, EXPRESSED OR IMPLIED, IS MADE REGARDING PERFORMANCE, SAFETY, SUITABILITY, STABILITY OR OTHERWISE. This information is not intended to be all-inclusive as to the manner and conditions of use, handling, storage, disposal and other factors that may involve other or additional legal, environmental, safety or performance considerations, and Occidental Chemical Corporation assumes no liability whatsoever for the use of or reliance upon this information. While our technical personnel will be happy to respond to questions, safe handling and use of the product remains the responsibility of the customer. No suggestions for use are intended as, and nothing herein shall be construed as, a recommendation to infringe any existing patents or to violate any federal, state, local or foreign laws.

OSHA Standard 29 CFR 1910.1200 requires that information be provided to employees regarding the hazards of chemicals by means of a hazard communication program including labeling, safety data sheets, training and access to written records. We request that you, and it is your legal duty to, make all information in this Safety Data Sheet available to your employees.

End of Safety Data Sheet

Safety Data Sheet

DIMETHYLFORMAMIDE

Version 1.5 Revision Date: 05/19/2022

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : DIMETHYLFORMAMIDE

Recommended use of the chemical and restrictions on use

Recommended use : SOLVENT

Manufacturer or supplier's details

Company : Univar Solutions USA, Inc.
Address 3075 Highland Pkwy Suite 200
Downers Grove, IL 60515
United States of America (USA)

Emergency telephone number:
Transport North America: CHEMTREC (1-800-424-9300)
CHEMTREC INTERNATIONAL Tel # 703-527-3887

Additional Information: : Responsible Party: Product Compliance Department
E-mail: SDSNA@univarsolutions.com
SDS Requests: 1-855-429-2661
Website: www.univarsolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids : Category 3

Acute toxicity (Inhalation) : Category 4

Acute toxicity (Dermal) : Category 4

Eye irritation : Category 2A

Reproductive toxicity : Category 1B

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H226 Flammable liquid and vapour.
H312 + H332 Harmful in contact with skin or if inhaled.
H319 Causes serious eye irritation.
H360 May damage fertility or the unborn child.

Precautionary statements : **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.

P240 Ground/bond container and receiving equipment.
P241 Use explosion-proof electrical/ ventilating/ lighting 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 skin thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response:
P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P312 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313 IF exposed or concerned: Get medical advice/ attention.
P337 + P313 If eye irritation persists: Get medical advice/ attention.
P363 Wash contaminated clothing before reuse.
P370 + P378 In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.

Storage:
P403 + P235 Store in a well-ventilated place. Keep cool.
P405 Store locked up.

Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Hazardous components

CAS-No.	Chemical name	Weight percent
68-12-2	Dimethylformamide	90 - 100

Any Concentration shown as a range is due to batch variation.

Synonyms : N,N-Dimethylformamide,

SECTION 4. FIRST AID MEASURES

General advice : Move out of dangerous area.
Show this safety data sheet to the doctor in attendance.
Do not leave the victim unattended.

If inhaled : If unconscious, place in recovery position and seek medical

		advice. If symptoms persist, call a physician.
In case of skin contact	:	If on skin, rinse well with water. If on clothes, remove clothes.
In case of eye contact	:	Immediately flush eye(s) with plenty of water. Remove contact lenses. Protect unharmed eye. Keep eye wide open while rinsing. If eye irritation persists, consult a specialist.
If swallowed	:	Keep respiratory tract clear. Do not give milk or alcoholic beverages. Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Take victim immediately to hospital. Do not induce vomiting without medical advice.
Notes to physician	:	If ingested, irrigate the stomach using activated charcoal in addition.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Alcohol-resistant foam Carbon dioxide (CO2) Dry chemical
Unsuitable extinguishing media	:	High volume water jet
Specific hazards during firefighting	:	Do not allow run-off from fire fighting to enter drains or water courses.
Hazardous combustion products	:	Carbon oxides formaldehyde
Specific extinguishing methods	:	Use a water spray to cool fully closed containers. Collect contaminated fire extinguishing water separately. This must not be discharged into drains.
Further information	:	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. For safety reasons in case of fire, cans should be stored separately in closed containments.
Special protective equipment for firefighters	:	Wear full firefighting turn-out gear (full Bunker gear), and respiratory protection (SCBA). Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Use personal protective equipment. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
Environmental precautions	:	Prevent product from entering drains. Prevent further leakage or spillage if safe to do so. If the product contaminates rivers and lakes or drains inform

respective authorities.

Methods and materials for containment and cleaning up	: Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion	: Do not spray on a naked flame or any incandescent material. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapours). Keep away from open flames, hot surfaces and sources of ignition. Vapours may form explosive mixtures with air.
Advice on safe handling	: Avoid formation of aerosol. Do not breathe vapours/dust. Avoid contact with skin and eyes. For personal protection see section 8. Smoking, eating and drinking should be prohibited in the application area. Take precautionary measures against static discharges. Provide sufficient air exchange and/or exhaust in work rooms. Open drum carefully as content may be under pressure. Dispose of rinse water in accordance with local and national regulations.
Conditions for safe storage	: No smoking. Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Observe label precautions. Electrical installations / working materials must comply with the technological safety standards.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

CAS-No.	Components	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
68-12-2	Dimethylformamide	TWA	10 ppm	ACGIH
		TWA	10 ppm 30 mg/m3	NIOSH REL
		TWA	10 ppm 30 mg/m3	OSHA Z-1
		TWA	10 ppm 30 mg/m3	OSHA P0

Personal protective equipment

Respiratory protection	: In the case of vapour formation use a respirator with an approved filter.

Hand protection

Remarks	: The suitability for a specific workplace should be discussed with the producers of the protective gloves.
Eye protection	: Eye wash bottle with pure water Tightly fitting safety goggles Wear face-shield and protective suit for abnormal processing problems.
Skin and body protection	: Impervious clothing Choose body protection according to the amount and concentration of the dangerous substance at the work place.
Hygiene measures	: When using do not eat or drink. When using do not smoke. Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: viscous, liquid
Colour	: colourless
Odour	: slight, amine-like, ammoniacal
Odour Threshold	: No data available
pH	: 6.5 - 8.5 @ 20 % @ 20 - 38 °C (68 - 100 °F)
Freezing Point (Melting point/freezing point)	: -61 °C (-78 °F)
Boiling Point (Boiling point/boiling range)	: 152 - 153 °C (306 - 307 °F) (1013 hPa)
Flash point	: 58 °C (136 °F) Method: Tag closed cup
Evaporation rate	: 0.5
Flammability (solid, gas)	: No data available
Upper explosion limit	: 15.2 - 16 %(V)
Lower explosion limit	: 2.2 %(V)
Vapour pressure	: 2.6 - 2.875 mmHg @ 20 °C (68 °F)
Relative vapour density	: 2.52 @ 20 °C (68 °F) (Air = 1.0)
Relative density	: 0.949 @ 20 °C (68 °F) Reference substance: (water = 1)
Density	: 0.949 g/cm3 @ 20 °C (68 °F)
Solubility(ies)	
Water solubility	: 200 g/l soluble @ 20 °C (68 °F)
Solubility in other solvents	: No data available
Partition coefficient: n-	: log Pow: -0.85

octanol/water		
Auto-ignition temperature	:	445 °C
Thermal decomposition	:	> 350 °C

Viscosity

Viscosity, dynamic	:	0.802 mPa.s @ 25 °C (77 °F)

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Vapours may form explosive mixture with air.
Conditions to avoid	:	Keep away from heat, flame, sparks and other ignition sources.
Incompatible materials	:	Strong acids Strong oxidizing agents halogenated hydrocarbons Alkali metals Reducing agents
Hazardous decomposition products	:	Carbon monoxide Nitrogen oxides (NOx) Ammonia Carbon dioxide (CO2) Hydrocarbons

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Product:

Acute inhalation toxicity	:	Acute toxicity estimate: 15.15 mg/l Exposure time: 4 h Test atmosphere: vapour
Acute dermal toxicity	:	Acute toxicity estimate: 1,111 mg/kg

Components:

68-12-2:

Acute inhalation toxicity	:	LC50 (Rat): 15 mg/l Exposure time: 4 h Assessment: The component/mixture is moderately toxic after short term inhalation.
Acute dermal toxicity	:	Assessment: The component/mixture is moderately toxic after single contact with skin. Remarks: No data available

Serious eye damage/eye irritation

Components:

68-12-2:
Species: Rabbit
Result: Irritating to eyes.

Respiratory or skin sensitisation

Product:

Germ cell mutagenicity

Components:

68-12-2:

Germ cell mutagenicity - Assessment	:	Tests on bacterial or mammalian cell cultures did not show mutagenic effects.

Carcinogenicity

Components:

68-12-2:

Carcinogenicity - Assessment	:	No evidence of carcinogenicity in animal studies.
IARC		No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA		No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.
NTP		No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Components:

68-12-2:

Effects on fertility	:	Test Type: Two-generation study Species: Mouse, male and female Application Route: Oral Dose: 0, 1000, 4000, 7000 ppm General Toxicity - Parent: LOAEL: < 1,000 ppm General Toxicity F1: LOAEL: 1,000 ppm Fertility: NOAEL: < 1,000 ppm Symptoms: Reduced maternal body weight gain Reduced offspring weight gain Reduced fertility
Effects on foetal development	:	Species: Rabbit Application Route: Inhalation

		Dose: 0, 0.15, 0.45, 1.36 mg/L Duration of Single Treatment: 13 d Frequency of Treatment: 6 hr/day General Toxicity Maternal: NOAEC: 0.15 mg/L Teratogenicity: NOAEC: 0.15 mg/L Symptoms: Maternal toxicity, Reduced body weight, Skeletal malformations, Visceral malformations
Reproductive toxicity - Assessment		Clear evidence of adverse effects on sexual function and fertility, based on animal experiments.
Teratogenicity - Assessment	:	Clear evidence of adverse effects on development, based on animal experiments.

STOT - repeated exposure

Product:

Assessment: The substance or mixture is classified as specific target organ toxicant, repeated exposure, category 1.

Aspiration toxicity

Product:

No aspiration toxicity classification

Experience with human exposure

Product:

Inhalation	:	Symptoms: Inhalation may provoke the following symptoms:, Liver disorders, Kidney disorders
Skin contact	:	Symptoms: Discomfort, Skin contact may provoke the following symptoms:, Severe irritation, Itching, Redness, Swelling of tissue
Eye contact	:	Symptoms: Severe irritation, Pain, Swelling of tissue, Redness, eye irregularities
Ingestion	:	Symptoms: Ingestion may provoke the following symptoms:, Kidney disorders, Liver disorders

Further information

Product:

Remarks: Solvents may degrease the skin.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

No data available

Persistence and degradability

Product:

Biodegradability	: Remarks: Readily biodegradable

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential	: Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).
Additional ecological information	: No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	: Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact Univar Solutions ChemCare: 1-800-637-7922
Contaminated packaging	: Empty remaining contents. Dispose of as unused product. Do not re-use empty containers. Do not burn, or use a cutting torch on, the empty drum.

SECTION 14. TRANSPORT INFORMATION

DOT (Department of Transportation):
UN2265, N,N-Dimethylformamide, 3, III

IATA (International Air Transport Association):
UN2265, N,N-Dimethylformamide, 3, III

IMDG (International Maritime Dangerous Goods):
UN2265, N,N-DIMETHYLFORMAMIDE, 3, III, Flash Point:58 °C(136 °F)

Special Notes: : In accordance with 49 CFR non-bulk containers (less than

450L/119 gallon capacity) of this material may be shipped as non-regulated when transported solely by land, as long as the material is not a hazardous waste, a marine pollutant, or specifically listed as a hazardous substance.

SECTION 15. REGULATORY INFORMATION

WHMIS Classification : B3: Combustible Liquid
D2A: Very Toxic Material Causing Other Toxic Effects
D2B: Toxic Material Causing Other Toxic Effects

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Dimethylformamide	68-12-2	100	101

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Flammable (gases, aerosols, liquids, or solids)
Acute toxicity (any route of exposure)
Serious eye damage or eye irritation
Reproductive toxicity

SARA 302 : No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : The following components are subject to reporting levels established by SARA Title III, Section 313:

68-12-2	Dimethylformamide

Clean Air Act

The following chemical(s) are listed as HAP under the U.S. Clean Air Act, Section 112 (40 CFR 61):

68-12-2	Dimethylformamide

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).

The following chemical(s) are listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489):

68-12-2	Dimethylformamide

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.

This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.

This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

Massachusetts Right To Know

68-12-2	Dimethylformamide

Pennsylvania Right To Know

68-12-2	Dimethylformamide

California Prop 65

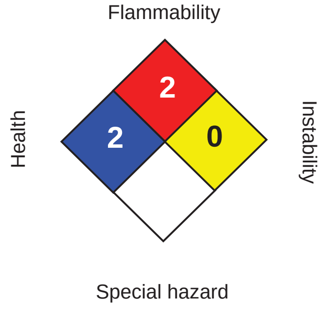
⚠ **WARNING**: This product can expose you to chemicals including Dimethylformamide, which is/are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

The components of this product are reported in the following inventories:

TSCA	: On TSCA Inventory
DSL	: All components of this product are on the Canadian DSL
AICS	: On the inventory, or in compliance with the inventory
NZIoC	: On the inventory, or in compliance with the inventory
ENCS	: On the inventory, or in compliance with the inventory
KECI	: On the inventory, or in compliance with the inventory
IECSC	: On the inventory, or in compliance with the inventory
PHIL	: On the inventory, or in compliance with the inventory

SECTION16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	2*
FLAMMABILITY	2
PHYSICAL HAZARD	0

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

The information accumulated is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made become available subsequently to the date hereof, we do not assume any responsibility for the results of its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by Univar Solutions Product Compliance Department (1-855-429-2661) SDSNA@univarsolutions.com.

Revision Date : 05/19/2022

Legacy SDS: : R0000780

Material number:
16191926, 16182819, 16178051, 16177215, 16180752, 16179304, 16169592, 16143606, 16153505, 16151958, 16137239, 16153986, 16158304, 16152231, 16158535, 16153873, 16153388, 16144025, 16158984, 16158985, 16130974, 16098590, 16068065, 16052262, 16049718, 16048530, 16048529, 20174, 658787, 610886, 592019, 554231, 554066, 58309, 69200, 70470, 55537, 103229, 69744, 54482, 71453, 101860, 54203, 69106, 86435, 103623, 54313, 20173

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program
CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level
EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philippines Inventory of Commercial Chemical Substances
MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Composition, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50	Lethal Concentration 50%		

Safety Data Sheet

DIMETHYLFORMAMIDE

Version 1.5 Revision Date: 05/19/2022

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : DIMETHYLFORMAMIDE

Recommended use of the chemical and restrictions on use

Recommended use : SOLVENT

Manufacturer or supplier's details

Company : Univar Solutions USA, Inc.
Address
3075 Highland Pkwy Suite 200
Downers Grove, IL 60515
United States of America (USA)

Emergency telephone number:
Transport North America: CHEMTREC (1-800-424-9300)
CHEMTREC INTERNATIONAL Tel # 703-527-3887

Additional Information: : Responsible Party: Product Compliance Department
E-mail: SDSNA@univarsolutions.com
SDS Requests: 1-855-429-2661
Website: www.univarsolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids : Category 3

Acute toxicity (Inhalation) : Category 4

Acute toxicity (Dermal) : Category 4

Eye irritation : Category 2A

Reproductive toxicity : Category 1B

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H226 Flammable liquid and vapour.
H312 + H332 Harmful in contact with skin or if inhaled.
H319 Causes serious eye irritation.
H360 May damage fertility or the unborn child.

Precautionary statements : **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.

P240 Ground/bond container and receiving equipment.
P241 Use explosion-proof electrical/ ventilating/ lighting 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 skin thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response:

P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P312 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313 IF exposed or concerned: Get medical advice/ attention.
P337 + P313 If eye irritation persists: Get medical advice/ attention.
P363 Wash contaminated clothing before reuse.
P370 + P378 In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.

Storage:

P403 + P235 Store in a well-ventilated place. Keep cool.
P405 Store locked up.

Disposal:

P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Hazardous components

CAS-No.	Chemical name	Weight percent
68-12-2	Dimethylformamide	90 - 100

Any Concentration shown as a range is due to batch variation.

Synonyms : N,N-Dimethylformamide**,**

SECTION 4. FIRST AID MEASURES

General advice : Move out of dangerous area.
Show this safety data sheet to the doctor in attendance.
Do not leave the victim unattended.

If inhaled : If unconscious, place in recovery position and seek medical

	advice. If symptoms persist, call a physician.
In case of skin contact	If on skin, rinse well with water. If on clothes, remove clothes.
In case of eye contact	Immediately flush eye(s) with plenty of water. Remove contact lenses. Protect unharmed eye. Keep eye wide open while rinsing. If eye irritation persists, consult a specialist.
If swallowed	Keep respiratory tract clear. Do not give milk or alcoholic beverages. Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Take victim immediately to hospital. Do not induce vomiting without medical advice.
Notes to physician	If ingested, irrigate the stomach using activated charcoal in addition.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	Alcohol-resistant foam Carbon dioxide (CO2) Dry chemical
Unsuitable extinguishing media	High volume water jet
Specific hazards during fire-fighting	Do not allow run-off from fire fighting to enter drains or water courses.
Hazardous combustion products	Carbon oxides formaldehyde
Specific extinguishing methods	Use a water spray to cool fully closed containers. Collect contaminated fire extinguishing water separately. This must not be discharged into drains.
Further information	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. For safety reasons in case of fire, cans should be stored separately in closed containments.
Special protective equipment for firefighters	Wear full firefighting turn-out gear (full Bunker gear), and respiratory protection (SCBA). Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	Use personal protective equipment. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
Environmental precautions	Prevent product from entering drains. Prevent further leakage or spillage if safe to do so. If the product contaminates rivers and lakes or drains inform

respective authorities.

Methods and materials for containment and cleaning up : Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion : Do not spray on a naked flame or any incandescent material. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapours). Keep away from open flames, hot surfaces and sources of ignition. Vapours may form explosive mixtures with air.

Advice on safe handling : Avoid formation of aerosol.
Do not breathe vapours/dust.
Avoid contact with skin and eyes.
For personal protection see section 8.
Smoking, eating and drinking should be prohibited in the application area.
Take precautionary measures against static discharges.
Provide sufficient air exchange and/or exhaust in work rooms.
Open drum carefully as content may be under pressure.
Dispose of rinse water in accordance with local and national regulations.

Conditions for safe storage : No smoking.
Keep container tightly closed in a dry and well-ventilated place.
Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Observe label precautions.
Electrical installations / working materials must comply with the technological safety standards.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

CAS-No.	Components	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
68-12-2	Dimethylformamide	TWA	10 ppm	ACGIH
		TWA	10 ppm 30 mg/m3	NIOSH REL
		TWA	10 ppm 30 mg/m3	OSHA Z-1
		TWA	10 ppm 30 mg/m3	OSHA P0

Personal protective equipment

Respiratory protection : In the case of vapour formation use a respirator with an approved filter.

Hand protection

Remarks : The suitability for a specific workplace should be discussed with the producers of the protective gloves.

Eye protection : Eye wash bottle with pure water
Tightly fitting safety goggles
Wear face-shield and protective suit for abnormal processing problems.

Skin and body protection : Impervious clothing
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures : When using do not eat or drink.
When using do not smoke.
Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : viscous, liquid
Colour : colourless
Odour : slight, amine-like, ammoniacal
Odour Threshold : No data available
pH : 6.5 - 8.5 @ 20 % @ 20 - 38 °C (68 - 100 °F)

Freezing Point (Melting point/freezing point) : -61 °C (-78 °F)
Boiling Point (Boiling point/boiling range) : 152 - 153 °C (306 - 307 °F) (1013 hPa)

Flash point : 58 °C (136 °F)
Method: Tag closed cup

Evaporation rate : 0.5

Flammability (solid, gas) : No data available
Upper explosion limit : 15.2 - 16 %(V)

Lower explosion limit : 2.2 %(V)

Vapour pressure : 2.6 - 2.875 mmHg @ 20 °C (68 °F)

Relative vapour density : 2.52 @ 20 °C (68 °F)
(Air = 1.0)

Relative density : 0.949 @ 20 °C (68 °F)
Reference substance: (water = 1)

Density : 0.949 g/cm3 @ 20 °C (68 °F)

Solubility(ies)
Water solubility : 200 g/l soluble @ 20 °C (68 °F)

Solubility in other solvents : No data available
Partition coefficient: n- : log Pow: -0.85

octanol/water		
Auto-ignition temperature	:	445 °C
Thermal decomposition	:	> 350 °C
Viscosity		
Viscosity, dynamic	:	0.802 mPa.s @ 25 °C (77 °F)

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Vapours may form explosive mixture with air.
Conditions to avoid	:	Keep away from heat, flame, sparks and other ignition sources.
Incompatible materials	:	Strong acids Strong oxidizing agents halogenated hydrocarbons Alkali metals Reducing agents
Hazardous decomposition products	:	Carbon monoxide Nitrogen oxides (NOx) Ammonia Carbon dioxide (CO2) Hydrocarbons

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Product:

Acute inhalation toxicity	:	Acute toxicity estimate: 15.15 mg/l Exposure time: 4 h Test atmosphere: vapour
Acute dermal toxicity	:	Acute toxicity estimate: 1,111 mg/kg

Components:

68-12-2:

Acute inhalation toxicity	:	LC50 (Rat): 15 mg/l Exposure time: 4 h Assessment: The component/mixture is moderately toxic after short term inhalation.
Acute dermal toxicity	:	Assessment: The component/mixture is moderately toxic after single contact with skin. Remarks: No data available

Serious eye damage/eye irritation

Components:

68-12-2:
Species: Rabbit
Result: Irritating to eyes.

Respiratory or skin sensitisation

Product:

Germ cell mutagenicity

Components:

68-12-2:

Germ cell mutagenicity - Assessment	:	Tests on bacterial or mammalian cell cultures did not show mutagenic effects.

Carcinogenicity

Components:

68-12-2:

Carcinogenicity - Assessment	:	No evidence of carcinogenicity in animal studies.
IARC		No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA		No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.
NTP		No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Components:

68-12-2:

Effects on fertility	:	Test Type: Two-generation study Species: Mouse, male and female Application Route: Oral Dose: 0, 1000, 4000, 7000 ppm General Toxicity - Parent: LOAEL: < 1,000 ppm General Toxicity F1: LOAEL: 1,000 ppm Fertility: NOAEL: < 1,000 ppm Symptoms: Reduced maternal body weight gain Reduced offspring weight gain Reduced fertility
Effects on foetal development	:	Species: Rabbit Application Route: Inhalation

		Dose: 0, 0.15, 0.45, 1.36 mg/L Duration of Single Treatment: 13 d Frequency of Treatment: 6 hr/day General Toxicity Maternal: NOAEC: 0.15 mg/L Teratogenicity: NOAEC: 0.15 mg/L Symptoms: Maternal toxicity, Reduced body weight, Skeletal malformations, Visceral malformations
Reproductive toxicity - Assessment		Clear evidence of adverse effects on sexual function and fertility, based on animal experiments.
Teratogenicity - Assessment	:	Clear evidence of adverse effects on development, based on animal experiments.

STOT - repeated exposure

Product:

Assessment: The substance or mixture is classified as specific target organ toxicant, repeated exposure, category 1.

Aspiration toxicity

Product:

No aspiration toxicity classification

Experience with human exposure

Product:

Inhalation	:	Symptoms: Inhalation may provoke the following symptoms:, Liver disorders, Kidney disorders
Skin contact	:	Symptoms: Discomfort, Skin contact may provoke the following symptoms:, Severe irritation, Itching, Redness, Swelling of tissue
Eye contact	:	Symptoms: Severe irritation, Pain, Swelling of tissue, Redness, eye irregularities
Ingestion	:	Symptoms: Ingestion may provoke the following symptoms:, Kidney disorders, Liver disorders

Further information

Product:

Remarks: Solvents may degrease the skin.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

No data available

Persistence and degradability

Product:

Biodegradability	: Remarks: Readily biodegradable

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential	: Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).
Additional ecological information	: No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	: Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact Univar Solutions ChemCare: 1-800-637-7922
Contaminated packaging	: Empty remaining contents. Dispose of as unused product. Do not re-use empty containers. Do not burn, or use a cutting torch on, the empty drum.

SECTION 14. TRANSPORT INFORMATION

DOT (Department of Transportation):
UN2265, N,N-Dimethylformamide, 3, III

IATA (International Air Transport Association):
UN2265, N,N-Dimethylformamide, 3, III

IMDG (International Maritime Dangerous Goods):
UN2265, N,N-DIMETHYLFORMAMIDE, 3, III, Flash Point:58 °C(136 °F)

Special Notes: : In accordance with 49 CFR non-bulk containers (less than

450L/119 gallon capacity) of this material may be shipped as non-regulated when transported solely by land, as long as the material is not a hazardous waste, a marine pollutant, or specifically listed as a hazardous substance.

SECTION 15. REGULATORY INFORMATION

WHMIS Classification : B3: Combustible Liquid
D2A: Very Toxic Material Causing Other Toxic Effects
D2B: Toxic Material Causing Other Toxic Effects

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Dimethylformamide	68-12-2	100	101

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Flammable (gases, aerosols, liquids, or solids)
Acute toxicity (any route of exposure)
Serious eye damage or eye irritation
Reproductive toxicity

SARA 302 : No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : The following components are subject to reporting levels established by SARA Title III, Section 313:

68-12-2	Dimethylformamide

Clean Air Act

The following chemical(s) are listed as HAP under the U.S. Clean Air Act, Section 112 (40 CFR 61):

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Massachusetts Right To Know

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Pennsylvania Right To Know

68-12-2	Dimethylformamide

California Prop 65

⚠ **WARNING**: This product can expose you to chemicals including Dimethylformamide, which is/are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

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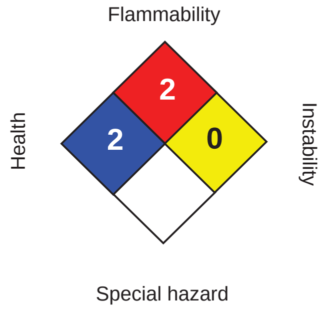
SECTION16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	**2***
FLAMMABILITY	**2**
PHYSICAL HAZARD	**0**

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

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Revision Date : 05/19/2022

Legacy SDS: : R0000780

Material number:
16191926, 16182819, 16178051, 16177215, 16180752, 16179304, 16169592, 16143606, 16153505, 16151958, 16137239, 16153986, 16158304, 16152231, 16158535, 16153873, 16153388, 16144025, 16158984, 16158985, 16130974, 16098590, 16068065, 16052262, 16049718, 16048530, 16048529, 20174, 658787, 610886, 592019, 554231, 554066, 58309, 69200, 70470, 55537, 103229, 69744, 54482, 71453, 101860, 54203, 69106, 86435, 103623, 54313, 20173

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ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Composition, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50	Lethal Concentration 50%		

COLUMBUS CHEMICAL INDUSTRIES

Safety Data Sheet

Hydrochloric Acid 20% (Electrode-Cleaner)

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: Hydrochloric Acid 20% (Electrode-Cleaner)

Synonyms/Generic Names: None

Product Number: 8587

Product Use: Industrial, Manufacturing or Laboratory use

Manufacturer: Columbus Chemical Industries, Inc.
N4335 Temkin Rd.
Columbus, WI. 53925

For More Information: 920-623-2140 (Monday-Friday 8:00-4:30)
www.columbuschemical.com

In Case of Emergency Call: CHEMTREC - 800-424-9300 or 703-527-3887 (24 Hours/Day, 7 Days/Week)

2. HAZARDS IDENTIFICATION

Hazard Not Otherwise Classified (HNOC): None

Target Organ(s): Kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, circulatory system, teeth

Signal Words: Danger

Pictograms:

GHS Classification:

Skin corrosion	Category 1B
Serious eye damage	Category 1
Specific target organ toxicity-single exposure	Category 3

GHS Label Elements, including precautionary statements:

Hazard Statements:

H314	Causes severe skin burns and eye damage.
H335	May cause respiratory irritation.

Precautionary Statements:

P260	Do not breathe dust or mists.
P264	Wash hands thoroughly after handling.

P280	Wear protective gloves/protective clothing/eye protection/face protection.
P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340	IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER/doctor/physician.
P363	Wash contaminated clothing before reuse.
P501	Dispose of contents/container to an approved waste disposal plant.

Potential Health Effects

Eyes	Causes eye burns.
Inhalation	May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin	Harmful if absorbed through skin. Causes skin burns.
Ingestion	Harmful if swallowed.

NFPA Ratings

Health	3
Flammability	0
Reactivity	0
Specific hazard	Not Available

HMIS Ratings

Health	3
Fire	0
Reactivity	0

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	Weight %	CAS #	EINECS# / ELINCS#	Formula	Molecular Weight
Hydrochloric Acid	19-21	7647-01-0	231-595-7	HCl	36.46 g/mol
Water	Balance	7732-18-5	231-791-2	H_2O	18.00 g/mol

4. FIRST-AID MEASURES

Eyes	Rinse with plenty of water for at least 15 minutes and seek medical attention immediately.
Inhalation	Move casualty to fresh air and keep at rest. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention immediately.
Skin	Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and wash using soap. Get medical attention immediately.
Ingestion	**Do Not Induce Vomiting!** Never give anything by mouth to an unconscious person. If conscious, wash out mouth with water. Get medical attention immediately.

5. FIRE-FIGHTING MEASURES

Suitable (and unsuitable) extinguishing media	Product is not flammable. Use appropriate media for adjacent fire. Cool containers with water.
Special protective equipment and precautions for firefighters	Wear self-contained, approved breathing apparatus and full protective clothing, including eye protection and boots.
Specific hazards arising from the chemical	Emits toxic (hydrogen chloride gas) fumes under fire conditions. (See also Stability and Reactivity section).

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	See section 8 for recommendations on the use of personal protective equipment.
Environmental precautions	Prevent spillage from entering drains. Any release to the environment may be subject to federal/national or local reporting requirements.
Methods and materials for containment and cleaning up	Prevent spillage from entering drains. Neutralize spill with sodium bicarbonate or lime. Absorb spill with noncombustible absorbent material, then place in a suitable container for disposal. Clean surfaces thoroughly with water to remove residual contamination. Dispose of all waste and cleanup materials in accordance with regulations.

7. HANDLING AND STORAGE

Precautions for safe handling
See section 8 for recommendations on the use of personal protective equipment. Use with adequate ventilation. Wash thoroughly after using. Keep container closed when not in use. Avoid formation of aerosols.

Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area. Keep away from incompatible materials (see section 10 for incompatibilities).

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure controls:

Component	Exposure Limits	Basis	Entity
Hydrogen Chloride	2 ppm 2.98 mg/m^3	CEIL	ACGIH
	5 ppm 7 mg/m^3	CEIL	OSHA
	5 ppm 7 mg/m^3	CEIL	NIOSH
	50 ppm	IDLH	OSHA

TWA: Time Weighted Average over 8 hours of work.
TLV: Threshold Limit Value over 8 hours of work.
REL: Recommended Exposure Limit
PEL: Permissible Exposure Limit
STEL: Short Term Exposure Limit during x minutes.
IDLH: Immediately Dangerous to Life or Health
WEEL: Workplace Environmental Exposure Levels
CEIL: Ceiling

Personal Protection

Eyes	Wear chemical safety glasses or goggles, and face shield.
Inhalation	Provide local exhaust, preferably mechanical. If exposure levels are excessive, use an approved respirator.
Skin	Wear nitrile or rubber gloves, and a full body suit. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Other	Not Available

Other Recommendations
Provide eyewash stations, quick-drench showers and washing facilities accessible to areas of use and handling.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance (physical state, color, etc.)	Light yellow liquid.
Odor	Strong, pungent odor.
Odor threshold	0.25-10 ppm
pH	Acidic.
Melting point/freezing point	Not Available
Initial boiling point and boiling range	Not Available
Flash point	Not Flammable
Evaporation rate	Not Available
Flammability (solid, gas)	Not Flammable
Upper/lower flammability or explosive limit	Not Explosive
Vapor pressure	Not Available
Vapor density	Not Available
Specific gravity	1.09-1.11 (water = 1)
Solubility (ies)	Soluble in water, methanol.
Partition coefficient: n-octanol/water	Not Available
Auto-ignition temperature	Not Available
Decomposition temperature	Not Available

10. STABILITY AND REACTIVITY

Chemical Stability	Stable
Possibility of Hazardous Reactions	Will not occur.
Conditions to Avoid	Not Available
Incompatible Materials	Metals, oxidizing agents, organic materials, alkalis, water.
Hazardous Decomposition Products	Hydrogen chloride gas.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Skin	Not Available
Eyes	Not Available
Respiratory	Not Available
Ingestion	Not Available

Carcinogenicity

IARC	3: Not classifiable as to its carcinogenicity to humans (hydrochloric acid).
ACGIH	A4: Not classifiable as a human carcinogen (hydrochloric acid).
NTP	No components of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA	No components of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Signs & Symptoms of Exposure

Skin	Irritation and burns.
Eyes	Severe eye irritation, conjunctivitis, burns, corneal necrosis.
Respiratory	Irritation, pain, inflammation of upper respiratory tract and mucous membranes, coughing, sneezing, choking.

Ingestion	Irritation, burning, ulceration, fever, vomiting, nausea, diarrhea, thirst, difficulty swallowing, salivation.

Chronic Toxicity	May damage organs.
Teratogenicity	Not Available
Mutagenicity	May alter genetic material.
Embryotoxicity	Not Available
Target Organ(s)	Kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, circulatory system, teeth.
Reproductive Toxicity	Not Available
Respiratory/Skin Sensitization	Not Available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Aquatic Vertebrate	Not Available
Aquatic Invertebrate	Not Available
Terrestrial	Not Available

Persistence and Degradability	Not Available
Bioaccumulative Potential	Not Available
Mobility in Soil	Not Available
PBT and vPvB Assessment	Not Available
Other Adverse Effects	Not Available

13. DISPOSAL CONSIDERATIONS

Waste Product or Residues	Users should review their operations in terms of the applicable federal/national or local regulations and consult with appropriate regulatory agencies if necessary before disposing of waste product or residue.
Product Containers	Users should review their operations in terms of the applicable federal/national or local regulations and consult with appropriate regulatory agencies if necessary before disposing of waste product container.

The information offered in section 13 is for the product as shipped. Use and/or alterations to the product may significantly change the characteristics of the material and alter the waste classification and proper disposal methods.

14. TRANSPORTATION INFORMATION

US DOT	UN1789, Hydrochloric acid, 8, pg II
TDG	UN1789, HYDROCHLORIC ACID, 8, PG II
IMDG	UN1789, HYDROCHLORIC ACID, 8, PG II
Marine Pollutant	No
IATA/ICAO	UN1789, Hydrochloric acid, 8, pg II

15. REGULATORY INFORMATION

TSCA Inventory Status	All ingredients are listed on the TSCA Active inventory.
DSL / NDSL	All ingredients are listed on the DSL inventory.
California Proposition 65	Not Listed

Rhode Island: Hazardous Substance List	Listed: Hydrochloric Acid
Massachusetts: Toxic or Hazardous Substance List, Right to Know	Listed: Hydrochloric Acid
Pennsylvania: Hazardous Substance List	Listed: Hydrochloric Acid
New Jersey: Right to Know Hazardous Substance List	Listed: Hydrochloric Acid
SARA 302	Not Listed
SARA 304	Not Listed
SARA 311	Acute Health Hazard, Chronic Health Hazard
SARA 312	Acute Health Hazard, Chronic Health Hazard
SARA 313	Not Listed
WHMIS Canada	Class D1A: Poisonous and infectious material – Immediate and serious effects – Very toxic. Class E: Corrosive material.

16. OTHER INFORMATION

Revision	Date
Original	12/04/2012
Revision 1	08/07/2013
Revision 2	12/02/2014
Revision 3	03/22/2018
Revision 4	02/04/2022

Disclaimer: The information provided in this Safety Data Sheet (“SDS”) is correct to the best of our knowledge, information, and belief at the date of publication. The information in this SDS relates only to the specific Product identified under Section 1, and does not relate to its use in combination with other materials or products, or its use as to any particular process. Those handling, storing, or using the Product should satisfy themselves that they have current information regarding the particular way the Product is handled, stored or used and that the same is done in accordance with federal, state and local law. WE DO NOT MAKE ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING (WITHOUT LIMITATION) WARRANTIES WITH RESPECT TO THE COMPLETENESS OR CONTINUING ACCURACY OF THE INFORMATION CONTAINED HEREIN OR WITH RESPECT TO FITNESS FOR ANY PARTICULAR USE. WE DO NOT ASSUME RESPOSIBILITY AND EXPRESSLY DISCLAIM LIABILITY FOR LOSS, INJURY, DAMAGE OR EXPENSE ARISING OUT OF OR IN ANY WAY CONNECTED WITH THE HANDLING, STORAGE, USE OR DISPOSAL OF THIS PRODUCT.

Hydrofluoric acid 49 %

000000001555

Version 2.2 Revision Date 09/16/2012 Print Date 06/10/2014

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Hydrofluoric acid 49 %
MSDS Number	:	000000001555
Product Use Description	:	Metal Pickling, Glass Etching, Chemical derivatives, Semiconductor etching
Company	:	Honeywell International, Inc. 101 Columbia Road Morristown, NJ 07962-1057
For more information call	:	1-800-279-9998 1-480-293-9800 www.HFacid.com (Monday-Friday, 9:00am-5:00pm)
In case of emergency call	:	**Medical (PROSAR): 1-800-498-5701 or +1-651-523-0309**
	:	**Transportation (CHEMTREC): 1-800-424-9300 or +1-703-527-3887**
	:	
	:	(24 hours/day, 7 days/week)

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Form	:	liquid
Color	:	colourless
Odor	:	stinging
Hazard Summary	:	The effects of contact with dilute solutions of hydrofluoric acid or its vapours may be delayed. Causes burns. Irritating to respiratory system.

Potential Health Effects

Skin	: Causes severe burns which may not be immediately painful or visible. Hydrofluoric Acid will penetrate skin and attack underlying tissues.
Eyes	: Corrosive to eyes Causes itching, burning, redness and tearing. May cause corneal injury.
Ingestion	: May cause nausea, vomiting, diarrhea, and abdominal discomfort. Ingestion causes burns of the upper digestive and respiratory tracts.
Inhalation	: May cause nose, throat, and lung irritation. May cause: Shortness of breath Inhalation causes narcotic effect/intoxication. Symptoms of overexposure are dizziness, headache, tiredness, nausea, unconsciousness, cessation of breathing.
Chronic Exposure	: May cause: fluorosis
Primary Routes of Entry	: Inhalation

Carcinogenicity

No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP, IARC, or OSHA.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No.	Concentration
Water	7732-18-5	51.00 %
Hydrofluoric acid	7664-39-3	49.00 %

SECTION 4. FIRST AID MEASURES

General advice : First aider needs to protect himself. Medical assistance essential. Remove all contaminated clothing while washing continuously. After thorough washing the burned area should be immersed in a solution of 0.1% iced aqueous Benzalkonium Chloride. As an alternate first aid treatment, 2.5% calcium gluconate gel may be continuously massaged into the burn area. Further treatment by physician.

Inhalation : Remove to fresh air. Keep patient warm and at rest. Get competent medical attention immediately. If breathing has stopped, start artificial respiration at once. An authorized person should administer oxygen to a victim who is having difficulty breathing, until the victim is able to breathe easily by himself. Calcium gluconate, 2.5% in normal saline may be given by nebulizer with oxygen. Do not give stimulants unless instructed to do so by a physician. Victim should be examined by a physician and held under observation for at least 24 hours.

Skin contact : Limit washing to 15 minutes if treatment specific for HF exposure is available.
Remove all contaminated clothing while washing continuously. After thorough washing for at least 5 minutes, the burned area should be immersed in a solution of 0.13% iced aqueous Benzalkonium chloride until pain is relieved. As an alternate first aid treatment, 2.5% calcium gluconate gel may be continuously massaged into the burn area until the pain is relieved. For larger burns or burns treated with calcium gluconate gel (in which pain is present longer than 30 minutes), a physician should inject 5% aqueous calcium gluconate beneath, around and in the burned area. Use of local anesthetics is not recommended, as reduction in pain is an indicator of effectiveness of treatment.

Eye contact : Protect unharmed eye. Irrigate eyes for at least 15 minutes with copious quantities of water, keeping eyelids apart and away from eyeballs during irrigation. Get competent medical attention immediately, preferably an eye specialist. If a physician is not immediately available, apply one or two drops of 0.5% tetracaine hydrochloride solution, or other aqueous, topical ophthalmic anesthetic and continue irrigation. Do not use the solution described for skin treatment (Benzalkonium chloride). Use no other medications unless instructed to do so by a physician. Rubbing of the eyes is to be avoided. Irrigate with 1% calcium gluconate in normal saline for 1 to 2 hours to prevent or lessen corneal damage.

Ingestion : Call a physician immediately. Drink plenty of water. Do NOT induce vomiting. Magnesium hydroxide (milk of Magnesia) as an antacid may be given.

Notes to physician

Treatment : For large skin area burns (totaling greater than 25 square inches), for ingestion and for significant inhalation exposure, severe systemic effects may occur. Monitor and correct for hypocalcemia, cardiac arrhythmias, hypomagnesemia and hyperkalemia. In some cases hemodialysis may be indicated. For certain burns, especially of the digits, use of intra-arterial calcium gluconate may be indicated. For inhalation exposures, treat as chemical pneumonia. Monitor for hypocalcemia. 2.5% calcium gluconate in normal saline by nebulizer or by intermittent positive pressure breathing with 100% oxygen may decrease pulmonary damage. Bronchodilators may also be administered.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media : Water spray
Foam
Carbon dioxide (CO_2)
Dry powder
The product is not flammable.

Specific hazards during firefighting : Fire may cause evolution of:
Hydrogen fluoride
Do not allow run-off from fire fighting to enter drains or water courses.

Special protective equipment for firefighters : Wear self-contained breathing apparatus and protective suit. No unprotected exposed skin areas.

Further information : Use extinguishing measures that are appropriate to local

circumstances and the surrounding environment.
Use water spray to cool unopened containers.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions : Evacuate personnel to safe areas.
Use personal protective equipment.
Keep people away from and upwind of spill/leak.
Wear full protective clothing and self-contained breathing apparatus.

Environmental precautions : Do not flush into surface water or sanitary sewer system.
Prevent further leakage or spillage if safe to do so.
If the product contaminates rivers and lakes or drains inform respective authorities.
Clean contaminated floors and objects thoroughly while observing environmental regulations.

Methods for cleaning up : Clean-up methods - large spillage
Suppress (knock down) gases/vapours/mists with a water spray jet.
Dilute with plenty of water.
Use chemical neutralising agents
Neutralise with the following product(s):
lime
Flush with water.
Suitable material for picking up
Universal binder
Never neutralise with the following products:
soda ash

Additional advice : Possible need to alert the neighbourhood.

SECTION 7. HANDLING AND STORAGE

Handling

Handling : Exhaust ventilation at the object is necessary.
Use only acid resistant equipment.
Perform filling operations only at stations with exhaust ventilation facilities.

Plan first aid action before beginning work with this product.
Always have on hand a first-aid kit, together with proper instructions.

Advice on protection against fire and explosion	: No special precautions required. The product is not flammable.

Storage

Further information on storage conditions	: Keep containers tightly closed in a dry, cool and well-ventilated place. Do not leave vessels/containers open Containers should be protected against falling down. Avoid product residues in/on containers Store in a place accessible by authorized persons only.
Other data	: The pressure in sealed containers can increase under the influence of heat.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective measures	: Avoid exposure - obtain special instructions before use. Recommended preventive skin protection Keep working clothes separately. Take off all contaminated clothing immediately.
Engineering measures	: acid resisting floor Emergency sprinkling nozzle Local exhaust
Eye protection	: see respiratory protection
Hand protection	: Protective gloves Gloves must be inspected prior to use. Replace when worn.
Skin and body protection	: Complete suit protecting against chemicals
Respiratory protection	: Full mask, filter B2
Hygiene measures	: Separate rooms are required for washing, showering and

changing clothes.
Regular cleaning of equipment, work area and clothing.
Contaminated work clothing should not be allowed out of the workplace.

Exposure Guidelines

Components	CAS-No.	Value	Control parameters	Update	Basis
Hydrofluoric acid	7664-39-3	TWA : time weighted average	(0.5 ppm)	2008	ACGIH:US. ACGIH Threshold Limit Values
Further information :	Expressed as : as F				

Hydrofluoric acid	7664-39-3	Ceiling : Ceiling Limit Value:	(2 ppm)	2008	ACGIH:US. ACGIH Threshold Limit Values
Further information :	Expressed as : as F				

Hydrofluoric acid	7664-39-3	SKIN_DES : Skin designation:	Can be absorbed through the skin.	2008	ACGIH:US. ACGIH Threshold Limit Values
Further information :	Expressed as : as F				

Hydrofluoric acid	7664-39-3	Ceil_Time : Ceiling Limit Value and Time Period (if specified) :	5 mg/m3 (6 ppm)	2005	NIOSH/GUIDE:US. NIOSH: Pocket Guide to Chemical Hazards

Hydrofluoric acid	7664-39-3	REL : Recommended exposure limit (REL):	2.5 mg/m3 (3 ppm)	2005	NIOSH/GUIDE:US. NIOSH: Pocket Guide to Chemical Hazards

Hydrofluoric acid	7664-39-3	PEL : Permissible exposure limit	2.5 mg/m3	02 2006	OSHA_TRANS:US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)
Further information	:	Expressed as : as F			

Hydrofluoric acid	7664-39-3	STEL : Short term exposure limit	(6 ppm)	1989	Z1A:US. OSHA Table Z-1-A (29 CFR 1910.1000)
Further information	:	Expressed as : as F			

Hydrofluoric acid	7664-39-3	TWA : time weighted average	(3 ppm)	1989	Z1A:US. OSHA Table Z-1-A (29 CFR 1910.1000)
Further information	:	Expressed as : as F			

Hydrofluoric acid	7664-39-3	TWA : time weighted average	(3 ppm)	02 2006	OSHA/Z2:US. OSHA Table Z-2 (29 CFR 1910.1000)

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state	:	liquid
Color	:	colourless

Odor : stinging

pH : Note: acidic

Melting point/freezing point : ca. -35 °C

Boiling point/boiling range : ca. 105 °C at 1,013 hPa

Flash point : Note: not applicable

Lower explosion limit : Note: not applicable

Upper explosion limit : Note: not applicable

Vapor pressure : 101 hPa
at 50 °C(122 °F)

Density : ca. 1.170 g/cm3 at 20 °C

Water solubility : Note: completely miscible

Ignition temperature : Note: not applicable

Decomposition temperature : Note: No decomposition if used as directed., Fire or intense heat may cause violent rupture of packages.

Corrosivity : Note: Corrosive to metals

SECTION 10. STABILITY AND REACTIVITY

Possibility of hazardous reactions	:	Corrosive in contact with metals
Conditions to avoid	:	Heating will cause pressure rise with risk of bursting
Incompatible materials to avoid	:	Glass and silicate-containing materials are attacked. Gives off hydrogen by reaction with metals. Incompatible with bases.
Hazardous decomposition products	:	No decomposition if stored normally. Stable under normal conditions.

SECTION 11. TOXICOLOGICAL INFORMATION

Acute inhalation toxicity	:	LC50: 1276 ppm Exposure time: 1 h Species: rat Note: anhydrous substance
Skin irritation	:	Species: rabbit Classification: Corrosive Method: OECD
Further information	:	Note: Can cause bone and joint changes in humans (fluorosis).

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Toxicity to fish	:	LC50: 107.5 mg/l Exposure time: 96 h

		Species: Oncorhynchus mykiss
	:	LC50: 925 mg/l Exposure time: 96 h Species: mosquito fish
Toxicity to daphnia and other aquatic invertebrates	:	EC50: 270 mg/l Exposure time: 48 h Species: Daphnia

Further information on ecology

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods : Observe all Federal, State, and Local Environmental regulations.

SECTION 14. TRANSPORT INFORMATION

DOT	UN/ID No.	:	UN 1790
	Proper shipping name	:	Hydrofluoric acid
	Class		8
	Packing group		II
	Hazard Labels		8 (6.1)
IATA	UN/ID No.	:	UN 1790
	Description of the goods	:	Hydrofluoric acid
	Class	:	8
	Packaging group	:	II
	Hazard Labels	:	8 (6.1)
	Packing instruction (cargo aircraft)	:	855
	Packing instruction (passenger aircraft)	:	851
	Packing instruction (passenger aircraft)	:	Y840
IMDG	UN/ID No.	:	UN 1790
	Description of the goods	:	Hydrofluoric acid

Class	: 8
Packaging group	: II
Hazard Labels	: 8 (6.1)
EmS Number	: F-A, S-B
Marine pollutant	: no

SECTION 15. REGULATORY INFORMATION

Inventories

US. Toxic Substances Control Act	: On TSCA Inventory
Australia. Industrial Chemical (Notification and Assessment) Act	: On the inventory, or in compliance with the inventory
Canada. Canadian Environmental Protection Act (CEPA). Domestic Substances List (DSL)	: All components of this product are on the Canadian DSL list.
Japan. Kashin-Hou Law List	: On the inventory, or in compliance with the inventory
Korea. Existing Chemicals Inventory (KECI)	: On the inventory, or in compliance with the inventory
Philippines. The Toxic Substances and Hazardous and Nuclear Waste Control Act	: On the inventory, or in compliance with the inventory
China. Inventory of Existing Chemical Substances	: On the inventory, or in compliance with the inventory
New Zealand. Inventory of Chemicals (NZIoC), as published by ERMA New Zealand	: On the inventory, or in compliance with the inventory

National regulatory information

US. EPA CERCLA Hazardous Substances (40 CFR 302) : The following component(s) of this product is/are subject to release reporting under 40 CFR 302 when release exceeds the Reportable Quantity (RQ):

Reportable quantity: 100 lbs

: Hydrofluoric acid 7664-39-3

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 302 Extremely Hazardous Substance (40 CFR 355, Appendix A) : The following component(s) of this product is/are subject to the emergency planning provisions of 40 CFR 355 when there are amounts equal to or greater than the Threshold Planning Quantity (TPQ):

Threshold Planning Quantity:: 100 lbs

:

Reportable quantity: 100 lbs

: Hydrofluoric acid 7664-39-3

SARA 302 Components : The following components are subject to reporting levels established by SARA Title III, Section 302:

: Hydrofluoric acid 7664-39-3

SARA 313 Components : The following components are subject to reporting levels established by SARA Title III, Section 313:

: Hydrofluoric acid 7664-39-3

SARA 311/312 Hazards : Acute Health Hazard
Chronic Health Hazard

CERCLA Reportable Quantity : 204 lbs

California Prop. 65 : This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

Massachusetts RTK : Hydrofluoric acid 7664-39-3

New Jersey RTK : Hydrofluoric acid 7664-39-3

Pennsylvania RTK	:	Hydrofluoric acid	7664-39-3

WHMIS Classification : D1A: Very Toxic Material Causing Immediate and Serious Toxic Effects
D2A: Very Toxic Material Causing Other Toxic Effects
E: Corrosive Material
This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

SECTION 16. OTHER INFORMATION

		HMIS III	NFPA
Health hazard	:	4*	4
Flammability	:	0	0
Physical Hazard	:	1	
Instability	:		1

* - Chronic health hazard

Hazard rating and rating systems (e.g. HMIS® III, NFPA): This information is intended solely for the use of individuals trained in the particular system.

Further information

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. Final determination of suitability of any material is the sole responsibility of the user. This information should not constitute a guarantee for any specific product properties.

Changes since the last version are highlighted in the margin. This version replaces all previous versions.
Previous Issue Date: 09/05/2008
Prepared by: Honeywell Performance Materials and Technologies Product Stewardship Group

Safety Data Sheet
HYDROGEN PEROXIDE 8 - <20%

Version 1.4 Revision Date: 07/27/2020

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : HYDROGEN PEROXIDE 8 - <20%

Recommended use of the chemical and restrictions on use

Recommended use : Industrial chemical

Manufacturer or supplier's details

Company : Univar Solutions USA, Inc.
Address
3075 Highland Pkwy Suite 200
Downers Grove, IL 60515
United States of America (USA)

Emergency telephone number:
Transport North America: CHEMTREC (1-800-424-9300)
CHEMTREC INTERNATIONAL Tel # 703-527-3887

Additional Information: : Responsible Party: Product Compliance Department
E-mail: SDSNA@univarsolutions.com
SDS Requests: 1-855-429-2661
Website: www.univarsolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Serious eye damage : Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H318 Causes serious eye damage.

Precautionary statements : **Prevention:**
P280 Wear eye protection/ face protection.
Response:
P305 + P351 + P338 + P310 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/doctor.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Hazardous components

CAS-No.	Chemical name	Weight percent
7722-84-1	Hydrogen peroxide (H_2O_2)	8 - 20

Actual concentration is withheld as a trade secret
Any Concentration shown as a range is due to batch variation.

SECTION 4. FIRST AID MEASURES

General advice	:	Move out of dangerous area. Consult a physician. Show this safety data sheet to the doctor in attendance. Do not leave the victim unattended.
If inhaled	:	If unconscious, place in recovery position and seek medical advice. If symptoms persist, call a physician.
In case of skin contact	:	Wash off with warm water and soap.
In case of eye contact	:	Small amounts splashed into eyes can cause irreversible tissue damage and blindness. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Continue rinsing eyes during transport to hospital. Remove contact lenses. Protect unharmed eye. Keep eye wide open while rinsing. If eye irritation persists, consult a specialist.
If swallowed	:	Clean mouth with water and drink afterwards plenty of water. Keep respiratory tract clear. Do NOT induce vomiting. Do not give milk or alcoholic beverages. Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Take victim immediately to hospital.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Use an extinguishing media appropriate for surrounding fire.
Unsuitable extinguishing media	:	High volume water jet
Specific hazards during firefighting	:	Do not allow run-off from fire fighting to enter drains or water courses.
Hazardous combustion products	:	Acetic acid
Further information	:	Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.
Special protective equipment for firefighters	:	Wear self-contained breathing apparatus for firefighting if necessary.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protec-	:	Use personal protective equipment.

tive equipment and emergency procedures

Environmental precautions : Prevent product from entering drains.
Prevent further leakage or spillage if safe to do so.
If the product contaminates rivers and lakes or drains inform respective authorities.

Methods and materials for containment and cleaning up : Neutralize with chalk, alkali solution or ammonia.
Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust).
Keep in suitable, closed containers for disposal.

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion : Normal measures for preventive fire protection.

Advice on safe handling : Do not breathe vapours/dust.
Avoid contact with skin and eyes.
For personal protection see section 8.
Smoking, eating and drinking should be prohibited in the application area.
To avoid spills during handling keep bottle on a metal tray.
Dispose of rinse water in accordance with local and national regulations.

Conditions for safe storage : Keep container tightly closed in a dry and well-ventilated place.
Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Electrical installations / working materials must comply with the technological safety standards.

Materials to avoid : Do not store near acids.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

CAS-No.	Components	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
7722-84-1	Hydrogen peroxide (H_2O_2)	TWA	1 ppm	ACGIH
		TWA	1 ppm 1.4 mg/m3	NIOSH REL
		TWA	1 ppm 1.4 mg/m3	OSHA Z-1
		TWA	1 ppm 1.4 mg/m3	OSHA P0

Personal protective equipment

Respiratory protection : General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where

		concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and use NIOSH/MSHA approved respirators. Protection provided by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection.
Hand protection		
Remarks	:	The suitability for a specific workplace should be discussed with the producers of the protective gloves.
Eye protection	:	Eye wash bottle with pure water Tightly fitting safety goggles Wear face-shield and protective suit for abnormal processing problems.
Skin and body protection	:	Impervious clothing Choose body protection according to the amount and concentration of the dangerous substance at the work place.
Hygiene measures	:	When using do not eat or drink. When using do not smoke. Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Colour	:	Water-white
Odour	:	none
Odour Threshold	:	No data available
pH	:	1 - 4
Freezing Point	:	No data available
Boiling Point (Boiling point/boiling range)	:	> 100 °C (> 212 °F)
Flash point	:	Not applicable
Evaporation rate	:	No data available
Flammability (solid, gas)	:	No data available
Upper explosion limit	:	No data available
Lower explosion limit	:	No data available
Vapour pressure	:	17.5 mmHg
Relative vapour density	:	No data available
Relative density	:	1.1Reference substance: (water = 1)
Density	:	0.9531 g/cm3
Solubility(ies)		
Water solubility	:	completely soluble
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	No data available
Auto-ignition temperature	:	No data available
Thermal decomposition	:	No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity	: No dangerous reaction known under conditions of normal use.
Chemical stability	: Stable under normal conditions.
Possibility of hazardous reactions	: No decomposition if stored and applied as directed.
Conditions to avoid	: Keep away from heat, flame, sparks and other ignition sources.
Incompatible materials	: Bases brass bronze Chromium oxides Combustible material Copper decomposition catalysts such as heavy metal ions hydrochloric acid Iron Metals Organic materials Reducing agents Silver Zinc Rust Dirt

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Product:

Acute oral toxicity : Acute toxicity estimate: 2,500 mg/kg

Components:

7722-84-1:

Acute oral toxicity : LD50 (Rat, male and female): 1,193 mg/kg
Assessment: The component/mixture is moderately toxic after single ingestion.

Skin corrosion/irritation

Components:

7722-84-1:
Species: Rabbit
Exposure time: 4 h
Result: Causes severe burns.

Serious eye damage/eye irritation

Components:

7722-84-1:
Species: Rabbit
Result: Risk of serious damage to eyes.
Exposure time: 20 s
Test substance: Hydrogen peroxide

Carcinogenicity

IARC	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Components:

7722-84-1:

Effects on foetal development	: Species: Rat Application Route: Oral Dose: 0, 0.02, 0.1, 2, 10 %diet Duration of Single Treatment: 7 d Teratogenicity: NOAEL: 0.02 % diet Developmental Toxicity: NOAEL: 0.02 % diet Symptoms: Skeletal malformations, Reduced number of viable fetuses Result: Embryotoxic effects and adverse effects on the offspring were detected.

STOT - single exposure

Components:

7722-84-1:
Target Organs: Respiratory system
Assessment: The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with respiratory tract irritation.

Further information

Product:

Remarks: No data available

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

7722-84-1:

Toxicity to daphnia and other aquatic invertebrates	: LC50 (Daphnia pulex (Water flea)): 2.4 mg/l Exposure time: 48 h Test Type: semi-static test Test substance: hydrogen peroxide
Toxicity to algae	: EC50 (Skeletonema costatum (marine diatom)): 1.38 mg/l End point: Growth rate Exposure time: 72 h Test Type: static test Test substance: hydrogen peroxide
Chronic aquatic toxicity- Assessment	: Harmful to aquatic life with long lasting effects.

Persistence and degradability

No data available

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential	: Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).
Additional ecological information	: An environmental hazard cannot be excluded in the event of unprofessional handling or disposal. Harmful to aquatic life.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	: Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including

disposal, recycling and waste stream reduction, contact Univar Solutions ChemCare: 1-800-909-4897

Contaminated packaging : Empty remaining contents.
Dispose of as unused product.
Do not re-use empty containers.

SECTION 14. TRANSPORT INFORMATION

DOT (Department of Transportation):
UN2984, Hydrogen peroxide, aqueous solutions, 5.1, III

IATA (International Air Transport Association):
UN2984, HYDROGEN PEROXIDE, AQUEOUS SOLUTION, 5.1, III

IMDG (International Maritime Dangerous Goods):
UN2984, HYDROGEN PEROXIDE, AQUEOUS SOLUTION, 5.1, III

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Hydrogen peroxide (H2O2)	7722-84-1	1000	5000

SARA 311/312 Hazards : Serious eye damage or eye irritation

SARA 302 :

7722-84-1	Hydrogen peroxide (H2O2)

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Clean Air Act

This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.
This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.
This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

Massachusetts Right To Know

7722-84-1	Hydrogen peroxide (H_2O_2)

Pennsylvania Right To Know

7732-18-5	Water
7722-84-1	Hydrogen peroxide (H_2O_2)

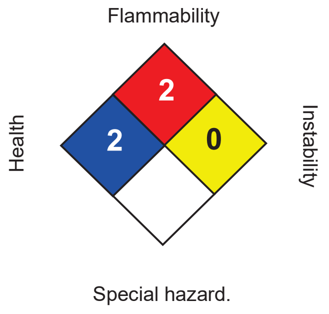
California Prop 65 : This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

The components of this product are reported in the following inventories:

TSCA	On TSCA Inventory
DSL	All components of this product are on the Canadian DSL
AICS	On the inventory, or in compliance with the inventory
NZIoC	Not in compliance with the inventory
ENCS	On the inventory, or in compliance with the inventory
KECI	On the inventory, or in compliance with the inventory
PICCS	On the inventory, or in compliance with the inventory
IECSC	On the inventory, or in compliance with the inventory

SECTION16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	2/
FLAMMABILITY	0
PHYSICAL HAZARD	2

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

The information accumulated is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made become available subsequently to the date hereof, we do not assume any responsibility for the results of its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by Univar Solutions Product Compliance Department (1-855-429-2661) SDSNA@univarsolutions.com.

Revision Date : 07/27/2020

Material number:
16161218, 16160869, 16151838, 16145935, 16143949, 16160482, 16149193, 16144098, 16140500

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program
CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level
EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philippines Inventory of Commercial Chemical Substances
MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Composition, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System

LC50	Lethal Concentration 50%		

Safety Data Sheet

ISOPROPANOL 99%

Version 1.11 Revision Date: 05/05/2022

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : ISOPROPANOL 99%

Recommended use of the chemical and restrictions on use

Recommended use : Alcohol solvent

Manufacturer or supplier's details

Company : Univar Solutions USA, Inc.
Address
3075 Highland Pkwy Suite 200
Downers Grove, IL 60515
United States of America (USA)

Emergency telephone number:
Transport North America: CHEMTREC (1-800-424-9300)
CHEMTREC INTERNATIONAL Tel # 703-527-3887

Additional Information: : Responsible Party: Product Compliance Department
E-mail: SDSNA@univarsolutions.com
SDS Requests: 1-855-429-2661
Website: www.univarsolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids : Category 2

Eye irritation : Category 2A

Specific target organ toxicity - single exposure : Category 3 (Central nervous system)

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H225 Highly flammable liquid and vapour.
H319 Causes serious eye irritation.
H336 May cause drowsiness or dizziness.

Precautionary statements : **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 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 skin thoroughly after handling.

P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves/ eye protection/ face protection.
Response:
P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P312 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
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.
P370 + P378 In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
Storage:
P403 + P233 Store in a well-ventilated place. Keep container tightly closed.
P403 + P235 Store in a well-ventilated place. Keep cool.
P405 Store locked up.
Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Hazardous components

CAS-No.	Chemical name	Weight percent
67-63-0	Isopropyl alcohol	90 - 100

Any Concentration shown as a range is due to batch variation.

Synonyms : 2-PROPANOL; ISOPROPYL ALCOHOL; IPA,

SECTION 4. FIRST AID MEASURES

General advice : Move out of dangerous area.
Show this safety data sheet to the doctor in attendance.
Do not leave the victim unattended.

If inhaled : Consult a physician after significant exposure.
If unconscious, place in recovery position and seek medical advice.

In case of skin contact : If on skin, rinse well with water.
If on clothes, remove clothes.

In case of eye contact : Immediately flush eye(s) with plenty of water.
Remove contact lenses.
Protect unharmed eye.
Keep eye wide open while rinsing.
If eye irritation persists, consult a specialist.

If swallowed : Keep respiratory tract clear.
Do not give milk or alcoholic beverages.
Never give anything by mouth to an unconscious person.
If symptoms persist, call a physician.
Do not induce vomiting without medical advice.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media : Alcohol-resistant foam
Carbon dioxide (CO2)
Dry chemical

Unsuitable extinguishing media : High volume water jet

Specific hazards during firefighting : Do not allow run-off from fire fighting to enter drains or water courses.

Hazardous combustion products : Carbon oxides
formaldehyde
corrosive vapors
Nitrogen oxides (NOx)

Further information : Collect contaminated fire extinguishing water separately. This must not be discharged into drains.
Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.
For safety reasons in case of fire, cans should be stored separately in closed containments.
Use a water spray to cool fully closed containers.

Special protective equipment for firefighters : Wear self-contained breathing apparatus for firefighting if necessary.
Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures : Use personal protective equipment.
Ensure adequate ventilation.
Remove all sources of ignition.
Evacuate personnel to safe areas.
Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

Environmental precautions : Prevent product from entering drains.
Prevent further leakage or spillage if safe to do so.
If the product contaminates rivers and lakes or drains inform respective authorities.

Methods and materials for containment and cleaning up : Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion : Do not spray on a naked flame or any incandescent material. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapours). Use only explosion-proof equipment. Keep away from open flames, hot surfaces and sources of ignition.

Advice on safe handling : Avoid formation of aerosol.
Do not breathe vapours/dust.
Avoid exposure - obtain special instructions before use.
Avoid contact with skin and eyes.
For personal protection see section 8.
Smoking, eating and drinking should be prohibited in the application area.
Take precautionary measures against static discharges.
Provide sufficient air exchange and/or exhaust in work rooms.
Container may be opened only under exhaust ventilation hood.
Open drum carefully as content may be under pressure.
Dispose of rinse water in accordance with local and national regulations.

Conditions for safe storage : No smoking.
Keep container tightly closed in a dry and well-ventilated place.
Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Observe label precautions.
Electrical installations / working materials must comply with the technological safety standards.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

CAS-No.	Components	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
67-63-0	Isopropyl alcohol	TWA	200 ppm	ACGIH
		STEL	400 ppm	ACGIH
		TWA	400 ppm 980 mg/m3	NIOSH REL
		ST	500 ppm 1,225 mg/m3	NIOSH REL
		TWA	400 ppm 980 mg/m3	OSHA Z-1
		TWA	400 ppm 980 mg/m3	OSHA P0
		STEL	500 ppm 1,225 mg/m3	OSHA P0
		PEL	400 ppm 980 mg/m3	CAL PEL
		STEL	500 ppm 1,225 mg/m3	CAL PEL

Personal protective equipment

Respiratory protection	: General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and use NIOSH/MSHA approved respirators. Protection provided by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection.
Hand protection	
Remarks	: The suitability for a specific workplace should be discussed with the producers of the protective gloves.
Eye protection	: Eye wash bottle with pure water Tightly fitting safety goggles Wear face-shield and protective suit for abnormal processing problems.
Skin and body protection	: Impervious clothing Choose body protection according to the amount and concentration of the dangerous substance at the work place.
Hygiene measures	: When using do not eat or drink. When using do not smoke. Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: liquid
Colour	: Clear, Colorless
Odour	: alcohol-like, characteristic
Odour Threshold	: 200 ppm
pH	: No data available
Freezing Point (Melting point/freezing point)	: -88 °C (-126 °F)
Boiling Point (Boiling point/boiling range)	: 82 - 83 °C (180 - 181 °F) (1013 hPa)
Flash point	: 12 °C (54 °F) Method: Tag closed cup
Evaporation rate	: < 3.9 (Butyl Acetate = 1)
Flammability (solid, gas)	: No data available
Upper explosion limit	: 13 %(V)
Lower explosion limit	: 2 %(V)
Vapour pressure	: No data available
Relative vapour density	: < 2.1 @ 15 - 20 °C (59 - 68 °F) (Air = 1.0)

Relative density	:	0.785 - 0.787 @ 20 °C (68 °F) Reference substance: (water = 1)
Density	:	0.785 - 0.787 g/cm3 @ 20 °C (68 °F)
Solubility(ies)		
Water solubility	:	completely miscible
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	log Pow: 0.05 @ 25 °C (77 °F)
Auto-ignition temperature	:	399 - 425 °C
Thermal decomposition	:	No data available
Viscosity		
Viscosity, dynamic	:	2.4 mPa.s @ 20 °C (68 °F)
Viscosity, kinematic	:	2.66 mm2/s @ 25 °C (77 °F)
Surface tension	:	22.7 mN/m, 20 °C

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Vapours may form explosive mixture with air.
Conditions to avoid	:	Keep away from heat, flame, sparks and other ignition sources.
Incompatible materials	:	Strong acids Aldehydes Oxidizing agents Rubber Oils Plastics Amines Metals Halogenated compounds Peroxides Bases
Hazardous decomposition products	:	Carbon oxides Sulphur oxides

SECTION 11. TOXICOLOGICAL INFORMATION

Serious eye damage/eye irritation

Components:

67-63-0:
Species: Rabbit

Result: Irritating to eyes.

Carcinogenicity

IARC	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
ACGIH	Confirmed animal carcinogen with unknown relevance to humans

64-17-5	Ethanol

STOT - single exposure

Components:

67-63-0:
Assessment: The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with narcotic effects.

Further information

Product:

Remarks: Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting.
Concentrations substantially above the TLV value may cause narcotic effects.
Solvents may degrease the skin.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

No data available

Persistence and degradability

No data available

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential	: Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B). Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	: Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact Univar Solutions ChemCare: 1-800-637-7922
Contaminated packaging	: Empty remaining contents. Dispose of as unused product. Do not re-use empty containers. Do not burn, or use a cutting torch on, the empty drum.

SECTION 14. TRANSPORT INFORMATION

DOT (Department of Transportation):
UN1219, ISOPROPANOL, 3, II

IATA (International Air Transport Association):
UN1219, ISOPROPANOL, 3, II

IMDG (International Maritime Dangerous Goods):
UN1219, ISOPROPANOL, 3, II, Flash Point:12 °C(54 °F)

SECTION 15. REGULATORY INFORMATION

WHMIS Classification	: B2: Flammable liquid D2B: Toxic Material Causing Other Toxic Effects

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards	:	Fire Hazard Acute Health Hazard
SARA 302	:	No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.
SARA 313	:	The following components are subject to reporting levels established by SARA Title III, Section 313:

67-63-0	Isopropyl alcohol

Clean Air Act

This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
The following chemical(s) are listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489):

67-63-0	Isopropyl alcohol

Clean Water Act

This product does not contain any Hazardous Substances listed under the U.S. CleanWater Act, Section 311, Table 116.4A.
This product does not contain any Hazardous Chemicals listed under the U.S. CleanWater Act, Section 311, Table 117.3.
This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

US State Regulations

Massachusetts Right To Know

67-63-0	Isopropyl alcohol	90 - 100 %

Pennsylvania Right To Know

67-63-0	Isopropyl alcohol	90 - 100 %

New Jersey Right To Know

67-63-0	Isopropyl alcohol	90 - 100 %
64-17-5	Ethanol	0.1 - 1 %

California Prop 65	:	This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

The components of this product are reported in the following inventories:

TSCA	:	On TSCA Inventory
DSL	:	All components of this product are on the Canadian DSL
AICS	:	On the inventory, or in compliance with the inventory

NZIoC : On the inventory, or in compliance with the inventory

ENCS : On the inventory, or in compliance with the inventory

KECI : On the inventory, or in compliance with the inventory

PHIL : On the inventory, or in compliance with the inventory

IECSC : On the inventory, or in compliance with the inventory

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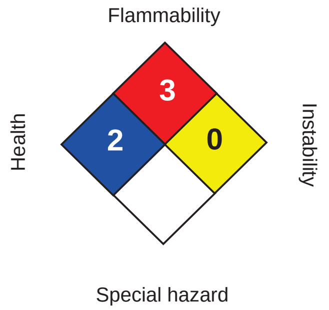
SECTION16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	1
FLAMMABILITY	3
PHYSICAL HAZARD	0

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

The information accumulated is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made become available subsequently to the date hereof, we do not assume any responsibility for the results of its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by Univar Solutions Product Compliance Department (1-855-429-2661) SDSNA@univarsolutions.com.

Revision Date : 05/05/2022

Legacy SDS: : R0001444, 100000027693, 100000061297

Material number:
16141730, 16187819, 16141123, 16185016, 16187197, 16185038, 16185039, 16184473, 16184512, 16184020, 16184810, 16184408, 16184314, 16185097, 16186271, 16183109, 16182974, 16178967, 16182648, 16175816, 16176549, 16175656, 16176457, 16176751, 16175879, 16174714, 16176870, 16175445, 16174727, 16174726, 16175555, 16180539, 16163494, 16151614, 16169230, 16169779, 16168235, 16170647, 16170200, 16170163, 16168234, 16173689, 16172502, 16145669, 16149765, 16171308, 16158552, 16146859, 16147074, 16147313, 16148783, 16148704, 16144452, 16146351, 16146089, 16144123, 16143652, 16167327, 16166321, 16165964, 16161591, 16149329, 16158191, 16152613, 16138602, 16137598, 16143917, 16140147, 16138087, 16137628, 16137534, 16137389, 16137356, 16156747, 16145782, 16160060, 16154121, 16159435, 16144176, 16152980,

16144004, 16153058, 16135462, 16143649, 16143998, 16148561, 16148563, 16135027, 16141526, 16159251, 16159182, 16143653, 16140155, 16140875, 16134646, 16134617, 16140663, 16157169, 16144470, 16143650

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program
CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level
EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philippines Inventory of Commercial Chemical Substances
MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Composition, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50	Lethal Concentration 50%		

Flibe

Safety Data Sheet

According To Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules And Regulations And According To The Hazardous Products Regulation (February 11, 2015).

Date of Issue: 04/02/2021 Version: 1.0

SECTION 1: IDENTIFICATION

1.1. Product Identifier

Product Form: Mixture

Product Name: Flibe

1.2. Intended Use of the Product

Research & Development (R&D)

1.3. Name, Address, and Telephone of the Responsible Party

Company

Kairos Power
700 West Tower Ave
Alameda, CA 94501
510-560-6688

1.4. Emergency Telephone Number

Emergency Number : All Clean Hazardous Materials Removal: 408-363-3678

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the Substance or Mixture

GHS-US/CA Classification

Acute Tox. 3 (Oral)	H301
Acute Tox. 3 (Dermal)	H311
Skin Irrit. 2	H315
Eye Irrit. 2	H319
Carc. 1B	H350
STOT SE 3	H335
STOT RE 1	H372
Aquatic Chronic 2	H411

Full text of hazard classes and H-statements : see section 16

2.2. Label Elements

GHS-US/CA Labeling

Hazard Pictograms (GHS-US/CA) :

GHS06

GHS07

GHS08

GHS09

Signal Word (GHS-US/CA) : Danger

Hazard Statements (GHS-US/CA) : H301+H311 - Toxic if swallowed or in contact with skin.
H315 - Causes skin irritation.
H319 - Causes serious eye irritation.
H335 - May cause respiratory irritation.
H350 - May cause cancer (Inhalation).
H372 - Causes damage to organs (respiratory system) through prolonged or repeated exposure (Inhalation).
H411 - Toxic to aquatic life with long lasting effects.

Precautionary Statements (GHS-US/CA) : P201 - Obtain special instructions before use.
P202 - Do not handle until all safety precautions have been read and understood.
P260 - Do not breathe vapors, mist, or spray.
P264 - Wash hands, forearms, and other exposed areas thoroughly after handling.
P270 - Do not eat, drink or smoke when using this product.
P271 - Use only outdoors or in a well-ventilated area.
P273 - Avoid release to the environment.
P280 - Wear protective gloves, protective clothing, and eye protection.
P301+P310 - IF SWALLOWED: Immediately call a POISON CENTER or doctor.

P302+P352 - IF ON SKIN: Wash with plenty of water.
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305+P351+P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308+P313 - If exposed or concerned: Get medical advice/attention.
P321 - Specific treatment (see section 4 on this SDS).
P330 - Rinse mouth.
P332+P313 - If skin irritation occurs: Get medical advice/attention.
P337+P313 - If eye irritation persists: Get medical advice/attention.
P361+P364 - Take off immediately all contaminated clothing and wash it before reuse.
P391 - Collect spillage.
P403+P233 - Store in a well-ventilated place. Keep container tightly closed.
P405 - Store locked up.
P501 - Dispose of contents/container in accordance with local, regional, national, territorial, provincial, and international regulations.

2.3. Other Hazards

Contact with acid liberates toxic gas. Exposure may aggravate pre-existing eye, skin, or respiratory conditions.

2.4. Unknown Acute Toxicity (GHS-US/CA)

No data available

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substance

Not applicable

3.2. Mixture

Name	Synonyms	Product Identifier	% *	GHS Ingredient Classification
Lithium fluoride (LiF)	Lithium fluoride	(CAS-No.) 7789-24-4	50	Acute Tox. 4 (Oral), H302 Eye Irrit. 2A, H319
Beryllium fluoride (BeF2)	Beryllium fluoride / Beryllium difluoride	(CAS-No.) 7787-49-7	50	Acute Tox. 3 (Oral), H301 Acute Tox. 3 (Dermal), H311 Skin Irrit. 2, H315 Eye Irrit. 2, H319 Carc. 1B, H350 STOT SE 3, H335 STOT RE 1, H372 Aquatic Chronic 2, H411

Full text of H-phrases: see section 16

*Percentages are listed in weight by weight percentage (w/w%) for liquid and solid ingredients. Gas ingredients are listed in volume by volume percentage (v/v%).

SECTION 4: FIRST AID MEASURES

4.1. Description of First-aid Measures

General: Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).

Inhalation: When symptoms occur: go into open air and ventilate suspected area. Obtain medical attention if breathing difficulty persists.

Skin Contact: Immediately remove contaminated clothing. Immediately drench affected area with water for at least 15 minutes. Immediately call a poison center or doctor/physician.

Eye Contact: Immediately rinse with water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center or doctor/physician.

Ingestion: Do NOT induce vomiting. Rinse mouth. Immediately call a POISON CENTER or doctor.

4.2. Most Important Symptoms and Effects Both Acute and Delayed

General: May cause drowsiness, dizziness and nausea. May cause stomach cramps and vomiting. May cause respiratory irritation. Causes damage to organs through prolonged or repeated exposure. Causes skin irritation. Causes serious eye irritation. Suspected of causing cancer. Toxic if swallowed. Toxic in contact with skin.

Inhalation: Irritation of the respiratory tract and the other mucous membranes.

Skin Contact: Redness, pain, swelling, itching, burning, dryness, and dermatitis. This material is toxic in small amounts through skin contact, and can cause adverse health effects or death. This material may be absorbed through the skin and eyes.

Eye Contact: Contact causes severe irritation with redness and swelling of the conjunctiva.

Ingestion: This material is toxic in small amounts orally, and can cause adverse health effects or death.

Chronic Symptoms: May cause cancer by inhalation. Causes damage to organs (respiratory system) through prolonged or repeated exposure (Inhalation).

4.3. Indication of Any Immediate Medical Attention and Special Treatment Needed

If exposed or concerned, get medical advice and attention. If medical advice is needed, have product container or label at hand.

SECTION 5: FIRE-FIGHTING MEASURES

5.1. Extinguishing Media

Suitable Extinguishing Media: Use extinguishing media appropriate for surrounding fire.

Unsuitable Extinguishing Media: Do not use direct water on the burning / molten product as the high-temperatures could cause water flash vaporization.

5.2. Special Hazards Arising From the Substance or Mixture

Fire Hazard: Not combustible.

Explosion Hazard: Product is not explosive.

Reactivity: Hazardous reactions will not occur under normal conditions.

5.3. Advice for Firefighters

Precautionary Measures Fire: Exercise caution when fighting any chemical fire.

Firefighting Instructions: Use water spray or fog for cooling exposed containers.

Protection During Firefighting: Do not enter fire area without proper protective equipment, including respiratory protection.

Hazardous Combustion Products: Toxic vapors. Metallic oxides. Fluorine compounds.

Other Information: Do not allow run-off from fire fighting to enter drains or water courses.

5.4. Reference to Other Sections

Refer to Section 9 for flammability properties.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal Precautions, Protective Equipment and Emergency Procedures

General Measures: Do not breathe dust. Do not get in eyes, on skin, or on clothing.

6.1.1. For Non-Emergency Personnel

Protective Equipment: Use appropriate personal protective equipment (PPE).

Emergency Procedures: Evacuate unnecessary personnel.

6.1.2. For Emergency Personnel

Protective Equipment: Equip cleanup crew with proper protection.

Emergency Procedures: Upon arrival at the scene, a first responder is expected to recognize the presence of dangerous goods, protect oneself and the public, secure the area, and call for the assistance of trained personnel as soon as conditions permit. Ventilate area.

6.2. Environmental Precautions

Prevent entry to sewers and public waters. Avoid release to the environment. Collect spillage.

6.3. Methods and Materials for Containment and Cleaning Up

For Containment: Contain solid spills with appropriate barriers and prevent migration and entry into sewers or streams.

Methods for Cleaning Up: Clean up spills immediately and dispose of waste safely. Recover the product by using wet methods and avoid dust generation. Transfer spilled material to a suitable container for disposal. Contact competent authorities after a spill.

6.4. Reference to Other Sections

See Section 8 for exposure controls and personal protection and Section 13 for disposal considerations.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for Safe Handling

Precautions for Safe Handling: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Do not breathe dust. Do not get in eyes, on skin, or on clothing. Handle empty containers with care because they may still present a hazard.

Hygiene Measures: Handle in accordance with good industrial hygiene and safety procedures.

7.2. Conditions for Safe Storage, Including Any Incompatibilities

Technical Measures: Comply with applicable regulations.

Storage Conditions: Keep container closed when not in use. Store in a dry, cool place. Keep/Store away from direct sunlight, extremely high or low temperatures and incompatible materials. Store locked up/in a secure area.

Incompatible Materials: Strong alkalis.

7.3. Specific End Use(s)

Research & Development (R&D)

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control Parameters

For substances listed in section 3 that are not listed here, there are no established exposure limits from the manufacturer, supplier, importer, or the appropriate advisory agency including: ACGIH (TLV), AIHA (WEEL), NIOSH (REL), OSHA (PEL), or Canadian provincial governments.

Lithium fluoride (7789-24-4)		
USA ACGIH	ACGIH OEL TWA	2.5 mg/m³ (as F)
USA ACGIH	BEI (BLV)	2 mg/l Parameter: Fluoride - Medium: urine - Sampling time: prior to shift (background, nonspecific) 3 mg/l Parameter: Fluoride - Medium: urine - Sampling time: end of shift (background, nonspecific)
USA OSHA	OSHA PEL (TWA) [1]	2.5 mg/m³ (as F)
USA IDLH	IDLH	250 mg/m³ (as F)
Alberta	OEL TWA	2.5 mg/m³ (as F)
British Columbia	OEL TWA	2.5 mg/m³ (as F)
Manitoba	OEL TWA	2.5 mg/m³ (as F)
New Brunswick	OEL TWA	2.5 mg/m³ (as F)
Newfoundland & Labrador	OEL TWA	2.5 mg/m³ (as F)
Nova Scotia	OEL TWA	2.5 mg/m³ (as F)
Ontario	OEL TWA	2.5 mg/m³ (as F)
Prince Edward Island	OEL TWA	2.5 mg/m³ (as F)
Québec	VEMP (OEL TWA)	2.5 mg/m³ (as F)
Saskatchewan	OEL STEL	5 mg/m³ (as F)
Saskatchewan	OEL TWA	2.5 mg/m³ (as F)
Yukon	OEL STEL	2.5 mg/m³ (as F)
Yukon	OEL TWA	2.5 mg/m³ (as F)

Beryllium fluoride (BeF2) (7787-49-7)		
USA ACGIH	ACGIH OEL TWA	0.00005 mg/m³ (inhalable particulate matter) (as Be)
USA OSHA	OSHA PEL (TWA) [1]	0.2 µg/m³ (as Be)
USA OSHA	OSHA PEL (STEL) [1]	2 µg/m3 (See 29 CFR 1910.1024) (as Be)
USA OSHA	OSHA PEL (Ceiling)	2 µg/m³ (as Be)
USA OSHA	Acceptable Maximum Peak Above The Acceptable Ceiling Concentration For An 8-Hr Shift	2 µg/m³ Peak (30 minutes) (as Be)
USA OSHA	OSHA Action Level/Excursion Limit	0.1 µg/m³ (Action Level, see 29 CFR 1910.1024) (as Be)
USA NIOSH	NIOSH REL (Ceiling)	0.0005 mg/m³ (as Be)
USA IDLH	IDLH	4 mg/m³ (as Be)
Alberta	OEL STEL	0.01 mg/m³ (as Be)

Alberta	OEL TWA	0.002 mg/m^3 (as Be)
British Columbia	OEL TWA	0.00005 mg/m^3 (inhalable) (as Be)
Manitoba	OEL TWA	0.00005 mg/m^3 (inhalable particulate matter) (as Be)
New Brunswick	OEL STEL	0.01 mg/m^3 (as Be)
New Brunswick	OEL TWA	0.002 mg/m^3 (as Be)
Newfoundland & Labrador	OEL TWA	0.00005 mg/m^3 (inhalable particulate matter) (as Be)
Nova Scotia	OEL TWA	0.00005 mg/m^3 (inhalable particulate matter) (as Be)
Nunavut	OEL STEL	0.01 mg/m^3 (as Be)
Nunavut	OEL TWA	0.002 mg/m^3 (as Be)
Northwest Territories	OEL STEL	0.01 mg/m^3 (as Be)
Northwest Territories	OEL TWA	0.002 mg/m^3 (as Be)
Ontario	OEL TWA	0.00005 mg/m^3 (inhalable particulate matter) (as Be)
Prince Edward Island	OEL TWA	0.00005 mg/m^3 (inhalable particulate matter) (as Be)
Québec	VEMP (OEL TWA)	0.00015 mg/m^3 (as Be)
Saskatchewan	OEL STEL	0.01 mg/m^3 (as Be)
Saskatchewan	OEL TWA	0.002 mg/m^3 (as Be)
Yukon	OEL TWA	0.002 mg/m^3 (as Be)

8.2. Exposure Controls

Appropriate Engineering Controls: Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure. Ensure adequate ventilation, especially in confined areas. Ensure all national/local regulations are observed.

Personal Protective Equipment: Gloves. Protective clothing. Protective goggles. Insufficient ventilation: wear respiratory protection. Face shield.

Materials for Protective Clothing: Chemically resistant materials and fabrics.

Hand Protection: Wear protective gloves.

Eye and Face Protection: Chemical safety goggles.

Skin and Body Protection: Wear suitable protective clothing.

Respiratory Protection: If exposure limits are exceeded or irritation is experienced, approved respiratory protection should be worn. In case of inadequate ventilation, oxygen deficient atmosphere, or where exposure levels are not known wear approved respiratory protection.

Other Information: When using, do not eat, drink or smoke.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on Basic Physical and Chemical Properties

Physical State : Solid
Appearance : Off-white
Odor : None
Odor Threshold : Not available
pH : Not available
Evaporation Rate : Not available
Melting Point : 350-870 °C (662-1598 °F)
Freezing Point : Not available
Boiling Point : 1160-1681 °C (2120-3058 °F)
Flash Point : Not available
Auto-ignition Temperature : Not available
Decomposition Temperature : Not available
Flammability (solid, gas) : Not available
Lower Flammable Limit : Not available

Upper Flammable Limit	:	Not available
Vapor Pressure	:	Not available
Relative Vapor Density at 20°C	:	Not available
Relative Density	:	2-3
Specific Gravity	:	Not available
Solubility	:	Not available
Partition Coefficient: N-Octanol/Water	:	Not available
Viscosity	:	Not available

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity: Hazardous reactions will not occur under normal conditions.

10.2. Chemical Stability: Stable under recommended handling and storage conditions (see section 7).

10.3. Possibility of Hazardous Reactions: Hazardous polymerization will not occur. May form acidic solutions and/or toxic gases upon interaction with water.

10.4. Conditions to Avoid: Direct sunlight, extremely high or low temperatures, and incompatible materials. Avoid dust formation.

10.5. Incompatible Materials: Strong alkalis.

10.6. Hazardous Decomposition Products: Thermal decomposition may produce: Hydrogen fluoride. Fluorine compounds. Metal oxides.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on Toxicological Effects - Product

Acute Toxicity (Oral): Toxic if swallowed.
Acute Toxicity (Dermal): Toxic in contact with skin.
Acute Toxicity (Inhalation): Not classified
LD50 and LC50 Data:

Flibe	
ATE US/CA (oral)	172.11 mg/kg body weight
ATE US/CA (dermal)	600.00 mg/kg body weight

Skin Corrosion/Irritation: Causes skin irritation.

Eye Damage/Irritation: Causes serious eye irritation.

Respiratory or Skin Sensitization: Not classified

Germ Cell Mutagenicity: Not classified

Carcinogenicity: May cause cancer (Inhalation).

Specific Target Organ Toxicity (Repeated Exposure): Causes damage to organs (respiratory system) through prolonged or repeated exposure (Inhalation).

Reproductive Toxicity: Not classified

Specific Target Organ Toxicity (Single Exposure): May cause respiratory irritation.

Aspiration Hazard: Not classified
Symptoms/Injuries After Inhalation: Irritation of the respiratory tract and the other mucous membranes.
Symptoms/Injuries After Skin Contact: Redness, pain, swelling, itching, burning, dryness, and dermatitis. This material is toxic in small amounts through skin contact, and can cause adverse health effects or death. This material may be absorbed through the skin and eyes.
Symptoms/Injuries After Eye Contact: Contact causes severe irritation with redness and swelling of the conjunctiva.
Symptoms/Injuries After Ingestion: This material is toxic in small amounts orally, and can cause adverse health effects or death.
Chronic Symptoms: May cause cancer by inhalation. Causes damage to organs (respiratory system) through prolonged or repeated exposure (Inhalation).

11.2. Information on Toxicological Effects - Ingredient(s)

LD50 and LC50 Data:

Lithium fluoride (7789-24-4)	
LD50 Oral Rat	706 mg/kg
LD50 Dermal Rat	> 2000 mg/kg

Beryllium fluoride (BeF2) (7787-49-7)	
LD50 Oral Rat	98 mg/kg
ATE US/CA (dermal)	300.00 mg/kg body weight

Beryllium fluoride (BeF2) (7787-49-7)	
IARC Group	1
OSHA Hazard Communication Carcinogen List	In OSHA Hazard Communication Carcinogen list.

SECTION 12: ECOLOGICAL INFORMATION

12.1. Toxicity

Ecology - General: Toxic to aquatic life with long lasting effects.

12.2. Persistence and Degradability

Flibe	
Persistence and Degradability	May cause long-term adverse effects in the environment.

12.3. Bioaccumulative Potential

Flibe	
Bioaccumulative Potential	Not established.

12.4. Mobility in Soil

Not available

12.5. Other Adverse Effects

Other Information: Avoid release to the environment.

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste Disposal Recommendations: Dispose of contents/container in accordance with local, regional, national, territorial, provincial, and international regulations.

Ecology - Waste Materials: Avoid release to the environment. This material is hazardous to the aquatic environment. Keep out of sewers and waterways.

SECTION 14: TRANSPORT INFORMATION

The shipping description(s) stated herein were prepared in accordance with certain assumptions at the time the SDS was authored, and can vary based on a number of variables that may or may not have been known at the time the SDS was issued.

14.1. In Accordance with DOT

Proper Shipping Name : BERYLLIUM COMPOUNDS, N.O.S. (Beryllium fluoride)
Hazard Class : 6.1
Identification Number : UN1566
Label Codes : 6.1

Packing Group : II
Marine Pollutant : Marine pollutant
ERG Number : 154

14.2. In Accordance with IMDG

Proper Shipping Name : BERYLLIUM COMPOUND, N.O.S. (Beryllium fluoride)
Hazard Class : 6.1
Identification Number : UN1566
Label Codes : 6.1

Packing Group : II
EmS-No. (Fire) : F-A
EmS-No. (Spillage) : S-A
Marine pollutant : Marine pollutant

14.3. In Accordance with IATA

Proper Shipping Name : BERYLLIUM COMPOUND, N.O.S. (Beryllium fluoride)
Hazard Class : 6.1
Identification Number : UN1566
Label Codes : 6.1

Packing Group : II

ERG Code (IATA) : 6L

14.4. In Accordance with TDG

Proper Shipping Name : BERYLLIUM COMPOUND, N.O.S. (Beryllium fluoride)
Hazard Class : 6.1
Identification Number : UN1566
Label Codes : 6.1

Packing Group : II
Marine Pollutant (TDG) : Marine pollutant

SECTION 15: REGULATORY INFORMATION

15.1. US Federal Regulations

Flibe	
SARA Section 311/312 Hazard Classes	Health hazard - Specific target organ toxicity (single or repeated exposure) Health hazard - Skin corrosion or Irritation Health hazard - Serious eye damage or eye irritation Health hazard - Carcinogenicity Health hazard - Acute toxicity (any route of exposure)

Lithium fluoride (7789-24-4)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Beryllium fluoride (BeF2) (7787-49-7)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory	
CERCLA RQ	1 lb

15.2. US State Regulations

Beryllium and beryllium compounds	
U.S. - California - Proposition 65 - Carcinogens List	Yes

California Proposition 65

⚠ **WARNING:** This product can expose you to beryllium and beryllium compounds, which are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

Beryllium fluoride (BeF2) (7787-49-7)
U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List U.S. - Massachusetts - Right To Know List U.S. - Pennsylvania - RTK (Right to Know) - Special Hazardous Substances U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List

15.3. Canadian Regulations

Lithium fluoride (7789-24-4)
Listed on the Canadian DSL (Domestic Substances List)

Beryllium fluoride (BeF2) (7787-49-7)
Listed on the Canadian NDSL (Non-Domestic Substances List)

SECTION 16: OTHER INFORMATION, INCLUDING DATE OF PREPARATION OR LAST REVISION

Date of Preparation or Latest Revision : 04/02/2021
Other Information : This document has been prepared in accordance with the SDS requirements of the OSHA Hazard Communication Standard 29 CFR 1910.1200 and Canada's Hazardous Products Regulations (HPR) SOR/2015-17.

GHS Full Text Phrases:

Acute Tox. 3 (Dermal)	Acute toxicity (dermal) Category 3
Acute Tox. 3 (Oral)	Acute toxicity (oral) Category 3
Acute Tox. 4 (Oral)	Acute toxicity (oral) Category 4
Aquatic Chronic 2	Hazardous to the aquatic environment - Chronic Hazard Category 2

Carc. 1B	Carcinogenicity Category 1B
Eye Irrit. 2	Serious eye damage/eye irritation Category 2
Eye Irrit. 2A	Serious eye damage/eye irritation Category 2A
Skin Irrit. 2	Skin corrosion/irritation Category 2
STOT RE 1	Specific target organ toxicity (repeated exposure) Category 1
STOT SE 3	Specific target organ toxicity — Single exposure, Category 3, Respiratory tract irritation
H301	Toxic if swallowed
H302	Harmful if swallowed
H311	Toxic in contact with skin
H315	Causes skin irritation
H319	Causes serious eye irritation
H335	May cause respiratory irritation
H350	May cause cancer
H372	Causes damage to organs through prolonged or repeated exposure
H411	Toxic to aquatic life with long lasting effects

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

NA GHS SDS 2015 (Can, US)

SAFETY DATA SHEET

Lithium Hydroxide Monohydrate

SDS Number: RS_000001117

Version	Revision Date:	Date of last issue: 31.05.2022	Print Date:
1.3	10.06.2022	Date of first issue: 16.05.2022	11.09.2023

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

: Lithium Hydroxide Monohydrate

Manufacturer or supplier's details

Company : Albemarle Lithium PTY LTD

Address : 109 Kemerton Road
Wellesley , WA 6233
Australia

Telephone : +61-8-9790-0101

Emergency telephone number : +32 (0) 70-233-201 (EUROPE)
(+1)225-344-7147 (US and WORLDWIDE)
+65-6733-1661 (ASIA PACIFIC)
+86-532-8388-9090 (CHINA)
+61 2 8014 4558 or 18000 74234 (AUSTRALIA only)

Contact person product safety : DEPARTMENT OF PRODUCT SAFETY

E-mail address : PRODUCTSAFETY@ALBEMARLE.COM

Recommended use of the chemical and restrictions on use

Recommended use : Lubricant assistants
Raw material for chemical industry.

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Acute toxicity (Oral)	: Category 4
Skin corrosion/irritation	: Sub-category 1B
Serious eye damage/eye irritation	: Category 1
Short-term (acute) aquatic hazard	: Category 3

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H302 Harmful if swallowed.
H314 Causes severe skin burns and eye damage.
H402 Harmful to aquatic life.

Precautionary statements :

Prevention:

P260 Do not breathe dust.
P264 Wash skin thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P273 Avoid release to the environment.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection/ hearing protection.

Response:

P301 + P312 + P330 IF SWALLOWED: Call a POISON CENTER/ doctor if you feel unwell. Rinse mouth.
P301 + P330 + P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
P304 + P340 + P310 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/ doctor.
P305 + P351 + P338 + P310 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/ doctor.
P363 Wash contaminated clothing before reuse.

Storage:

P405 Store locked up.

Disposal:

P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards which do not result in classification

The information required is contained in this Material Safety Data Sheet.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance
Chemical nature : Lithium Salts
Substance name : Lithium hydroxide monohydrate

CAS-No. : 1310-66-3

Components

Chemical name	CAS-No.	Concentration (% w/w)
lithium hydroxide	1310-65-2	>= 56.5
water	7732-18-5	< 43.5

SECTION 4. FIRST AID MEASURES

General advice	:	First Aid responders should pay attention to self-protection and use the recommended protective clothing Take off contaminated clothing and shoes immediately. Move out of dangerous area. Keep warm and in a quiet place.
If inhaled	:	Move to fresh air. If not breathing, give artificial respiration. Keep the victim calm and in a semi-upright position. Call a physician immediately.
In case of skin contact	:	Wash off immediately with plenty of water for at least 15 minutes. Call a physician immediately.
In case of eye contact	:	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Call a physician immediately.
If swallowed	:	Clean mouth with water and drink afterwards plenty of water. Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Call a physician immediately.
Most important symptoms and effects, both acute and delayed	:	If ingested, severe burns of the mouth and throat, as well as a danger of perforation of the oesophagus and the stomach.
Notes to physician	:	Treat symptomatically. For specialist advice physicians should contact the Poisons Information Service.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Water spray Foam Carbon dioxide (CO2) Dry powder
Unsuitable extinguishing media	:	High volume water jet
Specific hazards during firefighting	:	Hazardous decomposition products formed under fire conditions.
Hazardous combustion products	:	Metal oxides

Specific extinguishing methods	:	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. Collect contaminated fire extinguishing water separately. This must not be discharged into drains.
Special protective equipment for firefighters	:	Wear full protective clothing and self-contained breathing apparatus.
Hazchem Code	:	2X

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Ensure adequate ventilation. Wear personal protective equipment. Avoid contact with skin, eyes and clothing. Do not breathe dust/ fume/ gas/ mist/ vapours/ spray. Keep people away from and upwind of spill/leak.
Environmental precautions	:	Do not flush into surface water or sanitary sewer system. Avoid subsoil penetration.
Methods and materials for containment and cleaning up	:	Use mechanical handling equipment. Pick up and transfer to properly labelled containers. Avoid dust formation. Adequate disposal

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion	:	Normal measures for preventive fire protection.
Advice on safe handling	:	Provide sufficient air exchange and/or exhaust in work rooms. Wear personal protective equipment. Avoid creating dust. Handle in accordance with good industrial hygiene and safety practice. In general, emissions are controlled and prevented by implementing an appropriate management system, including regular informing and training workers.
Hygiene measures	:	Take off contaminated clothing and shoes immediately. Avoid contact with skin, eyes and clothing. Do not breathe dust/ fume/ gas/ mist/ vapours/ spray. Smoking, eating and drinking should be prohibited in the application area. Keep away from food, drink and animal feedingstuffs. Wash hands before breaks and at the end of workday.
Conditions for safe storage	:	Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from moisture.
Materials to avoid	:	Do not store near acids.

Avoid contact with amphoteric metals (e.g. aluminium, lead, zinc).

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Contains no substances with occupational exposure limit values.

Engineering measures : Provide sufficient air exchange and/or exhaust in work rooms.

Personal protective equipment

Respiratory protection : In case of inadequate ventilation wear respiratory protection. Respirator must be worn if exposed to dust.

Filter type : Filter type ABEK-P

Hand protection

Material : Wear suitable gloves.

Remarks : Protective gloves
The choice of an appropriate glove does not only depend on its material but also on other quality features and is different from one producer to the other. The exact break through time can be obtained from the protective glove producer and this has to be observed. Protective gloves have to be replaced at the first sign of deterioration.

Eye protection : Safety glasses with side-shields

Skin and body protection : Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Protective measures : Handle in accordance with good industrial hygiene and safety practice.
Ensure that eye flushing systems and safety showers are located close to the working place.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : crystalline

Colour : white, to, yellow

Odour : odourless

Odour Threshold : No data available

pH : ca. 12
Concentration: 0.4 g/l
(as aqueous solution)

Melting point/range : 424 °C
(1,013 hPa)

		Method: OECD Test Guideline 102
Initial boiling point and boiling range	:	No data available
Flash point	:	No data available
Evaporation rate	:	No data available
Flammability (solid, gas)	:	does not ignite Method: Flammability (solids) GLP: no
Upper explosion limit / Upper flammability limit	:	No data available
Lower explosion limit / Lower flammability limit	:	No data available
Vapour pressure	:	No data available
Relative vapour density	:	No data available
Relative density	:	No data available
Density	:	ca. 1.51 g/cm3 (20 °C)
Bulk density	:	800 kg/m3
Solubility(ies)		
Water solubility	:	200 g/l (20 °C) Method: OECD Test Guideline 105
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	No data available
Auto-ignition temperature	:	No data available
Decomposition temperature	:	To avoid thermal decomposition, do not overheat.
Viscosity, dynamic	:	No data available
Viscosity, kinematic	:	No data available
Explosive properties	:	no explosion risk
Oxidizing properties	:	No data available
Molecular weight	:	41.96 g/mol
Particle size	:	43 µm Method: ISO 13320

GLP: no

150 µm
Method: ISO 13320
GLP: no

634 mm
Method: ISO 13320
GLP: no

SECTION 10. STABILITY AND REACTIVITY

Reactivity : Risk of violent reaction.
Chemical stability : Stable under normal conditions.
Possibility of hazardous reactions : Reacts with the following substances:
Acids

Conditions to avoid : Protect from moisture.
Avoid dust formation.
Incompatible materials : Acids
Avoid contact with amphoteric metals (e.g. aluminium, lead, zinc).
Hazardous decomposition products : Decomposes by reaction with strong acids.

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Components:

lithium hydroxide:

Acute oral toxicity : LD50 (Rat): 330 mg/kg
Test substance: Read-across (Analogy)

Acute inhalation toxicity : LC50 (Rat, male and female): > 3.4 mg/l
Exposure time: 4 h
Test atmosphere: dust/mist
Method: OECD Test Guideline 403
Test substance: Read-across (Analogy)
GLP: yes
Remarks: Limit Test

Acute dermal toxicity : LD50 (Rat, male and female): > 2,000 mg/kg
Method: OECD Test Guideline 402
Test substance: Read-across (Analogy)
GLP: yes
Remarks: Limit Test

Skin corrosion/irritation

Product:

Remarks : Causes severe burns.

Components:

lithium hydroxide:

Method : In Vitro Membrane Barrier Test Method for Skin Corrosion - CORROSITEX
Result : Corrosive after 3 minutes to 1 hour of exposure
GLP : yes

Serious eye damage/eye irritation

Product:

Remarks : Causes serious eye damage.

Components:

lithium hydroxide:

Result : Irreversible effects on the eye
Remarks : Expert judgement

Respiratory or skin sensitisation

Product:

Remarks : No sensitising effects are known.

Components:

lithium hydroxide:

Test Type : Buehler Test
Exposure routes : Skin contact
Species : Guinea pig
Method : OECD Test Guideline 406
Result : Did not cause sensitisation on laboratory animals.
GLP : yes
Test substance : Read-across (Analogy)

Chronic toxicity

Germ cell mutagenicity

Components:

lithium hydroxide:

Genotoxicity in vitro : Test Type: reverse mutation assay

Test system: Salmonella typhimurium
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative
GLP: yes

Test Type: reverse mutation assay
Test system: Escherichia coli
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative
GLP: yes

Test Type: Chromosome aberration test in vitro
Test system: Human lymphocytes
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 473
Result: negative
GLP: yes

Test Type: In vitro mammalian cell gene mutation test
Test system: mouse lymphoma cells
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 476
Result: negative
GLP: yes

Reproductive toxicity

Components:

lithium hydroxide:

Effects on foetal development : Test Type: Two-generation study
Species: Rat, male and female
Application Route: Oral
General Toxicity Maternal: NOAEL: 10 mg/kg bw/day
Developmental Toxicity: NOAEL: 29 mg/kg bw/day
Target Organs: Adrenal gland, Liver, Kidney
Method: OECD Test Guideline 416
GLP: yes
Remarks: Read-across (Analogy)

Species: Rat, female
Application Route: Oral
General Toxicity Maternal: NOAEL: 19.5 mg/kg bw/day
Teratogenicity: NOAEL: 58.3 mg/kg bw/day
Method: OECD Test Guideline 414
GLP: yes
Remarks: Read-across (Analogy)

Repeated dose toxicity

Components:

lithium hydroxide:

NOAEL : 4.13 mg/kg
Application Route : Oral
Remarks : Epidemiological data

NOAEL : extrapolated 0.01447 mg/l
Application Route : Inhalation
Remarks : Epidemiological data

Further information

Product:

Remarks : If ingested, severe burns of the mouth and throat, as well as a danger of perforation of the oesophagus and the stomach.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

lithium hydroxide:

Toxicity to fish : LC50 (Danio rerio (zebra fish)): 62.22 mg/l
Exposure time: 96 h
Test Type: static test
Test substance: Read-across (Analogy)
Method: OECD Test Guideline 203
GLP: yes

Toxicity to daphnia and other aquatic invertebrates : EC50 (Daphnia magna (Water flea)): 19.1 mg/l
Exposure time: 48 h
Test Type: Immobilization
Method: OECD Test Guideline 202
GLP: yes

EC50 (Daphnia magna (Water flea)): pH adjustment 34.3 mg/l
Exposure time: 48 h
Test Type: Immobilization
Method: OECD Test Guideline 202
GLP: yes

Toxicity to algae/aquatic plants : EbC50 (Pseudokirchneriella subcapitata (green algae)): 23.75 mg/l
Exposure time: 72 h
Test Type: Growth inhibition

		Test substance: Read-across (Analogy) Method: OECD Test Guideline 201 GLP: yes
		ErC50 (Pseudokirchneriella subcapitata (green algae)): 87.57 mg/l Exposure time: 72 h Test Type: Growth inhibition Test substance: Read-across (Analogy) Method: OECD Test Guideline 201 GLP: yes
		NOEC (Pseudokirchneriella subcapitata (green algae)): 5.71 mg/l Exposure time: 72 h Test Type: Growth inhibition Test substance: Read-across (Analogy) Method: OECD Test Guideline 201 GLP: yes
Toxicity to fish (Chronic toxicity)	:	NOEC (Danio rerio (zebra fish)): 9.9 mg/l Exposure time: 34 d Test Type: Early life stage Test substance: Read-across (Analogy) GLP: yes
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC (Daphnia magna (Water flea)): 2.3 mg/l Exposure time: 21 d Test Type: Reproduction Test Test substance: Read-across (Analogy) Method: OECD Test Guideline 211 GLP: yes
Toxicity to microorganisms	:	EC50 (activated sludge): 180.8 mg/l Exposure time: 3 h Test Type: Respiration inhibition Method: OECD Test Guideline 209 GLP: yes

Persistence and degradability

Components:

lithium hydroxide:

Biodegradability	:	Remarks: The methods for determining biodegradability are not applicable to inorganic substances.

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Additional ecological information	:	Do not flush into surface water or sanitary sewer system. Avoid subsoil penetration. An environmental hazard cannot be excluded in the event of unprofessional handling or disposal. Harmful to aquatic life.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	:	Dispose of in accordance with local regulations.
Contaminated packaging	:	Refer to manufacturer/ supplier for information on recovery/ recycling.

SECTION 14. TRANSPORT INFORMATION

International Regulations

UNRTDG

UN number	:	UN 2680
Proper shipping name	:	LITHIUM HYDROXIDE
Class	:	8
Packing group	:	II
Labels	:	8

IATA-DGR

UN/ID No.	:	UN 2680
Proper shipping name	:	Lithium hydroxide
Class	:	8
Packing group	:	II
Labels	:	Corrosive
Packing instruction (cargo aircraft)	:	863
Packing instruction (passenger aircraft)	:	859

IMDG-Code

UN number	:	UN 2680
Proper shipping name	:	LITHIUM HYDROXIDE
Class	:	8
Packing group	:	II
Labels	:	8
EmS Code	:	F-A, S-B
Marine pollutant	:	no

Remarks : SGG 18, Alkalis

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

National Regulations

ADG

UN number : UN 2680
Proper shipping name : LITHIUM HYDROXIDE
Class : 8
Packing group : II
Labels : 8
Hazchem Code : 2X

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

SECTION 15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

Prohibition/Licensing Requirements : There is no applicable prohibition, authorisation and restricted use requirements, including for carcinogens referred to in Schedule 10 of the model WHS Act and Regulations.

The components of this product are reported in the following inventories:

TCSI : On the inventory, or in compliance with the inventory

TSCA : All substances listed as active on the TSCA inventory

AIIC : On the inventory, or in compliance with the inventory

DSL : All components of this product are on the Canadian DSL

ENCS : On the inventory, or in compliance with the inventory

ISHL : On the inventory, or in compliance with the inventory

KECI : On the inventory, or in compliance with the inventory

PICCS	:	On the inventory, or in compliance with the inventory
IECSC	:	On the inventory, or in compliance with the inventory
NZIoC	:	On the inventory, or in compliance with the inventory
EINECS	:	On the inventory, or in compliance with the inventory
TECI	:	On the inventory, or in compliance with the inventory

SECTION 16. OTHER INFORMATION

Revision Date : 10.06.2022
Date format : dd.mm.yyyy

Full text of other abbreviations

AIIC - Australian Inventory of Industrial Chemicals; ANTT - National Agency for Transport by Land of Brazil; ASTM - American Society for the Testing of Materials; bw - Body weight; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; n.o.s. - Not Otherwise Specified; Nch - Chilean Norm; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NOM - Official Mexican Norm; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; SADT - Self-Accelerating Decomposition Temperature; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TDG - Transportation of Dangerous Goods; TECI - Thailand Existing Chemicals Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative; WHMIS - Workplace Hazardous Materials Information System

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

AU / EN

Safety Data Sheet
CAUSTIC SODA 50%

Version 1.8 Revision Date: 08/29/2022

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : CAUSTIC SODA 50%

Recommended use of the chemical and restrictions on use

Recommended use : Reserved for industrial and professional use.

Manufacturer or supplier's details

Company : Univar Solutions USA, Inc.
Address
3075 Highland Pkwy Suite 200
Downers Grove, IL 60515
United States of America (USA)

Emergency telephone number:
Transport North America: CHEMTREC (1-800-424-9300)
CHEMTREC INTERNATIONAL Tel # 703-527-3887

Additional Information: : Responsible Party: Product Compliance Department
E-mail: SDSNA@univarsolutions.com
SDS Requests: 1-855-429-2661
Website: www.univarsolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Corrosive to metals : Category 1

Skin corrosion : Category 1A

Serious eye damage : Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.

Precautionary statements : **Prevention:**
P234 Keep only in original container.
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
Response:
P301 + P330 + P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P310 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/ doctor.

P305 + P351 + P338 + P310 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/ doctor.
P363 Wash contaminated clothing before reuse.
P390 Absorb spillage to prevent material damage.
Storage:
P405 Store locked up.
P406 Store in corrosive resistant container with a resistant inner liner.
Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Mixture

Hazardous components

CAS-No.	Chemical name	Weight percent
1310-73-2	Sodium hydroxide	50 - 70

Actual concentration is withheld as a trade secret
Any Concentration shown as a range is due to batch variation.

SECTION 4. FIRST AID MEASURES

General advice : Move out of dangerous area.
Consult a physician.
Show this safety data sheet to the doctor in attendance.
Do not leave the victim unattended.

If inhaled : If unconscious, place in recovery position and seek medical advice.
If symptoms persist, call a physician.

In case of skin contact : Immediate medical treatment is necessary as untreated wounds from corrosion of the skin heal slowly and with difficulty.
If on skin, rinse well with water.
If on clothes, remove clothes.

In case of eye contact : Small amounts splashed into eyes can cause irreversible tissue damage and blindness.
In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Continue rinsing eyes during transport to hospital.
Remove contact lenses.
Protect unharmed eye.
Keep eye wide open while rinsing.
If eye irritation persists, consult a specialist.
Take victim immediately to hospital.

If swallowed : Keep respiratory tract clear.

Do NOT induce vomiting.
Do not give milk or alcoholic beverages.
Never give anything by mouth to an unconscious person.
If symptoms persist, call a physician.
Take victim immediately to hospital.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Unsuitable extinguishing media	:	High volume water jet
Specific hazards during firefighting	:	Do not allow run-off from fire fighting to enter drains or water courses.
Hazardous combustion products	:	No hazardous combustion products are known
Further information	:	Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.
Special protective equipment for firefighters	:	Wear self-contained breathing apparatus for firefighting if necessary.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Use personal protective equipment.
Environmental precautions	:	Prevent product from entering drains. Prevent further leakage or spillage if safe to do so. If the product contaminates rivers and lakes or drains inform respective authorities.
Methods and materials for containment and cleaning up	:	Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Keep in suitable, closed containers for disposal.

SECTION 7. HANDLING AND STORAGE

Advice on protection against fire and explosion	:	Normal measures for preventive fire protection.
Advice on safe handling	:	Do not breathe vapours/dust. Avoid contact with skin and eyes. For personal protection see section 8. Smoking, eating and drinking should be prohibited in the application area. To avoid spills during handling keep bottle on a metal tray. Dispose of rinse water in accordance with local and national

regulations.

Conditions for safe storage : Keep container tightly closed in a dry and well-ventilated place.
Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Observe label precautions.
Electrical installations / working materials must comply with the technological safety standards.

Recommended storage temperature : > 16 °C

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

CAS-No.	Components	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
1310-73-2	Sodium hydroxide	C	2 mg/m3	ACGIH
		C	2 mg/m3	NIOSH REL
		TWA	2 mg/m3	OSHA Z-1
		C	2 mg/m3	OSHA P0
		C	2 mg/m3	CAL PEL

Personal protective equipment

Respiratory protection : General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and use NIOSH/MSHA approved respirators. Protection provided by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection.

Hand protection

Remarks : The suitability for a specific workplace should be discussed with the producers of the protective gloves.

Eye protection : Eye wash bottle with pure water
Tightly fitting safety goggles
Wear face-shield and protective suit for abnormal processing problems.

Skin and body protection : Impervious clothing
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures : When using do not eat or drink.
When using do not smoke.
Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Colour	:	No data available
Odour	:	No data available
Odour Threshold	:	No data available
pH	:	14
Freezing Point (Melting point/freezing point)	:	12 - 15 °C (54 - 59 °F)
Boiling Point (Boiling point/boiling range)	:	140 - 145 °C (284 - 293 °F)
Flash point	:	does not flash
Evaporation rate	:	No data available
Flammability (solid, gas)	:	No data available
Upper explosion limit	:	No data available
Lower explosion limit	:	No data available
Vapour pressure	:	No data available
Relative vapour density	:	No data available
Relative density	:	1.5298
Density	:	12.76 lb/gal
Water solubility	:	No data available
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	No data available
Auto-ignition temperature	:	No data available
Thermal decomposition	:	No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Corrosive to metals Exothermic reaction with acids.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	No decomposition if stored and applied as directed.
Conditions to avoid	:	Freezing temperatures. Heat No data available
Incompatible materials	:	Acids Metals Oxidizing agents Halogenated compounds organic nitro compounds Zinc Acids Halogenated compounds Metals organic nitro compounds Zinc
Hazardous decomposition products	:	Hydrogen

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Components:

1310-73-2:

Acute oral toxicity : LD50 (Rabbit): 325 mg/kg

Skin corrosion/irritation

Components:

1310-73-2:
Species: Rabbit
Result: Causes severe burns.

Serious eye damage/eye irritation

Components:

1310-73-2:
Species: Rabbit
Result: Risk of serious damage to eyes.

Carcinogenicity

IARC	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.
NTP	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Further information

Product:

Remarks: No data available

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

No data available

Persistence and degradability

No data available

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Ozone-Depletion Potential	: Regulation: 40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances Remarks: This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).
Additional ecological information	: No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	: Do not dispose of waste into sewer. Do not contaminate ponds, waterways or ditches with chemical or used container. Send to a licensed waste management company. Dispose of in accordance with all applicable local, state and federal regulations. For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact Univar Solutions ChemCare: 1-800-637-7922
Contaminated packaging	: Empty remaining contents. Dispose of as unused product. Do not re-use empty containers.

SECTION 14. TRANSPORT INFORMATION

DOT (Department of Transportation):
UN1824, Sodium hydroxide solution, 8, II

IATA (International Air Transport Association):
UN1824, Sodium hydroxide solution, 8, II

IMDG (International Maritime Dangerous Goods):
UN1824, SODIUM HYDROXIDE SOLUTION, 8, II

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Sodium hydroxide	1310-73-2	1000	2000
Sodium hydroxide	1310-73-2	1000	2000

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Corrosive to metals
Skin corrosion or irritation
Serious eye damage or eye irritation

SARA 302 : This material does not contain any components with a section 302 EHS TPQ.

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Clean Air Act

This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
This product does not contain any chemicals listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489).

Clean Water Act

The following Hazardous Substances are listed under the U.S. CleanWater Act, Section 311, Table 116.4A:
1310-73-2 Sodium hydroxide
The following Hazardous Chemicals are listed under the U.S. CleanWater Act, Section 311, Table 117.3:
1310-73-2 Sodium hydroxide
This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

Massachusetts Right To Know

1310-73-2	Sodium hydroxide

Pennsylvania Right To Know

1310-73-2	Sodium hydroxide
7732-18-5	Water

California Prop 65 : This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

The components of this product are reported in the following inventories:

TSCA : On TSCA Inventory

DSL : All components of this product are on the Canadian DSL

AICS : On the inventory, or in compliance with the inventory

NZIoC : On the inventory, or in compliance with the inventory

ENCS : On the inventory, or in compliance with the inventory

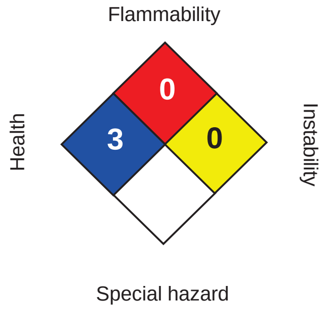
KECI : On the inventory, or in compliance with the inventory

PICCS : On the inventory, or in compliance with the inventory

IECSC : On the inventory, or in compliance with the inventory

SECTION16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	**3**
FLAMMABILITY	**0**
PHYSICAL HAZARD	**0**

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

The information accumulated is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made become available subsequently to the date hereof, we do not assume any responsibility for the results of its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by Univar Solutions Product Compliance Department (1-855-429-2661) SDSNA@univarsolutions.com.

Revision Date : 08/29/2022

Material number:
16191539, 16188943, 16188859, 16188905, 40509, 16144372, 85833, 16187875, 16187706, 16187503, 16187172, 16184289, 16184571, 16183215, 16183115, 16181535, 16174812, 16176162, 16176725, 16175550, 16177057, 16176719, 16176286, 16175611, 16175549, 16177342, 16174633, 16176146, 16175652, 16175317, 16174795, 16174563, 16176924, 16180636, 16169042, 16168322, 16168270, 16168140, 16168139, 16179411, 16169006, 16168617, 16150547, 16162842, 16162538, 16144429, 16173515, 16168911, 16162950, 16162022, 16144216, 16143594, 16162020, 16168720, 16166706, 16152119, 16173289, 16179365, 16166192, 16137935, 16161861, 16143735, 16151817, 85472, 52714, 71460, 54298, 16168314, 16146819, 16163462, 16148908, 16144035, 16166958, 16166445, 16137825, 16151508, 16151289, 16160192, 16147037, 16156058, 16155066, 16135486, 16159912, 16141649, 16140194, 16064783, 16064423, 16036726, 16036725, 613255, 122390, 70451, 103323, 69362, 69435, 16158900, 16135663, 16144460, 16141402,

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program
CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level
EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philippines Inventory of Commercial Chemical Substances
MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Composition, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50	Lethal Concentration 50%		

SAFETY DATA SHEET

THIONYL CHLORIDE

Version	Revision Date:	SDS Number:	Date of last issue: 10/20/2020
2.0	04/18/2022	203000014647	Country / Language: US / EN

SECTION 1. IDENTIFICATION

Product name : THIONYL CHLORIDE

Product code : 000000000000001902

Manufacturer or supplier's details

Company : LANXESS Corporation
Product Safety & Regulatory Affairs
111 RIDC Park West Drive
Pittsburgh, Pennsylvania 15275-1112

Responsible Department : (800) LANXESS
(412) 809-1000
lanxesshes@lanxess.com

Emergency telephone : CHEMTREC (800) 424-9300 or
(703) 527-3887 (Outside U.S.A) and mention CCN12916.
Lanxess Emergency Phone (800) 410-3063.

Recommended use of the chemical and restrictions on use

Recommended use : Chemical for synthesis

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute toxicity (Oral) : Category 4

Acute toxicity (Inhalation) : Category 3

Skin corrosion : Category 1A

Serious eye damage : Category 1

Specific target organ toxicity - single exposure (Inhalation) : Category 1 (Respiratory Tract)

GHS label elements

Hazard pictograms :

Signal Word : Danger

Hazard Statements : Harmful if swallowed.
Causes severe skin burns and eye damage.
Toxic if inhaled.
Causes damage to organs (Respiratory Tract) if inhaled.

Precautionary Statements :

Prevention:

Do not breathe dust/ fume/ gas/ mist/ vapors/ spray.
Wash skin thoroughly after handling.
Do not eat, drink or smoke when using this product.
Use only outdoors or in a well-ventilated area.
Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response:

IF SWALLOWED: Call a POISON CENTER/ doctor if you feel unwell. Rinse mouth.
IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/ doctor.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/ doctor.
IF exposed: Call a POISON CENTER or doctor/ physician.
Wash contaminated clothing before reuse.

Storage:

Store in a well-ventilated place. Keep container tightly closed.
Store locked up.

Disposal:

Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Components

Chemical name	CAS-No.	Concentration (% w/w)
thionyl dichloride	7719-09-7	> 99.6

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

SECTION 4. FIRST AID MEASURES

General advice	:	Do not leave the victim unattended.
If inhaled	:	Chemical burns must be treated promptly by a physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If unconscious, place in recovery position and get medical attention immediately. Maintain open airway. Loosen tight clothing such as a collar, tie, belt or waistband. If not breathing, if breathing is irregulor or respiratory arrest occurs, provide artifical respiration, or oxygen by a trained professional, using a pocket type respirator.
In case of skin contact	:	Chemical burns must be treated promptly by a physician. Wash off immediately with soap and plenty of water. Remove contaminated clothing and shoes. Continue to rinse for 30 minutes. Wash contaminated clothing before reuse. Thoroughly clean shoes before reuse.
In case of eye contact	:	Chemical burns must be treated promptly by a physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Remove contact lenses. Continue to rinse for 30 minutes. Continue rinsing eyes during transport to hospital.
If swallowed	:	Chemical burns must be treated promptly by a physician. Rinse mouth with water. Do not induce vomiting unless directed to do by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms and effects, both acute and delayed

Symptoms	:	Acute overexposure to this product may cause dizziness, headache, drowsiness, malaise, abdominal pain. Eye: Corrosive with symptoms of reddening, tearing, swelling, burning and possible permanent damage. Skin: Reddening, burning, and possible permanent damage.

		Ingestion: Corrosive with symptoms of coughing, burning, ulceration, and pain. Inhalation: Causes respiratory tract burns. May cause pulmonary edema with symptoms of breathing difficulty and tightness of chest.
Effects	:	Harmful if swallowed. Causes serious eye damage. Toxic if inhaled. Causes damage to organs if inhaled. Causes severe burns.
Protection of first-aiders	:	If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. Remove victims from the danger zone without endangering your own safety.
Notes to physician	:	Treat symptomatically.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Dry chemical Carbon dioxide (CO2)
Unsuitable extinguishing media	:	Water Foam
Specific hazards during fire fighting	:	Reacts violently with water. Contact with water liberates toxic gas. In a fire or if heated, a pressure increase will occur and the container may burst. May release toxic, irritating and/or corrosive gases.
Hazardous combustion products	:	Sulfur oxides Halogenated compounds
Further information	:	Move containers from fire if this can be done without risk. Fight fire from protected location or maximum possible distance. If this is impossible, withdraw from area and allow fire to burn.
Special protective equipment for fire-fighters	:	Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures : No action shall be taken involving any personal risk or without suitable training.
Evacuate personnel to safe areas.
Keep unnecessary and unprotected personnel from entering.
Do not touch or walk through spilled material.
Do not breathe vapors or spray mist.
Provide adequate ventilation.
Keep away from water.
Wear respiratory protection.
Put on appropriate personal protection equipment.

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.
Prevent further leakage or spillage if safe to do so.
Inform the responsible authorities in case of gas leakage, or of entry into waterways, soil or drains.

Methods and materials for containment and cleaning up : Stop leak if safe to do so.
Move containers from spill area.
Keep people away from and upwind of spill/leak.
Use non-sparking tools.
Do not flush with water.
Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13).
Contaminated absorbent material may pose the same hazard as the spilled product.
Disposed off through appropriate waste disposal carriers/authorities.
Do not allow into the sewerage system, surface waters or groundwater or into the soil.

SECTION 7. HANDLING AND STORAGE

Advice on safe handling : Avoid exposure - obtain special instructions before use.
Avoid inhalation, ingestion and contact with skin and eyes.
Use only with adequate ventilation/personal protection.
Protect from moisture.
Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use.
Empty containers retain product residue; observe all precautions for product.
Do not re-use empty containers.
Remove contaminated clothing and protective equipment before entering eating areas.
Workers should wash hands and face before eating, drinking and smoking.
Put on appropriate personal protection equipment.

Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed.

Conditions for safe storage : Keep away from water or moist air.
Store in accordance with local regulations.
Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink.
Container must be equipped with a pressure-relief valve.
Storage containers and associated equipment should be 304L or 316L stainless steel, nickel or lined with PTFE (Polytetrafluoroethylene), lead, porcelain enamel or galvanized steel.
Do not allow moisture to enter storage containers as this will cause an increased corrosion and cause the release of Hydrochloric Acid and Sulfur Dioxide.
Containers that have been opened must be carefully resealed and kept upright to prevent leakage.
Do not store in unlabeled containers.
Use appropriate container to avoid environmental contamination.

Further information on storage stability : No decomposition if stored and applied as directed.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
thionyl dichloride	7719-09-7	C	0.2 ppm	ACGIH

Occupational exposure limits of decomposition products

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
hydrogen chloride	7647-01-0	C	2 ppm	ACGIH
		C	5 ppm 7 mg/m3	OSHA Z-1
sulphur dioxide	7446-09-5	STEL	0.25 ppm	ACGIH
		TWA	5 ppm 13 mg/m3	OSHA Z-1
sulphur dioxide	7446-09-5	STEL	0.25 ppm	ACGIH
		TWA	5 ppm 13 mg/m3	OSHA Z-1

disulphur dichloride	10025-67-9	C	1 ppm	ACGIH
		TWA	1 ppm 6 mg/m3	OSHA Z-1
chlorine	7782-50-5	TWA	0.1 ppm	ACGIH
		STEL	0.4 ppm	ACGIH
		C	1 ppm 3 mg/m3	OSHA Z-1

Personal protective equipment

Respiratory protection : A NIOSH approved air purifying respirator with acid gas canisters or cartridges or an air-supplied respirator. In enclosed or highly concentrated areas, only a self-contained positive pressure breathing apparatus or a full face supplied air respirator should be utilized.

Hand protection
- Material : Fluorinated rubber - FKM
- Break through time : >= 4 h
- Glove thickness : >= 0.4 mm
- Wearing time : < 60 min

- Remarks : Do not wear leather gloves.
Gloves should be discarded and replaced if there is any indication of degradation or chemical breakthrough.

Eye protection : Tightly fitting safety goggles
Faceshield may be necessary in operations with splash potential but cannot be used in place of chemical safety goggles.

Skin and body protection : Complete suit protecting against chemicals
Choose body protection according to the amount and concentration of the dangerous substance at the work place.
Do not wear leather shoes.

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period.
Appropriate techniques should be used to remove potentially contaminated clothing.
Wash contaminated clothing before reusing.
Ensure that eyewash stations and safety showers are close to the workstation location.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state	:	liquid
Color	:	light yellow
Odor	:	Pungent smelling.
Odor Threshold	:	No data available
pH	:	No data available
Melting point/range	:	-156.1 °F / -104.5 °C
Boiling point/boiling range	:	169 °F / 76 °C (1,013 hPa)
Flash point	:	No data available
Evaporation rate	:	No data available
Self-ignition	:	No data available
Burning number	:	No data available
Upper explosion limit / Upper flammability limit	:	No data available
Lower explosion limit / Lower flammability limit	:	No data available
Vapor pressure	:	129 hPa (68 °F / 20 °C)
Relative density	:	No data available
Density	:	1.64 g/cm3 (68 °F / 20 °C)
Solubility(ies)		
Water solubility	:	hydrolyzes
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	No data available
Decomposition temperature	:	> 284 °F / > 140 °C
Viscosity		
Viscosity, dynamic	:	0.6 mPa.s (68 °F / 20 °C)

Viscosity, kinematic	:	No data available
Explosive properties	:	No data available
Oxidizing properties	:	No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Reacts with water, producing toxic and corrosive fumes.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Contact with water liberates toxic gas. Attacks many metals producing extremely flammable hydrogen gas which can form explosive mixtures with air.
Conditions to avoid	:	Extremes of temperature and direct sunlight.
Incompatible materials	:	water Alkalis Alcohols Amines Metals

Hazardous decomposition products

Contact with water or humid air	:	hydrogen chloride sulphur dioxide
Thermal decomposition	:	sulphur dioxide disulphur dichloride chlorine

SECTION 11. TOXICOLOGICAL INFORMATION

The most important known symptoms and effects are described in Section 2 and/or Section 4.

Information on likely routes of exposure

Inhalation
Eye contact
Skin contact
Ingestion

Acute toxicity

Harmful if swallowed.
Toxic if inhaled.

Product:

Acute oral toxicity	:	Acute toxicity estimate: 324 mg/kg Method: Calculation method
Acute inhalation toxicity	:	Acute toxicity estimate: 2.72 mg/l Exposure time: 4 h Test atmosphere: vapor Method: Calculation method

Components:

thionyl dichloride:

Acute oral toxicity	:	LD50 (Rat, male and female): 324 mg/kg Method: Regulation (EC) No. 440/2008, Annex, B.1 bis GLP: yes
Acute inhalation toxicity	:	LC50 (Rat, male and female): 2.717 mg/l Exposure time: 4 h Test atmosphere: vapor Method: OECD Test Guideline 403 GLP: no

Skin corrosion/irritation

Causes severe burns.

Components:

thionyl dichloride:

Assessment : Causes severe burns.

Serious eye damage/eye irritation

Causes serious eye damage.

Components:

thionyl dichloride:

Assessment : Risk of serious damage to eyes.

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

Germ cell mutagenicity

Not classified based on available information.

Components:

thionyl dichloride:

Genotoxicity in vitro	:	Test system: Salmonella typhimurium Metabolic activation: with and without metabolic activation Method: OECD Test Guideline 471 Result: negative GLP: yes

Carcinogenicity

Not classified based on available information.

IARC	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.
NTP	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Not classified based on available information.

STOT-single exposure

Causes damage to organs (Respiratory Tract) if inhaled.

Components:

thionyl dichloride:

Routes of exposure	:	Inhalation
Target Organs	:	Respiratory Tract
Assessment	:	The substance or mixture is classified as specific target organ toxicant, single exposure, category 1.

STOT-repeated exposure

Not classified based on available information.

Aspiration toxicity

Not classified based on available information.

Further information

Product:

Remarks	:	No data available

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

No data available

Persistence and degradability

Components:

thionyl dichloride:

Biodegradability : Remarks: The methods for determining the biological degradability are not applicable to inorganic substances.

Bioaccumulative potential

Components:

thionyl dichloride:

Bioaccumulation : Remarks: Not applicable

Mobility in soil

No data available

Other adverse effects

Product:

Additional ecological information : Toxic effect on fish, plankton and on sedentary organisms, also through shifting of pH value.

Components:

thionyl dichloride:

Results of PBT and vPvB assessment : Remarks: Not applicable

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

RCRA - Resource Conservation and Recovery Authorization Act : When discarded in its purchased form, this product meets the criteria of corrosivity, and should be managed as a hazardous waste (EPA Hazardous Waste Number D002). (40 CFR 261.20-24)
When discarded in its purchased form, this product meets the criteria of reactivity, and should be managed as a hazardous waste (EPA Hazardous Waste Number D003). (40 CFR 261.20-24)

Waste Code : D002: Corrosivity
D003: Reactivity

Waste from residues : The generation of waste should be avoided or minimized wherever possible.
This material and its container must be disposed of in a safe way.
Empty containers retain product residue; observe all precautions for product.
Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.
Waste disposal should be in accordance with existing federal, state, provincial and/or local environmental controls.

SECTION 14. TRANSPORT INFORMATION

International Regulations

IATA-DGR
Not permitted for transport

IMDG-Code
UN number : UN 1836
Proper shipping name : THIONYL CHLORIDE

Class : 8
Packing group : I
Labels : 8
:

EmS Code : F-A, S-B
Marine pollutant : no

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Domestic regulation

49 CFR
UN/ID/NA number : UN 1836
Proper shipping name : Thionyl chloride

Class : 8
Packing group : I
Labels : 8

:


ERG Code : 137
Marine pollutant : no

Hazard and Handling Notes.
Highly corrosive., Fuming., Pungent smelling., Keep dry., Otherwise dangerous reaction, Keep separated from foodstuffs

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

SECTION 15. REGULATORY INFORMATION

CERCLA Reportable Quantity

A characteristic waste RQ of 100 lbs applies to this product in a waste form: D002, D003

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 302 Extremely Hazardous Substances Threshold Planning Quantity

This material does not contain any components with a section 302 EHS TPQ.

SARA 311/312 Hazards : Acute toxicity (any route of exposure)
Specific target organ toxicity (single or repeated exposure)
Skin corrosion or irritation
Serious eye damage or eye irritation

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

US State Regulations

Massachusetts Right To Know

thionyl dichloride	7719-09-7	> 99.6
sulphur dioxide	7446-09-5	< 0.3

Pennsylvania Right To Know

thionyl dichloride	7719-09-7	> 99.6
sulphur dioxide	7446-09-5	< 0.3

California Prop. 65

WARNING: This product can expose you to chemicals including sulphur dioxide, which is/are known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

TSCA inventory

TSCA : All substances listed as active on the TSCA inventory

TSCA list

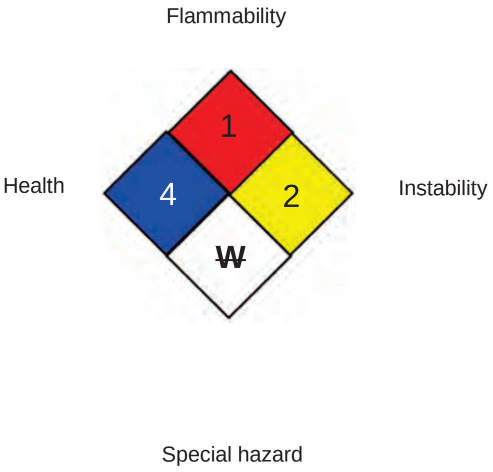
No substances are subject to a Significant New Use Rule.

No substances are subject to TSCA 12(b) export notification requirements.

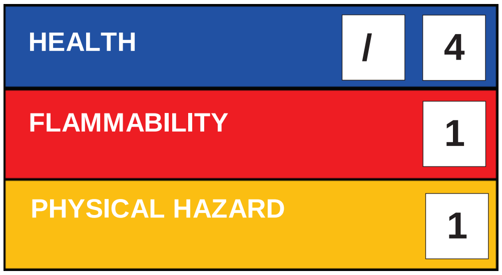
SECTION 16. OTHER INFORMATION

Further information

NFPA 704:



HMIS® IV:



HEALTH	/	4
FLAMMABILITY		1
PHYSICAL HAZARD		1

HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. The "*" represents a chronic hazard, while the "/" represents the absence of a chronic hazard.

Full text of other abbreviations

ACGIH	:	USA. ACGIH Threshold Limit Values (TLV)
OSHA Z-1	:	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
ACGIH / TWA	:	8-hour, time-weighted average
ACGIH / STEL	:	Short-term exposure limit
ACGIH / C	:	Ceiling limit
OSHA Z-1 / TWA	:	8-hour time weighted average
OSHA Z-1 / C	:	Ceiling

AIIC - Australian Inventory of Industrial Chemicals; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Hazardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TECI - Thailand Existing Chemicals Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

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The data contained in this Safety Data Sheet are based on our current knowledge and experience and describe the product only with regard to safety requirements. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered to be a guidance for processing and does not contain any warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. It is the responsibility of the recipient of the product to ensure that any proprietary rights and existing laws and legislation are observed.