SECTION 3.1

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Air Quality Division

1110 West Washington • Phoenix, AZ 85007 • Phone: (602) 771-2338

STANDARD CLASS II PERMIT APPLICATION FORM

(As required by A.R.S. § 49-426, and Chapter 2, Article 3, Arizona Administrative Code)

1. Permit to be issued to (Business license name of organization that is to receive permit): Linde Gas & Equipment, Inc.

2. Mailing Address: P.O. Box 6157

   City: Kingman State: AZ ZIP: 86401

3. Name (or names) of Responsible Official: Robert Sena

   Phone: (928) 718-8254 Fax: (928) 753-9707 Email: robert.sena@linde.com

4. Facility Manager/Contact Person and Title: Robert Sena / Plant Manager

   Phone: (928) 718-8254 Fax: (928) 753-9707 Email: robert.sena@linde.com

5. Facility Name: Linde Gas & Equipment, Inc. Kingman Facility

   Facility Location/Address (Current/Proposed): 3426 W Griffith Road

   City: Kingman County: Mojave ZIP: 86401

   Indian Reservation (if applicable, which one): ____

   Latitude/Longitude, Elevation: 35° 01' 40" N / 114° 08' 36" W, 730 m

6. General Nature of Business: Chemical Synthesis and Repackaging Facility

7. Type of Organization:

   ☐ Corporation ☐ Individual Owner ☐ Partnership ☐ Government Entity ☑ LLC

   ☐ Other ____

8. Permit Application Basis: ☐ New Source ☐ Revision ☑ Renewal of Existing Permit

   For renewal or modification, include existing permit number (and exp. date): #70386, exp. 07/25/2023

   Date of Commencement of Construction or Modification:

   Primary Standard Industrial Classification Code: 5169

9. I certify that I have knowledge of the facts herein set forth, that the same are true, accurate and complete to the best of my knowledge and belief, and that all information not identified by me as confidential in nature shall be treated by ADEQ as public record. I also attest that I am in compliance with the applicable requirements of the Permit and will continue to comply with such requirements and any future requirements that become effective during the life of the Permit. I will present a certification of compliance to ADEQ no less than annually and more frequently if specified by ADEQ. I further state that

I will assume responsibility for the construction, modification, or operation of the source in accordance with Arizona Administrative Code, Title 18, Chapter 2 and any permit issued thereof.

Signature of Responsible Official: ______________________

Printed Name of Signer/Official Title: Robert Sena / Plant Manager

Date: 1-24-2023 Telephone Number: (928) 718-8254

Section 3.5 - Equipment List (1 of 3)

Type of Equipment	Maximum Rated Capacity [1]	Make	Model	Serial Number	Date of Manufacture	Equipment ID Number
Ventilation Emergency Scrubber	30,000 scfm	Construction International, Inc.	Countercurrent Packed Column Wet Scrubber		N/A	VES-1
Arsine Guardian 1	2,000 scfm	Hoechst Celanese	Guardian 8		N/A	
Arsine Guardian 2	2,000 scfm	ATMI	Guardian 8		N/A	
Arsine Baghouse 1		Mikropul Environmental Systems	64S8 TRH"C"		N/A	
Arsine Baghouse 2		Mikropul Environmental Systems	64S8 TRH		N/A	
Silane Guardian	2,000 scfm	MG Industries	Guardian 8		N/A	
Silane Baghouses 1 and 2	1,800 acfm	STACLEAN Diffuser Co.	49-8-ADR		N/A	
Phosphine Guardian	1,300 scfm	Hoechst Celanese	Guardian 8		N/A	
Phosphine Dynawave Wet Scrubber	1,300 scfm	Monsanto Enviro-Chem	Reverse Jet Scrubbing System		N/A	
TCS Wet Scrubber A		Advanced Air Technologies	Apollo Series		N/A	
DCS Wet Scrubber B	200 scfm	Advanced Air Technologies	Apollo Series		N/A	
DCS Wet Scrubber C	200 scfm	Advanced Air Technologies	Apollo Series		N/A	
TCS Wet Scrubber D		Advanced Air Technologies	Apollo Series		N/A	
Emergency Generator	536 hp	Caterpillar	C13		TBD	002
VES-1 Diesel Generator	230 hp	Caterpillar	C6.6 DIT		03/2017	

[1} For generator sets, enter the maximum rated capacity of the engine rather than the maximum rated capacity of the generator.

All relevant equipment utilized at the facility should be included in the equipment list. Please complete all fields.
The date of manufacture must be included in order to determine applicability of regulations.
Indicate the units (tons/hour, horsepower, etc.) when recording the maximum rated capacity.
Make additional copies of this form if necessary.
***Submit photographs of the faceplates for all engines listed above.**
***If an engine is certified, please also include a copy of the engine certification with the application.**
***For any newly added equipment, include a copy of the specification sheet.**
***These documents will be used to verify equipment information and determine applicable regulations.**

Section 3.5 - Equipment List (2 of 3)

Type of Equipment	Maximum Rated Capacity [1]	Make	Model	Serial Number	Date of Manufacture	Equipment ID Number
Diesel Generator VES-2 Scrubber	136 hp	Onsite Energy / John Deere	N/A		2010	
Diesel Fire Water Pump	244 hp	Cummins Diesel	N/A		1990	
Cylinder Shot Blaster & Dust Collector	240 cyl/day	Viking Corp	GC112 (blaster), 9DC (collector)		04/2006	006
Spray Paint Booth	8,000 cfm (exhaust fan)	Global Finishing Solutions	DFECG-100816- NSB-4L-BD-SP	U144849-A	11/2022	007
Ammonia Recovery System	200 lb/hr	RM Technologies	N/A		07/2006	
Caustic Wet Scrubber	1,000 SCFM, 1.5 hp pump, 10 hp fan	Advanced Air Technologies	Orion Series		2010	VES-2
Process Caustic Wet Scrubber	50 scfm, 1.5 hp – pump	Advanced Air Technologies	Apollo 50 Series		04/09/2008	PCWS-1
Process Dry Scrubber	100 slpm	CS Clean Systems	CS200BS		2010	PDS-1
Vacuum Pump QDP-80	1.75 hp	Edwards Vacuum Pump	QDP80 with QMB250 blower		2010	SiF4/GeF4/BF3-11/F2 VAC-1
Gas Detection	N/A	Honeywell	Vertex		2010	N/A
Caustic Waste Hold Tank	1,200 gallons	N/A	1,200 gallons		2010	Waste Tank 1
Caustic Waste Transfer Pump	14.5 gpm	Sandpiper	S1FB3P2PPVS100		2010	Waste TP-1
GeF4 Fill, Process and Flow Test Panels	N/A	Praxair Custom	Custom		07/2008	
SiF4 Fill, Process, and Flow Test Panels	N/A	Praxair Custom	Custom		10/2008	
B11F3 Flow Test Panels	N/A	Praxair Custom	Custom		12/2003	

[1} For generator sets, enter the maximum rated capacity of the engine rather than the maximum rated capacity of the generator.

All relevant equipment utilized at the facility should be included in the equipment list. Please complete all fields.
The date of manufacture must be included in order to determine applicability of regulations.
Indicate the units (tons/hour, horsepower, etc.) when recording the maximum rated capacity.
Make additional copies of this form if necessary.
***Submit photographs of the faceplates for all engines listed above.**
***If an engine is certified, please also include a copy of the engine certification with the application.**
***For any newly added equipment, include a copy of the specification sheet.**
***These documents will be used to verify equipment information and determine applicable regulations.**

Section 3.5 - Equipment List (3 of 3)

Type of Equipment	Maximum Rated Capacity [1]	Make	Model	Serial Number	Date of Manufacture	Equipment ID Number
F2 Fill and Process Panel	N/A	Praxair Custom	Custom		2010	
Ventilation Emergency Scrubber	20 scfm	Advanced Air Technologies	Orion Series Twin Tower		TBD	VES-3
Internal Shot Blaster	50 scfm @ 100 psig	Galiso Inc.	ISB-1 with Dust Collector, BST-9 Cylinder Tumbler		N/A	ABU-1
Emergency Gas Release Absorber	1,060 scfm	CS Clean Solutions	CLEAN-PROTECT CP500SF		TBD	FES

[1} For generator sets, enter the maximum rated capacity of the engine rather than the maximum rated capacity of the generator.

All relevant equipment utilized at the facility should be included in the equipment list. Please complete all fields.
The date of manufacture must be included in order to determine applicability of regulations.
Indicate the units (tons/hour, horsepower, etc.) when recording the maximum rated capacity.
Make additional copies of this form if necessary.
***Submit photographs of the faceplates for all engines listed above.**
***If an engine is certified, please also include a copy of the engine certification with the application.**
***For any newly added equipment, include a copy of the specification sheet.**
***These documents will be used to verify equipment information and determine applicable regulations.**

SECTION 3.6 - EMISSION SOURCE FORM
(1 of 4)

Emission Point		Regulated Air Pollutant Name	PTE		USE THIS SECTION FOR MODIFICATIONS ONLY — PTE AFTER MODIFICATION		CHANGE IN PTE
Number	Name		lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr
001	VES-1	Arsine	7.5E-04	6.6E-04			
001	VES-1	Diborane	1.0E-05	2.5E-06			
001	VES-1	Diethyltelluride		5.0E-08			
001	VES-1	Phosphine	6.0E-04	1.9E-04			
001	VES-1	Silane	1.1E-03	4.8E-04			
001	VES-1	Methyl Bromide	1.3E-03	4.1E-05			
001	VES-1	Dichloromethane	5.3E-04	1.7E-05			
002	Emergency Diesel Generator	VOC	1.3E+00	1.3E-01			
002	Emergency Diesel Generator	Nitrogen Oxides	5.4E+00	5.4E-01			
002	Emergency Diesel Generator	Carbon Monoxide	1.4E+00	1.4E-01			
002	Emergency Diesel Generator	Sulfur Oxides	1.1E+00	1.1E-01			
002	Emergency Diesel Generator	PM10	1.2E-01	1.2E-02			
002	Emergency Diesel Generator	Carbon Dioxide	6.2E+02	6.2E+01			
002	Emergency Diesel Generator	Aldehydes	2.5E-01	2.5E-02			

****Submit emission calculations spreadsheet with your application****

SECTION 3.6 - EMISSION SOURCE FORM
(2 of 4)

Emission Point		Regulated Air Pollutant Name	PTE		USE THIS SECTION FOR MODIFICATIONS ONLY: PTE AFTER MODIFICATION		CHANGE IN PTE
Number	Name		lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr
016	VES-2 Stack	Hydrogen Fluoride	1.8E+00	1.6E-01			
016	VES-2 Stack	Fluorine	5.1E-04	4.5E-05			
003	VES-1 Diesel Generator	Nitrogen Oxides	1.4E+00	1.4E-01			
003	VES-1 Diesel Generator	Carbon Monoxide	2.9E-01	2.9E-02			
003	VES-1 Diesel Generator	Sulfur Oxides	4.7E-01	4.7E-02			
003	VES-1 Diesel Generator	PM10	6.8E-02	6.8E-03			
003	VES-1 Diesel Generator	Carbon Dioxide	2.6E+02	2.6E+01			
003	VES-1 Diesel Generator	Aldehydes	1.1E-01	1.1E-02			
003	VES-1 Diesel Generator	VOC	5.8E-01	5.8E-02			
004	Emergency Diesel Fire Pump	Nitrogen Oxides	7.6E+00	7.6E-01			
004	Emergency Diesel Fire Pump	Carbon Monoxide	1.6E+00	1.6E-01			
004	Emergency Diesel Fire Pump	Sulfur Oxides	5.0E-01	5.0E-02			
004	Emergency Diesel Fire Pump	PM10	5.4E-01	5.4E-02			
004	Emergency Diesel Fire Pump	Carbon Dioxide	2.8E+02	2.8E+01			
004	Emergency Diesel Fire Pump	Aldehydes	1.1E-01	1.1E-02			

****Submit emission calculations spreadsheet with your application****

SECTION 3.6 - EMISSION SOURCE FORM
(3 of 4)

Emission Point		Regulated Air Pollutant Name	PTE		USE THIS SECTION FOR MODIFICATIONS ONLY: PTE AFTER MODIFICATION		CHANGE IN PTE
Number	Name		lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr
004	Emergency Diesel Fire Pump	VOC	6.1E-01	6.1E-02			
TBD	Diesel Generator VES-2 Scrubber	Nitrogen Oxides	8.5E-01	8.5E-02			
TBD	Diesel Generator VES-2 Scrubber	Carbon Monoxide	1.1E+00	1.1E-01			
TBD	Diesel Generator VES-2 Scrubber	Sulfur Oxides	6.4E-04	6.4E-05			
TBD	Diesel Generator VES-2 Scrubber	PM10	6.6E-02	6.6E-03			
TBD	Diesel Generator VES-2 Scrubber	Carbon Dioxide	1.6E+02	1.6E+01			
TBD	Diesel Generator VES-2 Scrubber	NMHC	4.5E-02	4.5E-03			
TBD	Diesel Generator VES-2 Scrubber	Aldehydes	6.3E-02	6.3E-03			
006	Cylinder Shot Blaster	PM10	2.1E-02	9.2E-02			
007	Paint Spray Booth	2-butoxyethanol	1.4E-01	6.0E-01			
007	Paint Spray Booth	2-butanol	9.3E-02	4.1E-01			
007	Paint Spray Booth	PM	3.6E-04	1.6E-03			
007	Paint Spray Booth	VOC	5.8E-01	2.6E+00			
009	Ammonia Scrubber	Ammonia	2.0E-01	1.4E-01			

****Submit emission calculations spreadsheet with your application****

SECTION 3.6 - EMISSION SOURCE FORM
(4 of 4)

Emission Point		Regulated Air Pollutant Name	PTE		USE THIS SECTION FOR MODIFICATIONS ONLY: PTE AFTER MODIFICATION		CHANGE IN PTE
Number	Name		lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr
019	Abrasive Blasting Unit	PM	1.5E-04	6.5E-04			
TBD	VES-3 Stack	Diborane	1.5E-02	1.1E-03			
TBD	VES-3 Stack	Disilane	1.5E-03	1.0E-04			
TBD	VES-3 Stack	Silicon Tetrafluoride	1.5E-03	1.0E-04			
TBD	VES-3 Stack	Boron-11 Trifluoride	9.3E-05	3.9E-06			
TBD	VES-3 Stack	Boron Trifluoride	1.5E-03	1.0E-04			
TBD	VES-3 Stack	Dichlorosilane	5.0E-02	7.5E-02			
TBD	Atmosphere	Methyl Fluoride	4.0E-01	1.1E-01			
TBD	Atmosphere	Nitrous Oxides	5.7E-01	2.5E+00			
TBD	Fluorine Emergency Stack	Fluorine	2.0E-03	9.9E-07			

****Submit emission calculations spreadsheet with your application****

SECTION 5.0 -APPLICATION ADMINISTRATIVE COMPLETENESS CHECKLIST

	REQUIREMENT	MEETS REQUIREMENTS			COMMENT
		YES	NO	N/A	
1	Has the standard application form been completed?	X			
2	Has the responsible official signed the standard application form?	X			
3	Has a process description been provided?	X			
4	Are the facility's emissions documented with all appropriate supporting information?	X			
5	Is the facility subject to Minor NSR requirements? If the answer is "YES" , answer 6a, 6b and 6c as applicable. If the answer is "NO", skip to 7.		X		
6.a	If the facility chooses to implement RACT, is the RACT determination included for the affected pollutants for all affected emission units?			X	
6.b	If the facility chooses to demonstrate compliance with NAAQS by screen modeling, is the modeling analysis included?			X	
6.c	If refined modeling has been conducted, is a comprehensive modeling report along with all modeling files included?			X	
7	Does the application include an equipment list with the type, name, make, model, serial number, maximum rated capacity, and date of manufacture?	X			
8	Does the application include an identification and description of Pollution Controls? (if applicable)	X			
9	For any application component claimed as confidential, are the requirements of AR.S. 49-432 and A.A.C. R18-2-305 addressed?	X			
10	For any current non-compliance issue, is a compliance schedule attached?			X	
11	For minor permit revision that will make a modification upon submittal of application, has a suggested draft permit been attached?			X	

Air Permit Renewal Application

Prepared for:
Linde Gas & Equipment, Inc.
Kingman, AZ

Prepared by:
Ramboll US Consulting, Inc.
San Francisco, CA

Date:
January 2023

Project Number:
1690027722

Contents

List of Figures

List of Appendices

Acronyms and Abbreviations

AAC	Arizona Administrative Code
AAT, Inc.	Advanced Air Technology, Inc.
ADEQ	Arizona Department of Environmental Quality
BF_3	boron trifluoride
$B_{11}F_3$	enriched boron trifluoride
B_2H_6	diborane gas
B_2H_6/H_2	diborane balance hydrogen
bhp	brake horsepower
C_2H_2	acetylene
CH_3F	methyl fluoride
CO	carbon monoxide
CO_2	carbon dioxide
cfm	cubic feet per minute
DOT	Department of Transportation
EPSL	End Point Sensor Light
GeF_4	germanium tetrafluoride
HF	hydrogen fluoride
ISB	Internal Shot Blaster
lb	pound
LEL	lower explosive limit
NaOH	sodium hydroxide
NF_3	nitrogen trifluoride
NMHC	non-methane hydrocarbon
N_2O	nitrous oxide
NO_X	oxides of nitrogen
NSR	new source review
PH_3	phosphine
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
Ppm	parts per million
ppmv	parts per million by volume
PTE	potential to emit
psig	pounds per square inch - gauge
RO	reverse osmosis
scfm	standard cubic feet per minute
SiF_4	silicon tetrafluoride
Si_2H_6	disilane
SO_2	sulfur dioxide
VES	Ventilation Emergency Scrubber
VOC	volatile organic compound
yr	year

1 Introduction

1.1 General Description

The Kingman, Arizona, Linde Gas & Equipment, Inc. facility (hereafter “Facility”) manufactures arsine and phosphine and fills, processes, tests, and warehouses gaseous products used by the semiconductor industry and other industries. The general location of the Facility is identified in **Figure 1**.

1.2 Purpose of Permit Application

The Facility’s current Permit (No. 70386) was last amended on December 6, 2022 and expires on July 25, 2023. The purpose of this permit application is to renew the current permit before it’s expiry date. This submission includes equipment and emissions data for all existing processes at the Facility. No changes to the existing permit are being proposed concurrent with this renewal.

1.3 Organization of Permit Application

This application is organized as follows: In **Section 2.0**, the application identifies the process operations performed at the Facility. The application provides the required information corresponding to Item D in Section 3.2 of the ADEQ Standard Class II Permit Application (*dated September 7, 2022*).[1] In **Section 3.0**, the application provides a description of all process and control equipment for which permits are required. In **Section 4.0**, the application makes a determination regarding minor New Source Review (NSR) applicability. In **Section 5.0**, the application includes a listing of all insignificant activities at the Facility.

[1] No alternate operating scenarios or exemptions are proposed. Thus, the application does not address Items C and F, respectively.

2 Process Descriptions

2.1 Bulk Products

The following products are stored in bulk for use as purging and product blending balance gases: argon, liquid helium, hydrogen, and nitrogen.

Argon (CAS 7440-37-1) is delivered in liquid form in insulated tank trailers and is stored in a cryogenic storage tank. A typical tank filling requires connecting and disconnecting transfer hoses along with transfer hose purging. Each delivery vents approximately 400 cubic feet of argon gas to the atmosphere. The liquid argon is then pumped out of the tank, vaporized, and used or stored in high pressure, seamless American Society of Mechanical Engineers (ASME) coded receivers. These receivers allow gaseous argon to be available for process filling. Since liquid argon is stored at -302 degrees Fahrenheit (°F), a certain rate of vaporization occurs inside the tanks. This vaporized gas periodically vents automatically to the atmosphere to prevent an excessive pressure buildup.

Liquid helium (CAS 7440-59-7) arrives on site in an insulated trailer. Liquid helium is pumped directly from the trailer, is vaporized, and is used or stored in high-pressure seamless ASME-coded receivers. These receivers allow for gaseous helium to be available for process filling. Since liquid helium is stored at -452 °F, a certain rate of vaporization occurs inside the trailer. This vaporized gas periodically vents automatically to the atmosphere to prevent excessive pressure buildup.

Hydrogen (CAS 1333-74-0) is delivered in liquid form in insulated tank trailers and is stored in a cryogenic storage tank. A typical tank filling requires connecting and disconnecting transfer hoses along with transfer hose purging. Each delivery will vent approximately 400 cubic feet of hydrogen gas to the atmosphere. The liquid hydrogen is then pumped out of the tank, vaporized, and used or stored in high pressure, seamless ASME-coded receivers. These receivers allow gaseous hydrogen to be available for process filling. Since liquid hydrogen is stored at -423 °F, a certain rate of vaporization occurs inside the tanks. This vaporized gas periodically vents automatically to the atmosphere to prevent an excessive pressure buildup.

Nitrogen (CAS 7727-37-9) is delivered in liquid form in insulated tank trailers and is stored in two cryogenic storage tanks. A typical tank filling requires connecting and disconnecting transfer hoses along with transfer hose purging. Each delivery will vent approximately 400 cubic feet of nitrogen gas to the atmosphere. The liquid nitrogen is then pumped out of the tank, vaporized, and used or stored in high pressure, seamless ASME-coded pressure vessels called receivers. These receivers allow gaseous nitrogen to be available for process filling. Since liquid nitrogen is stored at -320 °F, a certain rate of vaporization occurs inside the tanks. This vaporized gas periodically vents automatically to the atmosphere to prevent an excessive pressure buildup.

2.2 Hydride production

2.2.1 Arsine Synthesis

2.2.1.1 Arsine Production

Process Description: Arsine is synthesized by the reaction of mixing zinc arsenide with sulfuric acid to produce zinc sulfate and pure arsine gas. The synthesis reaction takes place in bench-scale laboratory equipment that includes a glass reactor vessel, a water cooled condenser, two drying columns, and one liquid nitrogen cooled stainless steel collection vessel. This equipment can produce approximately 12.5 pounds of arsine gas per batch. Two systems can be operated at the same time. Arsine is collected into a source cylinder and transfilled into small cylinders of 0.5 pounds, 3 pounds, and 7 pounds for use in the semiconductor industry.

A recovery system is operational to further reduce emissions by collecting arsine product that was previously sent to abatement. This recovery system uses liquid nitrogen to condense arsine vapor back into the original source cylinders for re-use.

The synthesis reaction takes place in small 100 square-foot isolated rooms using a process that is entirely remote controlled. The synthesis rooms have special ventilation systems that exhaust the full air contents of the rooms to a process scrubber. The Ventilation Emergency Scrubber #1 (VES-1) captures any escaping gas from these rooms.

Waste process gases are sent to two Guardian (hydrogen-fueled) combustion units where the arsine is converted into arsenic trioxide. The Guardian combustion units are programmed to stop the flow of arsine process gases if an over-temperature condition occurs in the combustion chamber. The arsenic trioxide is captured in baghouses and is periodically collected in Department of Transportation (DOT) specification drums for disposal as hazardous waste. The exhaust from the baghouses discharges into the VES-1.

The raw materials, zinc arsenide and sulfuric acid, are purchased from commercial chemical companies and are shipped to the Kingman site in portable DOT specification containers by common carrier. The resulting co-product, zinc sulfate is disposed of as hazardous waste.

Product Description: Arsine (CAS 7784-42-1) is a colorless, toxic, flammable gas with a garlic-like odor. Inhalation can cause red blood cell, lung, liver kidney, nervous system and heart damage. It is a cancer suspect agent and may be fatal if inhaled. Symptoms of exposure may be delayed. It may form explosive mixtures with air.

Arsenic trioxide, which forms when arsine burns in air, is a poisonous, odorless, nonflammable solid. It contains inorganic arsenic and is a cancer hazard. It is harmful or fatal if inhaled or swallowed. It is harmful if absorbed through the skin. It irritates the eyes, skin, and respiratory tract. Contact may cause an allergic skin reaction. Contact may cause liver, kidney, blood cell, and nervous system damage.

Process Rates: Each production room can produce six batches per day if operated 24 hours per day. During each batch, approximately one pound of arsine is sent to the Guardian combustion units or the VES; each production room can potentially send up to six pounds of arsine per day to the Guardian combustion units or VES-1. While it is not known with certainty the fractions sent to each disposal system, a majority is conveyed to the Guardian so it has been assumed that 95 percent (0.95 pounds per batch [lb/batch]) goes to the Guardian and 5 percent (0.05 lb/batch) goes to VES-1.

- Maximum hourly process rate:
  - 1 lb/batch/room / 4 hr/batch = 0.25 lb/hr/room
  - 0.25 lb/hr/room x 2 production rooms = <u>0.5 lb/hr arsine</u>
- Maximum annual process rate:
  - 6 lb/day x 365 days/yr = 2,190 lb/yr per production room
  - 2 production rooms x 2,190 lb/yr = <u>4,380 lb/yr arsine</u>

2.2.1.2 Arsine Return Cylinder Processing

<u>Process Description</u>: Cylinders returned by customers usually have a small amount of unused product in them. The amount of arsine gas returned varies from cylinder to cylinder. Some returned product consists of part per million mixtures of arsine in a balance gas, usually hydrogen, helium, nitrogen or argon, while other returned product is pure arsine. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. If the returned product is of adequate purity and volume, it is first recovered into source cylinders. Then the residual is sent to a Guardian combustion unit, and then the product is purged using hydrogen and evacuated from the cylinders.

<u>Process Rates</u>:

Pure Arsine

An estimate of the number of returned cylinders processed based on past history and anticipated future growth is 600 cylinders per year of pure arsine in the smaller cylinder packages averaging 100 grams per cylinder (i.e., 0.22 pounds per cylinder). There are two process racks; each with eight stations.

- Maximum hourly process rate:
  - 6 lb/hr/system (pure arsine) x 2 systems = <u>12.0 lb/hr arsine</u>
- Maximum annual process rate:
  - 600 cylinders x 0.22 lb/cylinder = <u>132 lbs/yr arsine</u>

Arsine Mixtures

An estimate of the amount of arsine in returned arsine mixture cylinders processed based on past history and anticipated future growth is less than one pound of arsine per year (for the purpose of calculations, 10 pounds will be used). Arsine mixtures are processed on the same process racks as described above.

- Maximum hourly process rate: 3 lb/hr arsine (arsine mixtures)

- *This rate is not additive to the total process rate since the worst-case scenario is both processing racks operating and processing pure return cylinders.*

- Maximum annual process rate: 10 lb/yr arsine

2.2.1.3 Whole Plant Arsine Process Rates and Emissions

Process Rates:

- Maximum Hourly Process Rate (All Processes)
  - 0.5 lb/hr + 12.0 lb/hr = 12.5 lb/hr arsine
- Maximum Annual Process Rate (Whole Plant)
  - 4,380 lb/yr + 132 lb/yr + 10 lb/yr = 4,522 lb/yr arsine

Emission Estimates:

- Total Estimated Annual Arsine Emissions with Controls
  - 4,380 lb x 0.05 = 219 lb/yr to VES-1
  - 219 lb/yr x (1-0.995) = 1.095 lb/yr from VES-1
  - 4,522 lb/yr - 219 lb/yr to VES-1 = 4,303 lb/yr to the Guardians
  - 4,303 lb/yr x (1- 0.99) = 43.03 lb/yr from Guardian unit (conservative)
  - 43.03 lb/yr x (1- 0.995) = 0.215 lb/yr from VES-1 through the Guardian unit
  - Total = 1.095 lb/yr + 0.215 lb/yr = 1.31 lb/yr
  - 1.31 lb/yr x 1 ton/2000 lb = 0.000655 tons/yr with controls
- Total Estimated Hourly Arsine Emissions with Controls
  - 0.5 batches/hr x 0.95 lb/batch x (1 – 0.99995) = 0.00002375 lb/hr with controls
  - 0.5 batches/hr x 0.05 lb/batch x (1 – 0.995) = 0.000125 lb/hr with controls
  - 12 lb/hr x (1 – 0.99995) = 0.0006 lb/hr with controls
  - Total = 0.0000237 lb/hr + 0.000125 lb/hr + 0.0006 lb/hr = 0.000746 lb/hr with controls

2.2.2 Diborane Fill, Process, and Flow Test

Process Description: Cylinders returned by customers usually have a small amount of unused product in them. The amount of diborane gas (B_2H_6) returned varies from cylinder to cylinder. Some returned product consists of part per million mixtures of diborane in a balance gas, usually hydrogen, helium, nitrogen, or argon. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal for concentrations of diborane balance hydrogen (B_2H_6/H_2), the existing system sends B_2H_6 to the Silane Guardian and VES-1.

Linde prepares two types of B_2H_6 mixtures. One set of cylinders contains B_2H_6 and either boron trifluoride (BF_3) or enriched boron trifluoride ($B^{11}F_3$). Linde estimates that approximately 500 cylinders are produced per year with less than 0.25 pounds of mixture in each cylinder. Flow testing is performed at the rate of 500 grams of B_2H_6 per six cylinders tested. The second set of cylinders contains inert diborane mixtures (e.g., B_2H_6/N_2, B_2H_6/H_2, B_2H_6/Ar, B_2H_6/He). The process rates for these cylinders assume eight cylinders processed per day with a maximum of one cylinder processed per hour.

An estimate of the amount of B_2H_6 in returned cylinders processed based on past history and anticipated future growth is 100 pounds per year. Two eight-station racks are used to process returned cylinders.

Linde sends vented inert diborane mixtures to a process caustic wet scrubber (Ventilation Emergency Scrubber #3 [VES-3]) designed by Advanced Air Technology, Inc. (AAT, Inc.). In addition, Linde sends product vented from the filling, processing, and flow testing of cylinders with B_2H_6/BF_3 to VES-3. VES-3 exhaust discharges to the atmosphere.

Though the vented product is emitted through either VES-1 or VES-3, for emission estimates we conservatively assume all emissions pass through VES-3, which has lower total control efficiency for B_2H_6.

<u>Process Rates and Emissions:</u> Using the above information, the following process rates and emissions are calculated.

- Maximum Hourly Process Rate
  - Inert B_2H_6 Mixture Cylinder Processing (assumes 5% B_2H_6):

$$1.54\ \frac{ft^3}{cylinder}\ x\ 28.317\frac{L}{ft^3}\ x\ 1.216\frac{g\ B_2H_6}{L}\ x\ 0.0022\frac{lb}{g}\ x\ 1\frac{cylinder}{hr}\ \mathrm{x}\ 0.05 = 5.845\mathrm{x}10^{-3}\frac{lb}{hr}$$

  - B_2H_6 Cylinder Processing:

$$100\ \frac{g}{cylinder}\ x\ 0.0022\frac{lb}{g}\ x\ 2\frac{cylinders}{hr} = \ 0.44\frac{\mathrm{lb}}{\mathrm{hr}}$$

  - B_2H_6 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 6\frac{cylinders}{hr} = \ 1.1\frac{\mathrm{lb}}{\mathrm{hr}}$$

  - All Processes:

$$5.845\mathrm{x}10^{-3}\frac{lb}{hr} + 0.44\frac{lb}{hr} + 1.1\ \frac{lb}{hr} = \ 1.55\frac{lb}{hr}$$

- Maximum Annual Process Rate
  - Inert B_2H_6 Mixture Cylinder Processing (assumes 5% B_2H_6):

$$1.54\ \frac{ft^3}{cylinder}\ x\ 28.317\frac{L}{ft^3}\ x\ 1.216\frac{g\ B_2H_6}{L}\ x\ 0.0022\frac{lb}{g}\ x\ 8\frac{cylinders}{day}\ x\ 260\frac{days}{year}\ \text{x}\ 0.05 = 12.1\frac{lb}{year}$$

– B_2H_6 Cylinder Processing:

$$100\ \frac{g}{cylinder}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = \ 110\frac{\text{lb}}{\text{year}}$$

– B_2H_6 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = \ 91.7\frac{\text{lb}}{\text{year}}$$

– All Processes:

$$12.1\frac{lb}{year} + 110\frac{lb}{year} + 91.7\ \frac{lb}{year} = \ 214\frac{lb}{year}$$

- Total Estimated Maximum Hourly Diborane Emissions with Controls

– All Processes:

$$1.55\frac{lb}{hr}x\ (1 - 0.99) = 1.55x10^{-2}\frac{lb}{hr}$$

- Total Estimated Annual Diborane Emissions with Controls

– All Processes:

$$214\frac{lb}{year}\ x\ 0.0005\frac{ton}{lb}\ x\ (1 - 0.99) = 1.07x10^{-3}\frac{ton}{year}$$

2.2.3 Disilane Fill, Process, and Flow Test

Process Description: Disilane (Si_2H_6) arrives on site in cylinders and is transfilled into smaller cylinders for sale to customers. Prior to transfilling into these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish this removal, the returned product is first vented to VES-1. Any residual product is purged from the cylinders using nitrogen, after which the cylinders are refilled. Filled cylinders are then connected to a flow test manifold for testing.

Linde prepares mixtures of cylinders containing Si_2H_6 and silicon tetrafluoride (SiF_4). Linde estimates that approximately 500 cylinders are produced per year with approximately 200 grams of total mixture in each cylinder. An estimate of the amount of Si_2H_6 in returned cylinders processed based on past history and anticipated future growth is approximately 500 cylinders with residual product of 10 percent.

Si_2H_6 cylinders are processed on a single cylinder station rack in the SiF_4 fill room. A maximum of two cylinders can be processed per hour. Maximum capacity for the largest package is 100 grams; therefore, the maximum hourly process is 200 grams in one hour.

Linde sends vented product to the VES-3 where the Si_2H_6 reacts with water and sodium hydroxide (NaOH) to form hydrogen gas, sodium fluoride, and sodium silicate. The resulting "spent" scrubber solution is properly disposed of offsite as an industrial waste. VES-3 exhaust discharges to the atmosphere.

Though the mixture can be emitted through either the VES-1 or VES-3, for emission estimates we conservatively assume all emissions pass through VES-3, which has lower total control efficiency for Si_2H_6.

<u>Process Rates:</u> Using the above information, the following process rates and emissions are calculated.

- Maximum Hourly Process Rate
  - Si_2H_6 Cylinder Processing:

$$100\ \frac{g}{cylinder}\ x\ 0.0022\frac{lb}{g}\ x\ 2\frac{cylinders}{hr} = 0.44\frac{\mathrm{lb}}{\mathrm{hr}}$$

  - Si_2H_6 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 6\frac{cylinders}{hr} = 1.1\frac{\mathrm{lb}}{\mathrm{hr}}$$

  - All Processes:

$$0.44\frac{lb}{hr} + 1.1\ \frac{lb}{hr} = 1.54\frac{lb}{hr}$$

- Maximum Annual Process Rate
  - Si_2H_6 Cylinder Processing:

$$100\ \frac{g}{cylinder}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = 110\frac{\mathrm{lb}}{\mathrm{year}}$$

  - Si_2H_6 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = 91.7\frac{\mathrm{lb}}{\mathrm{year}}$$

  - All Processes:

$$110\frac{lb}{year} + 91.7\ \frac{lb}{year} = 202\frac{lb}{year}$$

- Total Estimated Maximum Hourly Disilane Emissions with Controls
  - All Processes:

$$1.54\frac{lb}{hr} x\ (1-0.999) = 1.54x10^{-3}\frac{lb}{hr}$$

- Total Estimated Annual Disilane Emissions with Controls
  - All Processes:

$$202\frac{lb}{year}\ x\ 0.0005\frac{ton}{lb}\ x\ (1-0.999) = 1.01x10^{-4}\frac{ton}{year}$$

2.2.4 Diethyltelluride Filling & Processing

Process Description: Diethyltelluride is received on site as a liquid in one pound containers. It is mixed with hydrogen with the diethyltelluride concentration between 50 and 200 parts per million. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, it is first sent to a Guardian combustion unit, and then any residual product is purged using hydrogen and evacuated from the cylinders. The exhaust from the Guardian combustion unit discharges into a baghouse where the tellurium oxides are collected. The exhaust from the baghouse discharges into VES-1.

The diethyltelluride source cylinder contains approximately 25 grams of product in it when it is "empty". These source cylinders have typically been processed (completely emptied as described above) prior to their return to Linde. Based on past history and estimate of future production, the maximum number of diethyltelluride source cylinders processed in a year is three.

Product Description: Diethyltelluride (CAS 627-54-3) is a toxic, flammable liquid with a garlic-like odor. It may form explosive mixtures with air; it may be harmful or fatal if inhaled. Diethyltelluride can cause skin irritation. It may cause dizziness and drowsiness. It may cause liver, kidney, heart, red blood cell, and blood vessel damage. Symptoms of exposure may be delayed.

Process Rates: Using the above information, the following process rates and emissions are calculated.

- Maximum Annual Diethyltelluride Emission Rate
  - 2 lb/yr processed (conservative estimate)
  - 2 lb/yr x (1-0.99995) x (1 ton/2,000 lb) = 5.0 x 10^{-8} ton/yr

2.2.5 Phosphine Synthesis

2.2.5.1 Phosphine Production

Process Description: Phosphine is synthesized through the pyrolytic reaction of phosphorous acid to produce phosphoric acid and pure phosphine gas.

The synthesis reaction takes place in bench scale laboratory equipment consisting of a glass reactor vessel, a water-cooled condenser, a drying column, and two liquid nitrogen cooled collection vessels. This equipment can produce approximately 22 pounds of phosphine gas per batch. There are two systems.

Synthesized phosphine requires additional purification to meet customer specifications. There are two systems used for phosphine purification.

The synthesis reaction takes place in small 100 square foot isolated rooms using a process that is entirely remote-controlled. The synthesis rooms have special ventilation systems that exhaust the full air contents of the rooms to a process scrubber. VES-1 captures any escaping gas from these rooms.

Phosphine production may be supplemented by purchasing phosphine from a supplier and purifying it in one of the two purification systems.

Waste process gases are sent to a Guardian combustion unit where the phosphine is converted into phosphorous pentoxide. The Guardian combustion unit is programmed to stop the flow of phosphine process gases if an over-temperature condition occurs in the combustion chamber. The phosphorous pentoxide is captured in a Dynawave Wet Scrubber where it is converted into phosphoric acid. The phosphoric acid is disposed of as hazardous waste. The exhaust from the Dynawave Wet Scrubber discharges into VES-1.

The raw material, crystalline phosphorous acid, is purchased from commercial chemical companies and is shipped to the Kingman facility in portable DOT specification containers by common carrier. The resulting co-product, phosphoric acid is disposed of as hazardous waste.

Product Description: Phosphine (CAS 7803-51-2) is a toxic, flammable high-pressure gas with an odor of decaying fish. It causes irritation of the respiratory tract and may be fatal if inhaled. Inhalation may cause lung, liver, kidney, heart, and central nervous system damage. Symptoms of exposure may be delayed. Phosphine can ignite on contact with air and may form explosive mixtures with air.

Process Rates: Each production room can produce two batches per day. During each batch, approximately three pounds of phosphine is sent to the Guardian combustion unit; each production room can potentially send up to six pounds of phosphine per day to the Guardian combustion unit.

- 6 lb/day x 365 days/yr = 2,190 lbs/yr per production room
- 2 production rooms x 2,190 lb/yr = 4,380 lb/yr phosphine

One purification system has product losses and the other doesn't (it has a cryogenic vessel in which residual product is collected). The system with losses can produce two purified cylinders per day. For every purified cylinder, approximately 0.5 pounds of product is vented to the Guardian combustion unit.

- 0.5 lb/cylinder x 2 cylinders/day x 365 days/yr = 365 lb/yr phosphine

2.2.5.2 Phosphine (Pure) Return Cylinder Processing

Process Description: Pure phosphine is filled into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. If the returned product is of adequate purity and volume, it is first recovered into source cylinders. Then the residual is sent to a Guardian combustion unit, and then any residual product is purged using hydrogen and evacuated from the cylinders.

Process Rates: An estimate of the number of returned cylinders processed based on past history and anticipated future growth is 900 cylinders per year of pure phosphine. Approximately three pounds of product is returned per cylinder that must be removed before refilling. There is one nine-station (i.e., nine cylinders can be processed at a time) process rack for pure phosphine in the Synthesis Area.

- Maximum Annual Process Rate: 900 cylinders/yr x 3 lb/cylinder = 2,700 lb/yr phosphine

2.2.5.3 Phosphine (Mixture) Return Cylinder Processing - North Fill

Process Description: Cylinders returned by customers usually have a small amount of unused product in them. The amount of phosphine gas returned varies from cylinder to cylinder. Some returned product consists of part per million mixtures of phosphine in a balance gas, usually hydrogen, helium, nitrogen or argon. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, it is first sent to a Guardian combustion unit. Then the product is purged from the cylinders using the balance gas of the original mixture and evacuated from the cylinders.

Process Rates: An estimate of the amount of phosphine in returned phosphine mixture cylinders processed based on past history and anticipated future growth is approximately 300 pounds of phosphine per year. Phosphine mixtures are processed on an eight-station rack in the North Fill Room.

- Maximum Annual Process Rate: 300 lb/yr phosphine

2.2.5.4 Whole Plant Phosphine Process Rates and Emissions

Process Rates:

- Maximum Hourly Process Rate (All Processes)
  - Limited by Guardian and Dynawave to 12 lb/hr
- Maximum Annual Process Rate (Whole Plant)
  - 4,380 lb + 365 lb + 2,700 lb + 300 lb = 7,745 lb/yr

Emission Estimates:

- Total Estimated Annual Phosphine Emissions with Controls
  - 7,745 lb/yr x (1- 0.99) = 77.45 lb/yr from Guardian unit (conservative)
  - 77.45 lb/yr x (1- 0.995) = 0.387 lb/yr with controls
  - 0.387 lb/yr x 1 ton/2000 lb = 0.000194 tons/yr with controls (or $1.94e^{-4}$ tons/yr)
- Total Estimated Hourly Phosphine Emissions with Controls
  - 12 lb/hr x (1 - 0.9995) = 0.0006 lbs/hr with controls

2.2.6 Silane Filling & Processing

Process Description: Silane is shipped to the Kingman site in high pressure bulk tube trailers and is filled into compressed gas cylinders as either a pure gas or as a component in a mixture. The balance gas for the mixtures can be argon, helium, hydrogen or nitrogen. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, it is first sent to a Guardian combustion unit, and then the product is purged using nitrogen and helium and evacuated from the cylinders.

Linde prepares mixtures of cylinders containing Si_2H_6 and SiF_4. Linde estimates that approximately 200 cylinders are produced per year with less than 3 pounds of mixture in each cylinder. All mixtures are prepared using the equipment and control devices currently approved for handling and controlling emissions of Si_2H_6 and SiF_4.

Product Description: Silane (CAS 7803-62-5) is a pyrophoric, flammable, high-pressure gas with a choking odor. It can ignite on contact with air and may form explosive mixtures with air. Silane may be harmful if inhaled and may cause respiratory system damage. The silicon dioxide formed when silane burns in air is a white or tan colored powder that is insoluble in water. Acute exposure may cause minor eye and upper respiratory tract irritation. The silica is inert and very light with a density range down to one pound per cubic foot.

2.2.6.1 Silane (Pure) Return Cylinder Processing

Process Rates: An estimate of the number of returned cylinders processed based on past history and anticipated future growth is 6,250 cylinders per year of pure silane. Approximately three pounds of product is returned per cylinder that must be removed before refilling. Although there are two eight-station racks in the South Fill Room to process both pure and mixture return cylinders, only one rack can be used at a time due to limitations in the Guardian system.

- Maximum Hourly Process Rate: 21.7 lb/hr (pure silane)
- Maximum Annual Process Rate: 6,250 cylinders/yr x 3 lb silane/cylinder = 18,750 lb/yr silane

2.2.6.2 Silane (Mixture) Return Cylinder Processing

Process Rates: An estimate of the amount of silane in returned silane mixture cylinders processed based on past history and anticipated future growth is approximately 300 pounds of silane per year. Silane mixtures are processed on the same racks as pure cylinders in the south fill room.

- Maximum Hourly Process Rate: Limited by the Guardian combustion unit as described above. A rack of returned mixture cylinders will contain much less silane than pure returned cylinders so the worst case maximum hourly rate is 21.7 lb/hr (pure silane).
- Maximum Annual Process Rate: 300 lb silane

2.2.6.3 Whole Plant Silane Process Rates and Emissions

Process Rates:

- Maximum Hourly Process Rate (All Processes)
  - 21.7 lb/hr silane
- Maximum Annual Process Rate (Whole Plant)
  - 18,750 lb + 300 lb = 19,050 lb/yr

Emission Estimates:

- Total Estimated Hourly Silane Emissions with Controls
  - 21.7 lb/hr x (1- 0.99) = 0.217 lb/hr from Guardian unit (conservative)
  - 0.217 lb/hr x (1-0.995) = 0.001085 lb/hr silane to atmosphere
- Total Estimated Annual Silane Emissions with Controls
  - 19,050 lb x (1-0.99) = 190.5 lb from Guardian unit (conservative)
  - 190.5 lb x (1-0.995) = 0.95 lb silane to atmosphere/yr
  - 0.95 lb/yr x 1 ton/2000 lb = 0.000475 tons/yr silane to atmosphere (or $4.75e^{-4}$ tons/yr)

2.3 Chlorosilane processing

2.3.1 Dichlorosilane Filling & Processing

Process Description: Dichlorosilane is repackaged at the Kingman facility. It is received in bulk "ton" containers and is transferred by weight into compressed gas cylinders for sale to customers. Some product is vented from cylinders to the caustic wet scrubbers during the purification process. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. Product in cylinders returned from customers is mostly recovered into half-ton containers and transported offsite for disposal or sold as a lower grade product. Some returned product is sent to the caustic wet scrubbers where the dichlorosilane reacts with the water and sodium hydroxide to form sodium silicate, sodium chloride, and hydrogen. The resulting "spent" scrubber solution is properly disposed of off-site as an industrial waste. The exhaust from the caustic wet scrubbers discharges into VES-3.

Product Description: Dichlorosilane (CAS 4109-96-0) is a toxic, flammable, corrosive liquid and gas with an irritating, choking odor. It may be harmful or fatal if inhaled, can cause eye, skin and respiratory tract burns, and can form explosive mixtures with air. It may ignite on contact with air or water.

Process Rates:

- Maximum Hourly Process Rate
  - 5.0 lb/hr
- Maximum Annual Process Rate
  - 15,000 lb/yr

Emission Estimates:

- Total Estimated Hourly Dichlorosilane Emissions with Controls
  - 5.0 lb/hr x (1-0.99) = 0.05 lb/hr
- Total Estimated Annual Dichlorosilane Emissions with Controls
  - 15,000 lb/yr x (1-0.99) = 150 lb/yr x (1 ton/2,000 lb) = 0.075 ton/yr

2.3.2 Trichlorosilane Filling and Processing

Process Description: Trichlorosilane arrives on site via tank truck and is transferred into a stationary bulk tank. Compressed gas cylinders are filled by weight from the bulk tank for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. Product in cylinders returned from customers is sent to a bulk recovery tank until a full tank-truck load can be sent to a vendor who purchases the returned product. The remaining vapor in the returned cylinders is sent to two caustic wet scrubbers (A & D) where the trichlorosilane reacts with the water and sodium hydroxide to form sodium silicate, sodium chloride and hydrogen. The resulting "spent" scrubber solution is properly disposed of off-site as an industrial waste. The exhaust from the caustic wet scrubbers discharges into VES-3.

Product Description: Trichlorosilane (CAS 10025-78-2) is a flammable, corrosive liquid with an irritating, choking odor. It may be harmful or fatal if inhaled and may cause eye and skin burns. Inhalation causes severe irritation of the respiratory tract. It may ignite on contact with air or water.

2.4 Methyl Bromide Filling and Processing

2.4.1 Methyl Bromide Mixtures Filling and Processing

Process Description: Methyl bromide is added as a component in customer-specified mixtures of gases. Other gases that may be included in these mixtures include: dichloromethane, methyl iodide, dibromomethane, hydrogen bromide, neon, krypton, xenon, silane, phosphine, nitrogen, argon, oxygen, and hydrogen. Methyl bromide-containing mixtures are created by adding methyl bromide to cylinders using a liquid injection method and adding other gases to the cylinder. After the integration is complete, the cylinders are rolled to mix the product and each cylinder will be analyzed.

During the filling and processing steps, the cylinders vent to VES-1, except for the filling and processing of mixtures containing Phosphine or Silane. These mixtures are vented to the Phosphine Guardian and Silane Guardian, respectively.

Product Description: Methyl bromide (CAS 74-83-9) is a toxic, flammable liquid and gas when under pressure. It may be fatal if inhaled and harmful if absorbed through the skin. It causes eye and skin burns and may cause lung, liver, kidney, and central nervous system damage.

Process Rates and Emission Estimates: Considering anticipated future growth, Linde estimates that production of methyl bromide-containing mixtures could reach 500 cylinders per year, with each cylinder containing a maximum of 75 grams (~0.1653 lb) of methyl bromide. Additionally, Linde has specified that a maximum of eight cylinders of methyl bromide-containing mixtures could be processed per hour. Using the above figures, the following process rates are calculated.

- Maximum Hourly Process Rate
  - 0.1653 lb/cylinder x 8 cylinder/hr = 1.32 lb/hr
- Maximum Annual Process Rate
  - 0.1653 lb/cylinder x 500 cylinder/yr = 82.7 lb/yr

Linde has estimated that the worst case amount of methyl bromide to be vented, assuming mix failures and large return residuals, is 20 percent. Using this figure, and conservatively assuming that mixtures of methyl bromide are not routed to the Phosphine or Silane guardians prior to emission to the VES-1, the following emission rates are calculated.

- Total Estimated Maximum Hourly Methyl Bromide Emissions with Controls
  - 1.32 lb/hr x 0.2 = 0.264 lb/hr to VES-1
  - 0.264 lb/hr x (1-0.995) = 1.3E-3 lb/hr with controls
- Total Estimated Annual Methyl Bromide Emissions with Controls
  - 82.7 lb/yr x 0.2 = 16.5 lb/yr to VES-1
  - 16.5 lb/yr x (1-0.995) = 0.0825 lb/yr from VES-1
  - 0.0825 lb/yr x (1 ton/2000 lb) = 4.1E-5 ton/yr with controls

2.4.2 Methyl Bromide Mixtures Return Cylinders Processing

Process Description: Cylinders returned by customers typically have a small amount of unused product in them. The amount of methyl bromide gas returned varies from cylinder to cylinder. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. Mixtures containing methyl bromide are purged using hydrogen, evacuated from the cylinders, and vented to VES-1, except for residuals containing Phosphine or Silane. These residuals are vented to the Phosphine Guardian and Silane Guardian, respectively.

Process Rates: An estimate of the amount of methyl bromide in returned cylinders based on anticipated future growth is approximately 500 cylinders with residual product of 10%.

Additionally, Linde has specified that a maximum of eight cylinders of methyl bromide-containing mixtures could be processed per hour. Using the above figures, the following process rates are calculated.

- Maximum Hourly Process Rate
  - 0.1653 lb/cylinder x 0.1 x 8 cylinder/hr = 0.132 lb/hr
- Maximum Annual Process Rate
  - 0.1653 lb/cylinder x 0.1 x 500 cylinder/yr = 8.27 lb/yr

When these values are combined with the estimates from filling and processing, the following whole plant process rates are calculated.

- Maximum Hourly Process Rate (All Processes)
  - 1.32 lb/hr + 0.132 lb/hr = 1.45 lb/hr
- Maximum Annual Process Rate (Whole Plant)
  - 82.7 lb/yr + 8.27 lb/yr = 91.0 lb/yr

Emissions from return cylinder processing are included in the assumptions used in the emissions calculated under **Section 2.4.1**.

2.5 Dichloromethane Filling and Processing

2.5.1 Dichloromethane Mixtures Filling and Processing

Process Description: Dichloromethane is a component in certain customer-specified mixtures of gases. Other gases that may be included in these mixtures include: methyl bromide, methyl iodide, dibromomethane, hydrogen bromide, neon, krypton, xenon, silane, phosphine, nitrogen, argon, oxygen, and hydrogen. Dichloromethane-containing mixtures are created by adding dichloromethane to cylinders using a liquid injection method and adding other gases to the cylinder. After the integration is complete, the cylinders are rolled to mix the product and each cylinder is analyzed.

During the filling and processing steps, the cylinders vent to VES-1, except for the filling and processing of mixtures containing phosphine or silane. These mixtures are vented to the Phosphine Guardian and Silane Guardian, respectively.

Product Description: Dichloromethane (CAS 75-09-2) is a volatile, colorless liquid with a chloroform-like odor. Inhalation of high concentrations may cause mental confusion, light-headedness, nausea, vomiting, headache, and irritation of the upper respiratory tract and eyes. Exposure to methylene chloride may make symptoms of angina more severe. Skin exposure to liquid methylene chloride may cause irritation or chemical burns.

Process Rates and Emission Estimates: Considering anticipated future growth, Linde estimates that production of dichloromethane containing mixtures could reach 500 cylinders per year, with each cylinder containing a maximum of 30 grams (~0.06614 lbs) of dichloromethane. Additionally, Linde has specified that a maximum of eight cylinders of dichloromethane-containing mixtures could be processed per hour. Using the above figures, the following process rates are calculated.

- Maximum Hourly Process Rate
  - 0.06614 lb/cylinder x 8 cylinder/hr = 0.529 lb/hr
- Maximum Annual Process Rate
  - 0.06614 lb/cylinder x 500 cylinder/yr = 33.1 lb/yr

Linde has estimated that the worst case amount of dichloromethane to be vented, assuming mix failures and large return residuals, would be 20 percent. Using this figure, and conservatively assuming that mixtures of dichloromethane are not routed to the Phosphine or Silane guardians prior to emission to VES-1, the following emission rates are calculated.

- Total Estimated Maximum Hourly Dichloromethane Emissions with Controls
  - 0.529 lb/hr x 0.2 = 0.106 lb/hr to VES-1
  - 0.106 lb/hr x (1-0.995) = 5.3E-4 lb/hr with controls
- Total Estimated Annual Dichloromethane Emissions with Controls
  - 33.1 lb/yr x 0.2 = 6.62 lb/yr to VES-1
  - 6.62 lb/yr x (1-0.995) = 0.0331 lb/yr from VES-1
  - 0.0331 lb/yr x (1 ton/2000 lb) = 1.7E-5 ton/yr with controls

2.5.2 Dichloromethane Mixtures Return Cylinder Processing

<u>Process Description:</u> Cylinders returned by customers typically have a small amount of unused product in them. The amount of dichloromethane gas returned varies from cylinder to cylinder. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. Mixtures containing dichloromethane are purged using hydrogen, evacuated from the cylinders, and vented to VES-1, except for residuals containing phosphine or silane. These residuals are vented to the Phosphine Guardian and Silane Guardian, respectively.

<u>Process Rates:</u> An estimate of the amount of dichloromethane in returned cylinders based on anticipated future growth is approximately 500 cylinders with residual product of 10 percent. Additionally, Linde has specified that a maximum of eight cylinders of dichloromethane-containing mixtures could be processed per hour. Using the above figures, the following process rates are calculated.

- Maximum Hourly Process Rate
  - 0.06614 lb/cylinder x 0.1 x 8 cylinder/hr = 0.0529 lb/hr
- Maximum Annual Process Rate
  - 0.06614 lb/cylinder x 0.1 x 500 cylinder/yr = 3.31 lb/yr

When these values are combined with the estimates from filling and processing, the following whole plant process rates are calculated:

- Maximum Hourly Process Rate (All Processes)
  - 0.529 lb/hr + 0.0529 lb/hr = 0.582 lb/hr

- Maximum Annual Process Rate (Whole Plant)
  - 33.1 lb/yr + 3.31 lb/yr = 36.4 lb/yr

Emissions from return cylinder processing are included in the assumptions used in the emissions calculated under **Section 2.5.1**.

2.6 Ammonia Processing

2.6.1 Ammonia Filling & Processing

Process Description: Anhydrous ammonia arrives on site in tank trucks and is transferred into a bulk 2,000 gallon stationary tank. The filling process consists of transferring liquid ammonia to an intermediate storage tank to 50 pound cylinders and 510 pound "ton" containers. Liquid is transferred by pump and purification of the liquid is performed in intermediate steps. An additional 10,000 gallon raw material tank is filled by tank trucks, where product is purified and pumped to fill a 1,000 gallon pure tank. This product is used for fill and passivation of 22,600 pound ISO trailers. A crossover is installed to feed product between tank systems.

During these processes, not all of the ammonia is transferred into the product cylinders, tanks, or ISO trailers. Some of it is vented from the filling manifolds and storage tanks (normal process). Additionally, customers typically return ammonia cylinders, ton containers, and ISO trailers with some residual product in them. Prior to refilling these containers, the returned product must be completely removed to ensure the very high purity of the product that the semiconductor manufacturer requires.

Ammonia liquid and vapor that is vented from any of the process systems is sent to an aqueous ammonia absorber tank where the ammonia is sparged into water and readily absorbed to form an aqueous ammonia solution. The resulting ammonium hydroxide co-product solution is approximately 18 to 30 percent ammonia by weight, and is sold to a third party. The ammonia absorption system consists of a 10,000 gallon stainless steel pressure vessel, a reverse osmosis (RO) water system, and a vapor collection duct. A 5,000 gallon plastic water supply tank contains RO water and a transfer pump. All vent lines from the process are routed into the 10,000 gallon absorber tank. The 5,000 gallon tank serves as a makeup tank. It stores RO water that is used to refill the 10,000 gallon tank immediately after a batch of aqueous ammonia is picked up by the third party. The ammonia absorption system also includes a cooling tower to control the temperature of the aqueous ammonia solution and a packed tower, water-based scrubber located on the absorption tank outlet/vent. This scrubber removes any ammonia vapors that escape the absorption tank when the outlet valve is open. This scrubber is also used to capture ammonia from pressure sensitive vents from lab instruments and vacuum pumps. These vents typically contain small volumes in reduced concentrations.

An additional 7,000 gallon aqueous ammonia storage tank allows product off-load of co-product for pick-up so that the absorption process can continue during product transfer. Additionally, a packed tower mini-scrubber is used for vacuum pump exhausts.

Product Description: Ammonia (CAS 7664-41-7) is a corrosive liquid and gas with a pungent, irritating odor. It may be harmful if inhaled. It causes eye, skin, and respiratory tract burns, and may cause kidney and respiratory system damage. Ammonia is also flammable.

Process Rates:

- Maximum Hourly Process Rate
  - The maximum hourly process rate is 200 lb/hr based on ton container returned product processing rate of 100 pounds in 30 minutes.
- Maximum Annual Process Rate
  - The maximum annual process rate is 288,000 lb/yr.

Emission Estimates:

- Maximum Hourly Ammonia Emissions with Controls
  - 200 lb/hr x (1-0.999) = 0.2 lb/hr
- Maximum Annual Ammonia Emissions with Controls
  - 288,000 lb/yr x (1-0.999) = 288 lb/yr = 0.144 tons/yr

2.7 Emergency Diesel Engines

2.7.1 Emergency Diesel Generator (002)

Process Description: The diesel-powered emergency backup generator was replaced through a permit modification in 2019. It automatically powers up whenever utility power drops below a predetermined voltage or one or more phases lose power. The generator provides emergency power to many critical systems in the plant. The diesel generator is maintained in ready-to-run condition.

The generator is a Tier 3 non-road engine with specifications as described below:

Manufacturer: Caterpillar
kW: 400 (536.4 horsepower [hp])
Displacement: 12.5 L
Fuel Type: Diesel
Fuel Consumption: 27.9 gal/hr @ 100% load

Process Rates and Emission Estimates: Emissions from the generator consist of oxides of nitrogen (NO_X), carbon monoxide (CO), carbon dioxide (CO_2), oxides of sulfur (SO_X), particulate matter less than 10 microns in diameter (PM_{10}), aldehydes, and volatile organic compounds (VOC). These emissions are estimated based on manufacturer-specified factors and guidance in AP-42 Chapter 3.3 for Gasoline and Diesel Industrial Engines (10/96). Each of the pollutant emission factors come from this guidance, aside from those of NO_X, CO, and PM_{10}, which were obtained from the supplier's equipment specification sheet. The annual emissions were calculated as follows:

- Estimated worst case hours of operation: 200 hours (hr) per year (yr)
- 200 hr/yr x 536.4 hp = 107,280 hp-hr/yr
- NO_X: 107,280 hp-hr/yr x 4.6 g/hp-hr / 453.6 g/lb = 1,088 lb/yr
- CO: 107,280 hp-hr/yr x 1.2 g/hp-hr / 453.6 g/lb = 283.81 lb/yr
- CO_2: 107,280 hp-hr/yr x 1.15 lb/hp-hr = 123,372 lb/yr

- SO_X: 107,280 hp-hr/yr x 0.00205 lb/hp-hr = 219.92 lb/yr
- PM_{10}: 107,280 hp-hr/yr x 0.1 g/hp-hr / 453.6 g/lb = 23.65 lb/yr
- Aldehydes: 107,280 hp-hr/yr x 0.000463 lb/hp-hr = 49.67 lb/yr
- VOC (Exhaust): 107,280 hp-hr/yr x 2.47E-3 lb/hp-hr = 264.98 lb/yr
- VOC (Crankcase): 107,280 hp-hr/yr x 4.41E-5 lb/hp-hr = 4.73 lb/yr

2.7.2 VES-1 Diesel Generator (003)

Process Description: The VES-1 system is designed to ventilate all production personnel areas (except those areas related to dichlorosilane, trichlorosilane, fluorinated products, and ammonia), the synthesis production rooms, many of the production fill hoods, and the analytical services areas. The ventilated air flow rate is measured as it enters the scrubber tower where it is "washed" with a four percent solution of potassium permanganate. The "washed" air is then exhausted out a vent stack where the quality is measured (monitored for hydride gases and hydrogen chloride) to comply with Linde engineering and operations standards. The VES-1 scrubber pump is backed up by a diesel-powered generator which automatically starts and runs when power is lost to the electric pump motor, or when a decreased amperage load is detected. An identical electric pump is installed in parallel with the main pump as an installed spare. The diesel generator is maintained in ready-to-run condition and comes with a 402 gallon diesel storage tank. Because this volume is less than 40,000 gallons, the tank's storage of diesel is considered an "insignificant activity" (Arizona Administrative Code [AAC] R18-2-101(68)(a)(i)). Similarly, operating the pump engine itself is also an "insignificant activity" because it is used for less than 500 hours per year for emergency replacement of the main pump (ACC R18-2-101(68)(b)).

Product Description:		
	Manufacturer:	Cummins Diesel
	HP:	115 @ 2500 RPM
	Displacement:	359 CID
	Type:	6 cylinder
	Serial No.:	44156598
	Fuel Type:	Diesel #2
	Fuel consumption:	10.4 gallons per hour
	Pump:	Goulds Model No. 3405

Process Rates and Emission Estimates: The methods used to calculate these emissions estimates are based on AP-42, 3.3 Gasoline and Diesel Industrial Engines (10/96). Each of the pollutant emission factors come from this guidance, aside from those for NO_X, CO, and PM_{10} which were obtained from the supplier's equipment specification sheet. The annual emissions were calculated as follows:

- Estimated worst case hours of operation: 200 hr/yr
- 200 hr/yr x 230 brake horsepower (bhp) = 46,000 bhp-hr/yr
- NO_X: 46,000 bhp-hr/yr x 6.15E-3 lb/hp-hr = 283.0 lb/yr
- CO: 46,000 bhp-hr/yr x 1.28E-3 lb/hp-hr = 58.9 lb/yr

- CO_2: 46,000 hp-hr/yr x 1.15 lb/hp-hr = 52,900 lb/yr
- SO_X: 46,000 bhp-hr/yr x 2.05E-3 lb/hp-hr = 94.3 lb/yr
- PM_{10}: 46,000 bhp-hr/yr x 2.99E-4 lb/hp-hr = 13.7 lb/yr
- Aldehydes: 46,000 bhp-hr/yr x 4.63E-4 lb/hp-hr = 21.3 lb/yr
- VOC (Exhaust): 46,000 bhp-hr/yr x 2.47E-3 lb/hp-hr = 113.6 lb/yr
- VOC (Crankcase): 46,000 bhp-hr/yr x 4.41E-5 lb/hp-hr = 2.0 lb/yr

2.7.3 Emergency Diesel Fire Pump (004)

Process Description: The diesel fire pump automatically starts when there is a pressure drop in the plant fire water system. The diesel pump is maintained in a ready-to-run condition.

Product Description:		
	Manufacturer:	Cummins Diesel
	HP (turbocharged):	244 @ 2100 RPM
	Displacement:	359 CID
	Type:	6 cylinder
	Serial No.:	44501160
	Fuel Type:	Diesel #2
	Fuel Consumption:	10.4 gallons per hour

Process Rates and Emission Estimates: All emission calculations are based on AP-42, 3.3 Gasoline and Diesel Industrial Engines (10/96).

- Estimated worst case hours of operation: 200 hr/yr
- 200 hr/yr x 244 hp = 48,800 hp-hr/yr
- NO_x: 48,800 hp-hr/yr x 0.031 lb/hp-hr = 1512.8 lb/yr
- CO: 48,800 hp-hr/yr x 6.68E-3 lb/hp-hr = 325.984 lb/yr
- CO_2: 48,800 hp-hr/yr x 1.15 lb/hp-hr = 56,120 lb/yr
- SO_x: 48,800 hp-hr/yr x 2.05E-3 lb/hp-hr = 100.04 lb/yr
- PM_{10}: 48,800 hp-hr/yr x 2.20E-3 lb/hp-hr = 107.36 lb/yr
- Aldehydes: 48,800 hp-hr/yr x 4.63E-4 lb/hp-hr = 22.594 lb/yr
- VOC (Exhaust): 48,800 hp-hr/yr x 2.47E-3 lb/hp-hr = 120.536 lb/yr
- VOC (Crankcase): 48,800 hp-hr/yr x 4.41E-5 lb/hp-hr = 2.152 lb/yr

2.7.4 Emergency Diesel Generator VES-2 Scrubber

Process Description: This diesel-powered backup generator for ventilation emergency scrubber #2 (VES-2) will automatically start and run when power is lost to the VES-2 system. The diesel pump is maintained in a ready-to-run condition.

Product Description:	Manufacturer:	Onsite Energy/John Deere
	HP:	136 @ 1800 RPM
	Displacement:	4.5 L
	Type:	4 cylinder
	Serial No.:	319032-1-1-0310
	Fuel Type:	Diesel
	Fuel consumption:	3 gallons per hour
	Pump:	Marathon Electric Model No. 362NSG1606-1

Process Rates and Emission Estimates: All emission calculations are based on Tier 3 nonroad diesel engine emission standards, with the exception of SOx emissions which are based on a sulfur content limit of 15 parts per million (ppm) for nonroad diesel fuel. The Tier 3 standards include a combined limit for NO_x and non-methane hydrocarbon (NMHC) emissions. For the purposes of calculating NO_x and NMHC emissions, a split of 95% NO_x and 5% NMHC was assumed. The emission calculations for aldehydes are based on AP-42, 3.3 Gasoline and Diesel Industrial Engines (10/96).

- Estimated worst case hours of operation: 200 hr/yr
- 200 hr/yr x 136 hp = 27,200 hp-hr/yr
- NOx: 27,200 hp-hr/yr x 3 g/hp-hr x 0.95 ÷ 453.592 g/lb = 170.9 lb/yr
- CO: 27,200 hp-hr/yr x 3.7 g/hp-hr ÷ 453.592 g/lb = 221.9 lb/yr
- CO_2: 27,200 hp-hr/yr x 1.15 lb/hp-hr = 31,280 lb/yr
- SOx: 200 hr/yr x 3 gal/hr x 7.1 lb/gal x 15 ppm S x 2 lb SOx/lb S = 0.13 lb/yr
- PM_{10}: 27,200 hp-hr/yr x 0.22 g/hp-hr ÷ 453.592 g/lb = 13.2 lb/yr
- Aldehydes: 27,200 hp-hr/yr x 4.63E-4 lb/hp-hr = 12.6 lb/yr
- NMHC: 27,200 hp-hr/yr x 3 g/hp-hr x 0.05 ÷ 453.592 g/lb = 9.0 lb/yr

2.8 Fluorocarbon Gases

2.8.1 Hexafluoroethane Filling & Processing

Process Description: Hexafluoroethane arrives on site in high-pressure bulk “ton” containers. Hexafluoroethane is transferred into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, the product is collected in recovery cylinders and the recovery cylinders are sent to a vendor who reclaims the product. Any product remaining in the returned cylinders is then vented to atmosphere and evacuated from the cylinders.

Product Description: Hexafluoroethane (CAS 76-16-4) is an odorless gas. It may be harmful if inhaled, may cause dizziness and drowsiness, and can cause rapid suffocation.

2.8.2 Octafluorocyclobutane Filling & Processing

Process Description: Octafluorocyclobutane is received in bulk "half-ton" containers and is transferred by weight into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, it is vented to the atmosphere and evacuated from the cylinders.

Product Description: Octafluorocyclobutane (CAS 115-25-3) is an odorless gas. It may be harmful if inhaled and can cause rapid suffocation. Inhalation may cause dizziness and drowsiness.

2.8.3 Octafluorotetrahydrofuran Filling & Processing

Process Description: Octafluorotetrahydrofuran is received in bulk "half-ton" containers and is transferred by weight into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, it is vented to the atmosphere and then evacuated from the cylinders.

Product Description: Octafluorotetrahydrofuran (CAS 773-14-8) is an odorless gas. It may be harmful if inhaled and can cause rapid suffocation. Inhalation may cause dizziness and drowsiness.

2.8.4 Perfluoropropane Filling & Processing

Process Description: Perfluoropropane arrives on site in bulk “half-ton” containers. Perfluoropropane is transferred into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, it is vented to the atmosphere and then evacuated from the cylinders.

Product Description: Perfluoropropane (CAS 76-19-7) is a gas with a faintly sweet odor. It can cause rapid suffocation. Inhalation may cause dizziness and drowsiness.

2.8.5 Trifluoromethane Repackaging

Process Description: Trifluoromethane is repackaged at the Kingman facility. It is received in bulk "ton" containers and is transferred by weight into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. Product in cylinders returned from customers is vented to the atmosphere and then evacuated from the cylinders.

Product Description: Trifluoromethane (CAS 75-46-7) is a gas with an ether-like odor. Inhalation can cause rapid suffocation and may cause dizziness and drowsiness.

2.9 Sulfur Hexafluoride Repackaging

Process Description: Sulfur hexafluoride is repackaged at the Kingman facility. It is received in bulk "ton" containers and is transferred by weight into compressed gas cylinders for sale to customers. Prior to refilling these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. Product in cylinders returned from customers is vented to the atmosphere and then evacuated from the cylinders.

Product Description: Sulfur hexafluoride (CAS 2551-62-4) is an odorless gas. Inhalation can cause rapid suffocation and may cause dizziness and drowsiness.

2.10 Cylinder Shot Blasting

2.10.1 Cylinder Shot Blaster (006)

Process Description: The shot blaster system is designed to efficiently remove surface coatings from empty compressed gas cylinder surfaces while minimizing the quantity of paint particulates emitted from the dust collector exhaust air. Surface coating (paint) is removed from compressed gas cylinders in a system that projects steel shot at the cylinder while it rotates in the unit.

Product Description:	Manufacturer:	DeVilbiss Company
	Model:	GC-111
	Rate:	240 cylinders/day
	Filter Area:	17,280 sq. in. (9 bags x 1920 sq. in.)
	Cloth Type:	Cotton Flannel
	Fan Motor:	2 HP, 3450 RPM, 220 Volt, 3 phase
	Dust Collector:	44" deep, 44" wide, 86" high
	Stack Height:	11'
	Stack Diameter:	6"
	Removal Efficiency:	99.5%
	Flow Rate:	1100 acfm
	Method of Bag Cleaning:	Agitator arm into a secure drum
	Pressure Drop (filter):	4 inches of water

Process Rates:
The number of cylinders that can potentially be shot blasted per year is:

- 10 cylinders per hour x 24 hours per day = 240 cylinders per day
- 240 cylinders per day x 365 days per year = 87,600 cylinders per year

In 2022, Linde began painting its product cylinders with a new paint called “Linde Blue”. Since cylinders painted with the old paint colors (i.e., Cranberry Enamel and Metallic Aluminum Enamel) are still in circulation, cylinders being blasted could be painted with any one of the three coatings. As a result, the emissions calculations conservatively assume that all cylinders are coated with the paint that produces the highest PM emissions. This corresponds to the paint with the highest solids content, which is the Metallic Aluminum Enamel paint. Additionally, the estimated PM_{10} and $PM_{2.5}$ emissions are conservatively assumed to be equivalent to the PM emissions for this process.

The Facility shot blasts five different styles of cylinder, each with a different size and thus, a different surface area. Assuming the shot blasting process removes a 6-mm layer of paint, the total volume of paint removed for each cylinder style is:

- T style cylinder: 10.396 cubic inches
- K style cylinder: 9.415 cubic inches
- Q style cylinder: 4.55 cubic inches
- G style cylinder: 2.60 cubic inches
- #4 style cylinder: 1.85 cubic inches

Based on historic information and a potential of 87,600 cylinders per year, the approximate number of each style of cylinder to be shot blasted and the resulting particle emission is as follows:

- Metallic Aluminum Enamel
  - T style: 31,614 cylinders x 10.396 cubic inches/cylinder = 328,659 cubic inches
  - K style: 48,617 cylinders x 9.415 cubic inches/cylinder = 457,729 cubic inches
  - Q style: 672 cylinders x 4.55 cubic inches/cylinder = 3,058 cubic inches
  - G style: 3,810 cylinders x 2.60 cubic inches/cylinder = 9,906 cubic inches
  - #4 style: 2,899 cylinders x 1.85 cubic inches/cylinder = 5,363 cubic inches
  - Total Volume of Metallic Aluminum paint solids = 804,715 cubic inches
  - 804,715 cubic inches x 1 cubic foot/1728 cubic inches = 465.69 cubic feet of solids
  - 465.69 cubic feet x 10.58 lb/gal x 7.48 gal/cubic foot = 36,854 lb/yr without controls
- Total Particulate Emissions from Cylinder Shot Blasting
  - 36,854 lb/yr x (1-0.995) = 184.27 lb/yr particulate emissions with controls
  - 184.27 lb/8,760 hr/yr = 0.021 lb/hr (average)
  - 184.27 lb/yr x 1 ton/2000 lb = 0.092 tons/yr paint particulate emissions with controls

2.10.2 Abrasive Blasting Unit (019)

Process Description: The Galiso Incorporated internal shot blaster system is designed to efficiently remove surface coatings from empty compressed gas cylinder surfaces while minimizing the quantity of particulates emitted from the dust collector exhaust air. Surface coating is removed from compressed gas cylinders in a system that projects steel shot at the cylinder while it rotates in the unit.

Product Description:	Manufacturer:	Galiso Inc.
	Model:	ISB-1
	Rate:	500 cylinders/year
	Cylinder Tumbler:	115 Volt 60 Hz, Cylinder Tumbler

Dust Collector:	44" deep, 44" wide, 86" high
Removal Efficiency:	99.931%
Flow Rate:	25 cubic feet per minute (cfm)
Pressure:	80 psi
Fan Blower:	700 cfm (1 hp 3450 rpm electric motor)

Process Rates: The number of cylinders that can potentially be shot blasted per year is:

- 500 cylinders per year
- Total Particulate Emissions from Abrasive Shot Blasting:
  - Amount of Abrasive per Cylinder = 1.5 cups steel shot x 2.5 lbs/cup = 3.8 lbs
  - PM Emission Factor = 0.69 lb/1,000 lb abrasive (from AP-42, Section 13.2.6).
  - Total Annual Particulate Emissions = 3.8 lbs abrasive/cylinder x 500 cylinders x 0.69 lb PM/1,000 lb abrasive = 1.29 lb PM/year
  - 1.29 lb/yr x 1 ton/2000 lb = 6.47E-4 tons/yr particulate emissions with controls
  - Total Hourly Particulate Emissions = 1.29 lb PM/year / 8,760 hr/yr = 1.48E-4 lb/hr

2.11 Paint Spray Booth (007)

Process Description: The Global Finishing Solutions paint spray booth, which replaced the Facility's previous paint booth following a 2022 permit modification, is designed to allow the spray painting of empty compressed gas cylinders while minimizing over-spray and maximizing the removal of paint particles from spray booth exhaust by means of disposable filters.

Product Description:		
	Manufacturer:	Global Finishing Solutions
	Model:	DEFCG-100816-NSB-4L-BD-SP
	Interior Dimensions:	10' W, 8' H, 16' D
	Fan Motor:	3 HP, 208/230/460 V, 3 phase
	Fan Diameter:	30"
	Exhaust Capacity:	8,000 cfm
	Filter Size:	20 pair of 20" x 20" x 2" wave pad
	Filter Removal Efficiency (solids):	98.83%
	Stack Gas Temperature:	Ambient
	Paint Vehicle:	Solvent base

Process Rates: Following the 2022 permit modification for the paint booth, the only paint product that Linde intends to use in the spray booth is Linde Blue. Estimated maximum paint usage based on historic data and anticipated business growth is 2,250 gallons per year of Linde Blue.

In the painting process, cylinders are manually sprayed with a pressurized spray gun. Although the paints used are water-based, they contain volatile organic compounds including 2-butoxyethanol (CAS 111-76-2) and 2-butanol (CAS 78-92-2).

Linde Blue contains 5.9 percent (wt/wt) 2-butoxyethanol, 4.0 percent (wt/wt) 2-butanol, and a total VOC content of 2.27 pounds per gallon. The specific gravity of Linde Blue is 1.056. It is 36 percent solids by weight.

- Linde Blue
  - 2,250 gal x 9.057 lb/gal x 0.059 = 1,202.3 lb 2-butoxyethanol
  - 2,250 gal x 9.057 lb/gal x 0.04 = 815.1 lb 2-butanol
  - 2,250 gal x 2.27 lb/gal = 5,107.5 lb total VOC
- Total 2-butoxyethanol emissions
  - 1,202.3 lb/yr / 8,760 hr/yr = 0.137 lb/hr (average)
  - 1,202.3 lb/yr x 1 ton/2000 lb = 0.601 tons/yr 2-butoxyethanol
- Total 2-butanol emissions
  - 815.1 lb/yr / 8,760 hr/yr = 0.093 lb/hr (average)
  - 815.1 lb/yr x 1 ton/2000 lb = 0.408 tons/yr 2-butanol
- Total VOC emissions
  - 5,107.5 lb/yr / 8760 hr/yr = 0.583 lb/hr (average)
  - 5,107.5 lb/yr x 1 ton/2000 lb = 2.554 tons/yr total VOC emissions
- Paint solids
  - 2,250 gal x 9.057 lb/gal = 20,378.25 lb
  - 20,378.25 lb x 0.36 = 7,336 lb solids total
- Particulate Emissions
  - Over spray approximately 25 percent to filters; 75 percent to cylinders (est.).
  - 7,336 lb x 0.25 = 1,834 lb/yr to filters w/o controls
  - 1,834 lb/yr x (1-0.9983) = 3.12 lb/yr particulates emitted to atmosphere with controls
  - 3.12 lb/yr / 8,760 hr/yr = 0.00036 lb/hr (average)
  - 3.12 lb/yr x 1 ton/2000 lb = 0.0016 tons/yr

2.12 Cylinder Valve Cleaning: Acetone Usage (Solvent)

Process Description: Acetone is received on site in 55 gallon drums and is transferred into smaller portable containers for use as a solvent on site. Acetone is used primarily to clean cylinder valve outlets prior to shipment to customers. Very small amounts are used to extinction during the valve cleaning process.

Product Description: Acetone (CAS 67-64-1) is a volatile, flammable liquid with a characteristic sweet odor. Prolonged or repeated contact with skin can cause redness and dryness. Inhalation may cause headache, fatigue, excitement, bronchial irritation, and in large amounts, narcosis.

Process Rates: The maximum amount of acetone used per year is estimated to be:

- 275 gal/yr x 6.64 lb/gal = 1,826 lb/yr

2.13 Laboratory Operations

Laboratory operations at the facility involve the certifying, via Quality Assurance/Quality Control, of products sold prior to shipment to customers. Analytical waste streams are handled by the same scrubbers as the production/filling waste streams.

2.14 Propane Powered Forklifts

Forklifts are used to load and unload trucks and move pallets of cylinders around the facility.

2.15 Diesel Powered Tractor

The tractor (commonly called a “yard dog” or a “trailer jockey”) is used to move shipping trailers and raw material trailers around the facility.

2.16 Silicon Tetrafluoride Fill, Process, and Flow Test

Process Description: Silicon tetrafluoride (SiF_4) arrives onsite in cylinders and is transfilled into smaller cylinders for sale to customers. Prior to transfilling into these cylinders, the returned product must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish this removal, the returned product is first vented to the existing process wet scrubber. Any residual product is purged from the cylinders using nitrogen, after which the cylinders are refilled. Filled cylinders are then connected to a flow test manifold for testing.

Linde prepares cylinders of mixtures containing Si_2H_6 and SiF_4. Linde estimates that approximately 500 cylinders are produced per year with less than 0.25 pounds of mixture in each cylinder. Vented product is sent to VES-3 where the SiF_4 reacts with water and NaOH to form sodium fluoride and sodium silicate. The resulting "spent" scrubber solution is properly disposed of offsite as an industrial waste. VES-3 exhaust discharges to the atmosphere.

Product Description: Silicon tetrafluoride (CAS 7783-61-1) is a poisonous, corrosive high pressure gas and is harmful if inhaled. It can cause eye, skin, and respiratory tract burns and is extremely irritating to mucous membranes and the respiratory tract. Contact with water may cause violent reaction. Contact with organic or silica materials may cause fire.

Process Rates and Emission Estimates: Each SiF_4 cylinder is flow tested on a six station manifold one at a time. Product vented during a typical flow test is approximately 500 grams per six cylinders in one hour. An estimate of the amount of SiF_4 in returned SiF_4 cylinders processed based on past history and anticipated future growth is approximately 500 cylinders with residual product of 100 grams per cylinder. SiF_4 cylinders are processed on a single cylinder station rack in the germanium tetrafluoride (GeF_4) and SiF_4 fill room. A maximum of two cylinders can be processed in an hour, with an average of one cylinder per hour.

- Maximum Hourly Process Rate
  - SiF_4 Cylinder Processing:

$$100\ \frac{g}{cylinder}\ x\ 0.0022\frac{lb}{g}\ x\ 2\frac{cylinders}{hr} = \ 0.44\frac{lb}{hr}$$

– SiF_4 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 6\frac{cylinders}{hr} = \ 1.1\frac{lb}{hr}$$

– All Processes:

$$0.44\frac{lb}{hr} + 1.1\ \frac{lb}{hr} = \ 1.54\frac{lb}{hr}$$

- Maximum Annual Process Rate

– SiF_4 Cylinder Processing:

$$100\ \frac{g}{cylinder}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = \ 110\frac{lb}{year}$$

– SiF_4 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = \ 91.7\frac{lb}{year}$$

– All Processes:

$$110\frac{lb}{year} + 91.7\ \frac{lb}{year} = \ 202\frac{lb}{year}$$

- Total Estimated Maximum Hourly Silicon Tetrafluoride Emissions with Controls

– All Processes:

$$1.54\frac{lb}{hr}x\ (1 - 0.999) = 1.54x10^{-3}\frac{lb}{hr}$$

- Total Estimated Annual Silicon Tetrafluoride Emissions with Controls

– All Processes:

$$202\frac{lb}{year}\ x\ 0.0005\frac{ton}{lb}\ x\ (1 - 0.999) = 1.01x10^{-4}\frac{ton}{year}$$

2.17 Germanium Tetrafluoride Fill, Process, and Flow Test

Process Description: Germanium tetrafluoride (GeF_4) arrives on site in cylinders and is transfilled into smaller cylinders for sale to customers. Prior to transfilling into these cylinders, the returned product in the smaller cylinders must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, the product in the cylinder is vented to the process wet scrubber. Then the remaining product is purged from the cylinders using nitrogen and evacuated from the cylinders. The cylinders are then filled. Filled cylinders are connected to a flow test manifold for testing. Venting of product during the fill, process, and flow test processes are sent to a process wet scrubber where the GeF_4 reacts with the water and sodium hydroxide to form fluorogermanic acid which is neutralized. The resulting "spent" scrubber solution is properly disposed of off-site as an industrial waste. The exhaust from the process wet scrubber discharges into VES-2.

Product Description: Germanium tetrafluoride (CAS 7783-58-6) is a poisonous, corrosive high pressure gas and is harmful if inhaled. GeF_4 can cause eye, skin, and respiratory tract burns and is extremely irritating to mucous membranes and the respiratory tract. Contact with water may cause violent reaction. Contact with organic or silica materials may cause fire.

Process Rates: An estimate of the amount of GeF_4 in returned GeF_4 cylinders processed based on past history and anticipated future growth is approximately 150 cylinders with residual product of approximately 10 percent.

- 150 cylinders x 150 grams x 10% = 2,250 grams/yr or 4.96 lb/yr

GeF_4 cylinders are processed on a single cylinder station rack in the GeF_4 and SiF_4 fill room. Only one cylinder can be processed in an hour. The maximum capacity for the largest package is 150 grams; therefore maximum hourly process is 150 grams in one hour.

GeF_4 cylinders are flow tested on a six station manifold. Product vented during a typical flow test is approximately 15 grams per cylinder in one hour. Projected production is 150 cylinders/yr.

- 150 cylinders x 15 grams = 2,250 grams/yr or 4.96 lb/yr
- Maximum Hourly Process Rate (Whole Plant)
  - Processing one cylinder of 150 grams
  - Flow testing of six cylinders of 15 grams each or 90 grams total
  - Maximum hourly is 150 + 90 = 240 grams/hr or 0.53 lb/hr
- Maximum Annual Process Rate (Whole Plant)
  - 4.96 lb/yr + 4.96 lb/yr = 9.92 lb/yr

2.18 Enriched Boron-11 Trifluoride and Boron Trifluoride Fill, Process, and Flow Test

Process Description: $B^{11}F_3$ and BF_3 arrive on site in cylinders and are transfilled into smaller cylinders for sale to customers. Prior to transfilling into these cylinders, the returned product in the smaller cylinders must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, the product in the cylinder is vented to VES-2. Then the remaining product is purged from the cylinders using nitrogen and evacuated from the cylinders. The cylinders are then filled. Filled cylinders are connected to a flow test manifold for testing.

Linde prepares mixtures of cylinders containing B_2H_6 and either BF_3 or enriched $B^{11}F_3$. Linde estimates that approximately 500 cylinders are produced per year with less than 3 pounds of mixture in each cylinder.

An estimate of the amount of BF_3 in returned BF_3 cylinders to be processed is approximately 500 cylinders with residual product of approximately 100 grams per cylinder. BF_3 cylinders are processed on a single cylinder station rack in the BF_3 fill room. A maximum of two cylinders can be processed in an hour. The maximum capacity for the largest package is 100 grams; therefore the maximum hourly process rate is 200 grams per hour.

BF_3 and $B^{11}F_3$ cylinders are flow tested on a six station manifold. Product vented during a typical flow test is approximately 500 grams per six cylinders, with up to six cylinders flow tested per hour. Projected production is 500 cylinders per year.

Linde sends vented product directly to the new VES-3. Although the boron mixture may be emitted through either VES-2 or VES-3, for emission estimates we conservatively assume all emissions go through VES-3 because of its lower total control efficiency.

<u>Process Rates and Emission Estimates:</u> Using the above information, the following process rates and emissions are calculated.

- Maximum Hourly Process Rate
  - BF_3 Cylinder Processing:

$$100\ \frac{g}{cylinder}\,x\ 0.0022\frac{lb}{g}\ x\ 2\frac{cylinders}{hr} = 0.44\frac{\mathrm{lb}}{\mathrm{hr}}$$

  - BF_3 Cylinder Flow-testing:

$$\frac{500\ \frac{grams}{test}}{6\ \frac{cylinders}{test}}\,x\ 0.0022\frac{lb}{g}\ x\ 6\frac{cylinders}{hr} = 1.1\frac{\mathrm{lb}}{\mathrm{hr}}$$

  - BF_3 All Processes:

$$0.44\frac{lb}{hr} + 1.1\ \frac{lb}{hr} = 1.54\frac{lb}{hr}$$

  - $B^{11}F_3$ Cylinder Flow-testing:

$$\frac{7\ \frac{grams}{cylinder}}{\mathrm{test}}\,x\ 0.0022\frac{lb}{g}\ x\ 6\frac{cylinders}{hr} = 9.24x10^{-2}\frac{\mathrm{lb}}{\mathrm{hr}}$$

- Maximum Annual Process Rate
  - BF_3 Cylinder Processing:

$$100\ \frac{g}{cylinder}\,x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = 110\frac{\mathrm{lb}}{\mathrm{year}}$$

  - BF_3 Cylinder Flow-testing:

$$\frac{500\ \dfrac{grams}{test}}{6\ \dfrac{cylinders}{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = \ 91.7\frac{\text{lb}}{\text{year}}$$

– BF_3 All Processes:

$$110\frac{lb}{year} + 91.7\ \frac{lb}{year} = \ 202\frac{lb}{year}$$

– $B^{11}F_3$ Cylinder Flow-testing:

$$\frac{7\ \dfrac{grams}{cylinder}}{\text{test}}\ x\ 0.0022\frac{lb}{g}\ x\ 500\frac{cylinders}{year} = \ 7.7\frac{\text{lb}}{\text{year}}$$

- Total Estimated Maximum Hourly Boron Trifluoride and Enriched Boron-11 Trifluoride Emissions with Controls

  – BF_3 All Processes:

$$1.54\frac{lb}{hr}x\ (1 - 0.999) = 1.54x10^{-3}\frac{lb}{hr}$$

  – $B^{11}F_3$ Processes:

$$9.24x10^{-2}\frac{lb}{hr}x\ (1 - 0.999) = 9.26x10^{-5}\frac{lb}{hr}$$

- Total Estimated Annual Boron Trifluoride and Enriched Boron-11 Trifluoride Emissions with Controls

  – BF_3 All Processes:

$$202\frac{lb}{year}\ x\ 0.0005\frac{ton}{lb}\ x\ (1 - 0.999) = 1.01x10^{-4}\frac{ton}{year}$$

  – $B^{11}F_3$ Processes:

$$7.7\frac{lb}{year}\ x\ 0.0005\frac{ton}{lb}\ x\ (1 - 0.999) = 3.85x10^{-6}\frac{ton}{year}$$

2.19 Silicon Tetrachloride Processing

Process Description: Silicon tetrachloride arrives on site via different sized containers and is transferred into the existing trichlorosilane bulk recovery tank until a full tank-truck load can be sent to a vendor who purchases the returned product. The trichlorosilane fill panel and recovery panel are used to facilitate this transfer. The remaining vapor in the process lines and the containers are sent to the AAT, Inc. caustic wet scrubbers (D) where the silicon tetrachloride reacts with the water and sodium hydroxide to form sodium silicate, sodium chloride, and hydrogen. The resulting "spent" scrubber solution is properly disposed of off-site as an industrial waste. The exhaust from the AAT, Inc. caustic wet scrubber discharges into VES-1.

Product Description: Silicon tetrachloride (CAS 10026-04-7) is a corrosive liquid and gas under pressure with an irritating, choking odor. It may be harmful or fatal if inhaled and may cause eye and skin burns. Inhalation causes severe irritation of the respiratory tract.

2.20 Fluorine and Inert Gas Mix Fill, Process, and Analytical Testing #1

Process Description: Fluorine arrives on site in cylinders. This fluorine is transfilled into other cylinders and mixed with other gases such as argon, krypton, and neon to make a unique mixture concentration as specified by the customer. Prior to transfilling into these cylinders, the returned product in the cylinders are completely removed to ensure the purity of the product the customer requires. To accomplish the removal of this returned product, the product in the cylinder is vented to the Process Dry Scrubber (PDS-1). Then the remaining product is purged from the cylinders using helium or argon and evacuated from the cylinders. The cylinders are then filled. Full cylinders are connected to an analytical test manifold for testing. Venting of product during the fill, process, and analytical test processes are sent to a process dry scrubber where the fluorine reacts with activated alumina to form oxygen and solid aluminium fluoride. The resulting "spent" scrubber solids is properly disposed of off-site as industrial waste. The exhaust from PDS-1 discharges into VES-2.

Product Description: Fluorine (CAS 07782-41-4) is a gas at normal room temperature and pressure with a very pungent odor. It is highly oxidizing and highly toxic. When exposed to moisture it can become highly corrosive to materials.

Process Rates and Emission Estimates: An estimate of the amount of fluorine mixes in returned cylinders processed based on an anticipated business of 200 cylinders a month where 10 percent are fluorine mixes is approximately 240 cylinders a year. With residual product of approximately 0.04 lb/cylinder, 240 cylinders x 0.04 lb = 9.6 lb/yr.

Fluorine mix cylinders are processed on a four-cylinder rack in the fluorine mix fill hood. Four cylinders can be processed in an hour. Maximum flow rate allowed to PDS-1 is 3.53 ft^3/min. Gas density of pure fluorine is 0.1 lb/ft^3, therefore a 1 percent F_2 mixture x 3.53 ft^3/min x 0.1 lb/ft^3 x 60 min/hr = 0.2118 lb/hr maximum hourly process rate.

- F_2 Maximum Hourly Process Rate
  - 0.2118 lb/hr
- F_2 Maximum Annual Process Rate
  - 9.6 lb/yr
- Total Estimated Annual F_2 Emissions with Controls
  - 9.6 lb/yr x (1- 0.98) = 0.192 lb/yr from PDS-1 (conservative)
  - 0.192 lb/yr x (1- 0.9997) = 5.76E-5 lb/yr with controls from VES-2
  - 5.76E-5 lb/yr x 1 ton/2000 lb = 2.88E-8 tons/yr with controls
- Total Estimated Maximum Hourly F_2 Emissions with Controls
  - 0.2118 lb/hr x (1- 0.98) = 4.24E-3 lb/hr from PDS-1 (conservative)

  - 4.24E-3 lb/hr x (1- 0.9997) = 1.3E-6 lb/hr from VES-2

The F_2 that remains after treatment by PDS-1 (98% control efficiency) is then treated by the VES-2 scrubber where it reacts with a water solution to produce hydrogen fluoride (HF). For emissions estimation purposes, it is assumed that all the F_2 that is successfully treated (99.97%) reacts to form HF at a rate of 2 moles of HF formed per every 1 mole of F_2 that reacts (according to the reaction equations $2 F_2 + 2 H_2O \rightarrow 4 HF + O_2$ and $F_2 + 2 H_2O \rightarrow 2 HF + H_2O_2$).

- Total Estimated Annual HF Emissions
  - 9.6 lb F_2/yr x (1 - 0.98) = 0.192 lb F_2/yr from PDS-1 (conservative)
  - 0.192 lb F_2/yr x (0.9997) = 0.19194 lb F_2/yr reacts with water inside the ventilation emergency scrubber (VES-2)
  - 0.19194 lb F_2/yr x (453.592 g/lb) x (1 mole F_2/37.997 g F_2) = 2.291 moles F^2/yr
  - 2.291 moles F_2/yr x (2 moles HF/1 mole F_2) = 4.583 moles HF/yr
  - 4.583 moles HF/yr x (20.01 g/1 mole HF) x (1 ton/907185 g) = 1.01E-4 ton HF/yr
- Total Estimated Maximum Hourly HF Emissions
  - 0.2118 lb F_2/hr x (1 - 0.98) = 4.24E-3 lb F_2/hr from PDS-1 unit (conservative)
  - 4.24E-3 lb F_2/hr x (0.9997) = 4.23E-3 lb F_2/hr reacts with water inside the ventilation emergency scrubber (VES-2)
  - 4.23E-3 lb F_2/hr x (453.592 g/lb) x (1 mole F2/37.997 g F_2) = 5.06E-2 moles F_2/hr
  - 5.06E-2 moles F_2/hr x (2 moles HF/1 mole F_2) = 1.01E-1 moles HF/hr
  - 1.01E-1 moles HF/hr x (20.01 g/1 mole HF) x (1 lb/453.592 g) = 4.46E-3 lb HF/hr

2.21 Fluorine and Inert Gas Mix Fill, Process, and Analytical Testing for Lithography

Process Description: This process was added through a permit modification completed in 2021. This process is similar to Fluorine and Inert Gas Mix Fill, Process, and Analytical Testing #1, but is designed for a varying product stream. It is primarily exhausted through VES-2 for air pollution control; however, in the event of equipment malfunction leading to a loss of containment of F_2 within the process cabinet, emissions are routed to the Fluorine Emergency Scrubber (FES). F_2 emissions routed through VES-2 react with a water solution and HF is produced as a byproduct.

Process Rates and Emission Estimates: As part of the mixing and cylinder-filling process, F_2 passes through a panel to be dispensed into various cylinders. During this step of the process, excess gas is vented through VES-2 in the amount of 0.01 lbs of F_2. This venting occurs once per batch of cylinders filled, a maximum of eight times per day. Using these figures, the following process rates are calculated:

- Maximum Hourly Process Rate:
  - 0.01 lbs/batch x 1 batch/hr = 0.01 lbs/hr
- Maximum Annual Process Rate:
  - 0.01 lbs/batch x 8 batch/day x 365 day/yr = 29.2 lbs/yr

The above process rates of F_2 emissions are routed through VES-2 for air pollution control. Using the designed control efficiency for VES-2 of 99.97%, the following emission rates are calculated:

- Total Estimated Maximum Hourly Fluorine Emissions with Controls:
  - 0.01 lbs/hr x (1-0.9997) = 3.0E-6 lbs/hr
- Total Estimated Maximum Annual Fluorine Emissions with Controls:
  - 29.2 lbs/yr x (1-0.9997) x (1 ton/2,000 lbs) = 4.4E-6 ton/yr

As part of this process, a mixture of 5% F_2 and 95% helium is used for passivation of the cylinders, and then vented through VES-2 in the amount of approximately 0.071 lbs of F_2 per cylinder. This venting occurs once per production cycle, a maximum of three times per week. Each cycle of passivation gas venting involves 24 cylinders. Using these figures, the following process rates are calculated:

- Maximum Hourly Process Rate:
  - 0.071 lbs/cylinder x 24 cylinder/cycle x 1 cycle/hr = 1.7 lbs/hr
- Maximum Annual Process Rate:
  - 0.071 lbs/cylinder x 24 cylinder/cycle x 3 cycle/wk x 52 wk/yr = 265.20 lbs/yr

The above process rates of F_2 emissions are routed through VES-2 for air pollution control. Using the designed control efficiency for VES-2 of 99.97%, the following emission rates are calculated:

- Total Estimated Maximum Hourly Fluorine Emissions with Controls:
  - 1.7 lbs/hr x (1-0.9997) = 5.1E-4 lbs/hr
- Total Estimated Maximum Annual Fluorine Emissions with Controls:
  - 265.20 lbs/yr x (1-0.9997) x (1 ton/2,000 lbs) = 4.0E-5 ton/yr

Following the F_2 mixing process, samples are collected and analytically tested. A maximum of sixteen cylinders per day and two cylinders per hour are tested. For each cylinder tested, the analyzer exhausts a gas mixture with a maximum F_2 concentration of 1% (by volume), a density of 0.1 lb/ft^3, and a flow rate of 1.0 standard liters per minute (slpm) over the course of 30 minutes. Using these figures, the following process rates are calculated:

- Maximum Hourly Process Rate:
  - 1% x 1.0 L/min x 30 min/cylinder x 2 cylinder/hr x (0.0353 ft^3/L) x 0.1 lbs/ft^3 = 0.0021 lbs/hr
- Maximum Annual Process Rate:
  - 1% x 1.0 L/min x 30 min/cylinder x 16 cylinder/day x 365 day/yr x (0.0353 ft^3/L) x 0.1 lbs/ft^3 = 6.2 lbs/yr

The above process rates of F_2 emissions are routed through VES-2 for air pollution control. Using the designed control efficiency for VES-2 of 99.97%, the following emission rates are calculated:

- Total Estimated Maximum Hourly Fluorine Emissions with Controls:
  - 0.0021 lbs/hr x (1-0.9997) = 6.4E-7 lbs/hr
- Total Estimated Maximum Annual Fluorine Emissions with Controls:
  - 6.2 lbs/yr x (1-0.9997) x (1 ton/2,000 lbs) = 9.3E-7 ton/yr

In the event of equipment malfunction leading to a loss of containment of F_2 within the process cabinet (i.e., during a process upset), a maximum of 4.5 lbs of F_2 are released per source cylinder and routed to air pollution control. An equipment failure of this nature is rare, and not anticipated to occur more than once per year. Using these figures, the following process rates are calculated:

- Maximum Hourly Process Rate:
  - 4.5 lbs/cylinder x 1 cylinder/hr = 4.5 lbs/hr
- Maximum Annual Process Rate:
  - 4.5 lbs/cylinder x 1 cylinder/yr = 4.5 lbs/yr

Emissions at the rates described above are routed to the FES for air pollution control. Using the designed control efficiency for the FES of 99.96%, the following emission rates are calculated:

- Total Estimated Maximum Hourly Fluorine Emissions with Controls:
  - 4.5 lbs/hr x (1-0.9996) = 2.0E-3 lbs/hr
- Total Estimated Maximum Annual Fluorine Emissions with Controls:
  - 4.5 lb/yr x (1-0.9996) x (1 ton/2,000 lbs) = 9.0E-7 ton/yr

The F_2 that is treated by the VES-2 scrubber reacts with a water solution that produces HF as a byproduct. For emissions estimation purposes, it is assumed that all the F_2 that is successfully treated (99.97%) reacts to form HF at a rate of 2 moles of HF formed per every 1 mole of F_2 that reacts (according to the reaction equations: $2\ F_2 + 2\ H_2O \rightarrow 4\ HF + O_2$ and $F_2 + 2\ H_2O \rightarrow 2\ HF + H_2O_2$).

- Total Estimated Maximum Hourly HF Emissions:
  - 0.01 lbs F_2/hr + 1.7 lbs F_2/hr + 0.0021 lbs F_2/hr = 1.71 lbs F_2/hr uncontrolled emissions
  - 1.71 lbs F_2/hr x 0.9997 = 1.7116 lbs F_2/hr reacts with water inside VES-2
  - 1.7116 lbs F_2/hr x (453.592 g/lb) x (1 mole F_2/37.997 g F2) = 20.43 moles F_2/hr
  - 20.43 moles F_2/hr x (2 moles HF/1 mole F_2) = 40.86 moles HF/hr
  - 40.86 moles HF/hr x (20.01 g/1 mole HF) x (1 lb/453.592 g) = 1.80 lbs HF/hr
- Total Estimated Annual HF Emissions:
  - 29.2 lbs F_2/yr + 265.20 lbs F_2/yr + 6.2 lbs F_2/yr = 300.6 lb F_2/yr uncontrolled emissions
  - 300.6 lbs F_2/yr x 0.9997 = 300.5 lbs F_2/yr reacts with water inside VES-2

- 300.5 lbs F_2/yr x (453.592 g/lb) x (1 mole F_2/37.997 g F_2) = 3,587 moles F_2/yr
- 3,587 moles F_2/yr x (2 moles HF/1 mole F_2) = 7,174 moles HF/yr
- 7,174 moles HF/yr x (20.01 g/1 mole HF) x (1 ton/907,185 g) = 0.16 ton HF/yr

2.22 Carbon Monoxide Fill, Process, and Flow Test

Process Description: Carbon monoxide (CO) arrives on site in cylinders and is transfilled into smaller cylinders for sale to customers. Prior to transfilling into these cylinders, the returned product in the smaller cylinders must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, the product in the cylinder is vented to the Silane Guardian. Then the remaining product is purged from the cylinders using nitrogen and evacuated from the cylinders. The cylinders are then filled. Filled cylinders are connected to a flow test manifold for testing. The control efficiency for the Silane Guardian is conservatively assumed to be 99 percent for the purpose of calculating controlled CO emissions.

Product Description: Carbon monoxide (CAS 630-08-0) is an odorless and colorless gas. Carbon monoxide can be toxic when encountered in higher concentrations. In the atmosphere however, it is short lived and spatially variable, since it combines with oxygen to form carbon dioxide and ozone.

Process Rates and Emission Estimates: An estimate of the amount of CO in returned CO cylinders to be processed is approximately 300 cylinders with residual product of approximately 10 percent.

- 300 cylinders x 200 gram x 10% = 6,000 grams/yr or 13.23 lb/yr

CO cylinders are processed on a single cylinder station rack in the CO fill room. Only one cylinder can be processed in an hour. The maximum capacity for the largest package is 200 grams; therefore maximum hourly process is 200 grams in one hour.

CO cylinders are flow tested on a six station manifold. Product vented during a typical flow test is approximately 500 grams per six cylinders, with one cylinder flow tested per hour. Projected production is 300 cylinders per yr.

- 300 cylinders/yr x 500 grams ÷ 6 cylinders = 25,000 grams/yr or 55.12 lb/yr
- Maximum Hourly Process Rate (Whole Plant):
  - Processing one cylinder of 200 grams
  - Flow testing of six cylinders of 500 grams
  - Maximum hourly is 200 + 500 = 700 grams/hr or 1.54 lb/hr
- Maximum Annual Process Rate (Whole Plant):
  - 13.23 lb/yr + 55.12 lb/yr = 68.34 lb/yr
- Total Estimated Annual CO Emissions with Controls:
  - 68.34 lb/yr x (1- 0.99) = 0.68 lb/yr from Guardian unit (conservative)

- 0.68 lb/yr x 1 ton/2000 lb = 3.42E-4 tons/yr with controls

- Total Estimated Hourly (24 hr Avg.) CO Emissions with Controls:
  - 68.34 lb/yr / 260 operating days/yr = 0.26 lb/day
  - 0.26 lb/day / 20 operating hours/day = 0.013 lb/hr
  - 0.013 lb/hr x (1- 0.99) = 1.31E-4 lb/hr from Guardian unit (conservative)
  - 1.31E-4 lb/hr x 1 ton/2000 lb = 6.57E-8 tons/hr

2.23 Carbon Dioxide Fill, Process, and Flow Test

Process Description: Carbon dioxide (CO_2) arrives on site in cylinders and is transfilled into smaller cylinders for sale to customers. Prior to transfilling into these cylinders, the returned product in the smaller cylinders must be completely removed to ensure the very high purity of the product the semiconductor industry requires. To accomplish the removal of this returned product, the product in the cylinder is vented to the atmosphere. Then the remaining product is purged from the cylinders using nitrogen and evacuated from the cylinders. The cylinders are then filled. Filled cylinders are connected to a flow test manifold for testing.

Product Description: Carbon dioxide (CAS 124-38-9) is an asphyxiant. CO_2 is a nonflammable, colorless, odorless gas at room temperature.

Process Rates and Emission Estimates: An estimate of the amount of CO_2 in returned CO_2 cylinders to be processed is approximately 300 cylinders per year with residual product of approximately 10 percent.

- 300 cylinders x 200 gram x 10% = 6,000 grams/yr or 13.23 lb/yr

CO_2 cylinders are processed on a single cylinder station rack in the CO_2 fill room. Only one cylinder can be processed in an hour. The maximum capacity for the largest package is 200 grams; therefore maximum hourly process is 200 grams in one hour.

CO_2 cylinders are flow tested on a six station manifold. Product vented during a typical flow test is approximately 500 grams per six cylinders, with one cylinder flow tested per hour. Projected production is 300 cylinders/yr.

- 300 cylinders x 500 grams ÷ 6 cylinders = 25,000 grams/yr or 55.12 lb/yr
- Maximum Hourly Process Rate (Whole Plant)
  - Processing one cylinder of 200 grams
  - Flow testing of six cylinders of 500 grams
  - Maximum hourly is 200 + 500 = 700 grams/hr or 1.54 lb/hr
- Maximum Annual Process Rate (Whole Plant)
  - 13.23 lb/yr + 55.12 lb/yr = 68.34 lb/yr

2.24 Methyl Fluoride Analytical Testing

Process Description: Full methyl fluoride (CH_3F) cylinders are connected to an analytical test manifold for testing.

Product Description: Methyl fluoride (CAS 593-53-3) is a flammable gas and is harmful if inhaled or ingested. CH_3F can cause blister, frostbite, and blurred vision if it comes in contact with the eyes or skin.

Process Rates: Analytical testing of CH_3F cylinders is conducted on a six station manifold. Product vented during a typical analytical test is approximately 30 grams per cylinder in one hour. Projected production is 275 cylinders/month.

- 275 cylinders/month x 30 gram x 12 months = 99,000 grams/yr or 218.3 lb/yr
- Maximum Hourly Process Rate (Whole Plant):
  - Analytical testing of six cylinders of 180 grams
  - Maximum hourly is 180 grams/hr or 0.40 lb/hr (no controls)
  - 0.40 lb/hr used = 0.4 lb/hr vented to atmosphere
- Maximum Annual Process Rate (Whole Plant):
  - 218.3 lb/yr (no controls)
  - 218.3 lb/yr used = 218.3 lb/yr vented to atmosphere

2.25 Nitrous Oxide for Product Repackaging

Process Description: The facility anticipates an annual throughput of 150,000 lbs of N_2O once the new process is fully implemented. This gas will be obtained from offsite and repackaged into cylindrical containers each holding 50 lbs of N_2O. A new 20-ton bulk tank will be installed to store the N_2O.

Process Rates and Emission Estimates: Estimates for the amount of N_2O emissions anticipated are based on conservative estimates for the amount emitted per cylinder repackaged, as well as general losses including fugitive emissions. The annual emissions were calculated as follows:

- Estimated throughput of N_2O: 150,000 lb/yr
- N_2O per packaged cylinder: 50 lb/cylinder
- Cylinders packaged annually: (150,000 lb/yr) / (50 lb/cylinder) = 3,000 cylinders
- Estimated emission of N_2O per cylinder packaged: 1 lb
- Estimated emissions from packaging: 3,000 cylinders x 1 lb/cylinder = 3,000 lb N_2O/yr
- Estimated emissions from processing losses and fugitive emissions: 0.667 lb/cylinder
- Estimated emissions from processing losses and fugitive emissions: 0.667 lb/cylinder x 3,000 cylinders/yr = 2,000 lb N_2O/yr.
- Total estimated N_2O emissions: 3,000 + 2,000 = 5,000 lb N2O/yr.

2.26 Nitrogen Trifluoride for Product Storage

The facility plans to store bulk quantities of NF_3. The NF_3 will not be handled other than for storage and as such, no emissions are anticipated.

2.27 Acetylene for Product Storage

The facility plans to store bulk quantities of acetylene (C_2H_2). The C_2H_2 will not be handled other than for storage and as such, no emissions are anticipated.

3 Control Equipment Descriptions

3.1 Description of Control Equipment

This section contains a description of all control equipment for which permits are required. See each process description above for details.

3.1.1 Ventilation Emergency Scrubber #1 (VES-1)

This ventilation emergency scrubber system is designed to ventilate all production personnel areas (except dichlorosilane, trichlorosilane, fluorinated products, and ammonia), the synthesis production rooms, many of the production fill hoods, and the analytical services areas. Ventilated air flow rate is measured as it enters the scrubber tower where it is "washed" with a four percent solution of potassium permanganate. The "washed" air is then exhausted out a vent stack where the quality is measured (monitored for hydride gases and hydrogen chloride) to comply with Linde engineering and operations standards.

Equipment	Manufacturer	Description
Scrubber Unit	Construction International, Inc.	Countercurrent packed column wet scrubber, Diameter = 12 ft, Column height = 50 ft, Packing height = 20 ft, Stack Height = 105 ft, Stack Diameter = 46 in. with a 40 inch outlet nozzle
Scrubber Fan	International Industrial, Inc.	Model RT3-455
Fan Motor	Reliance	Duty Master A/C motor frame 447T, Type P, Design B, 250 HP, 460 volts, 3 phase, 1785 RPM
Scrubber Pump	Goulds Pump, Inc	Model 3405, 3,200 GPM capacity, 1780 RPM
Packing	Jaeger	3.5” tri-packs

3.1.2 Arsine Guardians and Baghouses

The arsine disposal systems are designed to thermally oxidize the gaseous process vent streams containing arsine and its mixtures and diethyltelluride and its mixtures. The systems have two major components: a Guardian thermal oxidation system and a particle collector (baghouse).

The Guardians accept gaseous process vent streams from a number of sources in the arsine synthesis, purification, processing, laboratory, and filling areas. The gaseous vent streams are burned in the Guardian reaction chamber along with coincinerant hydrogen which is used to elevate the reaction chamber temperature to a suitable level. A nominal 1,300 standard cubic feet per minute (scfm) air flow is maintained through the Guardian. This air flow provides oxygen for combustion and for cooling the exhaust stream.

Solid combustion products (mostly arsenic trioxide) are carried by the airflow from the Guardian to the baghouse where they are collected for later disposal. Filtered air exiting the baghouse is directed to VES-1. Arsine gas that is not completely thermally oxidized in the Guardian will react with the permanganate solution in VES-1.

Arsine Guardian 1 and Baghouse 1B were installed during the original Kingman plant construction. They had been previously used at Phoenix Research Corporation in La Mesa, California. Baghouse 1A was later installed between Guardian 1 and Baghouse 1B. Arsine Guardian 1 and its baghouses service the synthesis rooms 100, 200, 10000 and many of the purification, filling, and lab systems. Arsine Guardian 1 is also used for diethyltelluride.

Arsine Guardian 2 and Baghouse 2 were installed in June 2001 and they service synthesis room 16000, synthesis room 16200, and one of the cylinder processing systems.

Equipment	Manufacturer	Description
AsH_3 Guardian 1	Hoechst Celanese	Model: Guardian 8
AsH_3 Guardian 2	ATMI	Model: Guardian 8, Part #: G8-LH24-050-NN
AsH_3 Baghouse 1A	Mikropul Environmental Systems	Model: 64S8 TRH"C"
AsH_3 Baghouse 1B	Hoechst Celanese	Unknown, no name plate
AsH_3 Baghouse 2	Mikropul Environmental Systems	Model: 64S8 TRH

3.1.3 Silane Guardian and Baghouses

The Silane disposal system is designed to thermally oxidize the gaseous process vent streams containing silane and its mixtures and diborane and its mixtures. Additionally, the Silane guardian oxidizes carbon monoxide vent streams. The system has three major components: a Guardian thermal oxidation system and two particle collectors (baghouses).

The Guardian accepts gaseous process vent streams from a number of sources in the silane, diborane, and carbon monoxide processing, filling, and laboratory areas. The gaseous vent streams are burned in the Guardian reaction chamber along with coincinerant hydrogen which is used to elevate the reaction chamber temperature to a suitable level. A nominal 1,300 scfm air flow is maintained through the Guardian. This air flow provides oxygen for combustion and for cooling the exhaust stream.

Solid combustion products (silicon dioxide and boron oxide) are carried by the airflow from the Guardian to the baghouses where they are collected for later disposal. Silica tends to plug filter bags rapidly and generally the bags cannot be cleaned while online. Therefore two baghouses have been installed in parallel; while one is online the other is in a cleaning cycle. Filtered air exiting the baghouses is directed to VES-1. Silane or diborane gas that is not completely thermally oxidized in the Guardian is hydrolyzed in the permanganate solution in VES-1. Carbon monoxide is oxidized to carbon dioxide.

The Silane Guardian and baghouses were installed during the original Kingman plant construction.

Equipment	Manufacturer	Description
SiF_4 Guardian	MG Industries	Model: Guardian 8
Silane Baghouses 1 and 2	STACLEAN™ Diffuser Co.	Model: 49-8-ADR Filter Area: 602 square feet Cloth Type: 8.5 oz. Gore-Tex w/Gore-Tex membrane Removal Efficiency: 99.9 % on all particulate > or = 1/2 micron Flow Rate: 1800 acfm

3.1.4 Phosphine Guardian and Dynawave

The phosphine (PH_3) disposal system is designed to thermally oxidize the gaseous process vent streams containing phosphine and its mixtures. The system has two major components: a Guardian thermal oxidation system and a Dynawave wet scrubber.

The Guardian accepts gaseous process vent streams from a number of sources in the phosphine synthesis, purification, processing, filling, and laboratory areas. The gaseous vent streams are burned in the Guardian reaction chamber along with coincinerant hydrogen which is used to elevate the reaction chamber temperature to a suitable level. A nominal 1,300 scfm air flow is maintained through the Guardian. This air flow provides oxygen for combustion and for cooling the exhaust stream.

Solid combustion products (mostly phosphorous pentoxide) are carried by the airflow from the Guardian to the Dynawave wet scrubber where they are reacted with water to form phosphoric acid. Filtered air exiting the Dynawave is directed to the VES-1. Phosphine gas that is not completely thermally oxidized in the Guardian reacts with the permanganate solution in VES-1.

The phosphine Guardian and Dynawave were installed during the original Kingman plant construction.

Equipment	Manufacturer	Description
PH_3 Guardian	Hoechst Celanese	Model: Guardian 8
PH_3 Dynawave	Monsanto Enviro-Chem	Reverse jet scrubbing system with sump and mist eliminator Design air flow: 1000 scfm Temperature: 392 F Pressure: -50.565" w.c.

3.1.5 Chlorosilane Caustic Wet Scrubbers

The dichlorosilane and trichlorosilane disposal systems are designed to react with the process vent streams containing dichlorosilane and trichlorosilane. The system is composed of four wet scrubbers (two for dichlorosilane and two for trichlorosilane) and a programmable logic controller that controls all four scrubbers.

The wet scrubbers accept process vent streams from a number of sources in the dichlorosilane and trichlorosilane purification, processing, filling, and laboratory areas. The vent streams are reacted with a sodium hydroxide solution to form siloxanes, sodium chlorides salts, hydrogen chloride gas, and hydrogen gas. Any hydrogen chloride byproduct gas is further reacted with the sodium hydroxide solution in the packed tower section. A nominal 200 scfm air flow is maintained through the wet scrubber. This air flow provides a way to remove byproduct gases and also cools the scrubbing solution.

Process gas or byproduct gas that is not completely reacted in the caustic wet scrubber reacts with the permanganate solution in VES-3.

Wet scrubbers A and B were installed in February 2002 to replace a single wet scrubber which was installed in 1998. Wet scrubbers C and D were installed in May 2003.

Equipment	Manufacturer	Description
TCS Wet Scrubber A	Advanced Air Technologies	Apollo Series acid gas scrubber, 2 ejectors, 400 gal rectangular sump, 20” diameter packed tower, 2” Jaeger tri-packs
DCS Wet Scrubber B	Advanced Air Technologies	Apollo Series acid gas scrubber, 2 ejectors, 400 gal rectangular sump, 20” diameter packed tower, 2” Jaeger tri-packs
DCS Wet Scrubber C	Advanced Air Technologies	Apollo Series acid gas scrubber, 2 ejectors, 800 gal rectangular sump, 20” diameter packed tower, 2” Jaeger tri-packs
TCS Wet Scrubber D	Advanced Air Technologies	Apollo Series acid gas scrubber, 2 ejectors, 400 gal rectangular sump, 20” diameter packed tower, 2” Jaeger tri-packs

3.1.6 Process Caustic Wet Scrubber

The silicon tetrafluoride, germanium tetrafluoride, and enriched boron-11 trifluoride disposal systems are designed to react with the process vent streams containing silicon tetrafluoride, germanium tetrafluoride, and enriched boron-11 trifluoride. The system is composed of two wet scrubbers (one for process system vents [process wet scrubber] and one for ventilation [ventilation emergency scrubber]).

The process wet scrubber accepts process vent streams from a number of sources in the silicon tetrafluoride and germanium tetrafluoride processing, filling and flow testing areas and the enriched boron-11 trifluoride flow test area. The vent streams are reacted with a sodium hydroxide solution to form sodium fluoroborate, boric oxide, sodium fluoride, sodium silicate, germanium oxide, fluorogermanic acid, and hydrofluoric acid which is then neutralized. Any other byproduct gas is further reacted with the sodium hydroxide solution in the packed tower section. A nominal 50 scfm air flow is maintained through the process wet scrubber. This air flow provides a way to remove byproduct gases and also cools the scrubbing solution. The process wet scrubber has a designed efficiency of 98 percent as stated by the manufacturer.

Process gas or byproduct gas that is not completely reacted in the process wet scrubber reacts with the caustic solution in VES-2.

Equipment	Manufacturer	Description
Process Wet Scrubber	Advanced Air Technologies	Apollo Series 50 acid gas scrubber, 1 ejector, 400 gal cylindrical sump, 20" diameter packed tower, 2" Jaeger tri-packs

3.1.7 Process Dry Scrubber (PDS-1)

The fluorine mix disposal systems are designed to react with the process vent streams containing fluorine, argon, neon, xenon, and krypton in varying quantities. The system is composed of a dry scrubber for process system vents. Effluent from this scrubber is directed to VES-2. Ventilation for the fluorine systems is provided by the ventilation emergency scrubber. The ventilation emergency scrubber is discussed separately in **Section 3.1.8**.

The process dry scrubber accepts process vent streams from a number of sources in the fluorine mix filling, processing, and analytical testing. The vent streams are reacted with activated alumina. A nominal 3.5 scfm flow is sent to the process dry scrubber. The process dry scrubber has a designed efficiency of 98 percent as stated by the manufacturer.

Process gas or byproduct gas that is not completely reacted in the process dry scrubber reacts with the solution in the ventilation emergency scrubber.

Equipment	Manufacturer	Description
Process Dry Scrubber	CS Clean Systems Inc.	CS200BS. 200 liter capacity of activated alumina with endpoint sensor. Single column

3.1.8 Ventilation Emergency Scrubber #2 (VES-2)

VES-2 accepts the process wet scrubber exhaust as well as ventilation exhaust from the fill room. The vent streams are reacted with a sodium hydroxide solution to form sodium fluoroborate, boric oxide, sodium fluoride, sodium silicate, germanium oxide, fluorogermanic acid, and hydrofluoric acid which is then neutralized. Any other byproduct gas is further reacted with the sodium hydroxide solution in the packed tower section. A nominal 1,000 scfm air flow is maintained through the process wet scrubber. The scrubber performance is based on an emission concentration of SiF_4 not to exceed 15 parts per million by volume (ppmv), which is ½-IDLH (Immediately Dangerous to Life and Health) concentration for hydrogen fluoride (HF) in the event of a design leak of the SiF_4 cylinder. The emergency ventilation scrubber has a designed control efficiency of 99.6 percent as stated by the manufacturer.

In addition, VES-2 accepts the process dry scrubber exhaust and ventilation exhaust from the fill hood and fluorine source gas cabinet. The vent streams are reacted with a water solution ($2\ F_2 + 2\ H_2O \rightarrow 4\ HF + O_2$ and $F_2 + 2\ H_2O \rightarrow 2\ HF + H_2O_2$). Any other byproduct gas is further reacted with the water spray in the packed tower section. A nominal 1,000 scfm air flow is maintained through the process wet scrubber. The scrubber performance is based on an emission concentration of F_2 not to exceed 25 ppmv, which is ½-IDLH concentration for F_2 in the event of a design leak. HF concentrations were calculated not to exceed 15 ppmv which is ½-IDLH. The emergency ventilation scrubber has a designed control efficiency of 99.97 percent for fluorine as stated by the manufacturer.

Equipment	Manufacturer	Description
Ventilation Emergency Scrubber #2 (VES-2)	Advanced Air Technologies	Orion Series acid gas scrubber, 1 ejector, 300 gal rectangular sump, 20” diameter packed tower, 2” Jaeger tri-packs

3.1.9 Fluorine Emergency Stack (FES)

The FES controls process upsets from Fluorine and Inert Gas Mix Fill, Process, and Analytical Testing for Lithography. It is an emergency gas release absorber with a performance based on an emission concentration of F_2 not to exceed 12.5 ppmv, which is half the IDLH concentration for F_2 in the event of an emergency. The system is designed to maintain a minimum of 300 cubic feet per minute (CFM) of airflow and a maximum of 1,060 CFM. As designed, the FES controls an F_2 loading of 44 ft^3 over a 5-minute period. This information was used to calculate a design control efficiency of 99.96 percent for F_2. Additional details regarding the equipment are summarized below:

Equipment	Manufacturer	Description
Fluorine Emergency Stack (FES)	CS Clean Solutions	CP500SF, 6.065” diameter, 500-liter CLEANSORB Granulate

3.1.10 Internal Shot Blaster, Abrasive Blasting Unit (ABU-1)

The Internal Shot Blaster (ISB) comes with a dust collector system (GDCA-3), Galiso Part No. 46-41-6009A. The dust collector system is comprised of a Cincinnati Fan (Model 100S) capable of retaining dust particles greater than 5 microns. The dust collector system includes a 700 cfm fan blower (with a 1 hp, 3,450 rpm electric motor), one dust filter bag, galvanized steel attachment nozzles and fittings, and a 5 foot wire reinforced rubber hose and shot catcher box.

The Galiso shot blaster system is designed to efficiently remove surface coatings from empty compressed gas cylinder surfaces while minimizing the quantity of particulates emitted from the dust collector exhaust air. Surface coating (e.g., paint) is removed from compressed gas cylinders in a system that projects steel shot at the cylinder while it rotates in the unit.

3.1.11 Process Caustic Wet Scrubber (VES-3)

This process caustic wet scrubber accepts the process exhaust from the BF_3/B_2H_6 system, the SiF_4/Si_2H_6 mix systems, and additionally, following a permit modification in 2019, Wet Scrubbers A, B, C, and D. Room ventilation exhaust from the fill room goes to VES-1. VES-3 has a gas handling process that handles a process exhaust stream of 20 scfm. Temperature and pressure are ambient. VES-3 is also used to handle the exhaust produced from returned cylinders containing diborane mixtures. This stream comes from multiple processing stations. It is desired to scrub these gases prior to emitting them to atmosphere. An AAT, Inc. Orion Series twin tower chemical scrubber is used for this service (see table below).

Equipment	Manufacturer	Description
Process Caustic Wet	Advanced Air Technologies, Inc.	Orion series twin tower chemical scrubber, counterflow packed tower,

Equipment	Manufacturer	Description
Scrubber (VES-3)		1,400 gallon sump tank, 12 ft x 16 ft x 20 ft tall

The cylinder gases are drawn into the scrubber using an ejector-venturi, which also provides initial scrubbing of the cylinder gases before they are diluted in 5,300 scfm of ambient air. Dilution air is needed to keep all H_2, either as carrier gas or product of chemical reactions, at 25 percent of its lower explosive limit (LEL). The diluted gas mixture is then final scrubbed in twin packed towers utilizing NaOH solution recirculated from the integral 1,400 gallon sump tank. The scrubber system is continuously maintained under slight vacuum using an induced draft fan situated just downstream of the scrubber at grade. Caustic (50% NaOH) is automatically dosed into the scrubber based on maintaining the sump liquid pH in the range of 11 to 12. Spent scrubber solution is pumped out and replaced with fresh water and caustic based on solution conductivity.

The Orion Scrubber is designed for - 14 inches water gauge (in. w.g.) at 160°F. The scrubber is installed outdoors in a non-freezing climate. Guy wires or other forms of lateral bracing against wind are required for stack (by others). The overall installation envelope of the scrubber including fan and stack is approximately 12 feet by 16 feet by 20 feet tall. Electrical area classification is non-hazardous. Available power supply is 480/3/60. The recirculation pumps are 2 hp and 10 hp, and the fan is 30 hp. Emissions of BF_3, B_2H_6 and HF are not to exceed half of their respective IDLH values of 25 ppmv, 15 ppmv, and 30 ppmv. Maximum usage of 50 percent NaOH is 1 gpm.

4 Citation and Description of Applicable Requirements

4.1 Minor New Source Review Applicability Assessment

The ADEQ Standard Class II Permit Application (*dated September 7, 2022*) requires a minor new source review (NSR) applicability determination, whereby if a modified source has an increase in the potential to emit of a regulated minor NSR pollutant greater than or equal to the permitting exemption threshold, then that regulated minor NSR pollutant is subject to minor NSR requirements. Under the ADEQ Standard Class II Permit Application, a "regulated minor NSR pollutant" is any pollutant (or its precursors) for which a national ambient air quality standard has been promulgated. The following precursors are emitted at the Facility:

- VOCs and NOx as precursors to ozone
- NOx and sulfur dioxide (SO_2) as precursors to particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)

The permit renewal proposed by this application does not increase the potential to emit of any regulated minor NSR pollutants.

5 Insignificant Activities

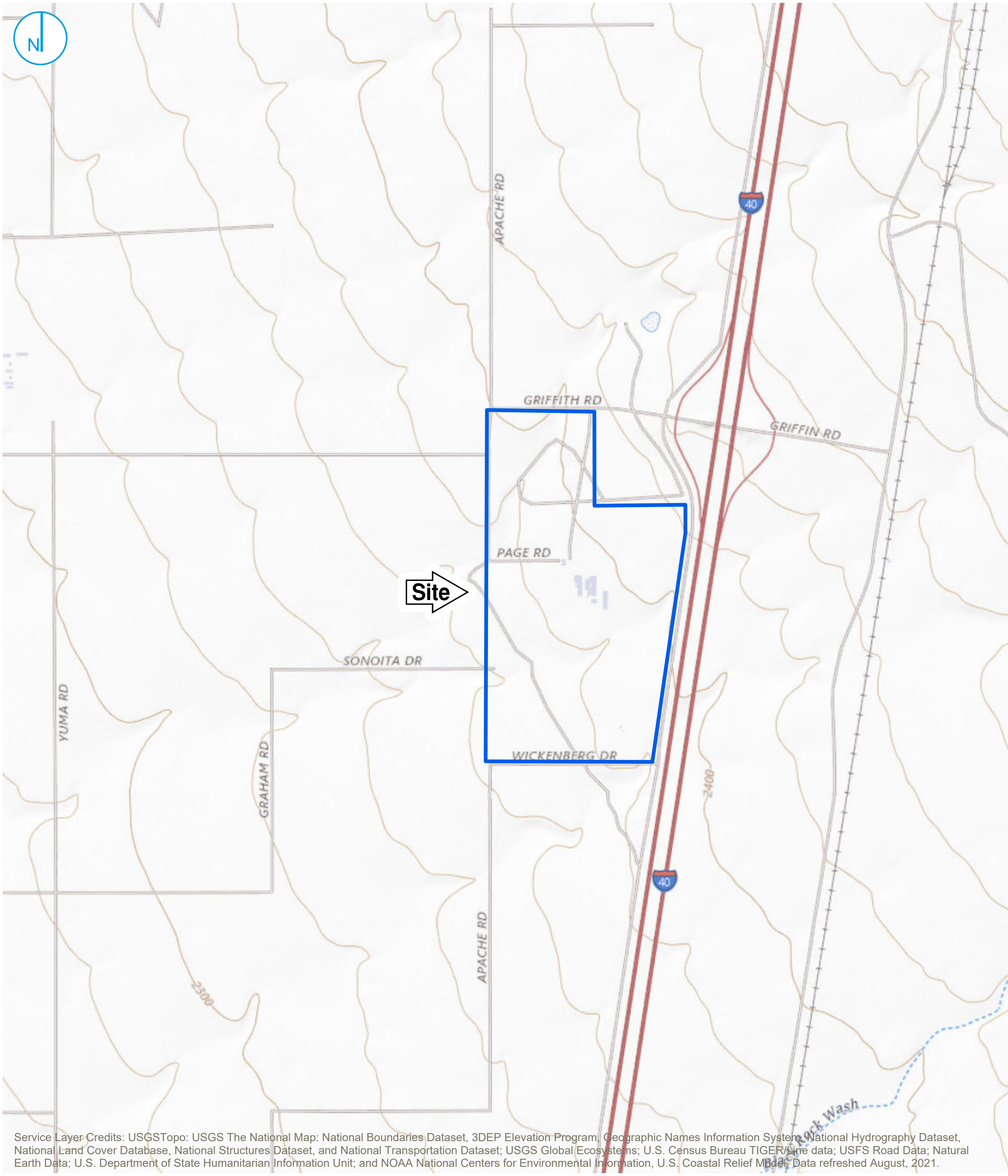
The following is a list of activities identified as "insignificant" as defined in the AAC R18-2-101(68) that take place at the Facility.

- Diesel fuel storage tanks associated with on-site emergency generators [AAC R18-2-101(68)(a)(i)]
- Internal combustion equipment for emergency replacement and engine-driven water pumps [AAC R18-2-101(68)(b)]
- Site maintenance including housekeeping activities [AAC R18-2-101(68)(d)(i)] and architectural painting and associated surface preparation [AAC R18-2-101(68)(d)(iv)]
- Laboratory operations [AAC R18-2-101(68)(e)(i)]
- General office activities, such a paper shredding, copying, and photographic activities [AAC R18-2-101(68)(f)(i)]
- Use of consumer products in the same manner as normal consumer use [AAC R18-2-101(68)(f)(ii)]

Figures

C:\Users\JDKing\Ramboll\Melody Kneale - Projects\Praxair\Kingman, AZ\Praxair - Kingman,AZ.aprx\1 - Site Location

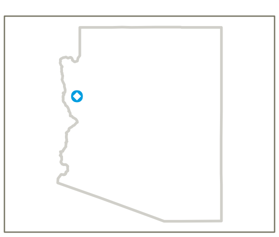
PROJECT: 169000XXXX | DATED: 9/7/2021 | DESIGNER: JDKING



Service Layer Credits: USGSTopo: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

Map Scale: 1:24,000 | Map Center: 114°8'22"W 35°1'41"N

Facility Boundary



KEY MAP (not to scale)

0 1,000 2,000 Feet

SITE LOCATION

FIGURE 01

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY

Linde Gas & Equipment, Inc.
3426 West Griffith Road
Kingman, Arizona

RAMBOLL