Edit: Application Tracking

Air Case ID: 12879 Permit Id: 598

FIN No.: A0385

Company Name: GOLDCORP DEE LLC

HA Basin No: 065 **Increment Tracked** ☐

Permit No: AP10412251 * Select a Permit No

Date App. Received: 03/05/2026 *

Permit Writer: Not Assigned (NA) *

Case Type: NMCP MOPTC New *

Default ODS Date: 03/19/2026 *

Actual ODS Date:

Date App. to be Closed: 05/18/2026 *

Stop Days: **Actual Date App. to be Closed:** 5/18/2026

App. Incomplete? ☐

Date App. Closed:

Fee Paid ($): 5000 *

Case Description:

Comments:

Flag (For Class 4) : None

Update Cancel

AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

RECEIVED
MAR 05 2026
BAPC/BAQP

Mercury Operating Permit to Construct No. AP1041-2251 Application

PREPARED FOR:
GOLDCORP DEE LLC

PROJECT NO. 430-1-1
FEBRUARY 2026

Table of Contents

General Information ..... Page 2

APPLICATION

Mercury Operating Permit to Construct Application Cover Page .....Page 3
General Company Information .....Page 4

Additional Forms
Mercury Unit Application Form ..... Appendix 1

Monitoring/Testing Plan ..... Appendix 2

Nevada MACT (NvMACT) Analysis ..... Appendix 3

De minimis emissions Request ..... Appendix 4

Application Certification ..... Appendix 5

State of Nevada
Division of Environmental Protection
Bureau of Air Pollution Control

APPLICATION FOR MERCURY OPERATING PERMIT TO CONSTRUCT

Please return to:

Nevada Division of Environmental Protection
Bureau of Air Pollution Control, Permitting Branch
901 South Stewart Street
Carson City, Nevada 89701-5249
(775) 687-9350 FAX (775) 687-6396

General Information

- This application is available from the Bureau of Air Pollution Control in a Microsoft Word file, or on the internet at http://www.ndep.nv.gov/bapc. All information required in the application may be computer generated and submitted to the Bureau on compact disk(s) or DVD(s). In addition, one printed copy must be submitted.
- All information required by the "General Company Information" and by the relevant forms in the Appendices must be completed.
- The application filing fee required by NAC 445B.3689 must be submitted with the completed application. Checks must be made payable to: "Nevada State Treasurer, Environmental Protection".
- This application packet shall be used for Tier 1, Tier 2 thermal units that emit mercury, for construction of new thermal units that emit mercury, for de minimis designation and construction and installation projects for thermal units that emit mercury at new and existing stationary sources.
- An application for a mercury operating permit to construct must be signed by a responsible official, as defined in Section NAC 445B.297.1. The certification/signature page is contained in Appendix 5.
- All items in the application must be addressed. If an item does not apply, please indicate so with "N/A" or similar notation in the appropriate blank. All other information must be provided. Incomplete applications will be returned to the responsible official.

Application for Mercury Air Quality Operating Permit to Construct

GENERAL COMPANY INFORMATION

All applicants shall complete each item or explain in the space provided why no information is needed. Please specify "N/A" (Not Applicable) if necessary. The application will be returned to the applicant if it is deemed incomplete.

1. **COMPANY NAME AND ADDRESS THAT ARE TO APPEAR ON THE OPERATING PERMIT** [NAC 445B.3671.1 and NAC 445B.3681.1]:

Goldcorp DEE LLC – Lone Tree Mine
(Name)

5190 Neil Rd, Suite 460
(Address)

Reno	**NV**	**89502**
(City)	(State)	(Zip Code)

2. Owner's Name and Address [NAC 445B.295.1]:

Goldcorp DEE LLC
(Name)

5190 Neil Rd, Suite 460
(Address)

Reno	**NV**	**89502**
(City)	(State)	(Zip Code)

3. Source Name and Mailing Address, if different from #1 [NAC 445B.3671.1 and NAC 445B.3681.1]:

N/A, Same as #1
(Name)

(Address)

(City)	(State)	(Zip Code)

4. Physical Location of Stationary Source [NAC 445B.3671.2 and NAC 445B.3681.7]: (if no physical address, describe location, e.g., 4 miles south of I-80 at xx Interchange)

291000 Lone Tree Mine Road, Valmy, NV 89438

Township(s):	**34**	N;	Range(s):	**42**	E;	Section(s): **1-3, 10-17. 21-24, 28-29, and 31-32**
	34			**43**		**18**
	33			**41**		**1**
	33			**42**		**5 and 6**

5. Responsible Official Name, Title and Address [NAC 445B.295.1]:

Mark Miller	**VP, Environmental & Permitting**	
(Name)	(Title)	

5190 Neil Rd, Suite 460
(Address)

Reno	**NV**	**89502**
(City)	(State)	(Zip Code)

(775) 397-3430	**N/A**	**mmiller@i80gold.com**
(Telephone #)	(FAX #)	(E-mail address)

6. Plant Manager or Other Appropriate Contact [NAC 445B.3671.1 and NAC 445B.3681.1]:

Shawn Lawson	**Lone Tree Site Manager**	
(Name)	(Title)	
291000 Lone Tree Mine Road		
(Address)		
Valmy	**NV**	**89438**
(City)	(State)	(Zip Code)
(775) 304-0286	**N/A**	**slawson@i80gold.com**
(Telephone #)	(FAX #)	(E-mail address)

7. If records required under the operating permit will be kept at a location other than the source, specify that location [NAC 445B.3671.5 and NAC 445B.3681].

N/A – Records will be kept onsite		
(Name)		
(Address)		
(City)	(State)	(Zip Code)

APPLICATION INFORMATION

8. This application is submitted for (please check appropriate box below):

Phase 1 Application

☐ Tier 1 Unit(s) – Please provide the following:

a. An identification and description of any equipment for control of mercury emissions from all existing thermal units that emit mercury, including any presumptive NvMACT controls. In addition to the identification and description, please complete Section 5 of the Mercury Unit application form in Appendix 1. A separate Mercury Unit application form is required for each thermal unit that emits mercury. [NAC 445B.3673.1]
b. A proposed monitoring plan for each thermal unit that emits mercury consistent with the requirements of NAC 445B.3673.2(a). Include the plan in Appendix 2.
c. For each requested mercury early reduction credit, the additional controls that are proposed to be implemented to reduce mercury emissions. [NAC 445B.3671.6]

☐ Tier 2 Unit(s) – Please provide the following:

a. An identification and description of any equipment for control of mercury emissions from all existing thermal units that emit mercury, including any presumptive NvMACT controls. In addition to the identification and description, please complete Section 5 of the Mercury Unit application form in Appendix 1. A separate Mercury Unit application form is required for each thermal unit that emits mercury. [Section 33.1 of amended NAC 445B]
b. A proposed monitoring plan for each thermal unit that emits mercury consistent with the requirements of Section 33.2(b) of amended NAC 445B. Include the plan in Appendix 2.

Phase 2 Application

☐ Tier 1 or Tier 2 Unit(s) – Please provide the following:

a. A proposed monitoring plan consistent with the requirements of NAC 445B.3675.2. Include the plan in Appendix 2.
b. The NvMACT analysis for each thermal unit that emits mercury consistent with the requirements of NAC 445B.3675.1. Include the analysis in Appendix 3.

☒ **New or Modified Thermal Unit that Emits Mercury**

a. Please provide the NvMACT analysis for each thermal unit that emits mercury consistent with the requirements of NAC 445B.3681.6. Include the analysis in Appendix 3.

☐ **Request for De Minimis Designation**

a. For a request for determination of de minimis mercury emissions, include a de minimis demonstration in Appendix 4. De minimis status is considered for each thermal unit. Demonstration must be at the individual unit level, but include cumulative impact of all de minimis units at a facility. [NAC 445B.3613 and NAC 445B.3657.3]
b. De minimis demonstration must include, at a minimum: identification of the proposed thermal unit, a process description, location, unit manufacturer, unit model, serial number and fuel type used (or specify if electric). Identify if any exhaust stacks are shared and if mercury emission controls are utilized. [NAC 445B.295]
c. Include potential to emit values based on unit operation at maximum design capacity at 8,760 hours per year. Supply laboratory test results, performance stack test results and calculations implemented to calculate potential to emit mercury emissions. Include a thorough discussion of any assumptions. [NAC 445B.295]
d. Identify under what Air Quality Operating Permit the proposed units are contained and if the proposed units are designated as "insignificant" or "non-permitted items." [NAC 445B.295]

9. The application must also contain:
   a. An identification of each thermal unit that emits mercury. In addition to the identification of each thermal unit that emits mercury, please complete Section 1 of the Mercury Unit application form in Appendix 1. Complete a separate Mercury Unit application form for each thermal unit that emits mercury. [NAC 445B.3671.2 and NAC 445B.3681.2]
   b. A description of the production rates, operating schedules, fuels, fuel use and raw materials to be used for each thermal unit that emits mercury. In addition to the description, please complete Sections 2 and 3 of the Mercury Unit application form in Appendix 1. Complete a separate Mercury Unit application form for each thermal unit that emits mercury. [NAC 445B.3671.3 and NAC 445B.3681]
   c. Limitations on the operation of stationary source or thermal unit that emits mercury or any work practices which may affect mercury emissions from the thermal unit that emits mercury. Use Sections 4 and 5 of the Mercury Unit application form in Appendix 1. Complete a separate Mercury Unit application form for each thermal unit that emits mercury. [NAC 445B.3671.4 and NAC 445B.3681.4]
   d. Requested emissions limits. Use Section 7 of the Mercury Unit application form in Appendix 1. Complete a separate Mercury Unit application form for each thermal unit that emits mercury. [NAC 445B.3671.7 and NAC 445B.3681.7]

11. Will the construction occur in more than one phase? ☐ Yes ☒ No

If the construction will occur in more than one phase, please provide the projected date of the commencement for each phase of construction (include additional phases if necessary): [NAC 445B.3687]

Phase 1: _____
Phase 2: _____
Phase 3: _____

12. **For Application Submittal:**
Please remove the cover page, Table of Contents and General Information page. Submit the remainder of the application packet as your formal application. This should consist of, at a minimum, the Mercury Operating Permit to Construct Application cover page, the general Company Information and Application Information, and any applicable Appendices.

Appendix 1

THERMAL MERCURY EMITTING UNIT APPLICATION FORM

Instructions

PLEASE RESPOND SEPARATELY TO ITEMS 1 through 7 FOR EACH EMISSION UNIT, as appropriate. Each emission unit at the stationary source must be identified by completion of the application form contained in this appendix. The forms may be duplicated for as many thermal mercury emission units as needed. Complete all applicable attachments (**Appendix 1**) included in this application package [NAC 445B.295].

Section 1. Equipment Description: Describe the processes and products by SIC, including any associated with an alternative operating scenario identified in this application, model number, manufacture date, dimensions and UTM coordinates.

Section 2. Design Rate/Operating Parameters: Describe all production rates, operating schedules and materials used in the process.

Section 3. Fuel Usage: Describe all fuels and fuel usage.

Section 4. Pollution Control Equipment/Exhaust Stack Parameters: Identify and describe all air pollution control equipment.

Section 5. Work Practice Standards: provide information on limitations on the operation or any standards for work practices which affect emissions for all regulated air pollutants. [NAC 445B.295.5]

Section 6. Compliance Monitoring Devices and Activities: Identify and describe any equipment for the control of air pollution and any devices or activities for monitoring compliance with emission limitations.

Section 7. Requested Emission Limits: Provide the requested emission limits for each emission unit. Include the emission rates of total mercury . The emission rates must be described in pounds per hour and pounds per year and any other units of measure for mercury emissions as may be proposed.

Alternative Operating Scenarios: Complete a separate application form for each emission unit having an alternative operating scenario. *(A common example of an alternative operating scenario is a steam boiler that utilizes natural gas as the primary fuel, but may combust diesel fuel as an alternate fuel source).* Please check the box in the upper right hand corner of each application form for emission units requesting an alternative operating scenario. Additionally, for each emission unit application form requesting an alternative operating scenario:

1. Define each alternative operating scenario;
2. Provide an alternative monitoring plan for each unit, for which an alternative operating scenario is requested, in Appendix 2, if different from the monitoring plan provided for the primary operating scenario. Contemporaneous log entries must be provided every time the source changes from one scenario to another.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
MERCURY OPERATING PERMIT TO CONSTRUCT

☐Check here if this is an alternative operating scenario

Section 1 - Equipment Description

a. Type of equipment **Autoclave (System 17, TU4.001)**

b. Standard Industrial Classification (SIC) Code **1041**

c. Manufacturer of equipment **Not Specified**

d. Model number **Not Specified** Serial number **Not Specified** *Equip. number **Not Specified**

e. Date equipment manufactured: **Not Specified**

f. UTM Coordinates **4,518,734** meters N; **480,361** meters E; Zone 11
(Please specify NAD 27 ☐ or NAD 83 ☒; Method used to obtain coordinates: ***Site Plan***)

g. Basic equipment dimensions (feet): L **N/A** W **N/A** H **N/A**

*The equipment number is the facility's own numbering system for this piece of equipment.

Section 2 - Design Rate/Operating Parameters

a. Maximum design capacity (tons per hour) **180**

b. Requested operating rate (tons per hour)* **N/A**

c. Requested operating time: (time of day)* **N/A** to _____

Hours per day _____ Days per year _____

d. Batch load or charge weight (tons) (if applicable) **N/A**

e. Total hours required to process batch or charge (if applicable) **N/A**

f. Maximum operating rate (tons per year) **No limit requested**

g. Requested operating rate (tons per year)* **N/A**

f. Type of material processed **Ore**

*Note: Please complete if other than the maximum design capacity (tons per hour and tons per year) and/or the maximum hours of operation (24 hours per day, 8,760 hours per year) are being requested. The permit will be limited to these values.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Autoclave

Section 3 - Fuel Usage / Heat Source – N/A

Electric Unit ☐

Type of Fuel	**Amount Used Per Hour**	**Heat Content (specify in Btus)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**
Oil- Specify Type(s)					
	gallons				
	gallons				
Gasoline	gallons				
Propane	cubic feet				
Natural Gas	cubic feet				
*Waste Oil	gallons				
Other					

Type of Coal Fuel	**Amount Used Per Hour (tons)**	**Heat Content (specify in BTUs)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**	**Percent moisture**	**Percent volatile matter**	**Percent fixed carbon**
Coal - Specify Type(s)								

If more than one type of fuel is combusted, under this operating scenario please specify primary fuel and percentage on a maximum hourly and annual basis (if fuel blending is the primary fuel, identify percentages of each fuel blended). Attach additional information to this form if necessary.

*Firing of waste oil will require multi metals test to insure fuel is non-hazardous.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Autoclave

Section 4 - Pollution Control Equipment/Exhaust Stack Parameters (this section *must* be completed)
-Complete for emissions **exhausting through a stack, chimney or vent**: (baghouse, wet scrubber, cyclone, sulfur impregnated carbon filter, uncontrolled stack, etc.)

	Gas Conditioning	Control #1	Control #2
Type of Control (See **Note 1**)	**Quench Vessel**	**Venturi Scrubber (VS-001)**	**Carbon Bed (CA-001)**
Pollutant(s) Controlled	**Gas Conditioning**	**Particulates & Mercury**	**Mercury**
Manufacturer	**Not Specified**	**Not Specified**	**Not Specified**
Manufacturer's Guarantee (see **Note 2**)	**N/A**	**N/A**	**N/A**
Stack height (feet from ground level)	**N/A**	**N/A**	**95**
Stack inside diameter (feet)	**N/A**	**N/A**	**1.6**
Temperature (°F) at design capacity	**N/A**	**N/A**	**220**
Stack exit velocity (feet per second)	**N/A**	**N/A**	**91**
Gas volume flow rate: Actual cubic feet per minute	**N/A**	**N/A**	**11,000**
Gas volume flow rate: Dry standard cubic feet per minute	**N/A**	**N/A**	**8,300**
Unusual stack characteristics (e.g. raincap, horizontal discharge)	**To Venturi Scrubber**	**To Carbon Bed**	**N/A**

Note 1: Specify "uncontrolled" if no pollution control device is installed.
Note 2: Manufacturer's guarantee of control efficiency must be attached to this form.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Autoclave

Section 5 - Identify and Describe Work Practice Standards, Etc. (attach additional pages if necessary

(Eg., 1. Baghouse housing and bags will be inspected weekly for holes/leaks.)

Autoclave

(a) **TU4.001** is equipped with a release vent located after the quench vessel and prior to **VS-001**. Use of the release vent shall be limited to **100** hours per year.

Venturi Scrubber (VS-001)

(a) The differential pressure across **VS-001** shall be maintained at or above **13** inches of water, based on a 1-hour period, except during the autoclave warm-up period. The warm-up period is defined as the period of time after start-up during which the autoclave is brought up to steady-state operation. The warm-up period shall not exceed 3 hours.
(b) The water flow rate to **VS-001** shall be maintained at or above **11** gallons per minute, based on a 1-hour period.

Carbon Bed (CA-001)

(a) **CA-001** shall contain at least **17,000** pounds of sulfur-impregnated carbon.
(b) The exhaust temperature entering **CA-001** shall be maintained at or below **220**° Fahrenheit, based on a 1-hour period.
(c) The differential pressure across **CA-001** shall be maintained at or below **25** inches of water, based on a 1-hour period.
(d) Sample and replace the carbon in **CA-001** as follows:
    1. The carbon may be sampled from a sampling canister or by grab sample. The carbon bed may include sampling canisters that will contain the equivalent carbon depth as the carbon filter. These canisters will receive a slip stream of the process gas during operation of **TU4.001**. The Permittee also has the option to directly collect representative carbon samples (grab samples) from the inlet and outlet of **CA-001**. The depth of the sample location will be recorded.
    2. The canister and grab-sample carbon sampling methods specified above may only be alternated at the point of complete carbon replacement in **CA-001**.
    3. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-001** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
        i. EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
        ii. EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
        iii. An alternative test method as approved by the Director.
(e) On an annual basis, perform a total loading analysis on the carbon in **CA-001**.
(f) Any sulfur-impregnated carbon replaced in **CA-001** will be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent or better performing mercury removal media.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Autoclave

Section 6 - Identify and Describe Compliance Monitoring Devices or Activities (attach additional pages if necessary)

(Eg., Emissions from this unit will be monitored by CEMS for mercury.)

The *Permittee* shall:

(a) Monitor the daily throughput of **ore** for **TU4.001**, in tons.
(b) Monitor the daily hours of operation for **TU4.001**.
(c) Monitor the number of hours when the release vent is in use for **TU4.001.**
(d) Monitor the differential pressure across **VS-001** in inches of water, once per day during operation.
(e) Monitor the water flow rate to **VS-001** in gallons per minute, once per day during operation.
(f) Monitor the inlet exhaust temperature for **CA-001** in degrees Fahrenheit, once per shift during operation.
(g) Monitor the differential pressure across **CA-001** in inches of water, once per day during operation.
(h) Monitor **CA-001** for percentage of mercury by weight, quarterly until reaching **50** percent capacity and then monthly until reaching **90** percent capacity.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Autoclave

Section 7 - Proposed Emission Rates

Pollutant	Potential to Emit (pounds/hour*)	Potential to Emit (tons/year)	Calculation (including reference or emissions tests) on Which Emissions Information is Based (attach supporting information including dates of tests/methods, if necessary)
Total Mercury (all forms)	N/A	N/A	
Total Mercury (alternative emissions limitations)	5.0×10^{-3} gr/dscf	N/A	NvMACT Interim Limit (TUTD)

*Note: In addition to lb/hr, alternative emissions limitations (e.g., lb/MMBtu, ppm, grains/dscf) may be requested by the applicant. If alternative emissions limitations are requested, please clearly describe the units in column 2 above. Use additional lines, as needed.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
MERCURY OPERATING PERMIT TO CONSTRUCT

☐ **Check here if this is an alternative operating scenario**

Section 1 - Equipment Description

a. Type of equipment **Carbon Regeneration Kiln (System 21, TU4.002)**

b. Standard Industrial Classification (SIC) Code **1041**

c. Manufacturer of equipment **Not Specified**

d. Model number **Not Specified** Serial number **Not Specified** *Equip. number **Not Specified**

e. Date equipment manufactured: **Not Specified**

f. UTM Coordinates **4,518,765** meters N; **480,375** meters E; Zone 11
(Please specify NAD 27 ☐ or NAD 83 ☒; Method used to obtain coordinates: ***Site Plan***)

g. Basic equipment dimensions (feet): L **N/A** W **N/A** H **N/A**

*The equipment number is the facility's own numbering system for this piece of equipment.

Section 2 - Design Rate/Operating Parameters

a. Maximum design capacity (tons per hour) **0.32**

b. Requested operating rate (tons per hour)* **N/A**

c. Requested operating time: (time of day)* **N/A** to _____

Hours per day _____ Days per year _____

d. Batch load or charge weight (tons) (if applicable) **N/A**

e. Total hours required to process batch or charge (if applicable) **N/A**

f. Maximum operating rate (tons per year) **No limit requested**

g. Requested operating rate (tons per year)* **N/A**

f. Type of material processed **Carbon**

*Note: Please complete if other than the maximum design capacity (tons per hour and tons per year) and/or the maximum hours of operation (24 hours per day, 8,760 hours per year) are being requested. The permit will be limited to these values.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Carbon Regeneration Kiln

Section 3 - Fuel Usage / Heat Source

Electric Unit ☒

Type of Fuel	Amount Used Per Hour	Heat Content (specify in Btus)	Ash Content (% by weight)	Sulfur Content (% by weight)	Trace Elements (% by weight)
Oil- Specify Type(s)					
	gallons				
	gallons				
Gasoline	gallons				
Propane	cubic feet				
Natural Gas	cubic feet				
*Waste Oil	gallons				
Other					

Type of Coal Fuel	Amount Used Per Hour (tons)	Heat Content (specify in BTUs)	Ash Content (% by weight)	Sulfur Content (% by weight)	Trace Elements (% by weight)	Percent moisture	Percent volatile matter	Percent fixed carbon
Coal - Specify Type(s)								

If more than one type of fuel is combusted, under this operating scenario please specify primary fuel and percentage on a maximum hourly and annual basis (if fuel blending is the primary fuel, identify percentages of each fuel blended). Attach additional information to this form if necessary.

*Firing of waste oil will require multi metals test to insure fuel is non-hazardous.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Carbon Regeneration Kiln

Section 4 - Pollution Control Equipment/Exhaust Stack Parameters (this section *must* be completed)
-Complete for emissions **exhausting through a stack, chimney or vent**: (baghouse, wet scrubber, cyclone, sulfur impregnated carbon filter, uncontrolled stack, etc.)

	Gas Conditioning	Gas Conditioning	Gas Conditioning	Control #1
Type of Control (See **Note 1**)	**Knockout Box**	**Heat Exchanger**	**Mist Eliminator**	**Carbon Bed (CA-002)**
Pollutant(s) Controlled	**Gas Conditioning**	**Gas Conditioning**	**Gas Conditioning**	**Mercury**
Manufacturer	**Not Specified**	**Not Specified**	**Not Specified**	**Not Specified**
Manufacturer's Guarantee (see **Note 2**)	**N/A**	**N/A**	**N/A**	**N/A**
Stack height (feet from ground level)	**N/A**	**N/A**	**N/A**	**55**
Stack inside diameter (feet)	**N/A**	**N/A**	**N/A**	**0.33**
Temperature (°F) at design capacity	**N/A**	**N/A**	**N/A**	**200**
Stack exit velocity (feet per second)	**N/A**	**N/A**	**N/A**	**59**
Gas volume flow rate: Actual cubic feet per minute	**N/A**	**N/A**	**N/A**	**310**
Gas volume flow rate: Dry standard cubic feet per minute	**N/A**	**N/A**	**N/A**	**210**
Unusual stack characteristics (e.g. raincap, horizontal discharge)	**To Heat Exchanger**	**To Mist Eliminator**	**To Carbon Bed**	**N/A**

Note 1: Specify "uncontrolled" if no pollution control device is installed.
Note 2: Manufacturer's guarantee of control efficiency must be attached to this form.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Carbon Regeneration Kiln

Section 5 - Identify and Describe Work Practice Standards, Etc. (attach additional pages if necessary

(Eg., 1. Baghouse housing and bags will be inspected weekly for holes/leaks.)

Carbon Regeneration Kiln

(a) The kiln drum will be visually inspected for structural damage and cracks annually.

Heat Exchanger

(a) Condensed mercury from the heat exchanger shall be collected quarterly.

Carbon Bed (CA-002)

(a) **CA-002** shall contain at least **450** pounds of sulfur-impregnated carbon.
(b) The exhaust temperature entering **CA-002** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
(c) The differential pressure across **CA-002** shall be maintained at or below **11** inches of water, based on a 1-hour period.
(d) Sample and replace the carbon in **CA-002** as follows:
Sample the carbon at the inlet and outlet of **CA-002** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-002** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
    i. EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
    ii. EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
    iii. An alternative test method as approved by the Director.
(e) On an annual basis, perform a total loading analysis on the carbon in **CA-002**.
(f) Any sulfur-impregnated carbon replaced in **CA-002** will be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent or better performing mercury removal media.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Carbon Regeneration Kiln

Section 6 - Identify and Describe Compliance Monitoring Devices or Activities (attach additional pages if necessary)

(Eg., Emissions from this unit will be monitored by CEMS for mercury.)

The *Permittee* shall:

(a) Monitor the daily throughput of **carbon** for **TU4.002**, in tons.
(b) Monitor the daily hours of operation for **TU4.002**.
(c) Monitor the amount of mercury drained from the heat exchanger quarterly.
(d) Monitor the inlet exhaust temperature for **CA-002** in degrees Fahrenheit, once per shift during operation.
(e) Monitor the differential pressure across **CA-002** in inches of water, once per day during operation.
(f) Monitor **CA-002** for percentage of mercury by weight, quarterly until reaching **50** percent capacity and then monthly until reaching **90** percent capacity.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Carbon Regeneration Kiln

Section 7 - Proposed Emission Rates

Pollutant	Potential to Emit (pounds/hour*)	Potential to Emit (tons/year)	Calculation (including reference or emissions tests) on Which Emissions Information is Based (attach supporting information including dates of tests/methods, if necessary)
Total Mercury (all forms)	N/A	N/A	
Total Mercury (alternative emissions limitations)	1.0×10^{-4} gr/dscf	N/A	General Industry NvMACT Limit

*Note: In addition to lb/hr, alternative emissions limitations (e.g., lb/MMBtu, ppm, grains/dscf) may be requested by the applicant. If alternative emissions limitations are requested, please clearly describe the units in column 2 above. Use additional lines, as needed.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
MERCURY OPERATING PERMIT TO CONSTRUCT

☐Check here if this is an alternative operating scenario

Section 1 - Equipment Description

a. Type of equipment **Pregnant and Barren Solution Tanks (System 22, TU4.003 & TU4.004)**

b. Standard Industrial Classification (SIC) Code **1041**

c. Manufacturer of equipment **Not Specified**

d. Model number **Not Specified** Serial number **Not Specified** *Equip. number **Not Specified**

e. Date equipment manufactured: **Not Specified**

f. UTM Coordinates **4,518,762** meters N; **480,375** meters E; Zone 11
(Please specify NAD 27 ☐ or NAD 83 ☒; Method used to obtain coordinates: ***Site Plan***)

g. Basic equipment dimensions (feet): L **N/A** W **N/A** H **N/A**

*The equipment number is the facility's own numbering system for this piece of equipment.

Section 2 - Design Rate/Operating Parameters

a. Maximum design capacity (tons per hour) **270 gpm, each**

b. Requested operating rate (tons per hour)* **N/A**

c. Requested operating time: (time of day)* **N/A** to _____

Hours per day _____ Days per year _____

d. Batch load or charge weight (tons) (if applicable) **N/A**

e. Total hours required to process batch or charge (if applicable) **N/A**

f. Maximum operating rate (tons per year) **No limit requested**

g. Requested operating rate (tons per year)* **N/A**

f. Type of material processed **Solution**

*Note: Please complete if other than the maximum design capacity (tons per hour and tons per year) and/or the maximum hours of operation (24 hours per day, 8,760 hours per year) are being requested. The permit will be limited to these values.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Pregnant and Barren Solution Tanks

Section 3 - Fuel Usage / Heat Source – N/A

Electric Unit ☐

Type of Fuel	**Amount Used Per Hour**	**Heat Content (specify in Btus)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**
Oil- Specify Type(s)					
	gallons				
	gallons				
Gasoline	gallons				
Propane	cubic feet				
Natural Gas	cubic feet				
*Waste Oil	gallons				
Other					

Type of Coal Fuel	**Amount Used Per Hour (tons)**	**Heat Content (specify in BTUs)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**	**Percent moisture**	**Percent volatile matter**	**Percent fixed carbon**
Coal - Specify Type(s)								

If more than one type of fuel is combusted, under this operating scenario please specify primary fuel and percentage on a maximum hourly and annual basis (if fuel blending is the primary fuel, identify percentages of each fuel blended). Attach additional information to this form if necessary.

*Firing of waste oil will require multi metals test to insure fuel is non-hazardous.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Pregnant and Barren Solution Tanks

Section 4 - Pollution Control Equipment/Exhaust Stack Parameters (this section *must* be completed)
-Complete for emissions **exhausting through a stack, chimney or vent**: (baghouse, wet scrubber, cyclone, sulfur impregnated carbon filter, uncontrolled stack, etc.)

	Gas Conditioning	Control #1
Type of Control (See **Note 1**)	**Mist Eliminator**	**Carbon Bed (CA-003)**
Pollutant(s) Controlled	**Gas Conditioning**	**Mercury**
Manufacturer	**Not Specified**	**Not Specified**
Manufacturer's Guarantee (see **Note 2**)	**N/A**	**N/A**
Stack height (feet from ground level)	**N/A**	**55**
Stack inside diameter (feet)	**N/A**	**0.50**
Temperature (°F) at design capacity	**N/A**	**200**
Stack exit velocity (feet per second)	**N/A**	**48**
Gas volume flow rate: Actual cubic feet per minute	**N/A**	**570**
Gas volume flow rate: Dry standard cubic feet per minute	**N/A**	**400**
Unusual stack characteristics (e.g. raincap, horizontal discharge)	**To Carbon Bed**	**N/A**

Note 1: Specify "uncontrolled" if no pollution control device is installed.
Note 2: Manufacturer's guarantee of control efficiency must be attached to this form.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Pregnant and Barren Solution Tanks

Section 5 - Identify and Describe Work Practice Standards, Etc. (attach additional pages if necessary

(Eg., 1. Baghouse housing and bags will be inspected weekly for holes/leaks.)

Pregnant and Barren Tanks

(a) **TU4.003** and **TU4.004** will be inspected every six months for leaks and corrosion.

Carbon Bed (CA-003)

(a) **CA-003** shall contain at least **650** pounds of sulfur-impregnated carbon.
(b) The exhaust temperature entering **CA-003** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
(c) The differential pressure across **CA-003** shall be maintained at or below **5** inches of water, based on a 1-hour period.
(d) Sample and replace the carbon in **CA-003** as follows:
Sample the carbon at the inlet and outlet of **CA-003** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-003** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
    i. EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
    ii. EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
    iii. An alternative test method as approved by the Director.
(e) On an annual basis, perform a total loading analysis on the carbon in **CA-003**.
(f) Any sulfur-impregnated carbon replaced in **CA-003** will be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent or better performing mercury removal media.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Pregnant and Barren Solution Tanks

Section 6 - Identify and Describe Compliance Monitoring Devices or Activities (attach additional pages if necessary)

(Eg., Emissions from this unit will be monitored by CEMS for mercury.)

The *Permittee* shall:

(a) Monitor the throughput rate of **solution** for **TU4.003** and **TU4.004,** each, in gallons per minute, once per day during operation.
(b) Monitor the daily hours of operation for **TU4.003** and **TU4.004,** each.
(c) Monitor the inlet exhaust temperature for **CA-003** in degrees Fahrenheit, once per shift during operation.
(d) Monitor the differential pressure across **CA-003** in inches of water, once per day during operation.
(e) Monitor **CA-003** for percentage of mercury by weight, quarterly until reaching **50** percent capacity and then monthly until reaching **90** percent capacity.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Pregnant and Barren Solution Tanks

Section 7 - Proposed Emission Rates

Pollutant	Potential to Emit (pounds/hour*)	Potential to Emit (tons/year)	Calculation (including reference or emissions tests) on Which Emissions Information is Based (attach supporting information including dates of tests/methods, if necessary)
Total Mercury (all forms)	N/A	N/A	
Total Mercury (alternative emissions limitations)	5.0×10^{-5} gr/dscf	N/A	General Industry NvMACT Limit

*Note: In addition to lb/hr, alternative emissions limitations (e.g., lb/MMBtu, ppm, grains/dscf) may be requested by the applicant. If alternative emissions limitations are requested, please clearly describe the units in column 2 above. Use additional lines, as needed.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
MERCURY OPERATING PERMIT TO CONSTRUCT

☐Check here if this is an alternative operating scenario

Section 1 - Equipment Description

a. Type of equipment **Electrowinning Circuit (3 Cells) (System 23, TU4.005)**

b. Standard Industrial Classification (SIC) Code **1041**

c. Manufacturer of equipment **Not Specified**

d. Model number **Not Specified** Serial number **Not Specified** *Equip. number **Not Specified**

e. Date equipment manufactured: **Not Specified**

f. UTM Coordinates **4,518,744** meters N; **480,245** meters E; Zone 11
(Please specify NAD 27 ☐ or NAD 83 ☒; Method used to obtain coordinates: ***Site Plan***)

g. Basic equipment dimensions (feet): L **N/A** W **N/A** H **N/A**

*The equipment number is the facility's own numbering system for this piece of equipment.

Section 2 - Design Rate/Operating Parameters

a. Maximum design capacity (tons per hour) **270 gpm**

b. Requested operating rate (tons per hour)* **N/A**

c. Requested operating time: (time of day)* **N/A** to _____

Hours per day _____ Days per year _____

d. Batch load or charge weight (tons) (if applicable) **N/A**

e. Total hours required to process batch or charge (if applicable) **N/A**

f. Maximum operating rate (tons per year) **No limit requested**

g. Requested operating rate (tons per year)* **N/A**

f. Type of material processed **Solution**

*Note: Please complete if other than the maximum design capacity (tons per hour and tons per year) and/or the maximum hours of operation (24 hours per day, 8,760 hours per year) are being requested. The permit will be limited to these values.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Electrowinning Circuit

Section 3 - Fuel Usage / Heat Source – N/A

Electric Unit ☐

Type of Fuel	**Amount Used Per Hour**	**Heat Content (specify in Btus)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**
Oil- Specify Type(s)					
	gallons				
	gallons				
Gasoline	gallons				
Propane	cubic feet				
Natural Gas	cubic feet				
*Waste Oil	gallons				
Other					

Type of Coal Fuel	**Amount Used Per Hour (tons)**	**Heat Content (specify in BTUs)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**	**Percent moisture**	**Percent volatile matter**	**Percent fixed carbon**
Coal - Specify Type(s)								

If more than one type of fuel is combusted, under this operating scenario please specify primary fuel and percentage on a maximum hourly and annual basis (if fuel blending is the primary fuel, identify percentages of each fuel blended). Attach additional information to this form if necessary.

*Firing of waste oil will require multi metals test to insure fuel is non-hazardous.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Electrowinning Circuit

Section 4 - Pollution Control Equipment/Exhaust Stack Parameters (this section *must* be completed)
-Complete for emissions **exhausting through a stack, chimney or vent**: (baghouse, wet scrubber, cyclone, sulfur impregnated carbon filter, uncontrolled stack, etc.)

	Gas Conditioning	Gas Conditioning	Control #1
Type of Control (See **Note 1**)	**Mist Eliminator**	**Heater**	**Carbon Bed (CA-004)**
Pollutant(s) Controlled	**Gas Conditioning**	**Gas Conditioning**	**Mercury**
Manufacturer	**Not Specified**	**Not Specified**	**Not Specified**
Manufacturer's Guarantee (see **Note 2**)	**N/A**	**N/A**	**N/A**
Stack height (feet from ground level)	**N/A**	**N/A**	**38**
Stack inside diameter (feet)	**N/A**	**N/A**	**1.46**
Temperature (°F) at design capacity	**N/A**	**N/A**	**200**
Stack exit velocity (feet per second)	**N/A**	**N/A**	**79**
Gas volume flow rate: Actual cubic feet per minute	**N/A**	**N/A**	**7,920**
Gas volume flow rate: Dry standard cubic feet per minute	**N/A**	**N/A**	**6,700**
Unusual stack characteristics (e.g. raincap, horizontal discharge)	**To Heater**	**To Carbon Bed**	**N/A**

Note 1: Specify "uncontrolled" if no pollution control device is installed.
Note 2: Manufacturer's guarantee of control efficiency must be attached to this form.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Electrowinning Circuit

Section 5 - Identify and Describe Work Practice Standards, Etc. (attach additional pages if necessary

(Eg., 1. Baghouse housing and bags will be inspected weekly for holes/leaks.)

Electrowinning Circuit

(a) The lids on **TU4.005** shall be closed during operation.

Carbon Bed (CA-004)

(a) **CA-004** is a **two-stage bed**, with each stage containing at least **5,500** pounds of sulfur-impregnated carbon.

(b) The exhaust temperature entering **CA-004** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.

(c) The differential pressure across **CA-004** shall be maintained at or below **9** inches of water, based on a 1-hour period.

(d) Sample and replace the carbon in **CA-004** as follows:
Sample the carbon at the inlet and outlet of **CA-004** or at the inlet and outlet of each stage of **CA-004** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-004** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:

iv. EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;

v. EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or

vi. An alternative test method as approved by the Director.

(e) On an annual basis, perform a total loading analysis on the carbon in **CA-004**.

(f) Any sulfur-impregnated carbon replaced in **CA-004** will be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent or better performing mercury removal media.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Electrowinning Circuit

Section 6 - Identify and Describe Compliance Monitoring Devices or Activities (attach additional pages if necessary)

(Eg., Emissions from this unit will be monitored by CEMS for mercury.)

The *Permittee* shall:

(a) Monitor the throughput rate of **solution** for **TU4.005** in gallons per minute, once per day during operation.
(b) Monitor the daily hours of operation for **TU4.005**.
(c) Monitor the inlet exhaust temperature for **CA-004** in degrees Fahrenheit, once per shift during operation.
(d) Monitor the differential pressure across **CA-004** in inches of water, once per day during operation.
(e) Monitor **CA-004** for percentage of mercury by weight, quarterly until reaching **50** percent capacity and then monthly until reaching **90** percent capacity.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Electrowinning Circuit

Section 7 - Proposed Emission Rates

Pollutant	Potential to Emit (pounds/hour*)	Potential to Emit (tons/year)	Calculation (including reference or emissions tests) on Which Emissions Information is Based (attach supporting information including dates of tests/methods, if necessary)
Total Mercury (all forms)	N/A	N/A	
Total Mercury (alternative emissions limitations)	5.0×10^{-5} gr/dscf	N/A	General Industry NvMACT Limit

*Note: In addition to lb/hr, alternative emissions limitations (e.g., lb/MMBtu, ppm, grains/dscf) may be requested by the applicant. If alternative emissions limitations are requested, please clearly describe the units in column 2 above. Use additional lines, as needed.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
MERCURY OPERATING PERMIT TO CONSTRUCT

☐Check here if this is an alternative operating scenario

Section 1 - Equipment Description

a. Type of equipment **Retort (System 24, TU4.006)**

b. Standard Industrial Classification (SIC) Code **1041**

c. Manufacturer of equipment **Not Specified**

d. Model number **Not Specified** Serial number **Not Specified** *Equip. number **Not Specified**

e. Date equipment manufactured: **Not Specified**

f. UTM Coordinates **4,518,747** meters N; **480,242** meters E; Zone 11
(Please specify NAD 27 ☐ or NAD 83 ☒; Method used to obtain coordinates: ***Site Plan***)

g. Basic equipment dimensions (feet): L **N/A** W **N/A** H **N/A**

*The equipment number is the facility's own numbering system for this piece of equipment.

Section 2 - Design Rate/Operating Parameters

a. Maximum design capacity (tons per hour) **0.26 tons per batch**

b. Requested operating rate (tons per hour)* **N/A**

c. Requested operating time: (time of day)* **N/A** to _____

Hours per day _____ Days per year _____

d. Batch load or charge weight (tons) (if applicable) **0.26**

e. Total hours required to process batch or charge (if applicable) **Not Specified**

f. Maximum operating rate (tons per year) **No limit requested**

g. Requested operating rate (tons per year)* **N/A**

f. Type of material processed **Precious metal bearing material**

*Note: Please complete if other than the maximum design capacity (tons per hour and tons per year) and/or the maximum hours of operation (24 hours per day, 8,760 hours per year) are being requested. The permit will be limited to these values.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Retort

Section 3 - Fuel Usage / Heat Source

Electric Unit ☒

Type of Fuel	Amount Used Per Hour	Heat Content (specify in Btus)	Ash Content (% by weight)	Sulfur Content (% by weight)	Trace Elements (% by weight)
Oil- Specify Type(s)					
	gallons				
	gallons				
Gasoline	gallons				
Propane	cubic feet				
Natural Gas	cubic feet				
*Waste Oil	gallons				
Other					

Type of Coal Fuel	Amount Used Per Hour (tons)	Heat Content (specify in BTUs)	Ash Content (% by weight)	Sulfur Content (% by weight)	Trace Elements (% by weight)	Percent moisture	Percent volatile matter	Percent fixed carbon
Coal - Specify Type(s)								

If more than one type of fuel is combusted, under this operating scenario please specify primary fuel and percentage on a maximum hourly and annual basis (if fuel blending is the primary fuel, identify percentages of each fuel blended). Attach additional information to this form if necessary.

*Firing of waste oil will require multi metals test to insure fuel is non-hazardous.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Retort

Section 4 - Pollution Control Equipment/Exhaust Stack Parameters (this section *must* be completed)
-Complete for emissions **exhausting through a stack, chimney or vent**: (baghouse, wet scrubber, cyclone, sulfur impregnated carbon filter, uncontrolled stack, etc.)

	Control #1	Control #2
Type of Control (See **Note 1**)	**Condenser (CO-001)**	**Carbon Bed (CA-005)**
Pollutant(s) Controlled	**Mercury**	**Mercury**
Manufacturer	**Not Specified**	**Not Specified**
Manufacturer's Guarantee (see **Note 2**)	**N/A**	**N/A**
Stack height (feet from ground level)	**N/A**	**38**
Stack inside diameter (feet)	**N/A**	**0.33**
Temperature (°F) at design capacity	**N/A**	**103**
Stack exit velocity (feet per second)	**N/A**	**17**
Gas volume flow rate: Actual cubic feet per minute	**N/A**	**90**
Gas volume flow rate: Dry standard cubic feet per minute	**N/A**	**75**
Unusual stack characteristics (e.g. raincap, horizontal discharge)	**To Carbon Bed**	**N/A**

Note 1: Specify "uncontrolled" if no pollution control device is installed.
Note 2: Manufacturer's guarantee of control efficiency must be attached to this form.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Retort

Section 5 - Identify and Describe Work Practice Standards, Etc. (attach additional pages if necessary

(Eg., 1. Baghouse housing and bags will be inspected weekly for holes/leaks.)

Retort

(a) During heating of **TU4.006**, the vacuum pressure will be maintained at or above **5** pounds per square inch absolute, based on a 1-hour period.
(b) **TU4.006** shall automatically shut off via interlock if the vacuum pressure is less than **5** pounds per square inch absolute, based on a 1-hour period.

Condenser (CO-001)

(a) The exhaust temperature at the outlet of **CO-001** shall be maintained at or below **85**° Fahrenheit, based on a 1-hour period.
(b) **TU4.006** shall automatically shut off via interlock if the **CO-001** outlet exhaust temperature is above **105**° Fahrenheit, based on a 1-hour period.
(c) Condensed mercury from **CO-001** shall be collected monthly.

Carbon Bed (CA-005)

(a) **CA-005** shall contain at least **530** pounds of sulfur-impregnated carbon.
(b) The exhaust temperature entering **CA-005** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
(c) The differential pressure across **CA-005** shall be maintained at or below **9** inches of water, based on a 1-hour period.
(d) Sample and replace the carbon in **CA-005** as follows:
Sample the carbon at the inlet and outlet of **CA-005** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-005** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
    iv. EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
    v. EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
    vi. An alternative test method as approved by the Director.
(e) On an annual basis, perform a total loading analysis on the carbon in **CA-005**.
(f) Any sulfur-impregnated carbon replaced in **CA-005** will be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent or better performing mercury removal media.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Retort

Section 6 - Identify and Describe Compliance Monitoring Devices or Activities (attach additional pages if necessary)

(Eg., Emissions from this unit will be monitored by CEMS for mercury.)

The *Permittee* shall:

(a) Monitor the batch weight of **precious metal bearing material** for **TU4.006**, in tons, for each batch.
(b) Monitor the daily hours of operation for **TU4.006**.
(c) Monitor the vacuum pressure on **TU4.006** in pounds per square inch, once per day during operation.
(d) Monitor the outlet exhaust temperature of **CO-001** in degrees Fahrenheit, once per day during operation.
(e) Monitor the amount of mercury drained from **CO-001** monthly.
(f) Monitor the inlet exhaust temperature for **CA-005** in degrees Fahrenheit, once per shift during operation.
(g) Monitor the differential pressure across **CA-005** in inches of water, once per day during operation.
(h) Monitor **CA-005** for percentage of mercury by weight, quarterly until reaching **50** percent capacity and then monthly until reaching **90** percent capacity.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Retort

Section 7 - Proposed Emission Rates

Pollutant	Potential to Emit (pounds/hour*)	Potential to Emit (tons/year)	Calculation (including reference or emissions tests) on Which Emissions Information is Based (attach supporting information including dates of tests/methods, if necessary)
Total Mercury (all forms)	N/A	N/A	
Total Mercury (alternative emissions limitations)	1.0×10^{-4} gr/dscf	N/A	General Industry NvMACT Limit

*Note: In addition to lb/hr, alternative emissions limitations (e.g., lb/MMBtu, ppm, grains/dscf) may be requested by the applicant. If alternative emissions limitations are requested, please clearly describe the units in column 2 above. Use additional lines, as needed.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
MERCURY OPERATING PERMIT TO CONSTRUCT

☐Check here if this is an alternative operating scenario

Section 1 - Equipment Description

a. Type of equipment **Melt Furnace (System 25, TU4.007)**

b. Standard Industrial Classification (SIC) Code **1041**

c. Manufacturer of equipment **Not Specified**

d. Model number **Not Specified** Serial number **Not Specified** *Equip. number **Not Specified**

e. Date equipment manufactured: **Not Specified**

f. UTM Coordinates **4,518,745** meters N; **480,243** meters E; Zone 11
(Please specify NAD 27 ☐ or NAD 83 ☒; Method used to obtain coordinates: ***Site Plan***)

g. Basic equipment dimensions (feet): L **N/A** W **N/A** H **N/A**

*The equipment number is the facility's own numbering system for this piece of equipment.

Section 2 - Design Rate/Operating Parameters

a. Maximum design capacity (tons per hour) **0.26 tons per batch**

b. Requested operating rate (tons per hour)* **N/A**

c. Requested operating time: (time of day)* **N/A** to _____

Hours per day _____ Days per year _____

d. Batch load or charge weight (tons) (if applicable) **0.26**

e. Total hours required to process batch or charge (if applicable) **Not Specified**

f. Maximum operating rate (tons per year) **No limit requested**

g. Requested operating rate (tons per year)* **N/A**

f. Type of material processed **Retorted precious metal bearing material**

*Note: Please complete if other than the maximum design capacity (tons per hour and tons per year) and/or the maximum hours of operation (24 hours per day, 8,760 hours per year) are being requested. The permit will be limited to these values.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Melt Furnace

Section 3 - Fuel Usage / Heat Source

Electric Unit ☒

Type of Fuel	**Amount Used Per Hour**	**Heat Content (specify in Btus)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**
Oil- Specify Type(s)					
	gallons				
	gallons				
Gasoline	gallons				
Propane	cubic feet				
Natural Gas	cubic feet				
*Waste Oil	gallons				
Other					

Type of Coal Fuel	**Amount Used Per Hour (tons)**	**Heat Content (specify in BTUs)**	**Ash Content (% by weight)**	**Sulfur Content (% by weight)**	**Trace Elements (% by weight)**	**Percent moisture**	**Percent volatile matter**	**Percent fixed carbon**
Coal - Specify Type(s)								

If more than one type of fuel is combusted, under this operating scenario please specify primary fuel and percentage on a maximum hourly and annual basis (if fuel blending is the primary fuel, identify percentages of each fuel blended). Attach additional information to this form if necessary.

*Firing of waste oil will require multi metals test to insure fuel is non-hazardous.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Melt Furnace

Section 4 - Pollution Control Equipment/Exhaust Stack Parameters (this section *must* be completed)
-Complete for emissions **exhausting through a stack, chimney or vent**: (baghouse, wet scrubber, cyclone, sulfur impregnated carbon filter, uncontrolled stack, etc.)

	Control #1	Control #2
Type of Control (See **Note 1**)	**Baghouse (BH-001)**	**Carbon Bed (CA-006)**
Pollutant(s) Controlled	**Particulates**	**Mercury**
Manufacturer	**Not Specified**	**Not Specified**
Manufacturer's Guarantee (see **Note 2**)	**N/A**	**N/A**
Stack height (feet from ground level)	**N/A**	**38**
Stack inside diameter (feet)	**N/A**	**1.03**
Temperature (°F) at design capacity	**N/A**	**200**
Stack exit velocity (feet per second)	**N/A**	**60**
Gas volume flow rate: Actual cubic feet per minute	**N/A**	**3,030**
Gas volume flow rate: Dry standard cubic feet per minute	**N/A**	**2,300**
Unusual stack characteristics (e.g. raincap, horizontal discharge)	**To Carbon Bed**	**N/A**

Note 1: Specify "uncontrolled" if no pollution control device is installed.
Note 2: Manufacturer's guarantee of control efficiency must be attached to this form.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Melt Furnace

Section 5 - Identify and Describe Work Practice Standards, Etc. (attach additional pages if necessary

(Eg., 1. Baghouse housing and bags will be inspected weekly for holes/leaks.)

Furnace

(a) **TU4.007** will process only retorted precious metal bearing material.

Baghouse (BH-001)

(a) The differential pressure across **BH-001** shall be maintained between **1.8** and **9.5** inches of water, based on a 1-hour period.

Carbon Bed (CA-006)

(a) **CA-006** shall contain at least **6,200** pounds of sulfur-impregnated carbon.
(b) The exhaust temperature entering **CA-006** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
(c) The differential pressure across **CA-006** shall be maintained at or below **12** inches of water, based on a 1-hour period.
(d) Sample and replace the carbon in **CA-006** as follows:
Sample the carbon at the inlet and outlet of **CA-006** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-006** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
vii. EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
viii. EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
ix. An alternative test method as approved by the Director.
(e) On an annual basis, perform a total loading analysis on the carbon in **CA-006**.
(f) Any sulfur-impregnated carbon replaced in **CA-006** will be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent or better performing mercury removal media.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Melt Furnace

Section 6 - Identify and Describe Compliance Monitoring Devices or Activities (attach additional pages if necessary)

(Eg., Emissions from this unit will be monitored by CEMS for mercury.)

The *Permittee* shall:

(a) Monitor the batch weight of **retorted precious metal bearing material** for **TU4.007**, in tons, for each batch.
(b) Monitor the daily hours of operation for **TU4.007**.
(c) Monitor the differential pressure across **BH-001** in inches of water, once per day during operation.
(d) Monitor the inlet exhaust temperature for **CA-006** in degrees Fahrenheit, once per day during operation.
(e) Monitor the differential pressure across **CA-006** in inches of water, once per day during operation.
(f) Monitor **CA-006** for percentage of mercury by weight, quarterly until reaching **50** percent capacity and then monthly until reaching **90** percent capacity.

THERMAL MERCURY EMITTING UNIT
APPLICATION FORM
(CONTINUED)

For Unit: Melt Furnace

Section 7 - Proposed Emission Rates

Pollutant	**Potential to Emit (pounds/hour*)**	**Potential to Emit (tons/year)**	**Calculation (including reference or emissions tests) on Which Emissions Information is Based (attach supporting information including dates of tests/methods, if necessary)**
Total Mercury (all forms)	**N/A**	**N/A**	
Total Mercury (alternative emissions limitations)	**5.0×10^{-3} gr/dscf**	**N/A**	**NvMACT Interim Limit (TUTD)**

*Note: In addition to lb/hr, alternative emissions limitations (e.g., lb/MMBtu, ppm, grains/dscf) may be requested by the applicant. If alternative emissions limitations are requested, please clearly describe the units in column 2 above. Use additional lines, as needed.

Appendix 2

Monitoring Plan For Each:

(Check Appropriate Box)

- ☐ **Phase 1, Tier 1;**
- ☐ **Phase 1, Tier 2;**
- ☐ **Phase 2; or**
- ☒ **New or Modified**

Thermal Mercury Emitting Unit

MONITORING PLAN
Autoclave

Limitations of Operation

- The maximum allowable throughput of **ore** for **TU4.001** shall not exceed 180 tons per any one-hour period.
- The Interim mercury emission limit during the demonstration period for establishment of the final mercury emission limit for **TU4.001** shall not exceed 5.0×10^{-3} grains per dry standard cubic foot (gr/dscf).
- **TU4.001** may operate 24 hours per day.
- **TU4.001** is equipped with a release vent located after the quench vessel and prior to **VS-001**. Use of the release vent shall be limited to **100** hours per year.

Work Practices

Venturi Scrubber (**VS-001**)

- The differential pressure across **VS-001** shall be maintained at or above **13** inches of water, based on a 1-hour period, except during the autoclave warm-up period. The warm-up period is defined as the period of time after start-up during which the autoclave is brought up to steady-state operation. The warm-up period shall not exceed 3 hours.
- The water flow rate to **VS-001** shall be maintained at or above **11** gallons per minute, based on a 1-hour period.

Carbon Bed (**CA-001**)

- **CA-001** shall contain at least **17,000** pounds of sulfur-impregnated carbon.
- The exhaust temperature entering **CA-001** shall be maintained at or below **220**° Fahrenheit, based on a 1-hour period.
- The differential pressure across **CA-001** shall be maintained at or below **25** inches of water, based on a 1-hour period.
- Sample and replace the carbon in **CA-001** as follows:
    - The carbon may be sampled from a sampling canister or by grab sample. The carbon bed may include sampling canisters that will contain the equivalent carbon depth as the carbon filter. These canisters will receive a slip stream of the process gas during operation of **TU4.001**. The Permittee also has the option to directly collect representative carbon samples (grab samples) from the inlet and outlet of **CA-001**. The depth of the sample location will be recorded.
    - The canister and grab-sample carbon sampling methods specified above may only be alternated at the point of complete carbon replacement in **CA-001**.
    - Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-001** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
        - EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;

    - EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
    - An alternative test method as approved by the Director.
- On an annual basis, perform a total loading analysis on the carbon in **CA-001**.
- Any sulfur-impregnated carbon replaced in **CA-001** shall be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent performing mercury removal media.

Monitoring and Recordkeeping

- Monitor and record the daily throughput of **ore** for **TU4.001**, in tons.
- Monitor and record the daily hours of operation for **TU4.001**.
- Monitor and record the number of hours when the release vent is in use for **TU4.001.**
- Monitor and record the differential pressure across **VS-001** in inches of water, once per day during operation.
- Monitor and record the water flow rate to **VS-001** in gallons per minute, once per day during operation.
- Monitor and record the inlet exhaust temperature for **CA-001** in degrees Fahrenheit, once per shift during operation.
- Monitor and record the differential pressure across **CA-001** in inches of water, once per day during operation.
- Monitor and record the percentage of mercury by weight on the carbon in **CA-001** according to the carbon sampling schedule.
- Monitor and record the depth of the sample location in the carbon bed or sampling canister for each sample taken.
- Monitor and record the date and amount of carbon replaced in **CA-001**.

Compliance Testing

- An annual Method 29 (or alternative test method approved by the Director) compliance test for mercury shall be conducted.

Performance Testing

- Upon the date of commencement of operation of **TU4.001**, a performance demonstration period for the establishment of a final NvMACT mercury emission limit for **TU4.001** shall begin and will consist of six consecutive Method 29 source tests at approximate 6-month intervals. The final NvMACT mercury emission limit, in gr/dscf, will be calculated using the maximum test value from the six performance demonstration tests plus one standard deviation. Performance demonstration tests may be used for the annual compliance tests.

Annual Reporting

- Mercury co-product shall be reported on an annual basis.
- Mercury emissions, based on mercury emission test data, shall be reported on an annual basis.

MONITORING PLAN
Carbon Kiln

Limitations of Operation

- The maximum allowable throughput of **carbon** for **TU4.002** shall not exceed **0.32** tons per any one-hour period.
- Mercury emissions from **TU4.002** shall not exceed **1.0 x 10^{-4}** gr/dscf.
- **TU4.002** may operate 24 hours per day.

Work Practices

Carbon Regeneration Kiln

- The kiln drum shall be visually inspected for structural damage and cracks annually.

Heat Exchanger

- Condensed mercury from the heat exchanger shall be collected quarterly.

Carbon Bed **(CA-002)**

- **CA-002** shall contain at least **450** pounds of sulfur-impregnated carbon.
- The exhaust temperature entering **CA-002** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
- The differential pressure across **CA-002** shall be maintained at or below **11** inches of water, based on a 1-hour period.
- Sample and replace the carbon in **CA-002** as follows:
    - Sample the carbon at the inlet and outlet of **CA-002** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-002** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
        - EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
        - EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
        - An alternative test method as approved by the Director.
- On an annual basis, perform a total loading analysis on the carbon in **CA-002**.
- Any sulfur-impregnated carbon replaced in **CA-002** shall be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent performing mercury removal media.

Monitoring and Recordkeeping

- Monitor and record the daily throughput of **carbon** for **TU4.002**, in tons.
- Monitor and record the daily hours of operation for **TU4.002**.
- Monitor and record the amount of mercury drained from the heat exchanger quarterly.
- Monitor and record the inlet exhaust temperature for **CA-002** in degrees Fahrenheit, once per shift during operation.
- Monitor and record the differential pressure across **CA-002** in inches of water, once per day during operation.
- Monitor and record the percentage of mercury by weight on the carbon in **CA-002** according to the carbon sampling schedule.
- Monitor and record the depth of the sample location in the carbon bed for each sample taken.
- Monitor and record the date and amount of carbon replaced in **CA-002**.

Compliance Testing

- An annual Method 29 (or alternative test method approved by the Director) compliance test for mercury shall be conducted.

Annual Reporting

- Mercury co-product shall be reported on an annual basis.
- Mercury emissions, based on mercury emission test data, shall be reported on an annual basis.

MONITORING PLAN
Pregnant and Barren Solution Tanks

Limitations of Operation

- The maximum allowable throughput rate of **solution** for **TU4.003** and **TU4.004,** each, shall not exceed **270** gallons per minute, based on a one-hour period.
- Mercury emissions from **TU4.003** and **TU4.004,** combined, shall not exceed **5.0 x 10^{-5}** gr/dscf.
- **TU4.003** and **TU4.004,** each, may operate 24 hours per day.

Work Practices

Pregnant and Barren Tanks

- **TU4.003** and **TU4.004** will be inspected every six months for leaks and corrosion.

Carbon Bed **(CA-003)**

- **CA-003** shall contain at least **650** pounds of sulfur-impregnated carbon.
- The exhaust temperature entering **CA-003** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
- The differential pressure across **CA-003** shall be maintained at or below **5** inches of water, based on a 1-hour period.
- Sample and replace the carbon in **CA-003** as follows:
    - Sample the carbon at the inlet and outlet of **CA-003** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-003** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
        - EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
        - EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
        - An alternative test method as approved by the Director.
- On an annual basis, perform a total loading analysis on the carbon in **CA-003**.
- Any sulfur-impregnated carbon replaced in **CA-003** shall be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent performing mercury removal media.

Monitoring and Recordkeeping

- Monitor and record the throughput rate of **solution** for **TU4.003** and **TU4.004,** each, in gallons per minute, once per day during operation.
- Monitor and record the daily hours of operation for **TU4.003** and **TU4.004,** each.
- Monitor and record the inlet exhaust temperature for **CA-003** in degrees Fahrenheit, once per shift during operation.
- Monitor and record the differential pressure across **CA-003** in inches of water, once per day during operation.
- Monitor and record the percentage of mercury by weight on the carbon in **CA-003** according to the carbon sampling schedule.
- Monitor and record the depth of the sample location in the carbon bed for each sample taken.
- Monitor and record the date and amount of carbon replaced in **CA-003**.

Compliance Testing

- An annual Method 29 (or alternative test method approved by the Director) compliance test for mercury shall be conducted.

Annual Reporting

- Mercury co-product shall be reported on an annual basis.
- Mercury emissions, based on mercury emission test data, shall be reported on an annual basis.

MONITORING PLAN
Electrowinning Circuit

Limitations of Operation

- The maximum allowable throughput rate of **solution** for **TU4.005** shall not exceed **270** gallons per minute, based on a one-hour period.
- Mercury emissions from **TU4.005** shall not exceed **5.0 x 10^{-5}** gr/dscf.
- **TU4.005** may operate 24 hours per day.

Work Practices

Electrowinning Circuit

- The lids on **TU4.005** shall be closed during operation.

Carbon Bed **(CA-004)**

- **CA-004** is a **two-stage bed**, with each stage containing at least **5,500** pounds of sulfur-impregnated carbon.
- The exhaust temperature entering **CA-004** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
- The differential pressure across **CA-004** shall be maintained at or below **9** inches of water, based on a 1-hour period.
- Sample and replace the carbon in **CA-004** as follows:
    - Sample the carbon at the inlet and outlet of **CA-004** or at the inlet and outlet of each stage of **CA-004** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-004** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
        - EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
        - EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
        - An alternative test method as approved by the Director.
- On an annual basis, perform a total loading analysis on the carbon in **CA-004**.
- Any sulfur-impregnated carbon replaced in **CA-004** shall be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent performing mercury removal media.

Monitoring and Recordkeeping

- Monitor and record the throughput rate of **solution** for **TU4.005** in gallons per minute, once per day during operation.
- Monitor and record the daily hours of operation for **TU4.005**.
- Monitor and record the inlet exhaust temperature for **CA-004** in degrees Fahrenheit, once per shift during operation.
- Monitor and record the differential pressure across **CA-004** in inches of water, once per day during operation.
- Monitor and record the percentage of mercury by weight on the carbon in **CA-004** according to the carbon sampling schedule.
- Monitor and record the depth of the sample location in the carbon bed for each sample taken.
- Monitor and record the date and amount of carbon replaced in **CA-004**.

Compliance Testing

- An annual Method 29 (or alternative test method approved by the Director) compliance test for mercury shall be conducted.

Annual Reporting

- Mercury co-product shall be reported on an annual basis.
- Mercury emissions, based on mercury emission test data, shall be reported on an annual basis.

MONITORING PLAN
Retort

Limitations of Operation

- The maximum allowable throughput of **precious metal bearing material** for **TU4.006** shall not exceed **0.26** tons per batch. **Precious metal bearing material** is defined as:
    - Material loaded with precious metals such as gold and silver, along with various other metals, that is produced by electrowinning, the Merrill-Crowe process, flotation and gravity separation processes, and other gold concentration or precipitation processes.
    - Material collected from the wash down of any equipment or surfaces contacted with precious metals that have been concentrated through the various concentration methods employed by precious metal mines.
- Mercury emissions from **TU4.006** shall not exceed **1.0 x 10^{-4}** gr/dscf.
- **TU4.006** may operate 24 hours per day.

Work Practices

Retort

- During heating of **TU4.006**, the vacuum pressure will be maintained at or above **5** pounds per square inch absolute, based on a 1-hour period.
- **TU4.006** shall automatically shut off via interlock if the vacuum pressure is less than **5** pounds per square inch absolute, based on a 1-hour period.

Condenser **(CO-001)**

- The exhaust temperature at the outlet of **CO-001** shall be maintained at or below **85**° Fahrenheit, based on a 1-hour period.
- **TU4.006** shall automatically shut off via interlock if the **CO-001** outlet exhaust temperature is above **105**° Fahrenheit, based on a 1-hour period.
- Condensed mercury from **CO-001** shall be collected monthly.

Carbon Bed **(CA-005)**

- **CA-005** shall contain at least **530** pounds of sulfur-impregnated carbon.
- The exhaust temperature entering **CA-005** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
- The differential pressure across **CA-005** shall be maintained at or below **9** inches of water, based on a 1-hour period.
- Sample and replace the carbon in **CA-005** as follows:
    - Sample the carbon at the inlet and outlet of **CA-005** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-005** shall be replaced no later than **30** days after reaching **90%** of the

carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:

- EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
- EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
- An alternative test method as approved by the Director.

- On an annual basis, perform a total loading analysis on the carbon in **CA-005**.
- Any sulfur-impregnated carbon replaced in **CA-005** shall be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent performing mercury removal media.

Monitoring and Recordkeeping

- Monitor and record the batch weight of **precious metal bearing material** for **TU4.006**, in tons, for each batch.
- Monitor and record the daily hours of operation for **TU4.006**.
- Monitor and record the vacuum pressure on **TU4.006** in pounds per square inch, once per day during operation.
- Monitor and record the outlet exhaust temperature of **CO-001** in degrees Fahrenheit, once per day during operation.
- Monitor and record the amount of mercury drained from **CO-001** monthly.
- Monitor and record the inlet exhaust temperature for **CA-005** in degrees Fahrenheit, once per shift during operation.
- Monitor and record the differential pressure across **CA-005** in inches of water, once per day during operation.
- Monitor and record the percentage of mercury by weight on the carbon in **CA-005** according to the carbon sampling schedule.
- Monitor and record the depth of the sample location in the carbon bed for each sample taken.
- Monitor and record the date and amount of carbon replaced in **CA-005**.
- Record the date and corrective action taken for any interlock shut-down.

Compliance Testing

- An annual Method 29 (or alternative test method approved by the Director) compliance test for mercury shall be conducted.

Annual Reporting

- Mercury co-product shall be reported on an annual basis.
- Mercury emissions, based on mercury emission test data, shall be reported on an annual basis.

MONITORING PLAN
Melt Furnace

Limitations of Operation

- The maximum allowable throughput of **retorted precious metal bearing material** for **TU4.007** shall not exceed **0.26** tons per batch.
- The Interim mercury emission limit during the demonstration period for establishment of the final mercury emission limit for **TU4.007** shall not exceed **5.0 x 10^{-3}** grains per dry standard cubic foot (gr/dscf).
- **TU4.007** may operate 24 hours per day.

Work Practices

Baghouse **(BH-001)**

- The differential pressure across **BH-001** shall be maintained between **1.8** and **9.5** inches of water, based on a 1-hour period.

Carbon Bed **(CA-006)**

- **CA-006** shall contain at least **6,200** pounds of sulfur-impregnated carbon.
- The exhaust temperature entering **CA-006** shall be maintained at or below **200**° Fahrenheit, based on a 1-hour period.
- The differential pressure across **CA-006** shall be maintained at or below **12** inches of water, based on a 1-hour period.
- Sample and replace the carbon in **CA-006** as follows:
    - Sample the carbon at the inlet and outlet of **CA-006** and record the depth of the sample location. Sample the carbon within **90** days after replacement of the carbon. The sampled carbon will be analyzed for mercury and the average percentage of mercury, by weight, will be calculated. The loading capacity of the sulfur-impregnated carbon is **20%** by weight. A sample of carbon will be analyzed quarterly until **50%** of the carbon loading capacity is reached. Upon reaching **50%** of the carbon loading capacity, the sampling of carbon shall occur monthly until **90%** of the carbon loading capacity is reached. The carbon in **CA-006** shall be replaced no later than **30** days after reaching **90%** of the carbon loading capacity. The required mercury analysis shall be performed utilizing one of the following methods:
        - EPA method 6020-Inductively Coupled Plasma-Mass Spectrometry;
        - EPA method 7471B- Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique); or
        - An alternative test method as approved by the Director.
- On an annual basis, perform a total loading analysis on the carbon in **CA-006**.
- Any sulfur-impregnated carbon replaced in **CA-006** shall be replaced with only the original manufacturer's design specification sulfur-impregnated carbon or with equivalent performing mercury removal media.

Monitoring and Recordkeeping

- Monitor and record the batch weight of **retorted precious metal bearing material** for **TU4.007**, in tons, for each batch.
- Monitor and record the daily hours of operation for **TU4.007**.
- Monitor and record the differential pressure across **BH-001** in inches of water, once per day during operation.
- Monitor and record the inlet exhaust temperature for **CA-006** in degrees Fahrenheit, once per shift during operation.
- Monitor and record the differential pressure across **CA-006** in inches of water, once per day during operation.
- Monitor and record the percentage of mercury by weight on the carbon in **CA-006** according to the carbon sampling schedule.
- Monitor and record the depth of the sample location in the carbon bed for each sample taken.
- Monitor and record the date and amount of carbon replaced in **CA-006**.

Compliance Testing

- An annual Method 29 (or alternative test method approved by the Director) compliance test for mercury shall be conducted.

Performance Testing

- Upon the date of commencement of operation of **TU4.007**, a performance demonstration period for the establishment of a final NvMACT mercury emission limit for **TU4.007** shall begin and will consist of six consecutive Method 29 source tests at approximate 6-month intervals. The final NvMACT mercury emission limit, in gr/dscf, will be calculated using the maximum test value from the six performance demonstration tests plus one standard deviation. Performance demonstration tests may be used for the annual compliance tests.

Annual Reporting

- Mercury co-product shall be reported on an annual basis.
- Mercury emissions, based on mercury emission test data, shall be reported on an annual basis.

Appendix 3

Nevada MACT Analysis For Each:

(Check Appropriate Box)

☐ **Phase 2;**
☒ **New or Modified; or**
☐ **Not Applicable**

Thermal Mercury Emitting Unit

NvMACT Analysis for the Autoclave

AUTOCLAVE NVMACT ANALYSIS - TABLE OF CONTENTS

3.0 NvMACT Analysis - Autoclaves 4

3.1 Introduction 4

3.2 Process Description 4

3.3 NvMACT Analysis 5

3.3.1 Part I – Existing Similar Thermal Units 5

3.3.1.1 Mercury Controls 5

3.3.1.1.1 Wet Scrubber 7

3.3.1.1.2 Carbon Adsorption 8

3.3.1.1.3 Work Practices 9

3.3.1.2 Mercury Emissions 9

3.3.1.3 Mercury Control Costs 10

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements .. 10

3.3.2 Part II – Other Controls and/or Work Practices 11

3.3.2.1 Other Mercury Control Options 11

3.3.2.1.1 Boliden-Norzink Process 11

3.3.2.1.2 Activated Carbon Injection 12

3.3.2.1.3 Selenium Scrubber 12

3.3.2.1.4 Selenium Filter 12

3.3.2.1.5 Condenser 13

3.3.2.2 Other Work Practices 14

3.3.3 Part III - Proposed NvMACT 14

3.3.3.1 Proposed Controls and Work Practices 15

3.3.3.2 Proposed Mercury Emission Limit 17

3.3.3.3 Cost of Controls 17

References 19

Tables

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits. 6
Table 3-2. Existing Similar Thermal Units: Compliance Test Results 10
Table 3-3. Existing Similar Thermal Units: Control Costs 10
Table 3-4. Carbon Bed Design Analysis 17
Table 3-5. Lone Tree Autoclave Control Costs 18

Figures

Figure 3-1. Autoclave Process Flow Diagram 4
Figure 3-3. Typical Rectangular Throat Venturi Scrubber, Spray Tower Scrubber, and Plate Tower Scrubber 7
Figure 3-5. Mercury Saturation Pressure Curve 13
Figure 3-6. Lone Tree Exhaust Gas Treatment 16

3.0 NvMACT ANALYSIS - AUTOCLAVE

3.1 Introduction

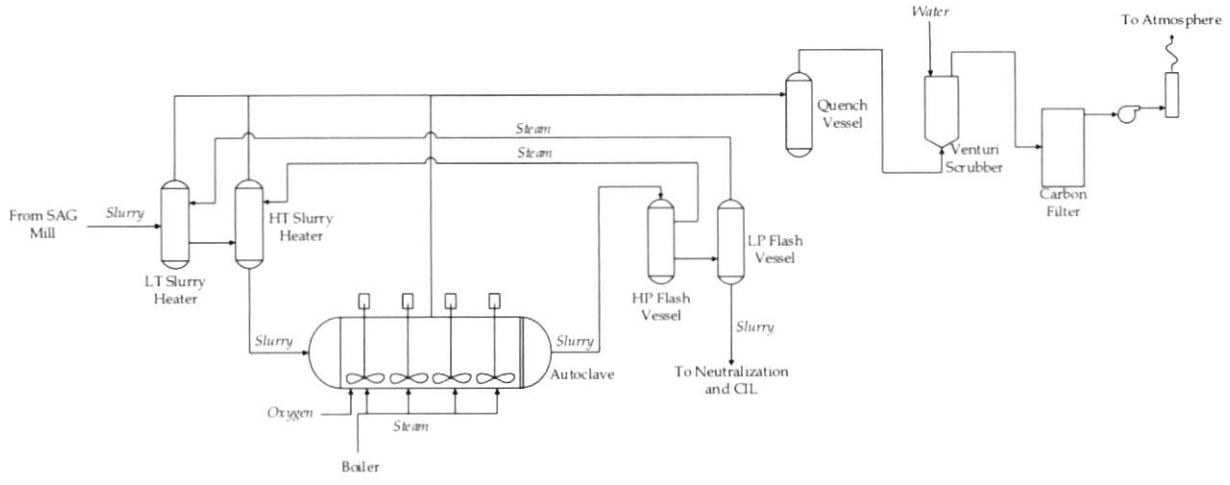
Goldcorp DEE LLC (Goldcorp) proposes to install and operate an autoclave circuit (autoclave) at the Lone Tree Mine (Lone Tree). Per Nevada Administrative Code (NAC) 445B.3681.6, a Nevada Maximum Achievable Control Technology (NvMACT) analysis is required for new thermal units that emit mercury, as a part of a Mercury Operating Permit to Construct (MOPTC) application. The NvMACT analysis provided herein for the autoclave addresses all the applicable requirements of NAC 445B.3681.6.

3.2 Process Description

The autoclave circuit consists of a low temperature slurry (LT) heater vessel, a high temperature slurry (HT) heater vessel, an autoclave, a high pressure (HP) flash vessel, and a low pressure (LP) flash vessel. In the autoclave circuit, ore slurry is fed to the LT and then HT heater vessels where it is preheated using steam flashed from the LP and HP flash vessels. From the HT heater vessel, the slurry is pumped into the autoclave where the ore is oxidized using pressure, steam, and oxygen. Following oxidation, the slurry is discharged to the HP flash vessel and then the LP flash vessel, where the pressure and slurry temperature are reduced, and the steam is recycled back to the slurry heater vessels.

Exhaust gases from the autoclave circuit are first ducted into the quench vessel to reduce the exhaust temperature and volume. Following the quench vessel, the exhaust passes through a venturi scrubber for particulate removal and then through a carbon bed to control mercury emissions prior to being released to the atmosphere. The system is designed with an emergency pressure relief vent for the autoclave and HP flash vessel, and with a release vent following the quench vessel. Pressure relief gases pass through a water vessel before release to the atmosphere. A process flow diagram is provided in Figure 3-1.

Figure 3-1. Autoclave Process Flow Diagram



3.3 NvMACT Analysis

3.3.1 Part I – Existing Similar Thermal Units

Part I of the NvMACT analysis provides a list of similar existing thermal units used for precious metal refining and describes the controls and work practices used to reduce mercury emissions. All information required by NAC 445B.3681, as described below, is provided herein:

NAC 445B.3681 New or modified thermal unit that emits mercury: Contents of required application.

☒ *6.(b) Sets forth a list of similar thermal units that emit mercury which are used for precious metal mining that includes, without limitation:*

- ☒ *(1) Any methods or technologies to control mercury emissions which are associated with the thermal units that emit mercury;*
- ☒ *(2) The level of mercury emissions associated with each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(3) The design for each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(4) Costs associated with reductions of mercury emissions as a result of each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(5) Costs associated with energy for each method or technology to control mercury emissions from the thermal units that emit mercury; and*
- ☒ *(6) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal units that emit mercury.*

3.3.1.1 Mercury Controls

The Nevada Mercury Control Program (NMCP) permits for existing autoclaves were downloaded from the Nevada Division of Environmental Protection (NDEP) Public Document Search website to obtain a list of the existing autoclaves mercury controls. This information is summarized in Table 3-1.

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits

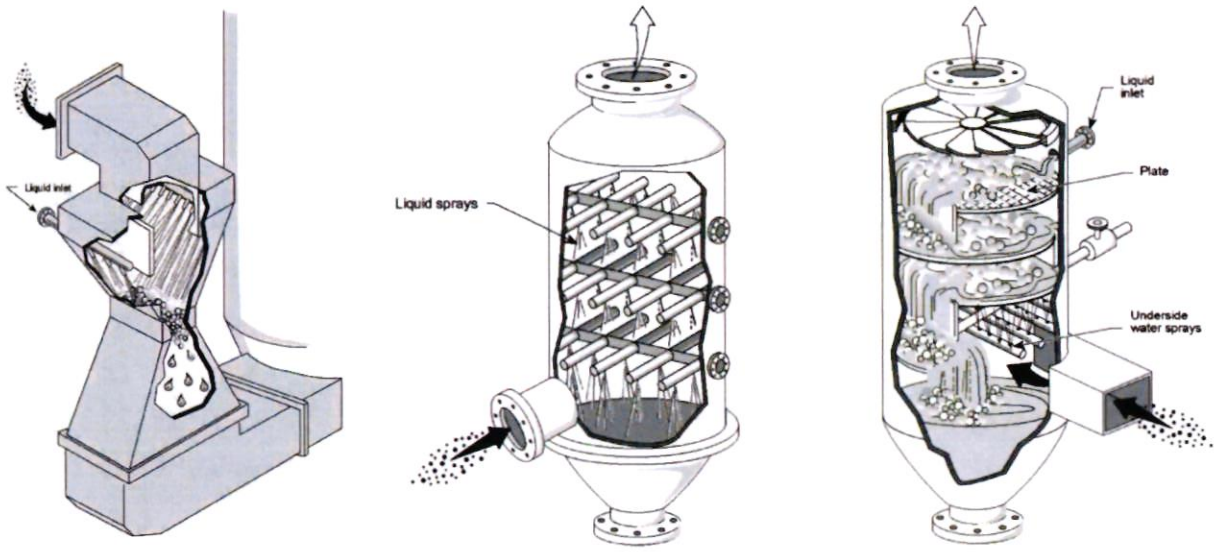
Facility Name	Permit No.	Date	Source	Control1	Control2	Control3	Carbon (lb)	Stack Flow	Stack Temp	Limit (gr/dscf)	Limit Notes
Nevada Gold Mines LLC - Goldstrike Mine	AP1041-2221	5/5/2025	Autoclave #2 (TU4.014) Autoclave #3 (TU4.015)	Venturi Scrubber (VS-001) on TU4.014	Venturi Scrubber (VS-002) on TU4.015		not applicable	8,000 dscfm	198	4.0E-04	Combined limit for TU4.014 and TU4.015
			Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	Primary Venturi Scrubbers (VS-004, VS-005, and VS-006) Secondary Venturi Scrubber (VS-007)	Gas Cooling Tower (GCT-001) Condenser (CO-001)	Carbon Filter (CA-007)	40,800	11,820 dscfm	110	7.8E-05	Combined limit for TU4.016 - TU4.018
Nevada Gold Mines LLC - Twin Creeks Mine	AP1041-2218	11/14/2023	Sage Mill Autoclave 1 (TU4.012)	Primary Quench Vessel (QV-001) Primary Venturi Scrubber (VS-001)	Secondary Quench Vessel (QV-002) Secondary Venturi Scrubber (VS-002)	Carbon Filter (CF-011) or (CF-013)	25000, each	11,400 dscfm	163	1.1HE-04	At least three of the four controls (Quench Vessels and Scrubbers) shall be in operation during operation of TU4.012 and TU4.013
			Sage Mill Autoclave 2 (TU4.013)	Primary Quench Vessel (QV-003) Primary Venturi Scrubber (VS-003)	Secondary Quench Vessel (QV-004) Secondary Venturi Scrubber (VS-004)	Carbon Filter (CF-012) or (CF-013)	25000, each	11,400 dscfm	163	1.1HE-04	

As shown in Table 3-1, the mercury controls installed for autoclaves include venturi scrubbers and carbon filters, with quench vessels and condensers used for gas conditioning.

3.3.1.1.1 Wet Scrubber

Common types of wet scrubbers include venturi, spray tower, and impingement plate wet scrubbers. These wet scrubbers are shown in Figure 3-3.

Figure 3-2. Typical Rectangular Throat Venturi Scrubber, Spray Tower Scrubber, and Plate Tower Scrubber[1]



Wet scrubbers control particulates, including particulate mercury, through impaction, diffusion, interception, and/or adsorption of the pollutant onto droplets of liquid (EPA 2002). Wet scrubbers may control oxidized mercury (Rong Yan, et al. 2004), as this form of mercury is soluble in the scrubber water, as well as elemental mercury if the scrubber's exhaust temperature is below the mercury saturation temperature. However, for autoclaves exhausts, the concentration of mercury in the exhaust stream is too dilute for mercury condensation. See Section 3.3.2.1.5 for additional discussion regarding condensers for autoclaves.

Venturi scrubbers use a converging-then-diverging flow channel, in which the cross-sectional area of the channel decreases, then increases, along the length of the channel. The narrowest area is called the throat. As the exhaust gas enters the venturi scrubber, the decrease in area causes the gas velocity and turbulence to increase. The scrubbing water is injected either slightly upstream of or directly into the throat. As the scrubbing solution is injected, the turbulence in the throat causes it to atomize, improving gas–liquid contact (EPA 2002). After passing through the throat, the gas-liquid mixture decelerates and causes additional particle-droplet impacts and droplet agglomeration. Before the gas exits the scrubber, the liquid droplets are separated from the gas in an entrainment section (EPA 2002).

---

[1] (NCSU 1998b)

As the gas passes through the venturi scrubber, there is a drop in pressure. For venturi scrubbers in general, the greater the pressure drop, the higher the particulate control efficiency. The liquid-to-gas ratio also affects venturi scrubber efficiency. Sufficient liquid must be injected into the scrubber to allow for coverage over the throat area and to create sufficient collection targets. After an optimal point, adding excess liquid to a scrubber does not increase the particulate control efficiency. The liquid-to-gas ratio for wet scrubbers typically ranges from 4 to 20 gallons per 1,000 actual cubic feet (NCSU 1998b).

Spray tower wet scrubbers are constructed very simply, consisting of empty cylindrical vessels made of steel or plastic and nozzles that spray liquid into the vessels. As shown in Figure 3-3, the exhaust stream enters at the bottom and flows upward, while liquid is sprayed downward from one or more levels (NCSU 1998b).

An impingement plate wet scrubber is a vertical column with one or more plates (trays) mounted horizontally inside. As shown in Figure 3-3, the exhaust stream enters at the bottom and flows upward, passing through openings in the plates. Liquid enters at the top of the tower, traveling across each plate to a downcomer, through which it reaches either the next plate below or the bottom of the tower. Pollutant collection occurs on each plate as the gas stream contacts and then atomizes the liquid flowing over each plate. Plate towers are very effective in removing gaseous pollutants (if soluble in the scrubbing solution) and can be used simultaneously for particle removal (NCSU 1998b).

3.3.1.1.2 Carbon Adsorption

Carbon adsorption filters use activated carbon particles to adsorb mercury from the gas stream. Adsorption occurs when gas molecules are passed through a bed of solid particles (activated carbon). The gas molecules migrate from the gas stream to the surface of the solids, where they are held by physical attraction (EPA 2002). Carbon impregnated with elemental sulfur increases the adsorption efficiency due to the sulfur–mercury reaction that forms mercury sulfide, a stable mercury compound with a low vapor pressure (Booz et al. 2001).

Carbon filters control all types of mercury: particulate-bound, oxidized, and elemental. The mercury in the gas stream is adsorbed to the carbon and collected as carbon loaded with mercury. Once the carbon reaches adsorptive capacity, it is replaced, and the spent carbon is reclaimed. The carbon filter's mercury content is monitored to ensure that the mercury loading does not exceed the value recommended by the manufacturer. The typical carbon loading capacity is approximately 20 percent (or more) mercury by weight (SION n.d.) (Klett et al. 2002). Carbon mercury loading can be monitored directly, or the mercury concentration in the exhaust at the outlet of the carbon filter can be monitored to ensure the effectiveness of the carbon adsorber.

Some factors that can affect carbon filter adsorption efficiency include residence time of the gas in the carbon filter, carbon particle size, and exhaust stream moisture content. Longer residence times and smaller carbon particle sizes increase the mercury removal efficiency of the carbon filter (Booz et al. 2001). According to Scotia International of Nevada (SION), *"Some moisture in*

the gas stream, and therefore in the carbon, catalyzes the mercury removal reaction. It is anticipated that as long as no free water is being released from the carbon, the moisture maximum would be 45%. Release of moisture from the carbon, would indicate that the gas stream is condensing within the carbon, which has the potential to inhibit the mercury removal reaction. The carbon is delivered with a nominal moisture of 5% (this value can vary by the ambient humidity of the area of usage)" (SION 2021).

In short, mercury removal may be inhibited when carbon is physically wet with water (where moisture exceeds 45 percent).

3.3.1.1.3 Work Practices

In addition to the controls listed in Table 3-1, the precious metal mining facilities in Nevada incorporate several different work practices into their processes to reduce mercury emissions. These work practices include inspecting the exhaust capture system and replacing the carbon prior to exceeding the recommended mercury loading levels.

The exhaust from the autoclaves must be captured and ducted to the control system and then to a stack before being released into the atmosphere. The equipment for the ventilation system consists of ductwork, fans, and a stack. The ductwork is inspected periodically to ensure proper emissions capture.

To ensure sufficient control efficiency by a carbon filter, the carbon filter media is replaced prior to exceeding maximum mercury loading as recommended by the manufacturer. This can be accomplished by:

- replacing the carbon on a schedule that ensures the recommended mercury loading is not exceeded, based on worst-case mercury loading data;
- monitoring the loading of mercury on the carbon directly by carbon analyses;
- monitoring the mercury levels in the exhaust from the carbon filter; or
- a combination of the above work/monitoring practices.

3.3.1.2 Mercury Emissions

NMCP permits for existing autoclaves were downloaded from the NDEP Public Document Search website to obtain a list of the existing mercury emission limits. This information is summarized in Table 3-1 of Section 3.3.1.1. As shown in the table, the NvMACT emission limits range from 7.8E-05 grains per dry standard cubic foot (gr/dscf) to 4.0E-04 gr/dscf.

NMCP compliance tests for existing autoclaves were downloaded from the NDEP Public Document Search website to obtain the actual mercury emissions data for autoclaves utilizing NvMACT controls. This information is summarized in Table 3-2 for years 2020 through 2025. As shown in Table 3-2, all stack test results are below the TUTD interim limit of 5.0E-03 gr/dscf (NDEP 2016).

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Temp. (F)
Nevada Gold Mines LLC - Goldstrike Mine	Autoclave #2 (TU4.014) Autoclave #3 (TU4.015)	6/9/2020	2.30E-04	N/A	2.7E-03	1,365	34,290	200.4
	Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	6/3/2020	5.18E-06	7.8E-05	not available	6,753	not available	79.2
	Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	5/20/2021	9.80E-06	7.8E-05	7.6E-04	9,035	11,840	94.5
	Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	8/11/2022	2.10E-06	7.8E-05	1.5E-04	8,540	11,427	120.0
	Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	9/28/2023	1.30E-06	7.8E-05	8.6E-05	7,658	9,778	94.3
	Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	12/10/2024	3.14E-05	7.8E-05	2.4E-03	9,047	11,488	85.1
	Autoclave Circuit #4 (TU4.016) Autoclave Circuit #5 (TU4.017) Autoclave Circuit #6 (TU4.018)	9/16/2025	6.63E-06	7.8E-05	7.1E-04	12,501	16,819	112.0
Nevada Gold Mines LLC - Twin Creeks Mine	Sage Mill Autoclave 1 (TU4.012)	10/5/2021	8.07E-08	1.14E-04	not available	6,972	not available	78.4
	Sage Mill Autoclave 2 (TU4.013)	10/6/2021	8.80E-08	1.14E-04	not available	6,837	not available	76.4
	Sage Mill Autoclave 1 (TU4.012)	10/24/2022	1.30E-05	1.14E-04	8.80E-04	7,479	9,132	66.8
	Sage Mill Autoclave 2 (TU4.013)	10/26/2022	7.40E-06	1.14E-04	4.80E-04	7,468	9,264	73.4
	Sage Mill Autoclave 1 (TU4.012)	5/25/2023	5.30E-07	1.14E-04	2.80E-05	6,225	7,779	75.0
	Sage Mill Autoclave 2 (TU4.013)	8/10/2023	2.52E-06	1.14E-04	9.97E-05	4,664	6,324	103.1
	Sage Mill Autoclave 1 (TU4.012)	6/10/2025	1.50E-06	1.14E-04	1.00E-04	8,054	11,045	105.2
	Sage Mill Autoclave 2 (TU4.013)	5/20/2025	1.93E-06	1.14E-04	1.50E-04	8,862	12,037	97.9

3.3.1.3 Mercury Control Costs

The costs for existing autoclave wet scrubbers and carbon filters listed in Table 3-1 were estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide capital costs, operational and maintenance (O&M) costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rates listed in Table 3-1, the estimated autoclaves control costs are summarized in Table 3-3.

Table 3-3. Existing Similar Thermal Units: Control Costs

Control	Exhaust Flow (scfm)	Capital Cost ($1,000)	O&M Cost ($1,000/ yr)	Annualized Cost ($1,000/ yr)
Venturi Wet Scrubber	8,000 to 11,820	168 to 249	891 to 1,316	1,423 to 2,102
Carbon Filter	8,000 to 11,820	841 to 1,243	not available	not available

(EPA 2003vs), (EPA 1999)
scfm = dry standard cubic feet per minute; yr = year

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements

The main non-air quality health and environmental impact caused by mercury control technologies for autoclaves is the reclamation of carbon loaded with mercury from carbon filters. Once the carbon reaches adsorptive capacity, it is replaced with fresh carbon and the loaded carbon is reclaimed. Reclaiming the used carbon at a reclamation facility has non-air quality health, environmental, and energy impacts.

Carbon filters and wet scrubbers also require increased energy consumption due to the use of exhaust fans and water pumps. Wet scrubbers and quench vessels use water as a scrubbing solution or to clean the collection plates and the discharge of this water has environmental impacts.

3.3.2 Part II – Other Controls and/or Work Practices

Part II of the NvMACT analysis examines other control options and/or work practices not currently employed with the existing autoclaves described in Part I – Existing Similar Thermal Units.

3.3.2.1 Other Mercury Control Options

In addition to the mercury control technologies employed with existing autoclaves, the following mercury control options are examined below:

1. Boliden-Norzink Process
2. Activated Carbon Injection
3. Selenium Scrubber
4. Selenium Filter
5. Condenser

3.3.2.1.1 Boliden-Norzink Process

In the Boliden-Norzink process, a mercuric chloride ($HgCl_2$) solution reacts with elemental mercury in the off-gas to form a mercurous chloride (HgCl) precipitate known as calomel, which then settles and is recovered. This reaction occurs in a packed column. Once the solid is removed, the wash solution can be recirculated. A portion of the precipitate can be used to regenerate the mercuric chloride solution using chlorine gas (Booz et al. 2001). The rest of the calomel is sent off-site for reclamation. The Boliden-Norzink process uses the following reaction:

$$HgCl_{2(sol'n)} + Hg_{(gas)} \rightarrow 2HgCl_{(solid)}$$

Boliden-Norzink scrubbers are installed on the Nevada Gold Mines LLC – Goldstrike (Goldstrike), Jerritt Canyon Gold, LLC (Jerritt Canyon), and Nevada Gold Mines LLC - Gold Quarry Operations (Gold Quarry) roasters. These roasters volatize large amounts of mercury and in turn produce large amounts of mercury co-product in the form of calomel. The calomel production at Goldstrike, Jerritt Canyon, and Gold Quarry averages 195,340 pounds, 7,640 pounds, and 9,120 pounds, respectively (Barrick 2018).

A Boliden-Norzink scrubber has not been applied to any existing autoclaves at precious metal mining facilities in Nevada. There is no basis for assessing its performance in such an application, given the dissimilarities between the autoclave (and its characteristic emission stream) and the units/emission streams where Boliden-Norzink scrubbers have been applied.

In addition, this technology requires a significant capital investment and produces wastewater (process water containing chloride ions) and solid waste (calomel). The capital costs of the Boliden-Norzink scrubbers installed at Goldstrike and Gold Quarry are $4.7 million and $3.2 million, respectively (Barrick 2018).

Based on the Boliden-Norzink process cost and environmental impacts, and the low amount of mercury emitted from autoclaves, Boliden-Norzink scrubbers are not representative of NvMACT for autoclaves.

3.3.2.1.2 Activated Carbon Injection

Activated carbon injection is similar to activated carbon filters in that activated carbon particles are used to adsorb mercury from the off-gas stream. In this process, the carbon particles are injected directly into the off-gas stream to adsorb mercury. They are then collected in downstream particulate controls, such as baghouses, wet scrubbers, or wet ESPs. Carbon injection is typically used in the power plant industry, where particulate control technologies have already been installed to clean fly-ash (and injected activated carbon) from the off-gas stream.

This process has not been applied to existing autoclaves at precious metal mining facilities in Nevada, and there is no basis for assessing its performance in such an application. In addition, the control efficiency of carbon injection is typically lower than that of carbon filters. Therefore, the most appropriate activated carbon technology application for autoclaves is a carbon adsorption filter.

3.3.2.1.3 Selenium Scrubber

Selenium scrubbers use selenium or a selenium compound within a scrubber to react with elemental mercury in the off-gas to form mercuric selenide (HgSe). HgSe has a lower vapor pressure than other common mercury compounds, which allows for mercury capture. The HgSe is removed in a sludge separation circuit, which requires a thickener and HgSe reclamation. Sulfuric acid, at concentrations between 10 and 60 percent, is used as the wash solution for the process.

Selenium scrubbers are appropriate for gas streams with high mercury loading. The outlet concentrations from this process are typically higher than the concentrations achieved from the Boliden-Norzink process discussed in Section 3.3.2.1.1. Selenium scrubbers are not widely used due to their low removal efficiency and expensive reagent and reclamation requirements. Therefore, this option is not considered an effective mercury control method for autoclaves.

3.3.2.1.4 Selenium Filter

Selenium filters are similar to selenium scrubbers in that they use selenium to react with the elemental mercury in the off-gas stream to form mercuric selenide. Selenium filters use a selenium-impregnated porous carrier structure, housed in a cylindrical tower. The selenium filter's maximum operating temperature is approximately 250°F. The filters require a dry gas

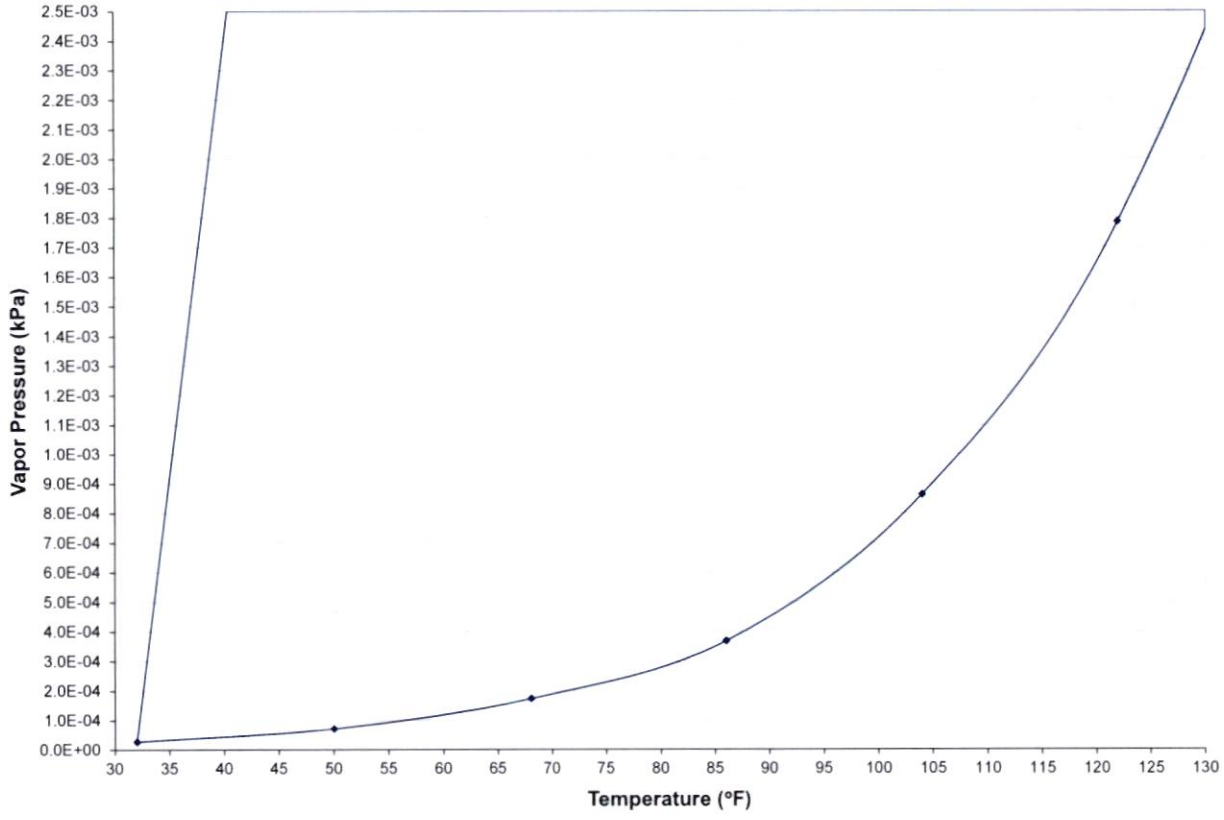
stream because moisture tends to degrade the filter media. The typical filter's carrying capacity is between 10 and 15 percent mercury by weight.

Selenium filters have been installed in only a few places in the world, and primarily in Sweden, and no operating data from these applications are available. Selenium filters are expensive to produce and to regenerate. There is no basis to believe that selenium filters would provide a better alternative to activated carbon filters. In addition, there is some concern that the selenium filters cause selenium air emissions. Therefore, this option is not considered an effective mercury control method for autoclaves.

3.3.2.1.5 Condenser

Condensers control mercury by cooling a gas stream containing mercury vapor below the mercury vapor saturation point. When the gas temperatures fall below the saturation point, mercury condensation occurs. Chilled water is circulated through the condenser to achieve lower gas stream temperatures. The required condensation temperature is determined by the mercury saturation pressure curve shown in Figure 3-5. The condensed mercury is collected as a co-product.

Figure 3-3. Mercury Saturation Pressure Curve[2]



[2] (Taylor and Francis Group 2005)

The two most common types of condensers are surface and contact condensers. Surface condensers cool gas streams by circulating water (or other cooling medium) through an enclosed water jacket surrounding the exhaust system or through a shell-and-tube type heat exchanger. Contact condensers cool gas streams by spraying cooled water into the gas stream. The following correlation exists for both types of condensers: the colder the circulating water, the colder the exhaust gas, and, for a constant inlet loading of mercury, the more efficient the removal of mercury from the gas stream (EPA 2002). Given the low concentration of mercury in autoclaves exhaust, condensers are not a viable NvMACT control option for autoclaves.

3.3.2.2 Other Work Practices

All viable work practices for reducing mercury emissions have already been addressed in Part I – Existing Similar Thermal Units. Thus, there are no other work practices, process changes, or material substitutions that can be instituted to reduce mercury emissions from autoclaves.

3.3.3 Part III - Proposed NvMACT

Per NAC 445B.3681.6.(a), the applicant must propose "*standards, methods of control or other limitations to be applied to the thermal unit for the reduction of mercury emissions that the applicant deems sufficient for the Director to determine to be NvMACT for the thermal unit that emits mercury.*"

The NvMACT proposed in this section follows the criteria required by the Director pursuant to NAC 445B.3683. All items considered in this NvMACT analysis are checked in the criteria list provided below:

NAC 445B.3683 Review of and action on application for new or modified thermal unit that emits mercury.

☒ *2.(b) Make a determination of NvMACT for the thermal unit that emits mercury in which the Director shall consider the following for each thermal unit that emits mercury:*

☒ *(1) The maximum degree of reduction of mercury emissions that is achievable for the thermal unit after considering:*

(I) The cost of achieving such a reduction; and

(II) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal unit that emits mercury to implement the NvMACT.

☒ *(2) The measures that reduce the volume or eliminate mercury emissions through process changes, substitution of materials or any other modifications.*

☒ *(3) The enclosure of systems or processes to eliminate mercury emissions.*

☒ *(4) The collection, capture or treatment of mercury emissions.*

☒ *(5) The design, equipment, work practice or operational standards of the thermal unit that emits mercury, including, without limitation, the requirements for training and certification of operators of the thermal unit that emits mercury.*

☒ *(6) The differences in the age, remaining operating life and configurations of similar thermal units that emit mercury. The Director may also consider the differences in the concentration of mercury in the ore, size and any other relevant factors of the similar thermal units that emit mercury.*

3.3.3.1 Proposed Controls and Work Practices

Based on the existing control technologies and work practices described in Part I and the additional control technology options described in Part II, Goldcorp proposes the following control equipment, work practices, and capture system as NvMACT for the proposed autoclave circuit:

Control equipment:

- Venturi Scrubber
- Carbon Bed

Work practices:

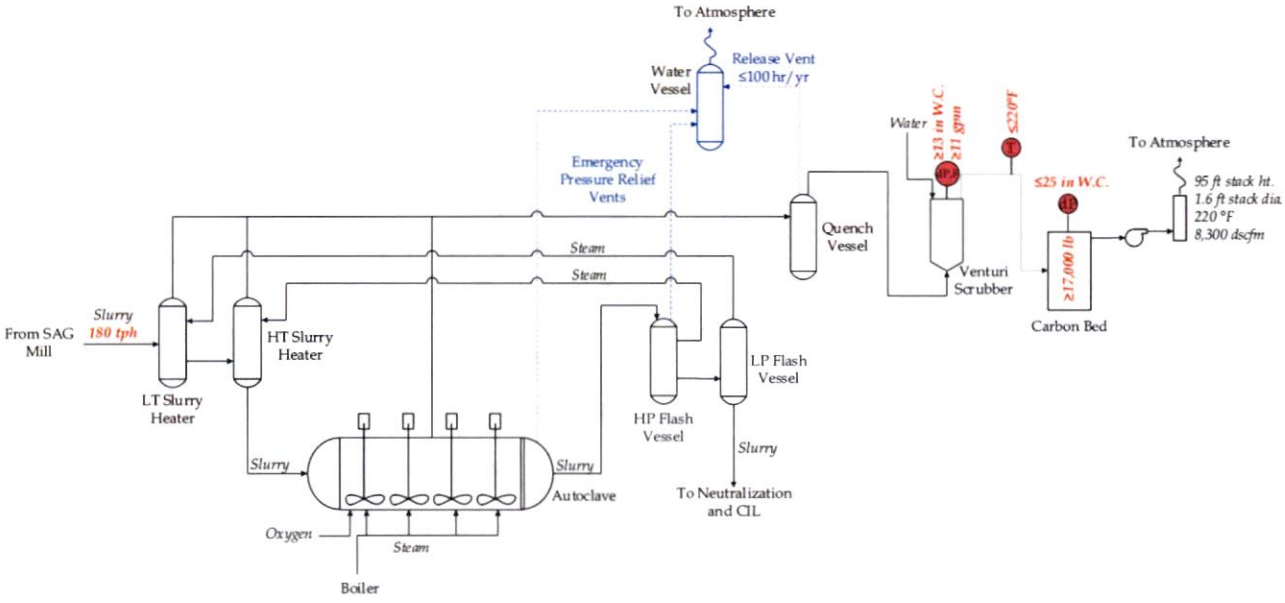
- The differential pressure (DP) across the venturi scrubber will be maintained at or above 13 inches of water column (in. W.C.), except during the autoclave warm-up period. The warm-up period is defined as the period of time after start-up during which the autoclave is brought up to steady-state operation. The warm-up period will not exceed 3 hours.
- The water flow rate to the venturi scrubber will be maintained at or above 11 gallons per minute (gpm).
- The carbon bed will contain at least 17,000 pounds of sulfur-impregnated carbon.
- The exhaust temperature entering the carbon bed will not exceed 220 degrees Fahrenheit (°F).
- The differential pressure across the carbon bed will not exceed 25 in. W.C.
- The carbon in the carbon bed shall be monitored and replaced prior to exceeding 20 percent mercury by weight.

Capture System:

The exhaust from the autoclave circuit will be pulled through the control system by an exhaust fan. The system will be designed so that all emissions from the autoclave circuit are captured and ducted through the venturi and carbon bed.

A flow diagram of the proposed NvMACT mercury control system is provided in Figure 3-6.

Figure 3-4. Lone Tree Exhaust Gas Treatment



The proposed autoclave circuit at Lone Tree is designed to process 180 tons of ore per hour. In the proposed emission control system, the exhaust from the LT heater vessel, HT heater vessel, and autoclave are first ducted into a quench vessel to reduce the exhaust temperature and volume. (The HP and LP flash vessel exhaust is ducted to the LT and HT heater vessels.) Following the quench vessel, the exhaust passes through a venturi scrubber for particulate removal and then through a carbon bed to control mercury emissions prior to being released to the atmosphere.

The autoclave circuit also includes emergency pressure relief vents for the autoclave and HP flash vessel, and a release vent following the quench vessel. The pressure relief vents and release vent are ducted through a shared emergency relief vent water vessel before release to the atmosphere. The pressure relief vents from the autoclave and HP flash vessel will only be used in emergency situations, however, Goldcorp is proposing to allow the limited use of the release vent from the quench vessel. The release vent use would be limited to 100 hours per year and would allow for maintenance, including carbon change out, of the venturi scrubber or carbon bed. In this situation, exhaust would pass through the quench vessel and emergency relief vent water vessel prior to release to the atmosphere.

The carbon bed will hold 17,000 pounds of sulfur-impregnated carbon. The bed is designed for an exhaust flow rate of approximately 8,300 dry standard cubic feet per minute (dscfm) with a residence time of 4.0 seconds (Hatch 2025). The loading capacity of the carbon is estimated to be 20 percent mercury by weight.

Table 3-4 provides the carbon bed design analysis using NDEP's NvMACT Specific Case-by-Case Worksheet for deep bed systems.

Table 3-4. Carbon Bed Design Analysis

Description	Calculated Value	[Unit]	Symbol	Equations
Volume of bed	**567**	ft^3	VB	VB=MC/CD
Total quantity of carbon	**17,000**	lbs	MC	Capacity of carbon bed
Carbon Hg capacity	**20**	%	CP	Scotia - 15% to 40%
Carbon density	**30**	lbs/ft^3	CD	NDEP default value
Velocity	**N/A**	ft/min	V	$V = Q/SA_{bed}$
Flow rate	**8,300**	DSCFM	Q	Exhaust flow rate
Mercury loading	**0.028**	lb/hr	L	Based on autoclave emissions without carbon control (Goldstrike AC 2/3)
Residence time	**4.1**	sec	T	T=((MC/CD)/Q)*60
Pressure drop	**25**	in H_2O	ΔP	(Hatch 2025)
Hg saturation (hours)	**119,478**	hr	S_h	Sh=MC*(CP/100)*(1/L)
Permit hours per year	**8,760**	hr/yr	HY	
Hg saturation (years)	**13.6**	yr	S_y	$S_y=S_h/HY$

As shown by Table 3-4, the volume of carbon is sufficient to provide adequate residence time (≥1 second based on the dry standard flow rate) and the total weight of carbon is sufficient for the expected mercury loading rate (mercury saturation is approximately 14 years). Based on this analysis, the proposed autoclave circuit control system meets NvMACT.

3.3.3.2 Proposed Mercury Emission Limit

Goldcorp is proposing to conduct True-Up/True-Down (TUTD) testing to establish the final NvMACT mercury emission limit for the autoclave circuit. During the TUTD testing period, Goldcorp is proposing the NvMACT interim mercury emission limit of 5.0E-03 gr/dscf for the autoclave circuit.

To account for mercury emissions during the limited use of the release vent, Goldcorp is proposing to use a mercury emission rate based on the NvMACT limit of 4.0E-04 gr/dscf for Autoclaves 2 and 3 at the Nevada Gold Mines LLC - Goldstrike mine, which do not employ carbon control. Given the Lone Tree autoclave maximum exhaust flow rate of 8,300 dry standard cubic feet per minute (dscfm), the mercury emissions during use of the release vent would be calculated using the mercury emission rate of 0.028 pounds per hour.

$$\frac{4.0E\text{-}04 \ \cancel{gr}}{\cancel{dscf}} \left| \frac{8{,}300 \ \cancel{dscf}}{\cancel{min}} \right| \frac{60 \ \cancel{min}}{hr} \left| \frac{lb}{7{,}000 \ \cancel{gr}} \right. = \frac{0.028 \ lb}{hr}$$

3.3.3.3 Cost of Controls

The costs of the proposed autoclave venturi scrubber and carbon bed were estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital costs, O&M costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rate of 8,300 dscfm, the estimated control costs are summarized in Table 3-5.

Table 3-5. Lone Tree Autoclave Control Costs

Control	Exhaust Flow (dscfm)	Capital Cost ($1,000)	O&M Cost ($1,000 / yr)	Annualized Cost ($1,000 / yr)
Venturi Scrubber	8,300	188	996	1,591
Carbon Bed	8,300	873	not available	not available

(EPA 2003vs), (EPA 1999)

REFERENCES

Barrick. 2018. "Barrick Goldstrike Mines Inc., MOPTC Phase II, AP1041-2221, Revised NvMACT Analysis and Application Forms, Roasters." Barrick Goldstrike Mines, Inc. (Barrick), September 19. Accessed August 25, 2021. DOC ID 19487 - https://documentviewerpublic.ndep.nv.gov/Common/login.aspx.

Booz et al. 2001. "Mercury Mass Balance and Emission Factor Estimates for Gold Ore Processing Facilities (Draft)." Report Prepared for U.S. EPA Region 9 by Booz Allen & Hamilton Inc., January 14.

EPA. 1999. "Technical Bulletin - Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA 456/F-99-004." United States Environmental Protection Agency (EPA), May.

—. 2002. "EPA Air Pollution Control Cost Manual, 6th Edition." EPA Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA/452/B-02-001, January.

—. 2003vs. "Air Pollution Control Technology Fact Sheet - Venturi Scrubber." *EPA-452/F-03-017.* United States Environmental Protection Agency (EPA). Accessed August 23, 2021. https://www.epa.gov/catc/clean-air-technology-center-products#factsheets.

—. 2018. "EPA Air Pollution Control Cost Manual 6th edition Section 3.1, Chapter 1 - Carbon Adsorbers." *Office of Air Quality Planning and Standards.* Research Triangle Park, North Carolina: United States Environmental Protection Agency (EPA), October. https://www.epa.gov/sites/default/files/2018-10/documents/final_carbonadsorberschapter_7thedition.pdf.

Hatch. 2025. "i-80 Gold Corp - Lone Tree Restart Permitting Inputs Sheet." *Document Number: H367753-0000-843-216-0001.* Hatch, November 7.

Klett et al. 2002. "The Cost of Mercury Removal in an IGCC Plant. Final Report." Michael G. Klett, Russell C. Maxwell, and Michael D. Rutkowski. Parsons Infrastructure and Technology Group Inc. Report prepared for The United States Department of Energy National Energy Technology Laboratory., September.

NCSU. 1998b. "Wet Scrubber System Operation Review." *APTI SI:412C, Second Edition.* U.S. Environmental Protection Agency (EPA) Air Pollution Training Institute (APTI).

NDEP. 2016. "Nevada Mercury Control Program Permitting Guidance, General Industry NvMACT Determinations (Draft)." Nevada Division of Environmental Protection (NDEP), February 29.

Rong Yan, et al. 2004. "Bench-scale experimental evaluation of carbon performance on mercury vapour adsorption." Fuel. Vol. 83, No. 17-18.

SION. 2021. "Trip Report to Rawhide Mine to Review the Operation of Melting Furnace Mercury Scrubber." Scotia International of Nevada (SION), July 26.

—. n.d. "Coal Based Activated Carbon Impregnated with Sulfur." *Product Bulletin COL-IS 60.* Scotia International of Nevada, Inc. (SION).

Taylor and Francis Group. 2005. "CRC Handbook of Chemistry and Physics." 86th Edition.

NvMACT Analysis for the Kiln

KILN NVMACT ANALYSIS – TABLE OF CONTENTS

3.0 NvMACT Analysis - Kiln 23
3.1 Introduction 23
3.2 Process Description 23
3.3 NvMACT Analysis 24
3.3.1 Part I – Existing Similar Thermal Units 24
3.3.1.1 Mercury Controls 24
3.3.1.1.1 Condensers 26
3.3.1.1.2 Wet Scrubbers 26
3.3.1.1.3 Carbon Adsorption 26
3.3.1.1.4 Work Practices 27
3.3.1.2 Mercury Emissions 28
3.3.1.3 Mercury Control Costs 31
3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements .. 31
3.3.2 Part II – Other Controls and/or Work Practices 31
3.3.2.1 Other Mercury Control Options 31
3.3.2.1.1 Boliden-Norzink Process 32
3.3.2.1.2 Activated Carbon Injection 32
3.3.2.1.3 Selenium Scrubber 33
3.3.2.1.4 Selenium Filter 33
3.3.2.1.5 Baghouse 33
3.3.2.2 Other Work Practices 34
3.3.3 Part III - Proposed NvMACT 34
3.3.3.1 Proposed Controls and Work Practices 35
3.3.3.2 Proposed Mercury Emission Limit 36
3.3.3.3 Cost of Controls 36
References 38

Tables

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits 25
Table 3-2. Existing Similar Thermal Units: Compliance Test Results 29
Table 3-3. Existing Similar Thermal Units: Control Costs 31
Table 3-4. Carbon Bed Design Analysis 36
Table 3-5. Lone Tree Kiln Control Costs 37

Figures

Figure 3-1. Kiln Process Flow Diagram 23
Figure 3-2. Lone Tree Exhaust Gas Treatment 35

3.0 NvMACT ANALYSIS - KILN

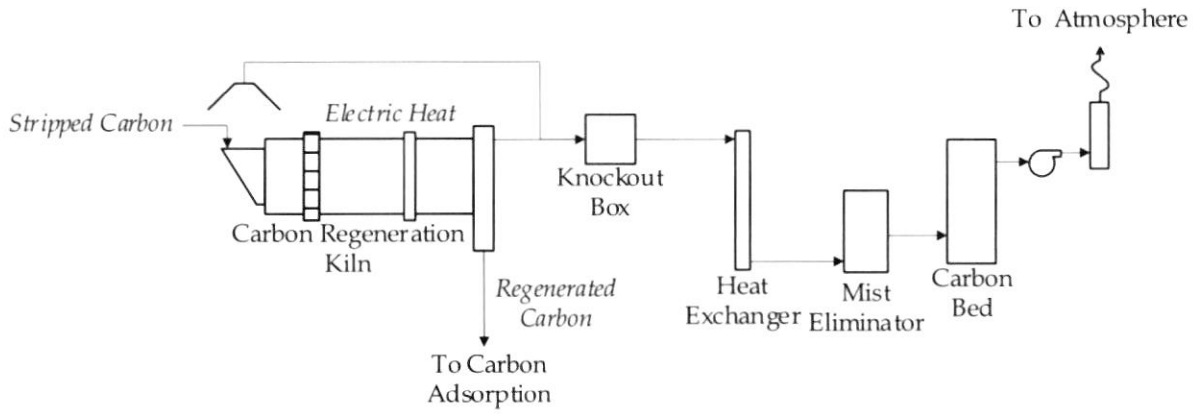
3.1 Introduction

Goldcorp DEE LLC (Goldcorp) proposes to install and operate an electric carbon regeneration kiln (kiln) at the Lone Tree Mine (Lone Tree). Per Nevada Administrative Code (NAC) 445B.3681.6, a Nevada Maximum Achievable Control Technology (NvMACT) analysis is required for new thermal units that emit mercury, as a part of a Mercury Operating Permit to Construct (MOPTC) application. The NvMACT analysis provided herein for the kiln addresses all the applicable requirements of NAC 445B.3681.6.

3.2 Process Description

Carbon is used in the gold recovery process to adsorb gold in solution from the ore slurry or from pregnant leach solution. After being stripped, the carbon used in the gold recovery process gradually loses its ability to effectively adsorb gold and requires regeneration. The proposed kiln at Lone Tree will be electrically heated. The exhaust stream from the kiln drum will pass through a knockout box, heat exchanger, mist eliminator, and carbon bed before being released to the atmosphere. See Figure 3-1 for a process flow diagram.

Figure 3-1. Kiln Process Flow Diagram



3.3 NvMACT Analysis

3.3.1 Part I – Existing Similar Thermal Units

Part I of the NvMACT analysis provides a list of similar existing thermal units used for precious metal refining and describes the controls and work practices used to reduce mercury emissions. All information required by NAC 445B.3681, as described below, is provided herein:

NAC 445B.3681 New or modified thermal unit that emits mercury: Contents of required application.

☒ *6.(b) Sets forth a list of similar thermal units that emit mercury which are used for precious metal mining that includes, without limitation:*

- ☒ *(1) Any methods or technologies to control mercury emissions which are associated with the thermal units that emit mercury;*
- ☒ *(2) The level of mercury emissions associated with each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(3) The design for each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(4) Costs associated with reductions of mercury emissions as a result of each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(5) Costs associated with energy for each method or technology to control mercury emissions from the thermal units that emit mercury; and*
- ☒ *(6) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal units that emit mercury.*

3.3.1.1 Mercury Controls

The Nevada Mercury Control Program (NMCP) permits for existing kilns were downloaded from the Nevada Division of Environmental Protection (NDEP) Public Document Search website to obtain a list of the existing kiln mercury controls. This information is summarized in Table 3-1.

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits

Facility Name	Permit No.	Date	Source	Control1	Control2	Control3	Carbon (lb)	Stack Flow	Stack Temp (F)	Limit (gr/dscf)	Limit Notes
Borealis Mining Company LLC	AP1041-2228	2/22/2013	Carbon Regeneration Kiln (TU4.001)	Wet Scrubber (WS-001)	-					5.0E-05	
			Smelting Furnace (TU4.003)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	8,000	2,000 acfm	120	-	
			Mercury Retort (TU4.002)	-	Condenser (MC-001)					-	
			Electrowinning Circuit (TU4.004)	-	-					-	
			Pregnant Tank (TU4.005)	-	-					-	
			Barren Tank (TU4.006)	-	-					-	
Florida Canyon Mining, Inc	AP1041-2256	2/1/2021	Carbon Regeneration Kiln (TU4.008)	Exhaust Demister Vessel (EDV-001)	Carbon Adsorption Vessel (DS-003)		8,462	3,091 acfm	120	1.0E-04	
GRP Pan, LLC	AP1041-3302	8/17/2016	Carbon Kiln - Drum (TU4.001)	Off-Gas Cooler	Carbon Filter (CF-001)		252	100 acfm	130	1.0E-04	
KG Mining (Bald Mountain) Inc.	AP1041-3927	7/15/2021	Carbon Regeneration Kiln (TU4.001)	Knockout Box (KB-001)	Condenser (CO-001)	Carbon Adsorption Filter (CF-001)	1,000	300 dscfm	100	1.0E-04	
Klondex Aurora Mine, Inc.	AP1041-2248	5/29/2019	Carbon Kiln (TU4.001)	Venturi Wet Scrubber (WS 001)	Carbon Deep Bed Scrubber (CA-001)		5,500	1,071 dscfm	200	1.0E-04	Combined limit for TU4.001 - TU4.003 and TU4.006
			Pregnant Tank (TU4.002)	-							
			Barren Tank (TU4.003)	-							
			Electrowinning Cells (TU4.006)	-							
Marigold Mining Company	AP1041-2254	1/27/2022	Carbon Kiln (TU4.001)	Wet Scrubber (WS-001)	Carbon Adsorption Unit (CA-001)		5,000	1,500 dscfm	120	1.0E-04	
McEwen Mining, Inc.	AP1041-3801	9/24/2020	Carbon Regeneration Kiln (Drum) (TU4.001)	Knockout Box (KB-001) Condenser Heat Exchanger (HX-701)	Mist Eliminator (MST-701) Duct Heater (HTR-701)	Carbon Filter (CF-004)	500	135 dscfm	150	1.4E-04	
Nevada Gold Mines LLC - Cortez	AP1041-2220	2/1/2021	Carbon Reactivation Kiln #1 (TU4.005)	Venturi Wet Scrubber (VS-001)	Exhaust Air De-Mister and Pre-Heater (PH-003)	Sulfur Impregnated Carbon Adsorption Bed (CA-004)	2,200	1,200 dscfm	100	1.0E-04	
			Carbon Reactivation Kiln #2 (TU4.006)							1.0E-04	
Nevada Gold Mines LLC - Gold Quarry Operations	AP1041-2219	4/23/2025	Carbon Regeneration Kiln #1 (TU4.027)	Wet Scrubber (500-DC-014)	Sulfur Impregnated Carbon Filter Packs (CF-		618	1,237 dscfm	95	3.1E-03	
			Carbon Regeneration Kiln #2 (TU4.028)	Wet Scrubber (2550-DC-03)	Sulfur Impregnated Carbon Filter Packs (CF-		618	1,234 dscfm	95	3.0E-03	
Nevada Gold Mines LLC - Goldstrike Mine	AP1041-2221	5/5/2025	Carbon Reactivation Kiln Drum (TU4.008)	Venturi Wet Scrubber (WS-001)	Condensation Tower (CT-001)	6.0-ton Carbon Bed (CA-001) 1.65-ton Carbon Bed (CA-002)	(CA-001) 12000 (CA-002) 3300	3,500 dscfm	158	5.0E-05	Combined limit for TU4.008 - TU4.012
			Pregnant Tank A-side (TU4.009)	-	-						
			Pregnant Tank B-side (TU4.010)	-	-						
			Barren Tank A-side (TU4.011)	-	-						
			Barren Tank B-side (TU4.012)	-	-						
Nevada Gold Mines LLC - Twin Creeks Mine	AP1041-2218	11/14/2023	Juniper Mill Carbon Kiln (TU4.003)	Wet Scrubber (WS-001)	Hypochlorite Scrubber (HS-001)		not applicable	1,300 dscfm	100	5.0E-03	
Newmont Mining Corporation, Phoenix Mine	AP1041-2247	8/13/2018	Electric Carbon Regeneration Kiln (TU4.001)	Wet Scrubber (WS-001)	Sulfur Impregnated Carbon Adsorption Columns		4,000	1,700 dscfm	175	1.0E-04	
Rawhide Mining, LLC	AP1041-2245	12/21/2021	Carbon Regeneration Kiln (TU4.001)	Chilled Mercury Condenser (CO-001)	Carbon Filter (CF-001)		780	410 dscfm	60	1.0E-04	
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	AP1041-2250	3/7/2024	Carbon Reactivation Kiln (TU4.001)	Wet Scrubber (WS-001)	Carbon Deep Bed Scrubber (CA-001)		5,000	700 dscfm	185	1.0E-04	
			Carbon Reactivation Kiln (TU4.006)	Condenser (MC-001)	Carbon Deep Bed Scrubber (CA-003)		590	95 dscfm	150	1.0E-04	
Walker Lane Minerals Corporation	AP1041-3895	11/17/2017	Carbon Regeneration Kiln (TU4.005	Wet Scrubber (WS-001)	-					1.0E-04	
			Pregnant Tank (TU4.001)	-	-	Deep Bed Scrubber (DBCS-001)	5,000	2,760 dscfm	200	-	
			Barren Tank (TU4.002)	-	-					-	
			Electrowinning Cells (TU4.003)	-	-					-	
			Mercury Retort (TU4.004)	-	Condenser (CO-001)					-	
WK-Allied Hasbrouck, LLC Three Hills Mine Project	AP1041-3669	6/25/2019	Carbon Regeneration Kiln (TU4.003	Venturi Scrubber (VS-002)						1.0E-04	
			Electrowinning Cell #1 (TU4.004)	-						-	
			Electrowinning Cell #2 (TU4.005)	-	Carbon Bed Vapor Pac (CB-001)		18,000	7,650 dscfm	115	-	
			Pregnant Solution Tank (TU4.006)	-						-	
			Barren Tank (TU4.007)	-						-	
			Smelting Furnace (Electric) (TU4.002)	Venturi Scrubber (VS-001)						-	

As shown in Table 3-1, the mercury controls installed for kilns include condensers, wet scrubbers, and carbon adsorbers.

3.3.1.1.1 Condensers

As shown in Table 3-1, many existing kilns employ a condenser in the control train. For these kilns, the exhaust stream passes through the condenser, which cools the gas and causes the water vapor, and possibly vaporized mercury to condense. Any condensed mercury is then bled from the condenser into a collection vessel. The species of mercury collected from the condensers at precious metal mining, processing, and refining facilities in Nevada is elemental.

The two most common types of condensers are surface and contact condensers. Surface condensers cool gas streams by circulating water (or other cooling medium) through an enclosed water jacket surrounding the exhaust system or through a shell-and-tube type heat exchanger. Contact condensers cool gas streams by spraying cooled water into the gas stream. The following correlation exists for both types of condensers: the colder the circulating water, the colder the exhaust gas, and, for a constant inlet loading of mercury, the more efficient the removal of mercury from the gas stream (EPA 2002). However, for many kilns, the concentration of mercury in the exhaust is too low for mercury condensation. The primary purpose of the condensers is to remove water droplets from the exhaust stream prior to the carbon filter.

3.3.1.1.2 Wet Scrubbers

As shown in Table 3-1, other existing kilns employ wet scrubbers in addition to or in place of a condenser in the control train. Wet scrubbers control particulates, including particulate mercury, through impaction, diffusion, interception, and/or adsorption of the pollutant onto droplets of liquid. As the gas passes through the wet scrubber, there is a drop in pressure. For wet scrubbers in general, the greater the pressure drop, the higher the particulate control efficiency. The liquid-to-gas ratio also affects scrubber efficiency. There must be sufficient liquid injected into the scrubber to allow contact with the particulate. After an optimal point, adding excess liquid to a scrubber does not increase the particulate control efficiency. The liquid-to-gas ratio for wet scrubbers typically ranges from 4 to 20 gallons per 1,000 actual cubic feet (EPA 1984).

One mine, Nevada Gold Mines LLC – Twin Creeks Mine, employs a hypochlorite wet scrubber to control the kiln exhaust. In this scrubber, hypochlorite solution is used to oxidize elemental mercury to mercuric chloride ($HgCl_2$). $HgCl_2$ is soluble in water and only slightly volatile at ordinary temperatures (0.1 mmHg at 100°C) (Akron n.d.).

3.3.1.1.3 Carbon Adsorption

Carbon adsorption filters use activated carbon particles to adsorb mercury from the gas stream. Adsorption occurs when gas molecules are passed through a bed of solid particles (activated carbon). The gas molecules migrate from the gas stream to the surface of the solids, where they are held by physical attraction (EPA 2002). Carbon impregnated with elemental sulfur increases

the adsorption efficiency due to the sulfur-mercury reaction that forms mercury sulfide, a stable mercury compound with a low vapor pressure (Booz et al. 2001).

Carbon filters control all types of mercury: particulate-bound, oxidized, and elemental. The mercury in the gas stream is adsorbed to the carbon and collected as carbon loaded with mercury. Once the carbon reaches adsorptive capacity, it is replaced, and the spent carbon is reclaimed. The carbon filter's mercury content is monitored to ensure that the mercury loading does not exceed the value recommended by the manufacturer. The typical carbon loading capacity is approximately 20 percent (or more) mercury by weight (SION n.d.) (Klett et al. 2002). Carbon mercury loading can be monitored directly, or the mercury concentration in the exhaust at the outlet of the carbon filter can be monitored to ensure the effectiveness of the carbon adsorber.

Some factors that can affect carbon filter adsorption efficiency include residence time of the gas in the carbon filter, carbon particle size, and exhaust stream moisture content. Longer residence times and smaller carbon particle sizes increase the mercury removal efficiency of the carbon filter (Booz et al. 2001). According to Scotia International of Nevada (SION), *"Some moisture in the gas stream, and therefore in the carbon, catalyzes the mercury removal reaction. It is anticipated that as long as no free water is being released from the carbon, the moisture maximum would be 45%. Release of moisture from the carbon, would indicate that the gas stream is condensing within the carbon, which has the potential to inhibit the mercury removal reaction. The carbon is delivered with a nominal moisture of 5% (this value can vary by the ambient humidity of the area of usage)"* (SION 2021).

In short, mercury removal may be inhibited when carbon is physically wet with water (where moisture exceeds 45 percent).

3.3.1.1.4 Work Practices

In addition to the controls listed in Table 3-1, most of the precious metal mining facilities in Nevada incorporate several different work practices into their processes to reduce mercury emissions. These work practices include inspecting the exhaust capture system and replacing the carbon prior to exceeding the recommended mercury loading levels.

The exhaust from the kiln must be captured and conveyed to the control system and then to a stack before being released to the atmosphere. The equipment for the ventilation system consists of hoods, ductwork, fans, and a stack. The hoods and ductwork are inspected periodically to ensure proper emissions capture.

To ensure sufficient control efficiency by a carbon filter, the carbon filter media is replaced prior to exceeding maximum mercury loading as recommended by the manufacturer. This can be accomplished by:

- replacing the carbon on a schedule that ensures the recommended mercury loading is not exceeded, based on worst-case mercury loading data;
- monitoring the loading of mercury on the carbon directly by carbon analyses;

- monitoring the mercury levels in the exhaust from the carbon filter; or
- a combination of the above work/monitoring practices.

3.3.1.2 Mercury Emissions

NMCP permits for existing kilns were downloaded from the NDEP Public Document Search website to obtain a list of the existing mercury emission limits. This information is summarized in Table 3-1 of Section 3.3.1.1. The NvMACT emission limits range from the General Industry NvMACT limit for kilns of 1.0E-04 grains per dry standard cubic foot (gr/dscf) to the True-Up/True-Down (TUTD) interim limit of 5.0E-03 gr/dscf (NDEP 2016), with the exception of two facilities (Borealis Mining Company and Nevada Gold Mines LLC – Goldstrike Mine) limited to 5.0E-05 gr/dscf, the General Industry NvMACT limit for exhaust streams including pregnant and barren tanks.

NMCP compliance tests for existing kilns were downloaded from the NDEP Public Document Search website to obtain the actual mercury emissions data for kilns utilizing NvMACT controls. This information is summarized in Table 3-2 for years 2018 through 2025. As shown in Table 3-2, all stack test results are below the TUTD interim limit of 5.0E-03 gr/dscf and many of the stack test results are also below the General Industry NvMACT limit for kilns of 1.0E-04 gr/dscf.

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Borealis Mining Company L	Carbon Regeneration Kiln (TU4.001)	10/15/2018	5.66E-07	5.0E-05	1.70E-06	344	441	66.1
	Carbon Regeneration Kiln (TU4.001)	6/10/2019	1.17E-05	5.0E-05	4.50E-05	449	628	96.2
	Carbon Regeneration Kiln (TU4.001)	8/10/2020	1.94E-06	5.0E-05	7.22E-06	437	604	87.3
	Carbon Regeneration Kiln (TU4.001)	8/30/2021	2.68E-06	5.0E-05	8.59E-06	374	528	97.3
	Carbon Regeneration Kiln (TU4.001)	10/20/2022	1.00E-05	5.0E-05	4.00E-05	453	624	90.3
	Carbon Regeneration Kiln (TU4.001)	8/1/2023	1.51E-05	5.0E-05	5.90E-05	484	667	83.6
Florida Canyon Mining, Inc.	Carbon Regeneration Kiln (TU4.008)	10/10/2018	7.24E-07	not available	6.87E-05	11,071	12,862	59.1
	Carbon Regeneration Kiln (TU4.008)	12/14/2018	3.46E-05	1.0E-04	4.35E-04	1,465	not available	59.8
	Carbon Regeneration Kiln (TU4.008)	10/13/2020	4.50E-04	1.0E-04	2.90E-03	907	757	78.3
	Carbon Regeneration Kiln (TU4.008)	12/16/2020	4.07E-06	1.0E-04	2.89E-05	830	950	61.9
	Carbon Regeneration Kiln (TU4.008)	4/8/2021	5.14E-06	1.0E-04	3.13E-05	708	868	87.2
	Carbon Regeneration Kiln (TU4.008)	1/21/2022	1.48E-05	1.0E-04	3.36E-04	2,653	not available	70.5
	Carbon Regeneration Kiln (TU4.008)	1/26/2023	1.98E-07	1.0E-04	4.00E-06	2,310	2,728	61.0
	Carbon Regeneration Kiln (TU4.008)	1/31/2024	1.60E-07	1.0E-04	2.33E-06	1,942	2,370	76.5
GRP Pan, LLC	Carbon Kiln - Drum (TU4.001)	12/18/2018	2.34E-05	not available	1.40E-04	699	860	53.0
	Carbon Kiln - Drum (TU4.001)	11/18/2019	1.40E-05	1.0E-04	4.70E-05	386	467	61.2
	Carbon Kiln - Drum (TU4.001)	11/10/2020	4.30E-04	1.0E-04	1.60E-03	432	568	89.7
	Carbon Kiln - Drum (TU4.001)	2/8/2021	4.30E-06	1.0E-04	1.70E-05	467	578	62.0
	Carbon Kiln - Drum (TU4.001)	12/13/2021	5.53E-05	1.0E-04	2.25E-04	474	not available	54.0
	Carbon Kiln - Drum (TU4.001)	11/15/2022	2.80E-05	1.0E-04	7.20E-05	301	294	60.4
	Carbon Kiln - Drum (TU4.001)	9/18/2023	8.88E-06	1.0E-04	3.62E-05	475	not available	75.2
	Carbon Kiln - Drum (TU4.001)	9/30/2024	5.03E-06	1.0E-04	2.00E-05	465	612	74.2
	Carbon Kiln - Drum (TU4.001)	10/20/2025	4.08E-06	1.0E-04	5.98E-06	171	not available	67.7
Klondex Aurora Mine, Inc.	Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003) Electrowinning Cells (TU4.006)	9/25/2018	3.20E-07	1.0E-04	5.50E-06	2,042	3,189	138.0
	Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003) Electrowinning Cells (TU4.006)	10/1/2019	1.90E-06	1.0E-04	3.80E-05	2,301	3,226	83.6
	Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003) Electrowinning Cells (TU4.006)	'Temporarily' stopped for economic reasons						
Marigold Mining Company	Carbon Kiln (TU4.001)	6/13/2019	8.25E-07	5.0E-03	2.46E-06	345	518	162.7
	Carbon Kiln (TU4.001)	8/27/2020	1.10E-06	1.0E-04	3.60E-06	392	563	157.8
	Carbon Kiln (TU4.001)	7/22/2021	1.00E-07	1.0E-04	3.70E-07	435	647	166.7
	Carbon Kiln (TU4.001)	7/22/2022	3.36E-06	1.0E-04	not available	432	639	171.3
	Carbon Kiln (TU4.001)	7/13/2023	9.40E-05	1.0E-04	3.30E-04	405	568	138.1
	Carbon Kiln (TU4.001)	9/13/2024	3.68E-06	1.0E-04	8.02E-06	254	362	150.4
	Carbon Kiln (TU4.001)	8/8/2025	5.28E-07	1.0E-04	3.43E-06	758	1,153	178.6
McEwen Mining, Inc.	Carbon Regeneration Kiln (Drum) (TU4.001)	4/24/2020	2.24E-05	5.0E-03	1.60E-05	83	107	65.0
	Carbon Regeneration Kiln (Drum) (TU4.001)	10/16/2020	4.79E-05	5.0E-03	3.69E-05	90	118	74.9
	Carbon Regeneration Kiln (Drum) (TU4.001)	4/23/2021	1.03E-04	5.0E-03	8.85E-05	100	134	74.0
	Carbon Regeneration Kiln (Drum) (TU4.001)	5/13/2022	9.30E-06	5.0E-03	9.30E-06	116	150	71.2
	Carbon Regeneration Kiln (Drum) (TU4.001)	12/1/2022	2.30E-06	5.0E-03	2.60E-06	131	174	70.5
	Carbon Regeneration Kiln (Drum) (TU4.001)	1/18/2024	1.30E-05	1.4E-04	1.07E-05	96	not available	74.3
	Carbon Regeneration Kiln (Drum) (TU4.001)	7/19/2024	2.23E-03	1.4E-04	1.46E-03	76	not available	87.6
	Carbon Regeneration Kiln (Drum) (TU4.001)	10/29/2024	7.83E-06	1.4E-04	5.86E-06	94	121	58.7
	Carbon Regeneration Kiln (Drum) (TU4.001)	6/11/2025	2.40E-06	1.4E-04	2.22E-06	106	146	89.4
Nevada Gold Mines LLC - Cortez	Carbon Reactivation Kiln #1 (TU4.005)	7/23/2018	7.59E-06	1.0E-04	1.56E-05	240	317	114.3
	Carbon Reactivation Kiln #2 (TU4.006)	7/20/2018	1.82E-05	1.0E-04	2.89E-05	186	249	119.3
	Carbon Reactivation Kiln #2 (TU4.006)	8/28/2019	7.03E-05	1.0E-04	4.51E-04	744	1,067	139.6
	Carbon Reactivation Kiln #1 (TU4.005)	11/20/2019	1.30E-03	1.0E-04	8.80E-03	813	985	56.6
	Carbon Reactivation Kiln #1 (TU4.005)	4/29/2020	8.80E-05	1.0E-04	5.50E-04	731	1,041	148.7
	Carbon Reactivation Kiln #1 (TU4.005)	8/24/2020	4.70E-05	1.0E-04	2.90E-04	714	1,008	139.3
	Carbon Reactivation Kiln #1 (TU4.005)	8/26/2021	2.52E-04	1.0E-04	1.59E-03	739	not available	123.4
	Carbon Reactivation Kiln #2 (TU4.006)	8/26/2021	1.00E-04	1.0E-04	6.25E-04	730	not available	118.5
	Carbon Reactivation Kiln #1 (TU4.005)	11/30/2021	2.79E-07	1.0E-04	1.73E-06	724	not available	123.5
	Carbon Reactivation Kiln #2 (TU4.006)	8/25/2022	1.96E-05	1.0E-04	1.28E-04	767	not available	125.8
	Carbon Reactivation Kiln #1 (TU4.005)	8/25/2022	1.01E-04	1.0E-04	6.65E-04	765	not available	123.3
	Carbon Reactivation Kiln #1 (TU4.005)	8/24/2023	4.50E-05	1.0E-04	4.40E-04	1,221	1,649	137.3
	Carbon Reactivation Kiln #2 (TU4.006)	8/24/2023	8.70E-05	1.0E-04	8.70E-04	1,145	1,530	130.8
	Carbon Reactivation Kiln #1 (TU4.005)	8/22/2024	7.50E-06	1.0E-04	5.80E-05	910	1,233	117.9
	Carbon Reactivation Kiln #2 (TU4.006)	8/22/2024	6.20E-06	1.0E-04	4.80E-05	892	1,237	122.3
	Carbon Reactivation Kiln #1 (TU4.005)	11/19/2025	4.33E-06	1.0E-04	3.50E-05	945	1,310	123.5
	Carbon Reactivation Kiln #2 (TU4.006)	11/20/2025	5.25E-06	1.0E-04	4.37E-05	969	1,330	121.0
Nevada Gold Mines LLC - Gold Quarry Operations	Carbon Regeneration Kiln #1 (TU4.027)	3/20/2018	7.05E-05	5.0E-03	1.91E-04	317	390	68.5
	Carbon Regeneration Kiln #2 (TU4.028)	3/21/2018	2.70E-04	5.0E-03	9.38E-04	404	503	67.4
	Carbon Regeneration Kiln #1 (TU4.027)	4/2/2019	8.48E-04	5.0E-03	2.43E-03	334	426	69.3
	Carbon Regeneration Kiln #2 (TU4.028)	4/4/2019	7.56E-04	5.0E-03	2.50E-03	385	470	61.2
	Carbon Regeneration Kiln #1 (TU4.027)	9/25/2019	2.39E-03	5.0E-03	7.24E-03	354	448	82.0
	Carbon Regeneration Kiln #2 (TU4.028)	9/25/2019	9.42E-04	5.0E-03	3.54E-03	440	555	80.8
	Carbon Regeneration Kiln #1 (TU4.027)	4/15/2020	1.39E-03	5.0E-03	4.02E-03	338	429	74.0
	Carbon Regeneration Kiln #2 (TU4.028)	4/14/2020	1.45E-03	5.0E-03	5.30E-03	425	518	64.0
	Carbon Regeneration Kiln #1 (TU4.027)	9/17/2020	6.25E-04	5.0E-03	1.65E-03	309	400	88.5
	Carbon Regeneration Kiln #2 (TU4.028)	9/16/2020	3.76E-04	5.0E-03	1.49E-03	462	581	87.3
	Carbon Regeneration Kiln #1 (TU4.027)	3/10/2021	1.06E-03	5.0E-03	2.13E-03	236	299	75.0
	Carbon Regeneration Kiln #2 (TU4.028)	3/8/2021	2.34E-03	5.0E-03	7.63E-03	380	470	65.3
	Carbon Regeneration Kiln #1 (TU4.027)	9/14/2021	2.29E-04	5.0E-03	7.21E-04	366	not available	81.2
	Carbon Regeneration Kiln #2 (TU4.028)	9/21/2021	1.74E-04	5.0E-03	6.42E-04	428	not available	76.2
	Carbon Regeneration Kiln #1 (TU4.027)	10/25/2022	4.93E-04	5.0E-03	1.57E-03	372	461	74.6
	Carbon Regeneration Kiln #2 (TU4.028)	10/20/2022	8.29E-04	5.0E-03	2.73E-03	383	483	80.3
	Carbon Regeneration Kiln #2 (TU4.028)	10/17/2023	5.59E-04	5.0E-03	2.04E-03	426	not available	79.2
	Carbon Regeneration Kiln #1 (TU4.027)	6/18/2024	1.25E-03	5.0E-03	3.57E-03	333	not available	65.3
	Carbon Regeneration Kiln #1 (TU4.027)	10/10/2024	4.34E-04	3.1E-03	1.43E-03	384	not available	73.1
	Carbon Regeneration Kiln #2 (TU4.028)	10/7/2024	2.32E-04	3.0E-03	8.61E-04	433	not available	78.0

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Nevada Gold Mines LLC - Goldstrike Mine	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	7/24/2018	3.60E-06	5.0E-03	4.27E-05	1,388	2,042	155.0
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	7/25/2018	3.65E-06	5.0E-03	4.40E-05	1,410	not available	155.4
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	8/7/2019	3.28E-06	5.00E-03	4.57E-05	1,646	2,412	142.9
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	11/4/2020	8.70E-06	5.0E-05	1.20E-04	1,544	2,207	138.3
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	9/21/2021	3.30E-07	5.00E-05	3.90E-06	1,366	1,897	132.4
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	9/8/2022	2.81E-06	5.0E-05	not available	1,301	not available	150.5
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	9/13/2023	2.30E-06	5.00E-05	2.60E-05	1,363	1,947	139.6
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	8/27/2024	6.49E-07	5.00E-05	8.17E-06	1,467	2,109	145
	Carbon Reactivation Kiln Drum (TU4.008) Pregnant Tank A-side (TU4.009) Pregnant Tank B-side (TU4.010) Barren Tank A-side (TU4.011) Barren Tank B-side (TU4.012)	6/24/2025	1.45E-06	5.00E-05	1.24E-05	1,000	1,381	127
Nevada Gold Mines LLC - Twin Creeks Mine	Juniper Mill Carbon Kiln (TU4.003)	5/3/2018	1.90E-04	5.0E-03	8.90E-04	546	746	105.9
	Juniper Mill Carbon Kiln (TU4.003)	5/6/2019	5.55E-04	5.0E-03	5.92E-03	1,247	1,733	105.0
	Juniper Mill Carbon Kiln (TU4.003)	10/22/2020	2.25E-05	5.0E-03	2.10E-04	1,091	not available	87.0
	Juniper Mill Carbon Kiln (TU4.003)	4/14/2021	3.71E-05	5.0E-03	4.06E-04	7,216	not available	84.0
	Juniper Mill Carbon Kiln (TU4.003)	4/18/2022-4/22/2022	8.62E-04	5.0E-03	not available	1,387	not available	70.2
	Juniper Mill Carbon Kiln (TU4.003)	3/22/2023	1.34E-03	5.0E-03	1.10E-02	970	1,294	96.6
	Juniper Mill Carbon Kiln (TU4.003)	5/1/2024	1.58E-04	5.0E-03	not available	1,636	not available	90.8
	Juniper Mill Carbon Kiln (TU4.003)	6/3/2025	1.56E-04	5.0E-03	3.10E-03	2,283	3,083	93.8
Newmont Mining Corporation, Phoenix Mine	Electric Carbon Regeneration Kiln (TU4.001)	5/6/2018	4.70E-07	1.0E-04	4.12E-06	1,035	1,560	147.0
	Electric Carbon Regeneration Kiln (TU4.001)	2019+ tests are not available, MOPTC was 'cancelled'						
Rawhide Mining, LLC	Carbon Regeneration Kiln (TU4.001)	12/6/2018	3.66E-06	1.0E-04	1.11E-05	352	388	32.6
	Carbon Regeneration Kiln (TU4.001)	10/3/2019	3.15E-06	1.0E-04	1.05E-05	389	483	76.1
	Carbon Regeneration Kiln (TU4.001)	12/9/2020	3.12E-04	1.0E-04	5.30E-04	198	237	59.2
	Carbon Regeneration Kiln (TU4.001)	5/11/2021	1.50E-05	1.0E-04	2.80E-05	214	267	88.4
	Carbon Regeneration Kiln (TU4.001)	11/16/2021	5.70E-05	1.0E-04	1.10E-04	232	291	78.6
	Carbon Regeneration Kiln (TU4.001)	8/4/2022	2.06E-05	1.0E-04	not available	195	not available	98.2
	Carbon Regeneration Kiln (TU4.001)	8/14/2023	6.21E-07	1.0E-04	7.57E-07	142	187	107.2
		Shutdown in 2023						
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	Carbon Reactivation Kiln (TU4.001)	4/11/2018	2.84E-06	1.0E-04	5.40E-06	221	294	89.0
	Carbon Reactivation Kiln (TU4.006)	4/14/2018	5.48E-05	1.0E-04	4.01E-05	85	105	66.0
	Carbon Reactivation Kiln (TU4.001)	4/17/2019	1.60E-04	1.0E-04	1.60E-04	120	153	71.1
	Carbon Reactivation Kiln (TU4.006)	4/22/2019	2.10E-04	1.0E-04	8.40E-05	47	60	61.9
	Carbon Reactivation Kiln (TU4.001)	9/4-5/2019	1.10E-04	1.0E-04	3.70E-04	393	588	112.9
	Carbon Reactivation Kiln (TU4.006)	9/6/2019	3.60E-06	1.0E-04	2.70E-06	88	118	91.2
	Carbon Reactivation Kiln (TU4.001)	1/28/2020	2.00E-05	1.0E-04	8.50E-05	508	662	63.1
	Carbon Reactivation Kiln (TU4.001)	5/5/2020	1.40E-06	1.0E-04	4.30E-06	352	512	119.3
	Carbon Reactivation Kiln (TU4.006)	5/13/2020	3.10E-05	1.0E-04	2.40E-05	89	113	65.9
	Carbon Reactivation Kiln (TU4.006)	8/8/2021	2.50E-07	1.0E-04	1.90E-07	88	116	86.0
	Carbon Reactivation Kiln (TU4.001)	8/10/2021	2.60E-07	1.0E-04	6.30E-07	279	398	106.7
	Carbon Reactivation Kiln (TU4.001)	10/5/2022	2.00E-06	1.0E-04	2.20E-06	130	169	66.7
	Carbon Reactivation Kiln (TU4.006)	10/3/2022	2.50E-05	1.0E-04	1.10E-05	49	62	70.7
	Carbon Reactivation Kiln (TU4.001)	9/22/2023	5.61E-05	1.0E-04	2.50E-04	528	685	65.1
	Carbon Reactivation Kiln (TU4.006)	9/19/2023	1.63E-05	1.0E-04	1.90E-05	130	166	80.0
	Carbon Reactivation Kiln (TU4.001)	8/6/2024	9.00E-06	1.0E-04	3.00E-05	391	551	118.3
	Carbon Reactivation Kiln (TU4.006)	8/8/2024	1.30E-05	1.0E-04	9.00E-06	82	109	84.7
Walker Lane Minerals Corporation	Carbon Regeneration Kiln (TU4.005)	4/28/2021	4.11E-06	1.0E-04	3.76E-05	1,065	not available	97.7
	Carbon Regeneration Kiln (TU4.005)	5/18/2022	1.14E-06	1.0E-04	9.33E-06	957	1,322	111.8
WK-Allied Hasbrouck, LLC Three Hills Mine Project	Carbon Regeneration Kiln (TU4.003)	not available	not available	not available	not available	not available	not available	not available

3.3.1.3 Mercury Control Costs

The costs of existing condensers, wet scrubbers, and carbon filters listed in Table 3-1 were estimated in current dollars using technical documents from the EPA Clean Air Technology Center and economies of scale (for the condenser). These documents provide the capital costs, operational and maintenance (O&M) costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rates listed in Table 3-1, the estimated carbon kiln control costs are summarized in Table 3-3.

Table 3-4. Existing Similar Thermal Units: Control Costs

Control	Exhaust Flow (scfm)	Capital Cost ($1,000)	O&M Cost ($1,000/ yr)	Annualized Cost ($1,000/ yr)
Condenser	95 to 410	8 to 32	3 to 13	4 to 18
Wet Scrubber	700 to 3,500	15 to 74	78 to 390	124 to 622
Carbon Filter	95 to 3,500	10 to 368	not available	not available

(EPA 2003cs) (EPA 2003vs) (EPA 1999) (M.A.Tribe, R.L.W.Alpine 1985)
scfm = standard cubic feet per minute; yr = year

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements

The main non-air-quality health and environmental impact caused by mercury control technologies for kilns is the reclamation of the carbon loaded with mercury from carbon filters. Once the carbon reaches adsorptive capacity, it is replaced with fresh carbon and the loaded carbon is reclaimed. In addition, shipping the used carbon to a reclamation facility has non-air-quality health, environmental, and energy impacts.

The use of condensers, wet scrubbers, and carbon filters would cause increased energy consumption due to the additional fan and pump power requirements and the energy required to cool the circulating water in the condenser. Wet scrubbers (including hypochlorite scrubbers) use water as a scrubbing solution and the discharge of this water has environmental impacts.

3.3.2 Part II – Other Controls and/or Work Practices

Part II of the NvMACT analysis examines other control options and/or work practices not currently employed at the existing kilns described in Part I – Existing Similar Thermal Units.

3.3.2.1 Other Mercury Control Options

In addition to the mercury control technologies employed with existing kilns, the following mercury control options are examined below:

1. Boliden-Norzink Process
2. Activated Carbon Injection
3. Selenium Scrubber

4. Selenium Filter
5. Baghouse

3.3.2.1.1 Boliden-Norzink Process

In the Boliden-Norzink process, a mercuric chloride ($HgCl_2$) solution reacts with elemental mercury in the off-gas to form a mercurous chloride (HgCl) precipitate known as calomel, which then settles and is recovered. This reaction occurs in a packed column. Once the solid is removed, the wash solution can be recirculated. A portion of the precipitate can be used to regenerate the mercuric chloride solution using chlorine gas (Booz et al. 2001). The rest of the calomel is sent off-site for reclamation. The Boliden-Norzink process uses the following reaction:

$$HgCl_{2(sol'n)} + Hg_{(gas)} \rightarrow 2HgCl_{(solid)}$$

Boliden-Norzink scrubbers are installed on the Nevada Gold Mines LLC – Goldstrike (Goldstrike), Jerritt Canyon Gold, LLC (Jerritt Canyon), and Nevada Gold Mines LLC - Gold Quarry Operations (Gold Quarry) roasters. These roasters volatilize large amounts of mercury and in turn produce large amounts of mercury co-product in the form of calomel. The calomel production at Goldstrike, Jerritt Canyon, and Gold Quarry averages 195,340 pounds, 7,640 pounds, and 9,120 pounds, respectively (Barrick 2018).

A Boliden-Norzink scrubber has not been applied to any existing kilns at precious metal mining facilities in Nevada. There is no basis for assessing its performance in such an application, given the dissimilarities between the carbon regeneration process (and its characteristic emission stream) and the units/emission streams where Boliden-Norzink scrubbers have been applied. In addition, this technology requires a significant capital investment and produces wastewater (process water containing chloride ions) and solid waste (calomel). The capital costs of the Boliden-Norzink scrubbers installed at Goldstrike and Gold Quarry are $4.7 million and $3.2 million, respectively (Barrick 2018).

Based on the Boliden-Norzink process cost and environmental impacts, and the low amount of mercury emitted from kilns, Boliden-Norzink scrubbers are not representative of NvMACT for kilns.

3.3.2.1.2 Activated Carbon Injection

Activated carbon injection is similar to activated carbon filters in that activated carbon particles are used to adsorb mercury from the off-gas stream. In this process, the carbon particles are injected directly into the off-gas stream to adsorb mercury. They are then collected in downstream particulate controls, such as baghouses, wet scrubbers, or wet ESPs. Carbon injection is typically used in the power plant industry, where particulate control technologies have already been installed to clean fly-ash (and injected activated carbon) from the off-gas stream.

This process has not been applied to existing kilns at precious metal mining facilities in Nevada, and there is no basis for assessing its performance in such an application. In addition, the control efficiency of carbon injection is typically lower than that of carbon filters. Therefore, the most appropriate activated carbon technology application for kilns is a carbon adsorption filter.

3.3.2.1.3 Selenium Scrubber

Selenium scrubbers use selenium or a selenium compound within a scrubber to react with elemental mercury in the off-gas to form mercuric selenide (HgSe). HgSe has a lower vapor pressure than other common mercury compounds, which allows for mercury capture. The HgSe is removed in a sludge separation circuit, which requires a thickener and HgSe reclamation. Sulfuric acid, at concentrations between 10 and 60 percent, is used as the wash solution for the process.

Selenium scrubbers are appropriate for gas streams with high mercury loading. The outlet concentrations from this process are typically higher than the concentrations achieved from the Boliden-Norzink process discussed in Section 3.3.2.1.1. Selenium scrubbers are not widely used due to their low removal efficiency and expensive reagent and reclamation requirements. Therefore, this option is not considered an effective mercury control method for kilns.

3.3.2.1.4 Selenium Filter

Selenium filters are similar to selenium scrubbers in that they use selenium to react with the elemental mercury in the off-gas stream to form mercuric selenide. Selenium filters use a selenium-impregnated porous carrier structure, housed in a cylindrical tower. The selenium filter's maximum operating temperature is approximately 250°F. The filters require a dry gas stream because moisture tends to degrade the filter media. The typical filter's carrying capacity is between 10 and 15 percent mercury by weight.

Selenium filters have been installed in only a few places in the world, and primarily in Sweden, and no operating data from these applications are available. Selenium filters are expensive to produce and to regenerate. There is no basis to believe that selenium filters would provide a better alternative to activated carbon filters. In addition, there is some concern that the selenium filters cause selenium air emissions. Therefore, this option is not considered an effective mercury control method for kilns.

3.3.2.1.5 Baghouse

Baghouses, also called fabric filters, collect particulates by passing the off-gas through filters where the particulates collect on the fabric surface. Baghouses control particulate mercury, but they do not control gaseous elemental mercury (Booz et al. 2001). Therefore, this option is not considered an effective mercury control method for kilns where the primary form of mercury emissions is elemental or oxidized mercury.

3.3.2.2 Other Work Practices

All viable work practices for reducing mercury emissions have already been addressed in Part I - Existing Similar Thermal Units. Thus, there are no other work practices, process changes, or material substitutions that can be instituted to reduce mercury emissions from kilns.

3.3.3 Part III - Proposed NvMACT

Per NAC 445B.3681.6.(a), the applicant must propose "*standards, methods of control or other limitations to be applied to the thermal unit for the reduction of mercury emissions that the applicant deems sufficient for the Director to determine to be NvMACT for the thermal unit that emits mercury.*"

The NvMACT proposed in this section follows the criteria required by the Director pursuant to NAC 445B.3683. All items considered in this NvMACT analysis are checked in the criteria list provided below:

NAC 445B.3683 Review of and action on application for new or modified thermal unit that emits mercury.

☒ *2.(b) Make a determination of NvMACT for the thermal unit that emits mercury in which the Director shall consider the following for each thermal unit that emits mercury:*

☒ *(1) The maximum degree of reduction of mercury emissions that is achievable for the thermal unit after considering:*

(I) The cost of achieving such a reduction; and

(II) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal unit that emits mercury to implement the NvMACT.

☒ *(2) The measures that reduce the volume or eliminate mercury emissions through process changes, substitution of materials or any other modifications.*

☒ *(3) The enclosure of systems or processes to eliminate mercury emissions.*

☒ *(4) The collection, capture or treatment of mercury emissions.*

☒ *(5) The design, equipment, work practice or operational standards of the thermal unit that emits mercury, including, without limitation, the requirements for training and certification of operators of the thermal unit that emits mercury.*

☒ *(6) The differences in the age, remaining operating life and configurations of similar thermal units that emit mercury. The Director may also consider the*

differences in the concentration of mercury in the ore, size and any other relevant factors of the similar thermal units that emit mercury.

3.3.3.1 Proposed Controls and Work Practices

Based on the existing control technologies and work practices described in Part I and the additional control technology options described in Part II, Goldcorp proposes the following control equipment, work practices, and capture system as NvMACT for the proposed kiln:

Control equipment:

- Carbon Bed

Work practices:

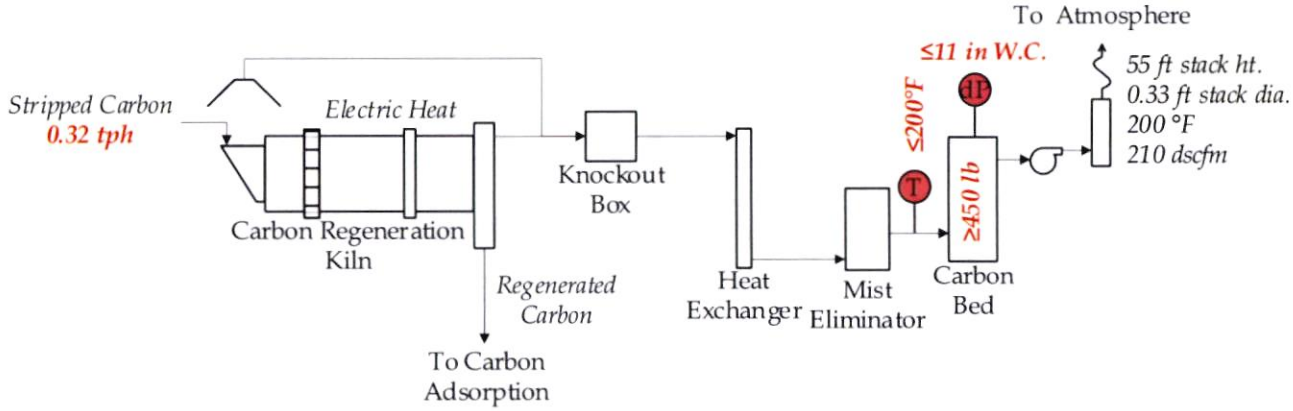
- The kiln drum will be visually inspected for structural damage and cracks annually.
- The carbon bed will contain at least 450 pounds of sulfur-impregnated carbon.
- The gas temperature entering the carbon bed will not exceed 200 degrees Fahrenheit (°F).
- The differential pressure (DP) across the carbon bed will not exceed 11 inches of water column (in WC).
- The carbon in the carbon bed shall be monitored and replaced prior to exceeding 20 percent mercury by weight.

Capture system:

The exhaust will be pulled through the control system by an exhaust fan. The system will be designed so that all emissions from the kiln are captured and ducted to the mercury control system.

A flow diagram of the proposed NvMACT mercury control system is provided in Figure 3-2.

Figure 3-2. Lone Tree Exhaust Gas Treatment



The proposed kiln will be designed to process 0.32 tons of carbon per hour. In the proposed control system, the exhaust stream from the carbon kiln will pass through a knockout box for passive particle control; then a heat exchanger and mist eliminator to cool the exhaust and remove water droplets; and finally, through a carbon bed for mercury removal.

The carbon bed will hold 450 pounds of sulfur-impregnated carbon. The bed is designed for an exhaust flow rate of approximately 210 dry standard cubic feet per minute (dscfm) with a residence time of 4.3 seconds (Hatch 2025). The loading capacity of the carbon is 20 percent mercury by weight.

Table 3-4 provides the carbon bed design analysis using NDEP's NvMACT Specific Case-by-Case Worksheet for deep bed systems.

Table 3-5. Carbon Bed Design Analysis

Description	Calculated Value	[Unit]	Symbol	Equations
Volume of bed	**15**	ft^3	VB	VB=MC/CD
Total quantity of carbon	**450**	lbs	MC	Capacity of carbon bed
Carbon Hg capacity	**20**	%	CP	Scotia - 15% to 40%
Carbon density	**30**	lbs/ft^3	CD	NDEP default value
Velocity	**N/A**	ft/min	V	$V = Q/SA_{bed}$
Flow rate	**210**	DSCFM	Q	Exhaust flow rate
Mercury loading	**0.009**	lb/hr	L	Calculated based on 98% control
Residence time	**4.3**	sec	T	T=((MC/CD)/Q)*60
Pressure drop	**11**	in H_2O	ΔP	(Hatch 2025)
Hg saturation (hours)	**10,000**	hr	S_h	Sh=MC*(CP/100)*(1/L)
Permit hours per year	**8,760**	hr/yr	HY	
Hg saturation (years)	**1.14**	yr	S_y	$S_y=S_h/HY$

As shown by Table 3-4, the volume of carbon is sufficient to provide adequate residence time (≥1 second based on the dry standard flow rate) and the total weight of carbon is sufficient for the expected mercury loading rate (mercury saturation is approximately 1.1 years). Based on this analysis, the proposed kiln control system meets NvMACT.

3.3.3.2 Proposed Mercury Emission Limit

As shown in Table 3-1 of Section 3.3.1.1, the NvMACT mercury emission limits for existing kilns range from the General Industry NvMACT limit of 1.0E-04 gr/dscf to the TUTD interim limit of 5.0E-03 gr/dscf. Goldcorp proposes the General Industry NvMACT Limit of 1.0E-04 gr/dscf for the proposed kiln.

3.3.3.3 Cost of Controls

The cost of the proposed kiln carbon bed was estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital costs, O&M costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rate of 210 dscfm, the estimated kiln control costs are summarized in Table 3-5.

Table 3-6. Lone Tree Kiln Control Costs

Control	Exhaust Flow (dscfm)	Capital Cost ($)	O&M Cost ($/ yr)	Annualized Cost ($/ yr)
Carbon Bed	210	22,100	not available	not available

(EPA 1999)

REFERENCES

Akron. n.d. "Mercuric Chloride." *The Chemical Database.* The Department of Chemistry at the University of Akron. Accessed December 26, 2007. http://ull.chemistry.uakron.edu/erd/chemicals/6001/6703.html.

Barrick. 2018. "Barrick Goldstrike Mines Inc., MOPTC Phase II, AP1041-2221, Revised NvMACT Analysis and Application Forms, Roasters." Barrick Goldstrike Mines, Inc. (Barrick), September 19. Accessed August 25, 2021. DOC ID 19487 - https://documentviewerpublic.ndep.nv.gov/Common/login.aspx.

Booz et al. 2001. "Mercury Mass Balance and Emission Factor Estimates for Gold Ore Processing Facilities (Draft)." Report Prepared for U.S. EPA Region 9 by Booz Allen & Hamilton Inc., January 14.

EPA. 1984. "APTI Course SI:412C Wet Scrubber Plan Review, Lesson 2." *Self-instructional Guidebook.* United States Enivronmental Protection Agency (EPA), March. Accessed August 30, 2022. https://nepis.epa.gov.

—. 1999. "Technical Bulletin - Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA 456/F-99-004." United States Environmental Protection Agency (EPA), May.

—. 2002. "EPA Air Pollution Control Cost Manual, 6th Edition." EPA Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA/452/B-02-001, January.

—. 2003cs. "Air Pollution Control Technology Fact Sheet - Condensation Scrubber." *EPA-452/F-03-010.* United States Environmental Protection Agency (EPA). Accessed August 4, 2022. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1008OGF.PDF.

—. 2003vs. "Air Pollution Control Technology Fact Sheet - Venturi Scrubber." *EPA-452/F-03-017.* United States Environmental Protection Agency (EPA). Accessed August 23, 2021. https://www.epa.gov/catc/clean-air-technology-center-products#factsheets.

Hatch. 2025. "i-80 Gold Corp - Lone Tree Restart Permitting Inputs Sheet." *Document Number: H367753-0000-843-216-0001.* Hatch, November 7.

Klett et al. 2002. "The Cost of Mercury Removal in an IGCC Plant. Final Report." Michael G. Klett, Russell C. Maxwell, and Michael D. Rutkowski. Parsons Infrastructure and Technology Group Inc. Report prepared for The United States Department of Energy National Energy Technology Laboratory., September.

M.A.Tribe, R.L.W.Alpine. 1985. "SCALE ECONOMIES AND THE "'0.6 RULE"." *Engineering Costs and Production Economics.* Elsevier Science Publishers B.V., Amsterdam, September 23. Accessed August 23, 2022. https://www.sciencedirect.com/science/article/pii/0167188X86900534.

NDEP. 2016. "Nevada Mercury Control Program Permitting Guidance, General Industry NvMACT Determinations (Draft)." Nevada Division of Environmental Protection (NDEP), February 29.

SION. 2021. "Trip Report to Rawhide Mine to Review the Operation of Melting Furnace Mercury Scrubber." Scotia International of Nevada (SION), July 26.

—. n.d. "Coal Based Activated Carbon Impregnated with Sulfur." *Product Bulletin COL-IS 60.* Scotia International of Nevada, Inc. (SION).

NvMACT Analysis for the Pregnant and Barren Solution Tanks

PREGNANT AND BARREN TANKS NVMACT ANALYSIS - TABLE OF CONTENTS

3.0 NvMACT Analysis - Pregnant and Barren tanks 42

3.1 Introduction 42

3.2 Process Description 42

3.3 NvMACT Analysis 43

3.3.1 Part I – Existing Similar Thermal Units 43

3.3.1.1 Mercury Controls 43

3.3.1.1.1 Condensers 45

3.3.1.1.2 Carbon Adsorption 45

3.3.1.1.3 Work Practices 46

3.3.1.2 Mercury Emissions 46

3.3.1.3 Mercury Control Costs 54

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements .. 54

3.3.2 Part II – Other Controls and/or Work Practices 54

3.3.2.1 Other Mercury Control Options 54

3.3.2.1.1 Boliden-Norzink Process 55

3.3.2.1.2 Activated Carbon Injection 55

3.3.2.1.3 Selenium Scrubber 56

3.3.2.1.4 Selenium Filter 56

3.3.2.1.5 Baghouse 56

3.3.2.2 Other Work Practices 56

3.3.3 Part III - Proposed NvMACT 57

3.3.3.1 Proposed Controls and Work Practices 58

3.3.3.2 Proposed Mercury Emission Limit 59

3.3.3.3 Cost of Controls 59

References 61

Tables

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits 44
Table 3-2. Existing Similar Thermal Units: Compliance Test Results 48
Table 3-3. Existing Similar Thermal Units: Control Costs 54
Table 3-4. Carbon Bed Design Analysis 59
Table 3-5. Lone Tree Pregnant and Barren Tanks Control Costs 60

Figures

Figure 3-1. Pregnant and Barren Tanks Process Flow Diagram 42
Figure 3-2. Lone Tree Exhaust Gas Treatment 58

3.0 NvMACT ANALYSIS - PREGNANT AND BARREN TANKS

3.1 Introduction

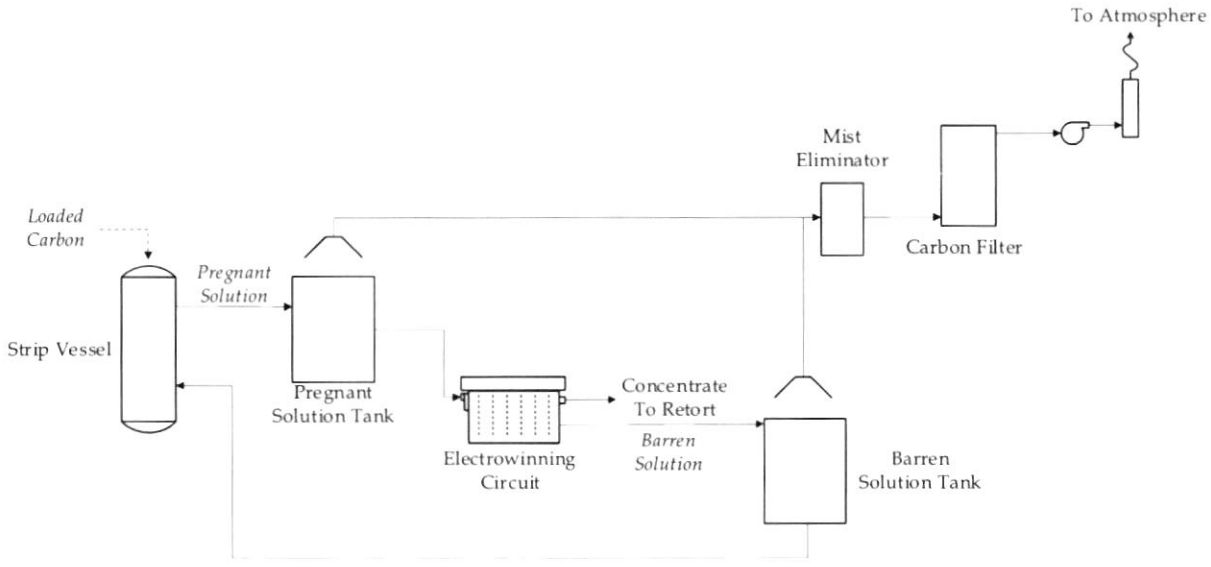
Goldcorp DEE LLC (Goldcorp) proposes to install and operate one pregnant solution tank and one barren solution tank as part of the strip circuit at the Lone Tree Mine (Lone Tree). Per Nevada Administrative Code (NAC) 445B.3681.6, a Nevada Maximum Achievable Control Technology (NvMACT) analysis is required for new thermal units that emit mercury, as a part of a Mercury Operating Permit to Construct (MOPTC) application. The NvMACT analysis provided herein addresses all the applicable requirements of NAC 445B.3681.6.

3.2 Process Description

In a strip circuit, gold and other metals including mercury are stripped from the gold-bearing carbon by first washing the carbon with an acidic solution in a vessel and then stripping the carbon with a heated strip solution (barren solution) in a strip vessel. The solution exiting the strip vessel (pregnant solution) contains gold and is pumped to the pregnant tank for storage prior to being pumped to the electrowinning (EW) circuit. The EW circuit is used to precipitate the gold, carried by the pregnant solution, via electrolysis. The barren solution exiting the EW circuit is sent to the barren tank for storage prior to being reused in the stripping process.

The exhaust streams from the pregnant and barren tanks at Lone Tree will be ducted together and routed through a carbon bed before being released to the atmosphere. See Figure 3-1 for a process flow diagram.

Figure 3-1. Pregnant and Barren Tanks Process Flow Diagram



3.3 NvMACT Analysis

3.3.1 Part I – Existing Similar Thermal Units

Part I of the NvMACT analysis provides a list of similar existing thermal units used for precious metal refining and describes the controls and work practices used to reduce mercury emissions. All information required by NAC 445B.3681, as described below, is provided herein:

NAC 445B.3681 New or modified thermal unit that emits mercury: Contents of required application.

☒ *6.(b) Sets forth a list of similar thermal units that emit mercury which are used for precious metal mining that includes, without limitation:*

- ☒ *(1) Any methods or technologies to control mercury emissions which are associated with the thermal units that emit mercury;*
- ☒ *(2) The level of mercury emissions associated with each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(3) The design for each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(4) Costs associated with reductions of mercury emissions as a result of each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(5) Costs associated with energy for each method or technology to control mercury emissions from the thermal units that emit mercury; and*
- ☒ *(6) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal units that emit mercury.*

3.3.1.1 Mercury Controls

The Nevada Mercury Control Program (NMCP) permits for existing strip circuit units (i.e., EW circuits, pregnant tanks, and barren tanks) were downloaded from the Nevada Division of Environmental Protection (NDEP) Public Document Search website to obtain a list of the existing strip circuit system mercury controls. This information is summarized in Table 3-1.

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits

Facility Name	Permit No.	Date	Source	Control1	Control2	Control3	Carbon (lb)	Stack Flow	Stack Temp	Limit (gr/dscf)	Limit Notes
Borealis Mining Company LLC	AP1041-2228	2/22/2013	Electrowinning Circuit (TU4.004)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	8,000	2,000 acfm	120	1.0E-04	Combined limit of TU4.004, TU4.005, TU4.006
			Pregnant Tank (TU4.005)	-	-					-	
			Barren Tank (TU4.006)	-	-					-	
			Mercury Retort Furnace (TU4.002)	Mercury Condenser(MC-001)	-					-	
			Carbon Regeneration Kiln (TU4.001)	-	Wet Scrubber (WS-001)					-	
			Smelting Furnace (TU4.003)	-						-	
Florida Canyon Mining, Inc	AP1041-2256	2/1/2021	Electrowinning Cell A (TU4.002)	-	-					-	
			Electrowinning Cell B (TU4.003)	Exhaust Demister Vessel (EDV-002)	Carbon Adsorption Vessel (DS-002)		3,950	1,500 acfm	130	5.0E-05	Combined limit for TU4.002, TU4.003, TU4.006, and TU4.007
			Pregnant Solution Tank (TU4.006)	-	-					-	
			Barren Solution Tank (TU4.007)	-	-					-	
GRP Pan, LLC	AP1041-3902	8/17/2016	Electrowinning Cells (TU4.004)	-	-					-	
			Barren Tank (TU4.005)	Carbon Filter (CF-004)	-		2,800	1,100 acfm	140	5.0E-05	Combined limit for TU4.004 - TU4.006
			Barren Tank (TU4.006)	-	-					-	
Jerritt Canyon Gold LLC	AP1041-2217	7/13/2022	Electrowinning Cell I (TU4.004)	-	-					-	
			Electrowinning Cell II (TU4.005)	Sulfur-Impregnated Carbon Tray (SIC-002)	-		4,950	3,200 dscfm	130	5.0E-05	Combined limit for TU4.004 - TU4.007
			Pregnant Tank (TU4.006)	-	-					-	
			Barren Tank (TU4.007)	-	-					-	
KG Mining (Bald Mountain) Inc	AP1041-3927	7/15/2021	Electrowinning Cells (TU4.002)	-	-					-	
			Barren Tank (TU4.003)	Carbon Filter (CF-002)	-		2,550	545 dscfm	120	5.0E-05	Combined limit for TU4.002 - TU4.004
			EW Barren Tank (TU4.004)	-	-					-	
Klondex Aurora Mine, Inc	AP1041-2248	5/29/2019	Electrowinning Cells (TU4.006) **(System 01A)**	-	-					-	
			Carbon Kiln (TU4.001)	Venturi Wet Scrubber (WS-001)	-					1.0E-04	Combined limit for TU4.001 - TU4.003 and TU4.006
			Pregnant Tank (TU4.002)	-	-					-	
			Barren Tank (TU4.003)	-	-					-	
			Electrowinning Cells (TU4.006) **(System 01B)**	-	-					-	
			Mercury Retort #1 (TU4.004)	Mercury Condenser (MC-001)	-	Carbon Deep Bed Scrubber (CA-001)	5500	1,071 dscfm	200	1.0E-04	Combined limit for TU4.002 - TU4.006
			Mercury Retort #2 (TU4.005)	-	-					-	
			Pregnant Tank (TU4.002)	-	-					-	
			Barren Tank (TU4.003)	-	-					-	
			Electrowinning Cells (TU4.006) **(System 01C)**	-	-					-	
			Dore Furnace (TU4.007)	-	Baghouse (BH-001)					1.0E-05	Combined limit for TU4.002, TU4.003, TU4.006, and TU4.007
			Pregnant Tank (TU4.002)	-	-					-	
			Barren Tank (TU4.003)	-	-					-	
Marigold Mining Compar	AP1041-2254	1/27/2022	Electrowinning Cells (2 Cells) (TU4.004)	-	-					-	
			Pregnant Tank (TU4.005)	-	Carbon Adsorption Unit (CA-002)		5,000	3,000 dscfm	100	5.0E-03	Combined limit for TU4.003 and TU4.004-TU4.006 or TU4.002 and TU4.004 - TU4.006
			Barren Tank (TU4.006)	-						-	
			Mercury Retort (TU4.002)	Mercury Condenser (CO-001)	-					-	
			Tilting Crucible Furnace (TU4.003)	-	-					-	
McEwen Mining, Inc	AP1041-3801	9/24/2020	Electrowinning Cell A (TU4.002)	-	-					-	
			Electrowinning Cell B (TU4.003)	Mist Eliminator (500-DC-004)	Duct Heater (500-DC-004-HT1)	Carbon Filter (CF-001)	1,500	441 dscfm	146	2.1E-04	Combined limit for TU4.002 - 4.005
			Barren Tank (TU4.004)	-	-					-	
			Eluant Tank (TU4.005)	-	-					-	
Nevada Gold Mines LLC - Cortez	AP1041-2220	2/1/2021	East Electro-Winning Cells (TU4.001)	Demister and Pre-Heater (PH-001)	Carbon Filter (CA-002)		1,500	3,000 dscfm	150	1.3E-04	Combined limit for TU4.001, TU4.008, and TU4.009
			West Electro-Winning Cells (TU4.002)	Demister and Pre-Heater (PH-002)	Carbon Filter (CA-003)		1,500	3,000 dscfm	150	1.3E-04	Combined limit for TU4.002, TU4.008, and TU4.009
			Pregnant Tank (TU4.008)	PH-001 or PH-002	CA-002 or CA-003		-	- -	-	-	
			Barren Tank (TU4.009)								
Nevada Gold Mines LLC - Gold Quarry Operations	AP1041-2219	4/23/2025	Electrowinning Cells (TU4.017)	Mercury Removal Media Filter Pack (CF-001A & B)	Wet Scrubber (WS-001)		2,800	8,000 dscfm	76	5.3E-04	Combined limit for TU4.016 - TU4.017
			Refinery Barren Tank (TU4.016)								
			Pregnant Tank (TU4.014)	Mercury Removal Media Filter Pack (CF-004)			309	300 dscfm	140	3.0E-03	Combined limit for TU4.014 - TU4.015
			Pregnant Tank (TU4.015)								
Nevada Gold Mines LLC - Goldstrike Mine	AP1041-2221	5/5/2025	Electrowinning Cells (TU4.024)	-	-					-	
			East Melting Furnace (TU4.022)	Baghouse (BH-001)	Carbon Bed (CA-004)		6,600	9,100 dscfm	140	7.3E-04	Combined limit for TU4.022 - TU4.024
			West Melting Furnace (TU4.023)	-	-					-	
			Electrowinning Cells (TU4.030)	-	-					-	
			Preg/Barren Tank A (TU4.031)	Heater	Carbon Bed (CA-006)		42,000	10,358 dscfm	140	5.0E-05	Combined limit for TU4.030 - TU4.032
			Preg/Barren Tank B (TU4.032)	-	-					-	
Nevada Gold Mines LLC - Twin Creeks Mine	AP1041-2218	5/19/2023	Electrowinning Cells (Six) (TU4.009)	Carbon Filter (CF-008)	-	-	2,880	9,216 dscfm	100	5.0E-05	
			Juniper Preg Tank A (TU4.006)	-	-					-	
			Juniper Preg Tank B (TU4.007)	Wet Scrubber (WS-002)	Carbon Filter (CF-007)	-	1,296	4,018 dscfm	140	3.4E-04	Combined limit for TU4.006 - TU4.008
			Juniper Barren Tank (TU4.008)	-	-					-	
			Pinon Pregnant Tank (TU4.010)	Carbon Filter (CF-009)	-	-	720	675 dscfm	120	5.0E-03	Combined limit for TU4.010 and TU4.011
			Pinon Barren Tank (TU4.011)	-	-					-	
Rawhide Mining, LLC	AP1041-2245	12/21/2021	Electrowinning Circuit (TU4.002)	Mercury (CO-002) Condenser	Carbon Filter (CF-002)		1,380	740 dscfm	77	5.0E-05	
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	AP1041-2250	3/7/2024	Electrowinning Cells (TU4.009)	-	-					-	
			Pregnant Tank (TU4.007)	Carbon Deep Bed Scrubber (CA-004)	-		4,800	2,660 dscfm	100	1.01E-04	Combined limit for TU4.007 - TU4.009
			Barren Tank (TU4.008)	-	-					-	
			Electrowinning Cells (TU4.012)	-	-					-	
			Pregnant Solution Tank (TU4.002)	Sulfur-Impregnated Carbon Filter (CA-007)	-		4,000	2,200 dscfm	150	5.0E-05	Combined limit for TU4.002 - TU4.004 and TU4.012
			Barren Solution Tank 1 (TU4.003)	-	-					-	
			Barren Solution Tank 2 (TU4.004)	-	-					-	
Walker Lane Minerals Corporation	AP1041-3895	not available	Electrowinning Cells (TU4.003)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	5,000	2,760 dscfm	200	5.0E-05	Combined limit for TU4.001 - TU4.003
			Pregnant Tank (TU4.001)	-	-					-	
			Barren Tank (TU4.002)	-	-					-	
			Mercury Retort (TU4.004)	Condenser (CO-001)	-					-	
			Carbon Regeneration Kiln (TU4.005)	-	Wet Scrubber (WS-001)					-	
WK-Allied Hasbrouck, LLC Three Hills Mine Project	AP1041-3669	6/25/2019	Electrowinning Cell #1 (TU4.004)	-	-	Carbon Bed Vapor Pac (CB-001)	18,000	7,650 dscfm	115	5.0E-05	Combined limit for TU4.004 - TU4.007
			Electrowinning Cell #2 (TU4.005)	-	-					-	
			Eluant Tank (TU4.006)	-	-					-	
			Barren Tank (TU4.007)	-	-					-	
			Smelting Furnace (Electric) (TU4.002)	Venturi Scrubber (VS-001)	-					-	
			Carbon Regeneration Kiln (TU4.003)	-	Venturi Scrubber (VS-002)					-	

As shown in Table 3-1, the primary mercury control installed for strip circuit units is a carbon adsorber. Some facilities also have condensers or mist eliminators for gas conditioning upstream of the carbon adsorbers. One facility, Nevada Gold Mines LLC – Gold Quarry Operations, employs a wet scrubber, however, it is located downstream of the carbon adsorber and therefore assumed not for mercury control.

3.3.1.1.1 Condensers

As shown in Table 3-1, some existing strip circuit systems employ a condenser in the control train. For these EW cells and tanks, the exhaust stream passes through the condenser, which cools the gas and causes the water vapor, and possibly vaporized mercury to condense. Any condensed mercury is then bled from the condenser into a collection vessel. The species of mercury collected from the condensers at precious metal mining, processing, and refining facilities in Nevada is elemental.

The two most common types of condensers are surface and contact condensers. Surface condensers cool gas streams by circulating water (or other cooling medium) through an enclosed water jacket surrounding the exhaust system or through a shell-and-tube type heat exchanger. Contact condensers cool gas streams by spraying cooled water into the gas stream. The following correlation exists for both types of condensers: the colder the circulating water, the colder the exhaust gas, and, for a constant inlet loading of mercury, the more efficient the removal of mercury from the gas stream (EPA 2002). However, for most strip circuit units, the concentration of mercury in the exhaust is too low for mercury condensation. The primary purpose of the condensers or mist eliminators is to remove water droplets from the exhaust stream prior to the carbon filter.

3.3.1.1.2 Carbon Adsorption

Carbon adsorption filters use activated carbon particles to adsorb mercury from the gas stream. Adsorption occurs when gas molecules are passed through a bed of solid particles (activated carbon). The gas molecules migrate from the gas stream to the surface of the solids, where they are held by physical attraction (EPA 2002). Carbon impregnated with elemental sulfur increases the adsorption efficiency due to the sulfur–mercury reaction that forms mercury sulfide, a stable mercury compound with a low vapor pressure (Booz et al. 2001).

Carbon filters control all types of mercury: particulate-bound, oxidized, and elemental. The mercury in the gas stream is adsorbed to the carbon and collected as carbon loaded with mercury. Once the carbon reaches adsorptive capacity, it is replaced, and the spent carbon is reclaimed. The carbon filter's mercury content is monitored to ensure that the mercury loading does not exceed the value recommended by the manufacturer. The typical carbon loading capacity is approximately 20 percent (or more) mercury by weight (SION n.d.) (Klett et al. 2002). Carbon mercury loading can be monitored directly, or the mercury concentration in the exhaust at the outlet of the carbon filter can be monitored to ensure the effectiveness of the carbon adsorber.

Some factors that can affect carbon filter adsorption efficiency include residence time of the gas in the carbon filter, carbon particle size, and exhaust stream moisture content. Longer residence

times and smaller carbon particle sizes increase the mercury removal efficiency of the carbon filter (Booz et al. 2001). According to Scotia International of Nevada (SION), *"Some moisture in the gas stream, and therefore in the carbon, catalyzes the mercury removal reaction. It is anticipated that as long as no free water is being released from the carbon, the moisture maximum would be 45%. Release of moisture from the carbon, would indicate that the gas stream is condensing within the carbon, which has the potential to inhibit the mercury removal reaction. The carbon is delivered with a nominal moisture of 5% (this value can vary by the ambient humidity of the area of usage)"* (SION 2021).

In short, mercury removal may be inhibited when carbon is physically wet with water (where moisture exceeds 45 percent).

3.3.1.1.3 Work Practices

In addition to the controls listed in Table 3-1, most of the precious metal mining facilities in Nevada incorporate several different work practices into their processes to reduce mercury emissions. These work practices include inspecting the exhaust capture system and replacing the carbon prior to exceeding the recommended mercury loading levels.

The exhaust from the strip circuit units must be captured and conveyed to the carbon filter and then to a stack before being released to the atmosphere. The equipment for the ventilation system consists of hoods, ductwork, fans, and a stack. The hoods and ductwork are inspected periodically to ensure proper emissions capture.

To ensure sufficient control efficiency by a carbon filter, the carbon filter media is replaced prior to exceeding maximum mercury loading as recommended by the manufacturer. This can be accomplished by:

- replacing the carbon on a schedule that ensures the recommended mercury loading is not exceeded, based on worst-case mercury loading data;
- monitoring the loading of mercury on the carbon directly by carbon analyses;
- monitoring the mercury levels in the exhaust from the carbon filter; or
- a combination of the above work/monitoring practices.

3.3.1.2 Mercury Emissions

NMCP permits for existing strip circuit units were downloaded from the NDEP Public Document Search website to obtain a list of the existing mercury emission limits. This information is summarized in Table 3-1 of Section 3.3.1.1. The NvMACT emission limits range from the General Industry NvMACT limit for fluid systems of 5.0E-05 grains per dry standard cubic foot (gr/dscf) to the True-Up/True-Down (TUTD) interim limit of 5.0E-03 gr/dscf (NDEP 2016), with the exception of one facility, Klondex Aurora Mine, Inc. limited to 1.0E-05 gr/dscf, that is applicable to their EW cells, tanks, and furnace operating scenario.

NMCP compliance tests for existing strip circuit units were downloaded from the NDEP Public Document Search website to obtain the actual mercury emissions data for these units utilizing

NvMACT controls. This information is summarized in Table 3-2 for years 2018 through 2025. As shown in Table 3-2, all stack test results are below the TUTD interim limit of 5.0E-03 gr/dscf and many of the stack test results are also below the General Industry NvMACT limit for fluid systems of 5.0E-05 gr/dscf

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Borealis Mining Company LLC	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	10/15/2018	7.60E-07	1.0E-04	2.19E-06	337	446	86.0
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	6/10/2019	7.47E-06	1.0E-04	2.65E-05	414	588	104.7
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	8/10/2020	1.73E-06	1.0E-04	6.65E-06	449	622	87.5
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	8/10/2021	1.73E-06	1.0E-04	6.88E-06	462	not available	87.5
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	10/14/2021	1.29E-05	1.0E-04	3.21E-05	291	not available	95.7
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	10/20/2022	2.50E-06	1.00E-04	9.90E-06	465	606	80.30
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/1/2023	9.75E-06	1.00E-04	4.20E-05	510	702	83.42
	Carbon Regeneration Kiln (TU4.001) Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	10/25/2024	2.12E-05	1.00E-04	6.10E-05	12/2/1900	458	3/24/1900
Florida Canyon Mining, Inc.	Electrowinning Cell A (TU4.002)	10/9/2018	5.17E-05	not available	1.28E-04	290	393	104.6
	Electrowinning Cell B (TU4.003)	10/9/2018	1.21E-05	not available	2.69E-05	260	362	107.5
	Electrowinning Cell A (TU4.002)	10/15/2020	3.10E-04	not available	7.70E-04	291	380	94.4
	Electrowinning Cell B (TU4.003)	10/15/2020	1.10E-04	not available	2.50E-04	265	349	95.8
	Electrowinning Cell A (TU4.002)	12/17/2020	6.27E-05	5.0E-05	1.27E-04	237	309	92.0
	Electrowinning Cell B (TU4.003)	12/17/2020	2.99E-05	5.0E-05	5.94E-05	232	302	88.1
	Electrowinning Cell A (TU4.002)	4/9/2021	1.09E-04	5.0E-05	3.09E-04	331	444	98.7
	Electrowinning Cell B (TU4.003)	4/9/2021	2.56E-05	5.0E-05	6.82E-05	311	424	100.3
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003)	1/20/2022	3.46E-04	5.0E-05	not available	1,520	not available	84.4
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Pregnant Solution Tank (TU4.006) Barren Solution Tank (TU4.007)	7/21/2022	2.24E-05	5.0E-05	2.43E-04	1,266	not available	100.6
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Pregnant Solution Tank (TU4.006) Barren Solution Tank (TU4.007)	5/19/2023	2.54E-07	5.00E-05	2.33E-06	1,068	1,370	106.58
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Pregnant Solution Tank (TU4.006) Barren Solution Tank (TU4.007)	26/2024-06/27/2	7.43E-07	5.00E-05	7.00E-06	1,104	1,450	118.86
GRP Pan, LLC	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	12/19/2018	2.61E-04	not available	1.40E-03	627	930	118.0
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	11/19/2019	7.80E-07	5.0E-05	5.30E-06	799	1,161	121.1
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	11/11/2020	6.70E-05	5.0E-05	5.00E-04	863	1,341	132.7
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	2/9/2021	1.50E-07	5.0E-05	9.90E-07	766	1,152	123.5
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	12/14/2021	2.17E-05	5.00E-05	1/0/1900	876	not available	129.29
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	11/14/2022	8.70E-07	5.0E-05	6.30E-06	848	1,322	118.0
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	9/19/2023	3.95E-07	5.00E-05	2.45E-06	724	not available	118.72
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	10/1/2024	2.39E-07	5.00E-05	1.33E-06	690	994	110.80
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	10/21/2025	2.07E-07	5.00E-05	4.25E-06	2,396	not available	105.33

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp (F)
Jerritt Canyon Gold LLC	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	8/16/2018	3.24E-04	5.0E-05	1.07E-02	3,851	5,236	88.4
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	7/31/2019	1.21E-05	5.0E-05	7.27E-04	7,007	9,511	100.0
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	7/28/2020	2.73E-05	5.0E-05	1.50E-03	6,422	8,718	90.0
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	6/16/2021	1.29E-04	5.0E-05	not available	3,830	not available	97.5
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	6/21/2022	1.82E-06	5.00E-05	2.61E-05	1,672	not available	137.03
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	8/17/2023	5.05E-06	5.00E-05	not available	1,026	not available	156.72
Klondex Aurora Mine, Inc.	Electrowinning Cells (TU4.006) (System 01A Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	9/25/2018	3.20E-07	1.0E-04	5.50E-06	2,042	3,189	138.0
	Electrowinning Cells (TU4.006) (System 01B Mercury Retort #1 (TU4.004) Mercury Retort #2 (TU4.005) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	9/26/2018	2.70E-07	1.0E-04	5.10E-06	2,169	3,384	138.0
	Electrowinning Cells (TU4.006) (System 01C Dore Furnace (TU4.007) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	9/27/2018	1.20E-06	not available	2.20E-05	2,218	3,480	139.0
	Electrowinning Cells (TU4.006) (System 01A Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	10/1/2019	1.90E-06	1.0E-04	3.80E-05	2,301	3,226	83.6
	Electrowinning Cells (TU4.006) (System 01B Mercury Retort #1 (TU4.004) Mercury Retort #2 (TU4.005) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	10/2/2019	1.40E-06	1.0E-04	2.90E-05	2,421	3,434	86.9
	Electrowinning Cells (TU4.006) (System 01C Dore Furnace (TU4.007) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	10/3/2019	7.70E-07	1.0E-05	1.70E-05	2,508	3,553	87.9

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Marigold Mining Company	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	5/21/2018	2.10E-06	5.0E-03	1.70E-05	917	1,497	142.0
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort (TU4.002)	6/11/2019	8.80E-07	5.0E-03	3.64E-06	481	726	142.2
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Tilting Crucible Furnace (TU4.003)	6/12/2019	6.70E-06	5.0E-03	7.75E-05	1,350	2,034	159.6
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	6/10/2019	1.04E-06	5.0E-03	4.45E-06	499	729	134.4
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort (TU4.002)	8/25/2020	2.20E-06	5.0E-03	5.90E-06	309	492	141.6
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Tilting Crucible Furnace (TU4.003)	8/26/2020	7.90E-06	5.0E-03	8.40E-05	1,232	1,892	146.6
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/24/2020	2.60E-06	5.0E-03	7.30E-06	326	520	148.5
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort (TU4.002)	7/20/2021	2.20E-07	5.0E-03	4.40E-07	235	442	152.3
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/21-22/2021	2.60E-07	5.0E-03	5.40E-07	241	448	153.0
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/21/2022	4.80E-06	5.0E-03	not available	263	not available	156.8
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/13/2023	1.40E-04	5.0E-03	8.50E-04	545	810	150.20
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	9/12/2024	2.20E-06	5.0E-03	5.51E-06	307	464	142.44
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/7/2025	5.23E-06	5.0E-03	1.55E-05	354	539	122.07
McEwen Mining, Inc	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	4/23/2020	1.49E-04	5.0E-03	3.69E-04	291	415	87.8
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	10/15/2020	7.54E-06	5.0E-03	1.73E-06	267	383	102.0
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	4/22/2021	3.80E-05	5.0E-03	8.68E-05	266	396	93.2
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	5/12/2022	1.60E-05	5.0E-03	3.10E-05	229	337	99.3
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	12/1/2022	8.40E-06	5.0E-03	1.90E-05	271	346	54.0
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	6/15/2023	2.04E-04	5.0E-03	5.77E-04	330.0	488	102.8
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	1/18/2024	9.43E-05	2.1E-04	3.01E-04	376.62	not available	85.99
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	7/18/2024	2.42E-04	2.1E-04	6.67E-04	329.84	not available	112.29
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	10/28/2024	3.22E-06	2.1E-04	2.55E-05	665.44	958	93.00
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	6/12/2025	9.20E-08	2.1E-04	4.97E-07	629.90	940	120.76

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp (F)
Nevada Gold Mines LLC - Cortez	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	7/19/2018	6.24E-06	1.3E-04	1.13E-04	2,123	2,847	104.9
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	7/19/2018	3.18E-06	1.3E-04	4.53E-05	1,667	2,317	115.6
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/22/2019	1.40E-05	1.3E-04	2.25E-04	1,882	2,527	110.8
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/22/2019	5.86E-05	1.3E-04	9.98E-04	1,988	2,733	110.2
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/20/2020	3.50E-06	1.3E-04	5.40E-05	1,783	2,368	108.1
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/20/2020	1.20E-04	1.3E-04	2.00E-03	1,981	2,704	110.9
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/25/2021	4.59E-06	1.3E-04	5.82E-05	1,482	not available	118.9
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/25/2021	2.07E-06	1.3E-04	4.61E-05	2,565	not available	113.5
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/24/2022	2.02E-05	1.3E-04	2.65E-04	1,517	not available	115.7
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/24/2022	8.80E-06	1.3E-04	1.03E-04	1,337	not available	112.7
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/23/2023	2.83E-05	1.30E-04	2.38E-04	979	1,383	115
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/23/2023	3.24E-05	1.30E-04	2.95E-04	1,074	1,407	156
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/21/2024	1.60E-05	1.30E-04	1.70E-04	1,264	1,788	116.70
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/21/2024	3.45E-05	1.30E-04	3.80E-04	1,261	1,769	118.00
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	7/2/2025	5.16E-07	1.30E-04	3.33E-06	718	1,055	125.20
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	10/28/2025	1.14E-04	1.30E-04	6.30E-04	644	911	125.00
Nevada Gold Mines LLC - Gold Quarry Operations	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	3/21/2018	9.04E-06	5.0E-03	3.28E-04	4,238	5,474	78.7
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	4/3/2019	6.25E-05	5.0E-03	2.40E-03	4,511	5,647	108.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	9/24/2019	9.74E-05	5.0E-03	4.71E-03	5,527	6,970	73.8
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	4/15/2020	2.59E-05	5.0E-03	1.12E-03	5,035	6,325	70.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	9/15/2020	7.70E-06	5.0E-03	3.51E-04	5,350	6,715	75.6
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	3/10/2021	3.85E-04	5.0E-03	1.73E-02	5,249	6,656	71.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	9/16/2021	8.02E-04	5.0E-03	3.29E-02	4,808	not available	80.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	12/6/2022	2.93E-05	5.0E-03	1.64E-03	6,538	8,142	67.7
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	12/12/2023	3.56E-06	5.0E-03	1.84E-04	8,000	not available	66.0
	Pregnant Tank (TU4.014) and Pregnant Tank (TU4.015)	10/9/2024	7.49E-05	3.0E-03	1.00E-04	157	not available	122.5
	Electrowinning Cells (TU4.017) and Refinery Barren Tank (TU4.016)	10/9/2024	1.80E-06	5.3E-04	8.32E-05	5,416	not available	81.8
Nevada Gold Mines LLC - Goldstrike Mine	Electrowinning Cells (TU4.024)	8/16/2017	4.64E-05	5.0E-03	1.69E-03	4,261	not available	118.4
	Electrowinning Cells (TU4.024)	9/12/2018	4.90E-05	5.0E-03	1.80E-03	4,264	6,093	111.0
	Electrowinning Cells (TU4.030) Preg/Barren Tank A (TU4.031) Preg/Barren Tank B (TU4.032)	9/13/2018	3.20E-07	5.0E-03	3.90E-05	14,336	18,255	85.0
	Electrowinning Cells (TU4.024)	10/15/2019	1.50E-04	5.0E-03	5.60E-03	4,464	6,544	109.0
	Electrowinning Cells (TU4.030) Preg/Barren Tank A (TU4.031) Preg/Barren Tank B (TU4.032)	10/16/2019	1.20E-06	5.0E-03	9.50E-05	8,944	11,614	87.0
	Electrowinning Cells (TU4.024)	8/19/2020	2.30E-05	7.3E-04	7.60E-04	3,962	5,647	109.5
	Electrowinning Cells (TU4.024)	9/9/2021	8.60E-06	7.3E-04	3.10E-04	4,278	6,303	116.9
	Electrowinning Cells (TU4.024)	9/20/2022	9.75E-05	7.3E-04	3.50E-03	4,217	6,251	122.4
	Electrowinning Cells (TU4.024)	11/16/2023	1.30E-05	7.3E-04	5.20E-04	4,496	5,782	91.6
	Electrowinning Cells (TU4.024)	11/20/2024	7.50E-06	7.3E-04	3.15E-04	4,908	6,794	103.4
	Electrowinning Cells (TU4.024)	9/23/2025	9.35E-06	7.3E-04	3.81E-04	4,767	6,666	117.3

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Nevada Gold Mines LLC - Twin Creeks Mine	Electrowinning Cells (Six) (TU4.009)	5/9/2018	1.43E-06	5.0E-03	1.07E-04	8,760	11,635	92.4
	Electrowinning Cells (Six) (TU4.009)	5/8/2019	1.01E-06	not available	7.08E-05	8,173	10,787	89.7
	Electrowinning Cells (Six) (TU4.009)	6/10/2020	2.60E-06	5.0E-03	not available	7,630	9,922	91.4
	Electrowinning Cells (Six) (TU4.009)	10/29/2020	5.09E-06	5.0E-03	3.20E-04	7,334	not available	79.9
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	4/15-16/2021	2.48E-04	5.0E-03	6.64E-03	3,112	not available	88.4
	Electrowinning Cells (Six) (TU4.009)	4/15/2021	1.48E-06	5.0E-03	4.93E-05	3,875	not available	81.2
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	4/18/2022	3.60E-05	5.0E-03	not available	3,407	not available	143.0
	Electrowinning Cells (Six) (TU4.009)	4/19/2022	7.55E-07	5.0E-03	not available	6,087	not available	66.4
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	10/18/2022	1.40E-05	5.0E-03	4.30E-04	3,484	4,463	85.8
	Electrowinning Cells (Six) (TU4.009)	10/21/2022	1.50E-06	5.0E-03	1.10E-04	8,552	10,971	82.5
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	5/17/2023	2.40E-05	5.0E-03	4.00E-04	1,920	2,523	90.3
	Electrowinning Cells (Six) (TU4.009)	5/16/2023	1.60E-06	5.0E-03	1.10E-04	7,760	9,943	88.3
Rawhide Mining, LLC	Electrowinning Circuit (TU4.002)	12/7/2018	2.81E-06	5.0E-05	1.13E-05	467	548	53.5
	Electrowinning Circuit (TU4.002)	10/3/2019	6.48E-05	5.0E-05	3.38E-04	607	811	100.6
	Electrowinning Circuit (TU4.002)	12/10/2020	3.64E-05	5.0E-05	1.84E-04	588	757	84.8
	Electrowinning Circuit (TU4.002)	11/17/2021	6.80E-07	5.0E-05	5.00E-06	858	1,049	70.9
	Electrowinning Circuit (TU4.002)	8/4/2022	6.84E-06	5.0E-05	not available	934	not available	105.3
	Electrowinning Circuit (TU4.002)	8/16/2023	1.76E-05	5.0E-05	1.24E-04	843	not available	104.9
		Shutdown in 2023						
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	4/12-13/2018	2.25E-05	5.0E-05	5.37E-04	2,787	4,054	127.0
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	4/17/2018	1.53E-05	1.0E-04	1.91E-04	1,457	2,028	99.0
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	4/18-19/2019	1.20E-04	5.0E-05	1.60E-03	1,511	2,091	92.7
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	4/20/2019	3.00E-05	1.0E-04	3.60E-04	1,379	1,997	108.5
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	9/5/2019	7.10E-07	5.0E-05	1.40E-05	2,280	3,399	129.7
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	5/6/2020	4.80E-06	5.0E-05	1.00E-04	2,420	3,654	133.0
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	5/8/2020	5.00E-07	1.0E-04	6.00E-06	1,408	1,937	97.6
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	8/5/2021	3.30E-07	1.0E-04	3.50E-06	1,212	1,762	103.4
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	8/11/2021	9.50E-08	5.0E-05	1.90E-06	2,386	3,676	127.5
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	10/4/2022	5.90E-05	5.0E-05	1.00E-03	1,983	3,058	66.30
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	1/4/2023	2.51E-05	5.0E-05	5.81E-04	2,725	3,974	125.7
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	9/20/2023	5.37E-06	5.0E-05	5.00E-05	1,096	1,520	72.80
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	11/28/2023	8.20E-06	5.0E-05	1.70E-04	not available	not available	not available
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	8/7/2024	5.90E-07	5.0E-05	8.50E-06	1,683	2,376	120.30
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	8/12/2024	3.90E-06	1.01E-04	5.00E-05	1,507	2,018	105.10
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	7/10/2025	7.94E-07	1.01E-04	1.10E-05	1,609	2,120	99.30
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	7/9/2025	2.60E-07	5.0E-05	3.10E-06	1,381	1,932	109.20

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp (F)
Walker Lane Minerals Corporation	Electrowinning Cells (TU4.003) Pregnant Tank (TU4.001) Barren Tank (TU4.002)	3/3-5/2020	5.60E-08	5.0E-05	8.05E-07	not available	not available	not available
	Electrowinning Cells (TU4.003) Pregnant Tank (TU4.001) Barren Tank (TU4.002)	4/28/2021	6.29E-07	5.0E-05	5.85E-06	1,086	not available	105.0
	Electrowinning Cells (TU4.003) Pregnant Tank (TU4.001) Barren Tank (TU4.002)	5/18/2022	6.49E-07	5.0E-05	5.86E-06	1,054	1,428	107.3

3.3.1.3 Mercury Control Costs

The cost of existing condensers and carbon filters listed in Table 3-1 were estimated in current dollars using technical documents from the EPA Clean Air Technology Center and the economies of scale. These documents provide the capital costs, operational and maintenance (O&M) costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rates listed in Table 3-1, the estimated strip circuit system control costs are summarized in Table 3-3.

Table 3-3. Existing Similar Thermal Units: Control Costs

Control	Exhaust Flow (scfm)	Capital Cost ($1,000)	O&M Cost ($1,000/ yr)	Annualized Cost ($1,000/ yr)
Condenser	740	38	16	21
Carbon Filter	441 to 10,358	46 to 1,090	not available	not available

(EPA 2003cs) (EPA 1999) (M.A.Tribe, R.L.W.Alpine 1985)
scfm = standard cubic feet per minute; yr = year

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements

The main non-air-quality health and environmental impact caused by mercury control technologies for strip circuit units is the reclamation of the carbon loaded with mercury from carbon filters. Once the carbon reaches adsorptive capacity, it is replaced with fresh carbon and the loaded carbon is reclaimed. In addition, shipping the used carbon to a reclamation facility has non-air-quality health, environmental, and energy impacts. Also, the use of condensers and carbon filters would cause increased energy consumption due to the additional fan and pump power requirements and the energy required to cool the circulating water in a condenser.

3.3.2 Part II – Other Controls and/or Work Practices

Part II of the NvMACT analysis examines other control options and/or work practices not currently employed with the existing strip circuit units described in Part I – Existing Similar Thermal Units.

3.3.2.1 Other Mercury Control Options

In addition to the mercury control technologies employed at existing strip circuit units, the following mercury control options are examined below:

1. Boliden-Norzink Process
2. Activated Carbon Injection
3. Selenium Scrubber
4. Selenium Filter
5. Baghouse

3.3.2.1.1 Boliden-Norzink Process

In the Boliden-Norzink process, a mercuric chloride ($HgCl_2$) solution reacts with elemental mercury in the off-gas to form a mercurous chloride (HgCl) precipitate known as calomel, which then settles and is recovered. This reaction occurs in a packed column. Once the solid is removed, the wash solution can be recirculated. A portion of the precipitate can be used to regenerate the mercuric chloride solution using chlorine gas (Booz et al. 2001). The rest of the calomel is sent off-site for reclamation. The Boliden-Norzink process uses the following reaction:

$$HgCl_{2(sol'n)} + Hg_{(gas)} \rightarrow 2HgCl_{(solid)}$$

Boliden-Norzink scrubbers are installed on the Nevada Gold Mines LLC – Goldstrike (Goldstrike), Jerritt Canyon Gold, LLC (Jerritt Canyon), and Nevada Gold Mines LLC - Gold Quarry Operations (Gold Quarry) roasters. These roasters volatilize large amounts of mercury and in turn produce large amounts of mercury co-product in the form of calomel. The calomel production at Goldstrike, Jerritt Canyon, and Gold Quarry averages 195,340 pounds, 7,640 pounds, and 9,120 pounds, respectively (Barrick 2018).

A Boliden-Norzink scrubber has not been applied to any existing strip circuit system at precious metal mining facilities in Nevada. There is no basis for assessing its performance in such an application, given the dissimilarities between the stripping and electrowinning process (and its characteristic emission stream) and the units/emission streams where Boliden-Norzink scrubbers have been applied. In addition, this technology requires a significant capital investment and produces wastewater (process water containing chloride ions) and solid waste (calomel). The capital costs of the Boliden-Norzink scrubbers installed at Goldstrike and Gold Quarry are $4.7 million and $3.2 million, respectively (Barrick 2018).

Based on the Boliden-Norzink process cost and environmental impacts, and the low amount of mercury emitted from strip circuit units, Boliden-Norzink scrubbers are not representative of NvMACT for pregnant and barren tanks.

3.3.2.1.2 Activated Carbon Injection

Activated carbon injection is similar to activated carbon filters in that activated carbon particles are used to adsorb mercury from the off-gas stream. In this process, the carbon particles are injected directly into the off-gas stream to adsorb mercury. They are then collected in downstream particulate controls, such as baghouses, wet scrubbers, or wet ESPs. Carbon injection is typically used in the power plant industry, where particulate control technologies have already been installed to clean fly-ash (and injected activated carbon) from the off-gas stream.

This process has not been applied to existing strip circuit systems at precious metal mining facilities in Nevada, and there is no basis for assessing its performance in such an application. In addition, the control efficiency of carbon injection is typically lower than that of carbon filters.

Therefore, the most appropriate activated carbon technology application for pregnant and barren tanks is a carbon adsorption filter.

3.3.2.1.3 Selenium Scrubber

Selenium scrubbers use selenium or a selenium compound within a scrubber to react with elemental mercury in the off-gas to form mercuric selenide (HgSe). HgSe has a lower vapor pressure than other common mercury compounds, which allows for mercury capture. The HgSe is removed in a sludge separation circuit, which requires a thickener and HgSe reclamation. Sulfuric acid, at concentrations between 10 and 60 percent, is used as the wash solution for the process.

Selenium scrubbers are appropriate for gas streams with high mercury loading. The outlet concentrations from this process are typically higher than the concentrations achieved from the Boliden-Norzink process discussed in Section 3.3.2.1.1. Selenium scrubbers are not widely used due to their low removal efficiency and expensive reagent and reclamation requirements. Therefore, this option is not considered an effective mercury control method for pregnant and barren tanks.

3.3.2.1.4 Selenium Filter

Selenium filters are similar to selenium scrubbers in that they use selenium to react with the elemental mercury in the off-gas stream to form mercuric selenide. Selenium filters use a selenium-impregnated porous carrier structure, housed in a cylindrical tower. The selenium filter's maximum operating temperature is approximately 250°F. The filters require a dry gas stream because moisture tends to degrade the filter media. The typical filter's carrying capacity is between 10 and 15 percent mercury by weight.

Selenium filters have been installed in only a few places in the world, and primarily in Sweden, and no operating data from these applications are available. Selenium filters are expensive to produce and to regenerate. There is no basis to believe that selenium filters would provide a better alternative to activated carbon filters. In addition, there is some concern that the selenium filters cause selenium air emissions. Therefore, this option is not considered an effective mercury control method for pregnant and barren tanks.

3.3.2.1.5 Baghouse

Baghouses, also called fabric filters, collect particulates by passing the off-gas through filters where the particulates collect on the fabric surface. Baghouses control particulate mercury, but they do not control gaseous elemental mercury (Booz et al. 2001). Therefore, this option is not considered an effective mercury control method for strip circuit units where the primary form of mercury emissions is elemental mercury.

3.3.2.2 Other Work Practices

All viable work practices for reducing mercury emissions have already been addressed in Part I – Existing Similar Thermal Units. Thus, there are no other work practices, process changes, or

material substitutions that can be instituted to reduce mercury emissions from pregnant and barren tanks.

3.3.3 Part III - Proposed NvMACT

Per NAC 445B.3681.6.(a), the applicant must propose *"standards, methods of control or other limitations to be applied to the thermal unit for the reduction of mercury emissions that the applicant deems sufficient for the Director to determine to be NvMACT for the thermal unit that emits mercury."*

The NvMACT proposed in this section follows the criteria required by the Director pursuant to NAC 445B.3683. All items considered in this NvMACT analysis are checked in the criteria list provided below:

NAC 445B.3683 Review of and action on application for new or modified thermal unit that emits mercury.

☒ *2.(b) Make a determination of NvMACT for the thermal unit that emits mercury in which the Director shall consider the following for each thermal unit that emits mercury:*

☒ *(1) The maximum degree of reduction of mercury emissions that is achievable for the thermal unit after considering:*

(I) The cost of achieving such a reduction; and

(II) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal unit that emits mercury to implement the NvMACT.

☒ *(2) The measures that reduce the volume or eliminate mercury emissions through process changes, substitution of materials or any other modifications.*

☒ *(3) The enclosure of systems or processes to eliminate mercury emissions.*

☒ *(4) The collection, capture or treatment of mercury emissions.*

☒ *(5) The design, equipment, work practice or operational standards of the thermal unit that emits mercury, including, without limitation, the requirements for training and certification of operators of the thermal unit that emits mercury.*

☒ *(6) The differences in the age, remaining operating life and configurations of similar thermal units that emit mercury. The Director may also consider the differences in the concentration of mercury in the ore, size and any other relevant factors of the similar thermal units that emit mercury.*

3.3.3.1 Proposed Controls and Work Practices

Based on the existing control technologies and work practices described in Part I and the additional control technology options described in Part II, Goldcorp proposes the following control equipment, work practices, and capture system as NvMACT for the proposed pregnant and barren tanks:

Control equipment:

- Carbon Bed

Work practices:

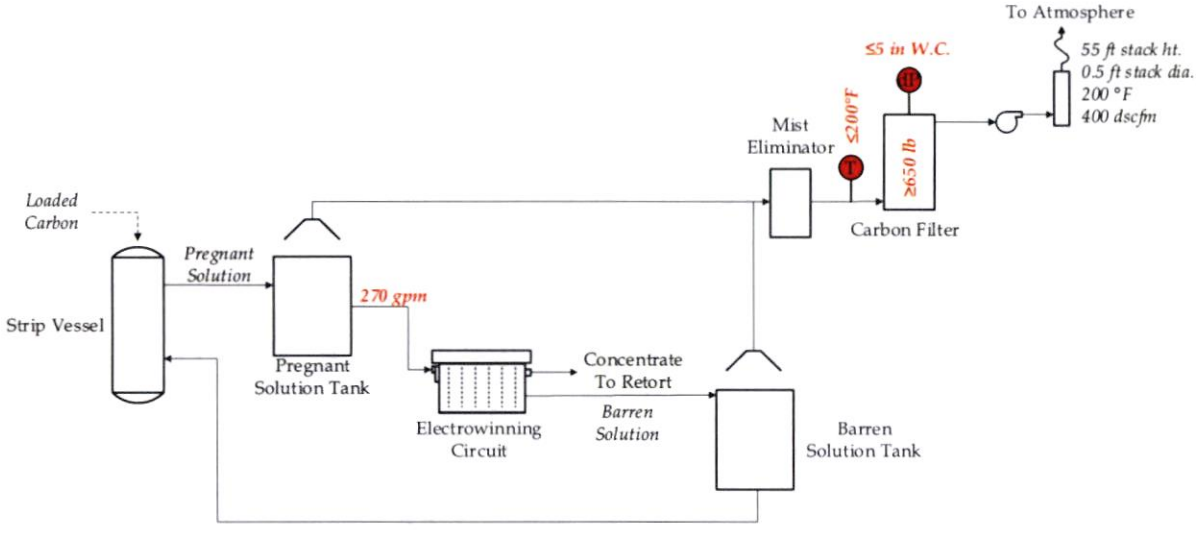
- The pregnant and barren solution tanks will be inspected every six months for leaks and corrosion.
- The carbon bed will contain at least 650 pounds of sulfur-impregnated carbon.
- The gas temperature entering the carbon bed will not exceed 200 degrees Fahrenheit (°F).
- The differential pressure (DP) across the carbon bed will not exceed 5 inches of water column (in WC).
- The carbon in the carbon bed shall be monitored and replaced prior to exceeding 20 percent mercury by weight.

Capture system:

The exhaust streams from the pregnant and barren tanks will be pulled through the control system by an exhaust fan. The system will be designed so that all emissions from the pregnant and barren tanks are captured and ducted through the carbon bed.

A flow diagram of the proposed NvMACT mercury control system is provided in Figure 3-2.

Figure 3-2. Lone Tree Exhaust Gas Treatment



The proposed pregnant and barren tanks will each be designed to process up to 270 gallons of solution per minute (gpm). In the proposed control system, the exhaust from the pregnant tank and barren tank will be ducted together and conditioned with a mist eliminator to collect any entrained water droplets prior to being pulled through a carbon bed to remove mercury.

The carbon bed will hold 650 pounds of sulfur-impregnated carbon. The bed is designed for an exhaust flow rate of approximately 400 dry standard cubic feet per minute (dscfm) with a residence time of 3.3 seconds (Hatch 2026). The loading capacity of the carbon is 20 percent mercury by weight.

Table 3-4 provides the carbon bed design analysis using NDEP's NvMACT Specific Case-by-Case Worksheet for deep bed systems.

Table 3-4. Carbon Bed Design Analysis

Description	Calculated Value	[Unit]	Symbol	Equations
Volume of bed	**22**	ft^3	VB	VB=MC/CD
Total quantity of carbon	**650**	lbs	MC	Capacity of carbon bed
Carbon Hg capacity	**20**	%	CP	Scotia - 15% to 40%
Carbon density	**30**	lbs/ft^3	CD	NDEP default value
Velocity	**N/A**	ft/min	V	$V = Q/SA_{bed}$
Flow rate	**400**	DSCFM	Q	Exhaust flow rate
Mercury loading	**0.009**	lb/hr	L	Calculated based on 98% control
Residence time	**3.3**	sec	T	T=((MC/CD)/Q)*60
Pressure drop	**5**	in H_2O	ΔP	(Hatch 2026)
Hg saturation (hours)	**15,167**	hr	S_h	Sh=MC*(CP/100)*(1/L)
Permit hours per year	**8,760**	hr/yr	HY	
Hg saturation (years)	**1.73**	yr	S_y	$S_y=S_h/HY$

As shown by Table 3-4, the volume of carbon is sufficient to provide adequate residence time (≥1 second based on the dry standard flow rate) and the total weight of carbon is sufficient for the expected mercury loading rate (mercury saturation is approximately 1.7 years). Based on this analysis, the proposed pregnant and barren tanks control system meets NvMACT.

3.3.3.2 Proposed Mercury Emission Limit

As shown in Table 3-1 of Section 3.3.1.1, the NvMACT mercury emission limits for existing strip circuit units range from the General Industry NvMACT limit of 5.0E-05 gr/dscf to the TUTD interim limit of 5.0E-03 gr/dscf. Goldcorp proposes the General Industry NvMACT Limit of 5.0E-05 gr/dscf for the proposed pregnant and barren tanks.

3.3.3.3 Cost of Controls

The cost of the proposed pregnant and barren tanks carbon bed was estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital costs, O&M costs, and annualized costs as functions of exhaust flow rate.

Based on the exhaust flow rate of 400 dscfm, the pregnant and barren tanks estimated control costs are summarized in Table 3-5.

Table 3-5. Lone Tree Pregnant and Barren Tanks Control Costs

Control	Exhaust Flow (dscfm)	Capital Cost ($)	O&M Cost ($/ yr)	Annualized Cost ($/ yr)
Carbon Bed	400	42,100	not available	not available

(EPA 1999)

REFERENCES

Barrick. 2018. "Barrick Goldstrike Mines Inc., MOPTC Phase II, AP1041-2221, Revised NvMACT Analysis and Application Forms, Roasters." Barrick Goldstrike Mines, Inc. (Barrick), September 19. Accessed August 25, 2021. DOC ID 19487 - https://documentviewerpublic.ndep.nv.gov/Common/login.aspx.

Booz et al. 2001. "Mercury Mass Balance and Emission Factor Estimates for Gold Ore Processing Facilities (Draft)." Report Prepared for U.S. EPA Region 9 by Booz Allen & Hamilton Inc., January 14.

EPA. 1999. "Technical Bulletin - Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA 456/F-99-004." United States Environmental Protection Agency (EPA), May.

—. 2002. "EPA Air Pollution Control Cost Manual, 6th Edition." EPA Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA/452/B-02-001, January.

—. 2003cs. "Air Pollution Control Technology Fact Sheet - Condensation Scrubber." *EPA-452/F-03-010.* United States Environmental Protection Agency (EPA). Accessed August 4, 2022. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1008OGF.PDF.

Hatch. 2026. "i-80 Gold Corp - Lone Tree Restart Permitting Inputs Sheet." *Document Number: H367753-0000-843-216-0001.* Hatch, February 4.

Klett et al. 2002. "The Cost of Mercury Removal in an IGCC Plant. Final Report." Michael G. Klett, Russell C. Maxwell, and Michael D. Rutkowski. Parsons Infrastructure and Technology Group Inc. Report prepared for The United States Department of Energy National Energy Technology Laboratory., September.

M.A.Tribe, R.L.W.Alpine. 1985. "SCALE ECONOMIES AND THE "'0.6 RULE"." *Engineering Costs and Production Economics.* Elsevier Science Publishers B.V., Amsterdam, September 23. Accessed August 23, 2022. https://www.sciencedirect.com/science/article/pii/0167188X86900534.

NDEP. 2016. "Nevada Mercury Control Program Permitting Guidance, General Industry NvMACT Determinations (Draft)." Nevada Division of Environmental Protection (NDEP), February 29.

SION. 2021. "Trip Report to Rawhide Mine to Review the Operation of Melting Furnace Mercury Scrubber." Scotia International of Nevada (SION), July 26.

—. n.d. "Coal Based Activated Carbon Impregnated with Sulfur." *Product Bulletin COL-IS 60.* Scotia International of Nevada, Inc. (SION).

NvMACT Analysis for the Electrowinning Circuit

ELECTROWINNING CELLS NVMACT ANALYSIS - TABLE OF CONTENTS

3.0 NvMACT Analysis – Electrowinning 65

3.1 Introduction 65

3.2 Process Description 65

3.3 NvMACT Analysis 66

3.3.1 Part I – Existing Similar Thermal Units 66

3.3.1.1 Mercury Controls 66

3.3.1.1.1 Condensers 68

3.3.1.1.2 Carbon Adsorption 68

3.3.1.1.3 Work Practices 69

3.3.1.2 Mercury Emissions 69

3.3.1.3 Mercury Control Costs 77

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements .. 77

3.3.2 Part II – Other Controls and/or Work Practices 77

3.3.2.1 Other Mercury Control Options 77

3.3.2.1.1 Boliden-Norzink Process 78

3.3.2.1.2 Activated Carbon Injection 78

3.3.2.1.3 Selenium Scrubber 79

3.3.2.1.4 Selenium Filter 79

3.3.2.1.5 Baghouse 79

3.3.2.2 Other Work Practices 79

3.3.3 Part III - Proposed NvMACT 80

3.3.3.1 Proposed Controls and Work Practices 81

3.3.3.2 Proposed Mercury Emission Limit 82

3.3.3.3 Cost of Controls 82

References 84

Tables

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits 67
Table 3-2. Existing Similar Thermal Units: Compliance Test Results 71
Table 3-3. Existing Similar Thermal Units: Control Costs 77
Table 3-4. Carbon Bed Design Analysis 82
Table 3-5. Lone Tree EW Cells Control Costs 83

Figures

Figure 3-1. Electrowinning Circuit Process Flow Diagram 65
Figure 3-2. Lone Tree Exhaust Gas Treatment 81

3.0 NvMACT ANALYSIS – ELECTROWINNING

3.1 Introduction

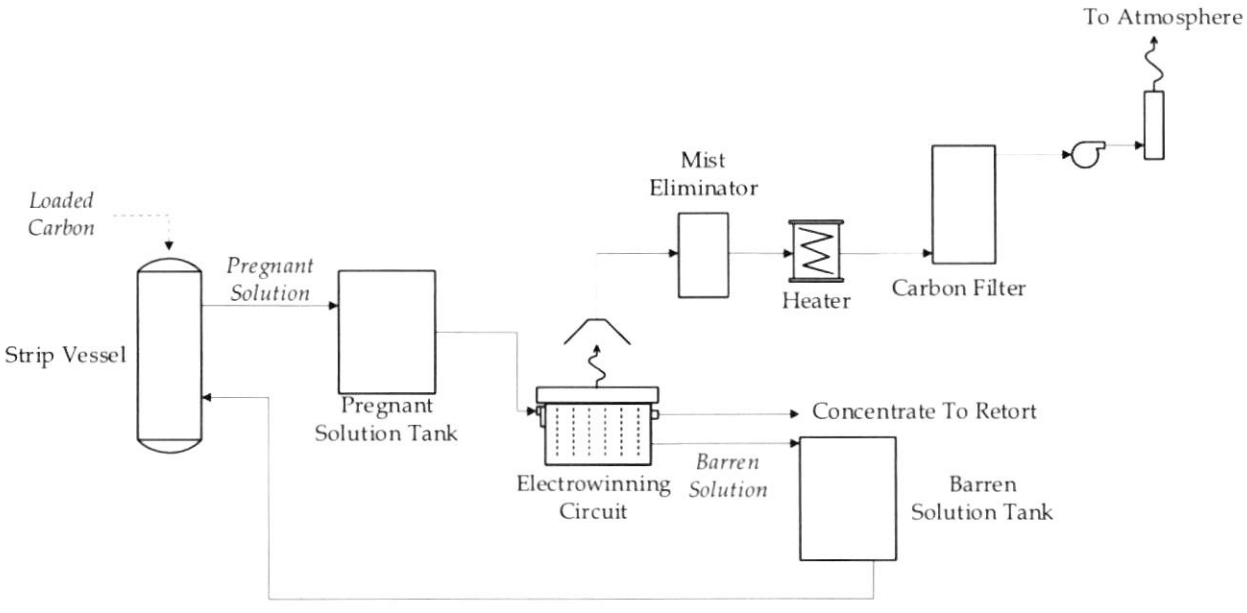
Goldcorp DEE LLC (Goldcorp) proposes to install and operate one electrowinning (EW) circuit, consisting of three cells, as part of the strip circuit at the Lone Tree Mine (Lone Tree). Per Nevada Administrative Code (NAC) 445B.3681.6, a Nevada Maximum Achievable Control Technology (NvMACT) analysis is required for new thermal units that emit mercury, as a part of a Mercury Operating Permit to Construct (MOPTC) application. The NvMACT analysis provided herein addresses all the applicable requirements of NAC 445B.3681.6.

3.2 Process Description

In a strip circuit, gold and other metals including mercury are stripped from the gold-bearing carbon by first washing the carbon with an acidic solution in a vessel and then stripping the carbon with a heated strip solution (barren solution) in a strip vessel. The solution exiting the strip vessel (pregnant solution) contains gold and is pumped to the pregnant tank for storage prior to being pumped to EW circuit. The EW circuit is used to precipitate the gold, carried by the pregnant solution, via electrolysis. The barren solution exiting the EW circuit is sent to the barren tank for storage prior to being reused in the stripping process.

The exhaust stream from the electrowinning circuit at Lone Tree will be routed through a carbon bed before being released to the atmosphere. See Figure 3-1 for a process flow diagram.

Figure 3-1. Electrowinning Circuit Process Flow Diagram



3.3 NvMACT Analysis

3.3.1 Part I – Existing Similar Thermal Units

Part I of the NvMACT analysis provides a list of similar existing thermal units used for precious metal refining and describes the controls and work practices used to reduce mercury emissions. All information required by NAC 445B.3681, as described below, is provided herein:

NAC 445B.3681 New or modified thermal unit that emits mercury: Contents of required application.

☒ *6.(b) Sets forth a list of similar thermal units that emit mercury which are used for precious metal mining that includes, without limitation:*

- ☒ *(1) Any methods or technologies to control mercury emissions which are associated with the thermal units that emit mercury;*
- ☒ *(2) The level of mercury emissions associated with each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(3) The design for each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(4) Costs associated with reductions of mercury emissions as a result of each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(5) Costs associated with energy for each method or technology to control mercury emissions from the thermal units that emit mercury; and*
- ☒ *(6) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal units that emit mercury.*

3.3.1.1 Mercury Controls

The Nevada Mercury Control Program (NMCP) permits for existing strip circuit units (i.e., EW circuits, pregnant tanks, and barren tanks) were downloaded from the Nevada Division of Environmental Protection (NDEP) Public Document Search website to obtain a list of the existing strip circuit system mercury controls. This information is summarized in Table 3-1.

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits

Facility Name	Permit No.	Date	Source	Control1	Control2	Control3	Carbon (lb)	Stack Flow	Stack Temp	Limit (gr/dscf)	Limit Notes
Borealis Mining Company LLC	AP1041-2228	2/22/2013	Electrowinning Circuit (TU4.004)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	8,000	2,000 acfm	120	1.0E-04	Combined limit of TU4.004, TU4.005, TU4.006
			Pregnant Tank (TU4.005)	-	-					-	
			Barren Tank (TU4.006)	-	-					-	
			Mercury Retort Furnace (TU4.002)	Mercury Condenser(MC-001)	-					-	
			Carbon Regeneration Kiln (TU4.001)	-	Wet Scrubber (WS-001)					-	
			Smelting Furnace (TU4.003)	-	-					-	
Tonda Canyon Mining, Inc	AP1041-2256	2/1/2021	Electrowinning Cell A (TU4.002)	Exhaust Demister Vessel (EDV-002)	Carbon Adsorption Vessel (DS-002)		3,950	1,500 acfm	130	5.0E-05	Combined limit for TU4.002, TU4.003, TU4.006, and TU4.007
			Electrowinning Cell B (TU4.003)								
			Pregnant Solution Tank (TU4.006)								
			Barren Solution Tank (TU4.007)								
GRP Pan, LLC	AP1041-3302	8/17/2016	Electrowinning Cells (TU4.004)	Carbon Filter (CF-004)			2,800	1,100 acfm	140	5.0E-05	Combined limit for TU4.004 - TU4.006
			Barren Tank (TU4.005)								
			Barren Tank (TU4.006)								
Jerritt Canyon Gold LLC	AP1041-2217	7/13/2022	Electrowinning Cell I (TU4.004)	Sulfur-Impregnated Carbon Tray (SIC-002)			4,950	3,200 dscfm	130	5.0E-05	Combined limit for TU4.004 - TU4.007
			Electrowinning Cell II (TU4.005)								
			Pregnant Tank (TU4.006)								
			Barren Tank (TU4.007)								
KG Mining (Bald Mountain) Inc	AP1041-3927	7/15/2021	Electrowinning Cells (TU4.002)	Carbon Filter (CF-002)			2,550	545 dscfm	120	5.0E-05	Combined limit for TU4.002 - TU4.004
			Barren Tank (TU4.003)								
			EW Barren Tank (TU4.004)								
Klondex Aurora Mine, Inc	AP1041-2248	5/29/2019	Electrowinning Cells (TU4.006) **(System 01A)**	-	-						
			Carbon Kiln (TU4.001)	Venturi Wet Scrubber (WS-001)	-					1.0E-04	Combined limit for TU4.001 - TU4.003 and TU4.006
			Pregnant Tank (TU4.002)	-	-						
			Barren Tank (TU4.003)	-	-						
			Electrowinning Cells (TU4.006) **(System 01B)**	-	-						
			Mercury Retort #1 (TU4.004)	Mercury Condenser (MC-001)	-	Carbon Deep Bed Scrubber (CA-001)	5500	1,071 dscfm	200	1.0E-04	Combined limit for TU4.002 - TU4.006
			Mercury Retort #2 (TU4.005)		-						
			Pregnant Tank (TU4.002)	-	-						
			Barren Tank (TU4.003)	-	-						
			Electrowinning Cells (TU4.006) **(System 01C)**	-	-						
			Dore Furnace (TU4.007)	-	Baghouse (BH-001)					1.0E-05	Combined limit for TU4.002, TU4.003, TU4.006, and TU4.007
			Pregnant Tank (TU4.002)	-	-						
			Barren Tank (TU4.003)	-	-						
Marigold Mining Compar	AP1041-2254	1/27/2022	Electrowinning Cells (2 Cells) (TU4.004)	-	-						
			Pregnant Tank (TU4.005)	-	Carbon Adsorption Unit (CA-002)						
			Barren Tank (TU4.006)	-			5,000	3,000 dscfm	100	5.0E-03	Combined limit for TU4.003 and TU4.004-TU4.006 or TU4.002 and TU4.004 - TU4.006
			Mercury Retort (TU4.002)	Mercury Condenser (CO-001)							
			Tilting Crucible Furnace (TU4.003)	-							
McEwen Mining, Inc	AP1041-3801	9/24/2020	Electrowinning Cell A (TU4.002)	Mist Eliminator (500-DC-004)	Duct Heater (500-DC-004-HTI)	Carbon Filter (CF-001)	1,500	441 dscfm	146	2.1E-04	Combined limit for TU4.002 - 4.005
			Electrowinning Cell B (TU4.003)								
			Barren Tank (TU4.004)								
			Eluant Tank (TU4.005)								
Nevada Gold Mines LLC - Cortez	AP1041-2220	2/1/2021	East Electro-Winning Cells (TU4.001)	Demister and Pre-Heater (PH-001)	Carbon Filter (CA-002)		1,500	3,000 dscfm	150	1.3E-04	Combined limit for TU4.001, TU4.008, and TU4.009
			West Electro-Winning Cells (TU4.002)	Demister and Pre-Heater (PH-002)	Carbon Filter (CA-003)		1,500	3,000 dscfm	150	1.3E-04	Combined limit for TU4.002, TU4.008, and TU4.009
			Pregnant Tank (TU4.008)	PH-001 or PH-002	CA-002 or CA-003		-	- -	-	-	
			Barren Tank (TU4.009)								
Nevada Gold Mines LLC - Gold Quarry Operations	AP1041-2219	4/23/2025	Electrowinning Cells (TU4.017)	Mercury Removal Media Filter Pack (CF-001A & B)	Wet Scrubber (WS-001)		2,800	8,000 dscfm	76	5.3E-04	Combined limit for TU4.016 - TU4.017
			Refinery Barren Tank (TU4.016)								
			Pregnant Tank (TU4.014)	Mercury Removal Media Filter Pack (CF-004)			309	300 dscfm	140	3.0E-03	Combined limit for TU4.014 - TU4.015
			Pregnant Tank (TU4.015)								
Nevada Gold Mines LLC - Goldstrike Mine	AP1041-2221	5/5/2025	Electrowinning Cells (TU4.024)	Baghouse (BH-001)	Carbon Bed (CA-004)		6,600	9,100 dscfm	140	7.3E-04	Combined limit for TU4.022 - TU4.024
			East Melting Furnace (TU4.022)								
			West Melting Furnace (TU4.023)								
			Electrowinning Cells (TU4.030)	Heater	Carbon Bed (CA-006)		42,000	10,358 dscfm	140	5.0E-05	Combined limit for TU4.030 - TU4.032
			Preg/Barren Tank A (TU4.031)								
			Preg/Barren Tank B (TU4.032)								
Nevada Gold Mines LLC - Twin Creeks Mine	AP1041-2218	5/19/2023	Electrowinning Cells (Six) (TU4.009)	Carbon Filter (CF-008)	-	-	2,880	9,216 dscfm	100	5.0E-05	
			Juniper Preg Tank A (TU4.006)	Wet Scrubber (WS-002)	Carbon Filter (CF-007)	-	1,296	4,018 dscfm	140	3.4E-04	Combined limit for TU4.006 - TU4.008
			Juniper Preg Tank B (TU4.007)								
			Juniper Barren Tank (TU4.008)								
			Piñon Pregnant Tank (TU4.010)	Carbon Filter (CF-009)	-	-	720	675 dscfm	120	5.0E-03	Combined limit for TU4.010 and TU4.011
			Piñon Barren Tank (TU4.011)								
Rawhide Mining, LLC	AP1041-2245	12/21/2021	Electrowinning Circuit (TU4.002)	Mercury (CO-002) Condenser	Carbon Filter (CF-002)		1,380	740 dscfm	77	5.0E-05	
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	AP1041-2250	3/7/2024	Electrowinning Cells (TU4.009)	Carbon Deep Bed Scrubber (CA-004)			4,800	2,660 dscfm	100	1.01E-04	Combined limit for TU4.007 - TU4.009
			Pregnant Tank (TU4.007)								
			Barren Tank (TU4.008)								
			Electrowinning Cells (TU4.012)	Sulfur-Impregnated Carbon Filter (CA-007)			4,000	2,200 dscfm	150	5.0E-05	Combined limit for TU4.002 - TU4.004 and TU4.012
			Pregnant Solution Tank (TU4.002)								
			Barren Solution Tank 1 (TU4.003)								
			Barren Solution Tank 2 (TU4.004)								
Walker Lane Minerals Corporation	AP1041-3895	not available	Electrowinning Cells (TU4.003)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	5,000	2,760 dscfm	200	5.0E-05	Combined limit for TU4.001 - TU4.003
			Pregnant Tank (TU4.001)	-	-					-	
			Barren Tank (TU4.002)	-	-					-	
			Mercury Retort (TU4.004)	Condenser (CO-001)	-					-	
			Carbon Regeneration Kiln (TU4.005)	-	Wet Scrubber (WS-001)					-	
WK-Allied Hasbrouck, LLC Three Hills Mine Project	AP1041-3669	6/25/2019	Electrowinning Cell #1 (TU4.004)	-	-	Carbon Bed Vapor Pac (CB-001)	18,000	7,650 dscfm	115	5.0E-05	Combined limit for TU4.004 - TU4.007
			Electrowinning Cell #2 (TU4.005)	-	-						
			Eluant Tank (TU4.006)	-	-						
			Barren Tank (TU4.007)	-	-						
			Smelting Furnace (Electric) (TU4.002)	Venturi Scrubber (VS-001)	-						
			Carbon Regeneration Kiln (TU4.003)	-	Venturi Scrubber (VS-002)					-	

As shown in Table 3-1, the primary mercury control installed for strip circuit units is a carbon adsorber. Some facilities also have condensers or mist eliminators for gas conditioning upstream of the carbon adsorbers. One facility, Nevada Gold Mines LLC - Gold Quarry Operations, employs a wet scrubber, however, it is located downstream of the carbon adsorber and therefore assumed not for mercury control.

3.3.1.1.1 Condensers

As shown in Table 3-1, some existing strip circuit systems employ a condenser in the control train. For these EW cells and tanks, the exhaust stream passes through the condenser, which cools the gas and causes the water vapor, and possibly vaporized mercury to condense. Any condensed mercury is then bled from the condenser into a collection vessel. The species of mercury collected from the condensers at precious metal mining, processing, and refining facilities in Nevada is elemental.

The two most common types of condensers are surface and contact condensers. Surface condensers cool gas streams by circulating water (or other cooling medium) through an enclosed water jacket surrounding the exhaust system or through a shell-and-tube type heat exchanger. Contact condensers cool gas streams by spraying cooled water into the gas stream. The following correlation exists for both types of condensers: the colder the circulating water, the colder the exhaust gas, and, for a constant inlet loading of mercury, the more efficient the removal of mercury from the gas stream (EPA 2002). However, for most strip circuit units, the concentration of mercury in the exhaust is too low for mercury condensation. The primary purpose of the condensers or mist eliminators is to remove water droplets from the exhaust stream prior to the carbon filter.

3.3.1.1.2 Carbon Adsorption

Carbon adsorption filters use activated carbon particles to adsorb mercury from the gas stream. Adsorption occurs when gas molecules are passed through a bed of solid particles (activated carbon). The gas molecules migrate from the gas stream to the surface of the solids, where they are held by physical attraction (EPA 2002). Carbon impregnated with elemental sulfur increases the adsorption efficiency due to the sulfur-mercury reaction that forms mercury sulfide, a stable mercury compound with a low vapor pressure (Booz et al. 2001).

Carbon filters control all types of mercury: particulate-bound, oxidized, and elemental. The mercury in the gas stream is adsorbed to the carbon and collected as carbon loaded with mercury. Once the carbon reaches adsorptive capacity, it is replaced, and the spent carbon is reclaimed. The carbon filter's mercury content is monitored to ensure that the mercury loading does not exceed the value recommended by the manufacturer. The typical carbon loading capacity is approximately 20 percent (or more) mercury by weight (SION n.d.) (Klett et al. 2002). Carbon mercury loading can be monitored directly, or the mercury concentration in the exhaust at the outlet of the carbon filter can be monitored to ensure the effectiveness of the carbon adsorber.

Some factors that can affect carbon filter adsorption efficiency include residence time of the gas in the carbon filter, carbon particle size, and exhaust stream moisture content. Longer residence

times and smaller carbon particle sizes increase the mercury removal efficiency of the carbon filter (Booz et al. 2001). According to Scotia International of Nevada (SION), *"Some moisture in the gas stream, and therefore in the carbon, catalyzes the mercury removal reaction. It is anticipated that as long as no free water is being released from the carbon, the moisture maximum would be 45%. Release of moisture from the carbon, would indicate that the gas stream is condensing within the carbon, which has the potential to inhibit the mercury removal reaction. The carbon is delivered with a nominal moisture of 5% (this value can vary by the ambient humidity of the area of usage)"* (SION 2021).

In short, mercury removal may be inhibited when carbon is physically wet with water (where moisture exceeds 45 percent).

3.3.1.1.3 Work Practices

In addition to the controls listed in Table 3-1, most of the precious metal mining facilities in Nevada incorporate several different work practices into their processes to reduce mercury emissions. These work practices include inspecting the exhaust capture system and replacing the carbon prior to exceeding the recommended mercury loading levels.

The exhaust from the strip circuit units must be captured and conveyed to the carbon filter and then to a stack before being released to the atmosphere. The equipment for the ventilation system consists of hoods, ductwork, fans, and a stack. The hoods and ductwork are inspected periodically to ensure proper emissions capture.

To ensure sufficient control efficiency by a carbon filter, the carbon filter media is replaced prior to exceeding maximum mercury loading as recommended by the manufacturer. This can be accomplished by:

- replacing the carbon on a schedule that ensures the recommended mercury loading is not exceeded, based on worst-case mercury loading data;
- monitoring the loading of mercury on the carbon directly by carbon analyses;
- monitoring the mercury levels in the exhaust from the carbon filter; or
- a combination of the above work/monitoring practices.

3.3.1.2 Mercury Emissions

NMCP permits for existing strip circuit units were downloaded from the NDEP Public Document Search website to obtain a list of the existing mercury emission limits. This information is summarized in Table 3-1 of Section 3.3.1.1. The NvMACT emission limits range from the General Industry NvMACT limit for fluid systems of 5.0E-05 grains per dry standard cubic foot (gr/dscf) to the True-Up/True-Down (TUTD) interim limit of 5.0E-03 gr/dscf (NDEP 2016), with the exception of one facility, Klondex Aurora Mine, Inc. limited to 1.0E-05 gr/dscf, that is applicable to their EW cells, tanks, and furnace operating scenario.

NMCP compliance tests for existing strip circuit units were downloaded from the NDEP Public Document Search website to obtain the actual mercury emissions data for these units utilizing

NvMACT controls. This information is summarized in Table 3-2 for years 2018 through 2025. As shown in Table 3-2, all stack test results are below the TUTD interim limit of 5.0E-03 gr/dscf and many of the stack test results are also below the General Industry NvMACT limit for fluid systems of 5.0E-05 gr/dscf

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Borealis Mining Company LLC	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	10/15/2018	7.60E-07	1.0E-04	2.19E-06	337	446	86.0
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	6/10/2019	7.47E-06	1.0E-04	2.65E-05	414	588	104.7
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	8/10/2020	1.73E-06	1.0E-04	6.65E-06	449	622	87.5
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort Furnace (TU4.002) Carbon Regeneration Kiln (TU4.001) Smelting Furnace (TU4.003)	8/10/2021	1.73E-06	1.0E-04	6.88E-06	462	not available	87.5
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	10/14/2021	1.29E-05	1.0E-04	3.21E-05	291	not available	95.7
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	10/20/2022	2.50E-06	1.00E-04	9.90E-06	465	606	80.30
	Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/1/2023	9.75E-06	1.00E-04	4.20E-05	510	702	83.42
	Carbon Regeneration Kiln (TU4.001) Electrowinning Circuit (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	10/25/2024	2.12E-05	1.00E-04	6.10E-05	12/2/1900	458	3/24/1900
Florida Canyon Mining, Inc.	Electrowinning Cell A (TU4.002)	10/9/2018	5.17E-05	not available	1.28E-04	290	393	104.6
	Electrowinning Cell B (TU4.003)	10/9/2018	1.21E-05	not available	2.69E-05	260	362	107.5
	Electrowinning Cell A (TU4.002)	10/15/2020	3.10E-04	not available	7.70E-04	291	380	94.4
	Electrowinning Cell B (TU4.003)	10/15/2020	1.10E-04	not available	2.50E-04	265	349	95.8
	Electrowinning Cell A (TU4.002)	12/17/2020	6.27E-05	5.0E-05	1.27E-04	237	309	92.0
	Electrowinning Cell B (TU4.003)	12/17/2020	2.99E-05	5.0E-05	5.94E-05	232	302	88.1
	Electrowinning Cell A (TU4.002)	4/9/2021	1.09E-04	5.0E-05	3.09E-04	331	444	98.7
	Electrowinning Cell B (TU4.003)	4/9/2021	2.56E-05	5.0E-05	6.82E-05	311	424	100.3
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003)	1/20/2022	3.46E-04	5.0E-05	not available	1,520	not available	84.4
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Pregnant Solution Tank (TU4.006) Barren Solution Tank (TU4.007)	7/21/2022	2.24E-05	5.0E-05	2.43E-04	1,266	not available	100.6
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Pregnant Solution Tank (TU4.006) Barren Solution Tank (TU4.007)	5/19/2023	2.54E-07	5.00E-05	2.33E-06	1,068	1,370	106.58
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Pregnant Solution Tank (TU4.006) Barren Solution Tank (TU4.007)	26/2024-06/27/2	7.43E-07	5.00E-05	7.00E-06	1,104	1,450	118.86
GRP Pan, LLC	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	12/19/2018	2.61E-04	not available	1.40E-03	627	930	118.0
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	11/19/2019	7.80E-07	5.0E-05	5.30E-06	799	1,161	121.1
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	11/11/2020	6.70E-05	5.0E-05	5.00E-04	863	1,341	132.7
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	2/9/2021	1.50E-07	5.0E-05	9.90E-07	766	1,152	123.5
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	12/14/2021	2.17E-05	5.00E-05	1/0/1900	876	not available	129.29
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	11/14/2022	8.70E-07	5.0E-05	6.30E-06	848	1,322	118.0
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	9/19/2023	3.95E-07	5.00E-05	2.45E-06	724	not available	118.72
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	10/1/2024	2.39E-07	5.00E-05	1.33E-06	690	994	110.80
	Electrowinning Cells (TU4.004) Barren Tank (TU4.005) Barren Tank (TU4.006)	10/21/2025	2.07E-07	5.00E-05	4.25E-06	2,396	not available	105.33

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Jerritt Canyon Gold LLC	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	8/16/2018	3.24E-04	5.0E-05	1.07E-02	3,851	5,236	88.4
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	7/31/2019	1.21E-05	5.0E-05	7.27E-04	7,007	9,511	100.0
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	7/28/2020	2.73E-05	5.0E-05	1.50E-03	6,422	8,718	90.0
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	6/16/2021	1.29E-04	5.0E-05	not available	3,830	not available	97.5
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	6/21/2022	1.82E-06	5.00E-05	2.61E-05	1,672	not available	137.03
	Electrowinning Cell I (TU4.004) Electrowinning Cell II (TU4.005) Pregnant Tank (TU4.006) Barren Tank (TU4.007)	8/17/2023	5.05E-06	5.00E-05	not available	1,026	not available	156.72
Klondex Aurora Mine, Inc	Electrowinning Cells (TU4.006) (System 01A Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	9/25/2018	3.20E-07	1.0E-04	5.50E-06	2,042	3,189	138.0
	Electrowinning Cells (TU4.006) (System 01B Mercury Retort #1 (TU4.004) Mercury Retort #2 (TU4.005) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	9/26/2018	2.70E-07	1.0E-04	5.10E-06	2,169	3,384	138.0
	Electrowinning Cells (TU4.006) (System 01C Dore Furnace (TU4.007) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	9/27/2018	1.20E-06	not available	2.20E-05	2,218	3,480	139.0
	Electrowinning Cells (TU4.006) (System 01A Carbon Kiln (TU4.001) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	10/1/2019	1.90E-06	1.0E-04	3.80E-05	2,301	3,226	83.6
	Electrowinning Cells (TU4.006) (System 01B Mercury Retort #1 (TU4.004) Mercury Retort #2 (TU4.005) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	10/2/2019	1.40E-06	1.0E-04	2.90E-05	2,421	3,434	86.9
	Electrowinning Cells (TU4.006) (System 01C Dore Furnace (TU4.007) Pregnant Tank (TU4.002) Barren Tank (TU4.003)	10/3/2019	7.70E-07	1.0E-05	1.70E-05	2,508	3,553	87.9

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Marigold Mining Company	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	5/21/2018	2.10E-06	5.0E-03	1.70E-05	917	1,497	142.0
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort (TU4.002)	6/11/2019	8.80E-07	5.0E-03	3.64E-06	481	726	142.2
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Tilting Crucible Furnace (TU4.003)	6/12/2019	6.70E-06	5.0E-03	7.75E-05	1,350	2,034	159.6
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	6/10/2019	1.04E-06	5.0E-03	4.45E-06	499	729	134.4
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort (TU4.002)	8/25/2020	2.20E-06	5.0E-03	5.90E-06	309	492	141.6
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Tilting Crucible Furnace (TU4.003)	8/26/2020	7.90E-06	5.0E-03	8.40E-05	1,232	1,892	146.6
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/24/2020	2.60E-06	5.0E-03	7.30E-06	326	520	148.5
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006) Mercury Retort (TU4.002)	7/20/2021	2.20E-07	5.0E-03	4.40E-07	235	442	152.3
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/21-22/2021	2.60E-07	5.0E-03	5.40E-07	241	448	153.0
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/21/2022	4.80E-06	5.0E-03	not available	263	not available	156.8
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/13/2023	1.40E-04	5.0E-03	8.50E-04	545	810	150.20
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	9/12/2024	2.20E-06	5.0E-03	5.51E-06	307	464	142.44
	Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/7/2025	5.23E-06	5.0E-03	1.55E-05	354	539	122.07
McEwen Mining, Inc.	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	4/23/2020	1.49E-04	5.0E-03	3.69E-04	291	415	87.8
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	10/15/2020	7.54E-06	5.0E-03	1.73E-06	267	383	102.0
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	4/22/2021	3.80E-05	5.0E-03	8.68E-05	266	396	93.2
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	5/12/2022	1.60E-05	5.0E-03	3.10E-05	229	337	99.3
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	12/1/2022	8.40E-06	5.0E-03	1.90E-05	271	346	54.0
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	6/15/2023	2.04E-04	5.0E-03	5.77E-04	330.0	488	102.8
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	1/18/2024	9.43E-05	2.1E-04	3.01E-04	376.62	not available	85.99
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	7/18/2024	2.42E-04	2.1E-04	6.67E-04	329.84	not available	112.29
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	10/28/2024	3.22E-06	2.1E-04	2.55E-05	665.44	958	93.00
	Electrowinning Cell A (TU4.002) Electrowinning Cell B (TU4.003) Barren Tank (TU4.004) Eluant Tank (TU4.005)	6/12/2025	9.20E-08	2.1E-04	4.97E-07	629.90	940	120.76

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Nevada Gold Mines LLC - Cortez	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	7/19/2018	6.24E-06	1.3E-04	1.13E-04	2,123	2,847	104.9
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	7/19/2018	3.18E-06	1.3E-04	4.53E-05	1,667	2,317	115.6
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/22/2019	1.40E-05	1.3E-04	2.25E-04	1,882	2,527	110.8
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/22/2019	5.86E-05	1.3E-04	9.98E-04	1,988	2,733	110.2
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/20/2020	3.50E-06	1.3E-04	5.40E-05	1,783	2,368	108.1
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/20/2020	1.20E-04	1.3E-04	2.00E-03	1,981	2,704	110.9
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/25/2021	4.59E-06	1.3E-04	5.82E-05	1,482	not available	118.9
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/25/2021	2.07E-06	1.3E-04	4.61E-05	2,565	not available	113.5
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/24/2022	2.02E-05	1.3E-04	2.65E-04	1,517	not available	115.7
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/24/2022	8.80E-06	1.3E-04	1.03E-04	1,337	not available	112.7
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/23/2023	2.83E-05	1.30E-04	2.38E-04	979	1,383	115
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/23/2023	3.24E-05	1.30E-04	2.95E-04	1,074	1,407	156
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/21/2024	1.60E-05	1.30E-04	1.70E-04	1,264	1,788	116.70
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	8/21/2024	3.45E-05	1.30E-04	3.80E-04	1,261	1,769	118.00
	West Electro-Winning Cells (TU4.002) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	7/2/2025	5.16E-07	1.30E-04	3.33E-06	718	1,055	125.20
	East Electro-Winning Cells (TU4.001) Pregnant Tank (TU4.008) Barren Tank (TU4.009)	10/28/2025	1.14E-04	1.30E-04	6.30E-04	644	911	125.00
Nevada Gold Mines LLC - Gold Quarry Operations	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	3/21/2018	9.04E-06	5.0E-03	3.28E-04	4,238	5,474	78.7
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	4/3/2019	6.25E-05	5.0E-03	2.40E-03	4,511	5,647	108.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	9/24/2019	9.74E-05	5.0E-03	4.71E-03	5,527	6,970	73.8
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	4/15/2020	2.59E-05	5.0E-03	1.12E-03	5,035	6,325	70.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	9/15/2020	7.70E-06	5.0E-03	3.51E-04	5,350	6,715	75.6
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	3/10/2021	3.85E-04	5.0E-03	1.73E-02	5,249	6,656	71.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	9/16/2021	8.02E-04	5.0E-03	3.29E-02	4,808	not available	80.0
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	12/6/2022	2.93E-05	5.0E-03	1.64E-03	6,538	8,142	67.7
	Electrowinning Cells (TU4.017) and Refinery Barren Tanks (TU4.016)	12/12/2023	3.56E-06	5.0E-03	1.84E-04	8,000	not available	66.0
	Pregnant Tank (TU4.014) and Pregnant Tank (TU4.015)	10/9/2024	7.49E-05	3.0E-03	1.00E-04	157	not available	122.5
	Electrowinning Cells (TU4.017) and Refinery Barren Tank (TU4.016)	10/9/2024	1.80E-06	5.3E-04	8.32E-05	5,416	not available	81.8
Nevada Gold Mines LLC - Goldstrike Mine	Electrowinning Cells (TU4.024)	8/16/2017	4.64E-05	5.0E-03	1.69E-03	4,261	not available	118.4
	Electrowinning Cells (TU4.024)	9/12/2018	4.90E-05	5.0E-03	1.80E-03	4,264	6,093	111.0
	Electrowinning Cells (TU4.030) Preg/Barren Tank A (TU4.031) Preg/Barren Tank B (TU4.032)	9/13/2018	3.20E-07	5.0E-03	3.90E-05	14,336	18,255	85.0
	Electrowinning Cells (TU4.024)	10/15/2019	1.50E-04	5.0E-03	5.60E-03	4,464	6,544	109.0
	Electrowinning Cells (TU4.030) Preg/Barren Tank A (TU4.031) Preg/Barren Tank B (TU4.032)	10/16/2019	1.20E-06	5.0E-03	9.50E-05	8,944	11,614	87.0
	Electrowinning Cells (TU4.024)	8/19/2020	2.30E-05	7.3E-04	7.60E-04	3,962	5,647	109.5
	Electrowinning Cells (TU4.024)	9/9/2021	8.60E-06	7.3E-04	3.10E-04	4,278	6,303	116.9
	Electrowinning Cells (TU4.024)	9/20/2022	9.75E-05	7.3E-04	3.50E-03	4,217	6,251	122.4
	Electrowinning Cells (TU4.024)	11/16/2023	1.30E-05	7.3E-04	5.20E-04	4,496	5,782	91.6
	Electrowinning Cells (TU4.024)	11/20/2024	7.50E-06	7.3E-04	3.15E-04	4,908	6,794	103.4
	Electrowinning Cells (TU4.024)	9/23/2025	9.35E-06	7.3E-04	3.81E-04	4,767	6,666	117.3

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Nevada Gold Mines LLC - Twin Creeks Mine	Electrowinning Cells (Six) (TU4.009)	5/9/2018	1.43E-06	5.0E-03	1.07E-04	8,760	11,635	92.4
	Electrowinning Cells (Six) (TU4.009)	5/8/2019	1.01E-06	not available	7.08E-05	8,173	10,787	89.7
	Electrowinning Cells (Six) (TU4.009)	6/10/2020	2.60E-06	5.0E-03	not available	7,630	9,922	91.4
	Electrowinning Cells (Six) (TU4.009)	10/29/2020	5.09E-06	5.0E-03	3.20E-04	7,334	not available	79.9
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	4/15-16/2021	2.48E-04	5.0E-03	6.64E-03	3,112	not available	88.4
	Electrowinning Cells (Six) (TU4.009)	4/15/2021	1.48E-06	5.0E-03	4.93E-05	3,875	not available	81.2
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	4/18/2022	3.60E-05	5.0E-03	not available	3,407	not available	143.0
	Electrowinning Cells (Six) (TU4.009)	4/19/2022	7.55E-07	5.0E-03	not available	6,087	not available	66.4
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	10/18/2022	1.40E-05	5.0E-03	4.30E-04	3,484	4,463	85.8
	Electrowinning Cells (Six) (TU4.009)	10/21/2022	1.50E-06	5.0E-03	1.10E-04	8,552	10,971	82.5
	Juniper Pregnant and Barren Tanks TU4.006 - TU4.008	5/17/2023	2.40E-05	5.0E-03	4.00E-04	1,920	2,523	90.3
	Electrowinning Cells (Six) (TU4.009)	5/16/2023	1.60E-06	5.0E-03	1.10E-04	7,760	9,943	88.3
Rawhide Mining, LLC	Electrowinning Circuit (TU4.002)	12/7/2018	2.81E-06	5.0E-05	1.13E-05	467	548	53.5
	Electrowinning Circuit (TU4.002)	10/3/2019	6.48E-05	5.0E-05	3.38E-04	607	811	100.6
	Electrowinning Circuit (TU4.002)	12/10/2020	3.64E-05	5.0E-05	1.84E-04	588	757	84.8
	Electrowinning Circuit (TU4.002)	11/17/2021	6.80E-07	5.0E-05	5.00E-06	858	1,049	70.9
	Electrowinning Circuit (TU4.002)	8/4/2022	6.84E-06	5.0E-05	not available	934	not available	105.3
	Electrowinning Circuit (TU4.002)	8/16/2023	1.76E-05	5.0E-05	1.24E-04	843	not available	104.9
		Shutdown in 2023						
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	4/12-13/2018	2.25E-05	5.0E-05	5.37E-04	2,787	4,054	127.0
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	4/17/2018	1.53E-05	1.0E-04	1.91E-04	1,457	2,028	99.0
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	4/18-19/2019	1.20E-04	5.0E-05	1.60E-03	1,511	2,091	92.7
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.012)	4/20/2019	3.00E-05	1.0E-04	3.60E-04	1,379	1,997	108.5
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	9/5/2019	7.10E-07	5.0E-05	1.40E-05	2,280	3,399	129.7
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008)	5/6/2020	4.80E-06	5.0E-05	1.00E-04	2,420	3,654	133.0
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.012)	5/8/2020	5.00E-07	1.0E-04	6.00E-06	1,408	1,937	97.6
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	8/5/2021	3.30E-07	1.0E-04	3.50E-06	1,212	1,762	103.4
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	8/11/2021	9.50E-08	5.0E-05	1.90E-06	2,386	3,676	127.5
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	10/4/2022	5.90E-05	5.0E-05	1.00E-03	1,983	3,058	66.30
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	1/4/2023	2.51E-05	5.0E-05	5.81E-04	2,725	3,974	125.7
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	9/20/2023	5.37E-06	5.0E-05	5.00E-05	1,096	1,520	72.80
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	11/28/2023	8.20E-06	5.0E-05	1.70E-04	not available	not available	not available
	Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004) Electrowinning Cells (TU4.012)	8/7/2024	5.90E-07	5.0E-05	8.50E-06	1,683	2,376	120.30
	Electrowinning Cells (TU4.009) Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.009)	8/12/2024	3.90E-06	1.01E-04	5.00E-05	1,507	2,018	105.10
	Pregnant Tank (TU4.007) Barren Tank (TU4.008) Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	7/10/2025	7.94E-07	1.01E-04	1.10E-05	1,609	2,120	99.30
	Electrowinning Cells (TU4.012) Pregnant Solution Tank (TU4.002) Barren Solution Tank 1 (TU4.003) Barren Solution Tank 2 (TU4.004)	7/9/2025	2.60E-07	5.0E-05	3.10E-06	1,381	1,932	109.20

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp (F)
Walker Lane Minerals Corporation	Electrowinning Cells (TU4.003) Pregnant Tank (TU4.001) Barren Tank (TU4.002)	3/3-5/2020	5.60E-08	5.0E-05	8.05E-07	not available	not available	not available
	Electrowinning Cells (TU4.003) Pregnant Tank (TU4.001) Barren Tank (TU4.002)	4/28/2021	6.29E-07	5.0E-05	5.85E-06	1,086	not available	105.0
	Electrowinning Cells (TU4.003) Pregnant Tank (TU4.001) Barren Tank (TU4.002)	5/18/2022	6.49E-07	5.0E-05	5.86E-06	1,054	1,428	107.3

3.3.1.3 Mercury Control Costs

The cost of existing condensers and carbon filters listed in Table 3-1 were estimated in current dollars using technical documents from the EPA Clean Air Technology Center and the economies of scale. These documents provide the capital costs, operational and maintenance (O&M) costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rates listed in Table 3-1, the estimated strip circuit system control costs are summarized in Table 3-3.

Table 3-3. Existing Similar Thermal Units: Control Costs

Control	Exhaust Flow (scfm)	Capital Cost ($1,000)	O&M Cost ($1,000/ yr)	Annualized Cost ($1,000/ yr)
Condenser	740	38	16	21
Carbon Filter	441 to 10,358	46 to 1,090	not available	not available

(EPA 2003cs) (EPA 1999) (M.A.Tribe, R.L.W.Alpine 1985)
scfm = standard cubic feet per minute; yr = year

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements

The main non-air-quality health and environmental impact caused by mercury control technologies for strip circuit units is the reclamation of the carbon loaded with mercury from carbon filters. Once the carbon reaches adsorptive capacity, it is replaced with fresh carbon and the loaded carbon is reclaimed. In addition, shipping the used carbon to a reclamation facility has non-air-quality health, environmental, and energy impacts. Also, the use of condensers and carbon filters would cause increased energy consumption due to the additional fan and pump power requirements and the energy required to cool the circulating water in a condenser.

3.3.2 Part II – Other Controls and/or Work Practices

Part II of the NvMACT analysis examines other control options and/or work practices not currently employed with the existing strip circuit units described in Part I – Existing Similar Thermal Units.

3.3.2.1 Other Mercury Control Options

In addition to the mercury control technologies employed at existing strip circuit units, the following mercury control options are examined below:

1. Boliden-Norzink Process
2. Activated Carbon Injection
3. Selenium Scrubber
4. Selenium Filter
5. Baghouse

3.3.2.1.1 Boliden-Norzink Process

In the Boliden-Norzink process, a mercuric chloride ($HgCl_2$) solution reacts with elemental mercury in the off-gas to form a mercurous chloride (HgCl) precipitate known as calomel, which then settles and is recovered. This reaction occurs in a packed column. Once the solid is removed, the wash solution can be recirculated. A portion of the precipitate can be used to regenerate the mercuric chloride solution using chlorine gas (Booz et al. 2001). The rest of the calomel is sent off-site for reclamation. The Boliden-Norzink process uses the following reaction:

$$HgCl_{2(sol'n)} + Hg_{(gas)} \rightarrow 2HgCl_{(solid)}$$

Boliden-Norzink scrubbers are installed on the Nevada Gold Mines LLC – Goldstrike (Goldstrike), Jerritt Canyon Gold, LLC (Jerritt Canyon), and Nevada Gold Mines LLC - Gold Quarry Operations (Gold Quarry) roasters. These roasters volatilize large amounts of mercury and in turn produce large amounts of mercury co-product in the form of calomel. The calomel production at Goldstrike, Jerritt Canyon, and Gold Quarry averages 195,340 pounds, 7,640 pounds, and 9,120 pounds, respectively (Barrick 2018).

A Boliden-Norzink scrubber has not been applied to any existing strip circuit system at precious metal mining facilities in Nevada. There is no basis for assessing its performance in such an application, given the dissimilarities between the stripping and electrowinning process (and its characteristic emission stream) and the units/emission streams where Boliden-Norzink scrubbers have been applied. In addition, this technology requires a significant capital investment and produces wastewater (process water containing chloride ions) and solid waste (calomel). The capital costs of the Boliden-Norzink scrubbers installed at Goldstrike and Gold Quarry are $4.7 million and $3.2 million, respectively (Barrick 2018).

Based on the Boliden-Norzink process cost and environmental impacts, and the low amount of mercury emitted from strip circuit units, Boliden-Norzink scrubbers are not representative of NvMACT for EW circuits.

3.3.2.1.2 Activated Carbon Injection

Activated carbon injection is similar to activated carbon filters in that activated carbon particles are used to adsorb mercury from the off-gas stream. In this process, the carbon particles are injected directly into the off-gas stream to adsorb mercury. They are then collected in downstream particulate controls, such as baghouses, wet scrubbers, or wet ESPs. Carbon injection is typically used in the power plant industry, where particulate control technologies have already been installed to clean fly-ash (and injected activated carbon) from the off-gas stream.

This process has not been applied to existing strip circuit systems at precious metal mining facilities in Nevada, and there is no basis for assessing its performance in such an application. In addition, the control efficiency of carbon injection is typically lower than that of carbon filters.

Therefore, the most appropriate activated carbon technology application for EW circuits is a carbon adsorption filter.

3.3.2.1.3 Selenium Scrubber

Selenium scrubbers use selenium or a selenium compound within a scrubber to react with elemental mercury in the off-gas to form mercuric selenide (HgSe). HgSe has a lower vapor pressure than other common mercury compounds, which allows for mercury capture. The HgSe is removed in a sludge separation circuit, which requires a thickener and HgSe reclamation. Sulfuric acid, at concentrations between 10 and 60 percent, is used as the wash solution for the process.

Selenium scrubbers are appropriate for gas streams with high mercury loading. The outlet concentrations from this process are typically higher than the concentrations achieved from the Boliden-Norzink process discussed in Section 3.3.2.1.1. Selenium scrubbers are not widely used due to their low removal efficiency and expensive reagent and reclamation requirements. Therefore, this option is not considered an effective mercury control method for EW circuits.

3.3.2.1.4 Selenium Filter

Selenium filters are similar to selenium scrubbers in that they use selenium to react with the elemental mercury in the off-gas stream to form mercuric selenide. Selenium filters use a selenium-impregnated porous carrier structure, housed in a cylindrical tower. The selenium filter's maximum operating temperature is approximately 250°F. The filters require a dry gas stream because moisture tends to degrade the filter media. The typical filter's carrying capacity is between 10 and 15 percent mercury by weight.

Selenium filters have been installed in only a few places in the world, and primarily in Sweden, and no operating data from these applications are available. Selenium filters are expensive to produce and to regenerate. There is no basis to believe that selenium filters would provide a better alternative to activated carbon filters. In addition, there is some concern that the selenium filters cause selenium air emissions. Therefore, this option is not considered an effective mercury control method for EW circuits.

3.3.2.1.5 Baghouse

Baghouses, also called fabric filters, collect particulates by passing the off-gas through filters where the particulates collect on the fabric surface. Baghouses control particulate mercury, but they do not control gaseous elemental mercury (Booz et al. 2001). Therefore, this option is not considered an effective mercury control method for strip circuit units where the primary form of mercury emissions is elemental mercury.

3.3.2.2 Other Work Practices

All viable work practices for reducing mercury emissions have already been addressed in Part I – Existing Similar Thermal Units. Thus, there are no other work practices, process changes, or material substitutions that can be instituted to reduce mercury emissions from EW circuits.

3.3.3 Part III - Proposed NvMACT

Per NAC 445B.3681.6.(a), the applicant must propose "*standards, methods of control or other limitations to be applied to the thermal unit for the reduction of mercury emissions that the applicant deems sufficient for the Director to determine to be NvMACT for the thermal unit that emits mercury.*"

The NvMACT proposed in this section follows the criteria required by the Director pursuant to NAC 445B.3683. All items considered in this NvMACT analysis are checked in the criteria list provided below:

NAC 445B.3683 Review of and action on application for new or modified thermal unit that emits mercury.

☒ 2.*(b) Make a determination of NvMACT for the thermal unit that emits mercury in which the Director shall consider the following for each thermal unit that emits mercury:*

☒ *(1) The maximum degree of reduction of mercury emissions that is achievable for the thermal unit after considering:*

(I) The cost of achieving such a reduction; and

(II) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal unit that emits mercury to implement the NvMACT.

☒ *(2) The measures that reduce the volume or eliminate mercury emissions through process changes, substitution of materials or any other modifications.*

☒ *(3) The enclosure of systems or processes to eliminate mercury emissions.*

☒ *(4) The collection, capture or treatment of mercury emissions.*

☒ *(5) The design, equipment, work practice or operational standards of the thermal unit that emits mercury, including, without limitation, the requirements for training and certification of operators of the thermal unit that emits mercury.*

☒ *(6) The differences in the age, remaining operating life and configurations of similar thermal units that emit mercury. The Director may also consider the differences in the concentration of mercury in the ore, size and any other relevant factors of the similar thermal units that emit mercury.*

3.3.3.1 Proposed Controls and Work Practices

Based on the existing control technologies and work practices described in Part I and the additional control technology options described in Part II, Goldcorp proposes the following control equipment, work practices, and capture system as NvMACT for the proposed EW circuit:

Control equipment:

- Carbon Bed (Two Stage)

Work practices:

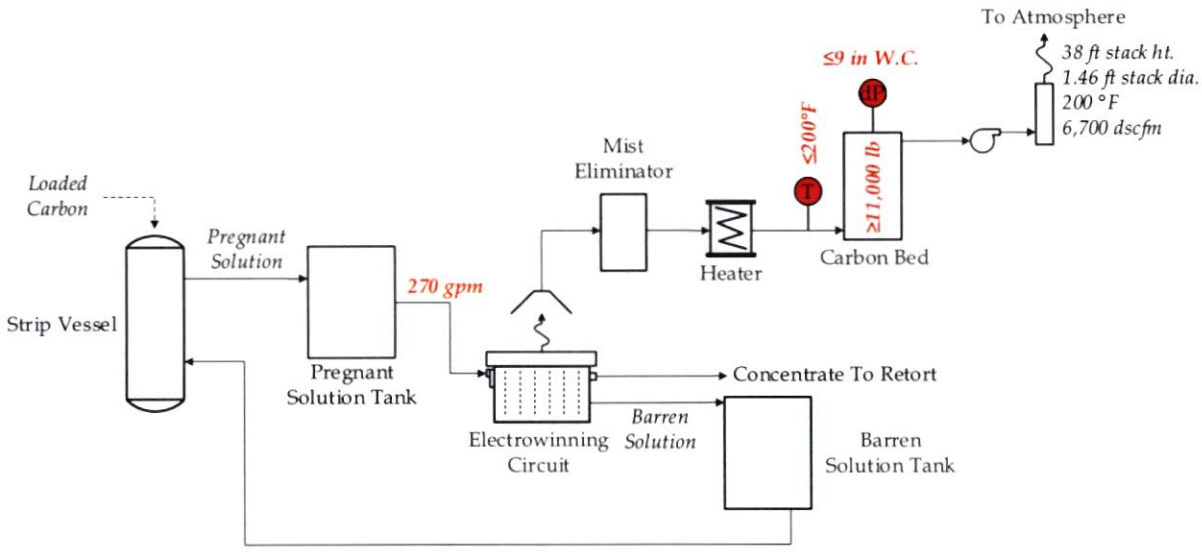
- The lids on the EW cells will be closed during operation.
- The carbon bed will contain at least 5,500 pounds of sulfur-impregnated carbon in each of the two stages of the bed (11,000 pounds total).
- The gas temperature entering the carbon bed will not exceed 200 degrees Fahrenheit (°F).
- The differential pressure (DP) across the carbon bed will not exceed 9 inches of water column (in WC).
- The carbon in the carbon bed shall be monitored and replaced prior to exceeding 20 percent mercury by weight.

Capture system:

The exhaust stream from the EW circuit will be pulled through the control system by an exhaust fan. The system will be designed so that all emissions from the EW circuit are captured and ducted through the carbon bed.

A flow diagram of the proposed NvMACT mercury control system is provided in Figure 3-2.

Figure 3-2. Lone Tree Exhaust Gas Treatment



The proposed EW circuit is designed to process up to 270 gallons of solution per minute (gpm). In the proposed control system, the exhaust from the three EW cells will be ducted together and conditioned with a mist eliminator to collect any entrained water droplets and a heater to ensure that any moisture in the exhaust is above the dew point. After conditioning, the exhaust will be pulled through a two-stage carbon bed to remove mercury.

The two-stage carbon bed will hold a total of 11,000 pounds of sulfur-impregnated carbon, with 5,500 pounds in each stage. The bed is designed for an exhaust flow rate of approximately 6,700 dry standard cubic feet per minute (dscfm) with a residence time of 3.3 seconds (Hatch 2026). The loading capacity of the carbon is 20 percent mercury by weight.

Table 3-4 provides the carbon bed design analysis using NDEP's NvMACT Specific Case-by-Case Worksheet for deep bed systems.

Table 3-4. Carbon Bed Design Analysis

Description	Calculated Value	[Unit]	Symbol	Equations
Volume of bed	**367**	ft^3	VB	VB=MC/CD
Total quantity of carbon	**11,000**	lbs	MC	Capacity of carbon bed
Carbon Hg capacity	**20**	%	CP	Scotia - 15% to 40%
Carbon density	**30**	lbs/ft^3	CD	NDEP default value
Velocity	**N/A**	ft/min	V	$V = Q/SA_{bed}$
Flow rate	**6,700**	DSCFM	Q	Exhaust flow rate
Mercury loading	**0.14**	lb/hr	L	Calculated based on 98% control
Residence time	**3.3**	sec	T	T=((MC/CD)/Q)*60
Pressure drop	**9**	in H_2O	ΔP	(Hatch 2026)
Hg saturation (hours)	**15,323**	hr	S_h	Sh=MC*(CP/100)*(1/L)
Permit hours per year	**8,760**	hr/yr	HY	
Hg saturation (years)	**1.75**	yr	S_y	$S_y=S_h/HY$

As shown by Table 3-4, the volume of carbon is sufficient to provide adequate residence time (≥1 second based on the dry standard flow rate) and the total weight of carbon is sufficient for the expected mercury loading rate (mercury saturation is approximately 1.7 years). Based on this analysis, the proposed EW circuit control system meets NvMACT.

3.3.3.2 Proposed Mercury Emission Limit

As shown in Table 3-1 of Section 3.3.1.1, the NvMACT mercury emission limits for existing strip circuit units range from the General Industry NvMACT limit of 5.0E-05 gr/dscf to the TUTD interim limit of 5.0E-03 gr/dscf. Goldcorp proposes the General Industry NvMACT Limit of 5.0E-05 gr/dscf for the proposed EW circuit.

3.3.3.3 Cost of Controls

The cost of the proposed EW circuit carbon bed was estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital

costs, O&M costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rate of 6,700 dscfm, the EW circuit estimated control costs are summarized in Table 3-5.

Table 3-5. Lone Tree EW Cells Control Costs

Control	Exhaust Flow (dscfm)	Capital Cost ($)	O&M Cost ($/ yr)	Annualized Cost ($/ yr)
Carbon Bed	6,700	704,700	not available	not available

(EPA 1999)

REFERENCES

Barrick. 2018. "Barrick Goldstrike Mines Inc., MOPTC Phase II, AP1041-2221, Revised NvMACT Analysis and Application Forms, Roasters." Barrick Goldstrike Mines, Inc. (Barrick), September 19. Accessed August 25, 2021. DOC ID 19487 - https://documentviewerpublic.ndep.nv.gov/Common/login.aspx.

Booz et al. 2001. "Mercury Mass Balance and Emission Factor Estimates for Gold Ore Processing Facilities (Draft)." Report Prepared for U.S. EPA Region 9 by Booz Allen & Hamilton Inc., January 14.

EPA. 1999. "Technical Bulletin - Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA 456/F-99-004." United States Environmental Protection Agency (EPA), May.

—. 2002. "EPA Air Pollution Control Cost Manual, 6th Edition." EPA Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA/452/B-02-001, January.

—. 2003cs. "Air Pollution Control Technology Fact Sheet - Condensation Scrubber." *EPA-452/F-03-010.* United States Environmental Protection Agency (EPA). Accessed August 4, 2022. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1008OGF.PDF.

Hatch. 2026. "i-80 Gold Corp - Lone Tree Restart Permitting Inputs Sheet." *Document Number: H367753-0000-843-216-0001.* Hatch, February 4.

Klett et al. 2002. "The Cost of Mercury Removal in an IGCC Plant. Final Report." Michael G. Klett, Russell C. Maxwell, and Michael D. Rutkowski. Parsons Infrastructure and Technology Group Inc. Report prepared for The United States Department of Energy National Energy Technology Laboratory., September.

M.A.Tribe, R.L.W.Alpine. 1985. "SCALE ECONOMIES AND THE "'0.6 RULE"." *Engineering Costs and Production Economics.* Elsevier Science Publishers B.V., Amsterdam, September 23. Accessed August 23, 2022. https://www.sciencedirect.com/science/article/pii/0167188X86900534.

NDEP. 2016. "Nevada Mercury Control Program Permitting Guidance, General Industry NvMACT Determinations (Draft)." Nevada Division of Environmental Protection (NDEP), February 29.

SION. 2021. "Trip Report to Rawhide Mine to Review the Operation of Melting Furnace Mercury Scrubber." Scotia International of Nevada (SION), July 26.

—. n.d. "Coal Based Activated Carbon Impregnated with Sulfur." *Product Bulletin COL-IS 60.* Scotia International of Nevada, Inc. (SION).

NvMACT Analysis for the Retort

RETORT NVMACT ANALYSIS - TABLE OF CONTENTS

3.0 NvMACT Analysis - Retort 88

3.1 Introduction 88

3.2 Process Description 88

3.3 NvMACT Analysis 89

3.3.1 Part I – Existing Similar Thermal Units 89

3.3.1.1 Mercury Controls 89

3.3.1.1.1 Condensers 91

3.3.1.1.2 Carbon Adsorption 91

3.3.1.1.3 Work Practices 92

3.3.1.2 Mercury Emissions 93

3.3.1.3 Mercury Control Costs 98

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements .. 98

3.3.2 Part II – Other Controls and/or Work Practices 98

3.3.2.1 Other Mercury Control Options 98

3.3.2.1.1 Boliden-Norzink Process 99

3.3.2.1.2 Activated Carbon Injection 99

3.3.2.1.3 Selenium Scrubber 100

3.3.2.1.4 Selenium Filter 100

3.3.2.1.5 Baghouse 100

3.3.2.2 Other Work Practices 100

3.3.3 Part III - Proposed NvMACT 101

3.3.3.1 Proposed Controls and Work Practices 102

3.3.3.2 Proposed Mercury Emission Limit 104

3.3.3.3 Cost of Controls 104

References 105

Tables

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits 90
Table 3-2. Existing Similar Thermal Units: Compliance Test Results 94
Table 3-3. Existing Similar Thermal Units: Control Costs 98
Table 3-4. Carbon Bed Design Analysis 103
Table 3-5. Lone Tree Retort Control Costs 104

Figures

Figure 3-1. Retort Process Flow Diagram 88
Figure 3-2. Mercury Vapor Pressure Versus Temperature Curve 92
Figure 3-3. Lone Tree Exhaust Gas Treatment 103

3.0 NvMACT ANALYSIS - RETORT

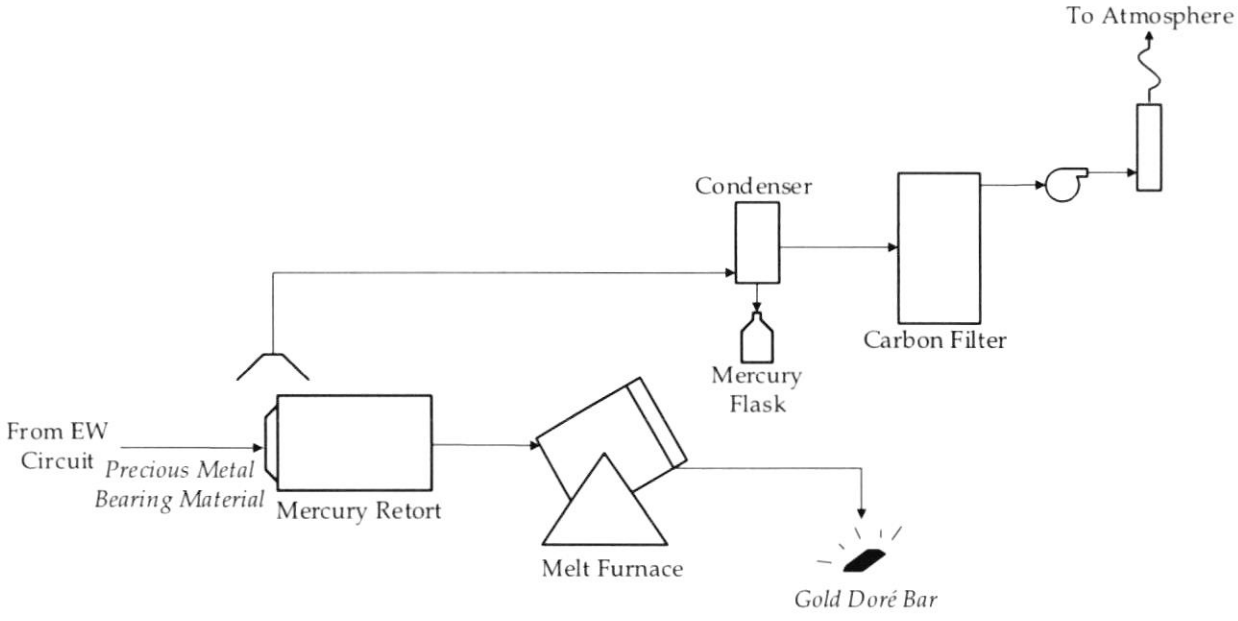
3.1 Introduction

Goldcorp DEE LLC (Goldcorp) proposes to install and operate a mercury retort (retort) at the Lone Tree Mine (Lone Tree). Per Nevada Administrative Code (NAC) 445B.3681.6, a Nevada Maximum Achievable Control Technology (NvMACT) analysis is required for new thermal units that emit mercury, as a part of a Mercury Operating Permit to Construct (MOPTC) application. The NvMACT analysis provided herein addresses all the applicable requirements of NAC 445B.3681.6.

3.2 Process Description

A retort holds trays or pans of wet precious metal bearing material collected from the electrowinning circuit. In the retort, the wet precious metal bearing material is placed under a vacuum and heated for several hours to dry the material and to volatilize its mercury content. After retorting, the precious metal bearing material is mixed with fluxes and transferred to a melt furnace to produce doré bars. The proposed retort at Lone Tree will be electrically heated. The retort exhaust stream will be routed through a condenser and carbon bed before being released to the atmosphere. See Figure 3-1 for a process flow diagram.

Figure 3-1. Retort Process Flow Diagram



3.3 NvMACT Analysis

3.3.1 Part I – Existing Similar Thermal Units

Part I of the NvMACT analysis provides a list of similar existing thermal units used for precious metal refining and describes the controls and work practices used to reduce mercury emissions. All information required by NAC 445B.3681, as described below, is provided herein:

NAC 445B.3681 New or modified thermal unit that emits mercury: Contents of required application.

☒ *6.(b) Sets forth a list of similar thermal units that emit mercury which are used for precious metal mining that includes, without limitation:*

- ☒ *(1) Any methods or technologies to control mercury emissions which are associated with the thermal units that emit mercury;*
- ☒ *(2) The level of mercury emissions associated with each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(3) The design for each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(4) Costs associated with reductions of mercury emissions as a result of each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(5) Costs associated with energy for each method or technology to control mercury emissions from the thermal units that emit mercury; and*
- ☒ *(6) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal units that emit mercury.*

3.3.1.1 Mercury Controls

The Nevada Mercury Control Program (NMCP) permits for existing retorts were downloaded from the Nevada Division of Environmental Protection (NDEP) Public Document Search website to obtain a list of the existing retort mercury controls. This information is summarized in Table 3-1.

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits

Facility Name	Permit No.	Date	Source	Control1	Control2	Control3	Carbon (lb)	Stack Flow	Inlet Temp (F)	Limit (gr/dscf)	Limit Notes
Borealis Mining Company LLC	AP1041-2228	2/22/2013	Mercury Retort (TU4.002)	Mercury Condenser with Chiller (MC-001)	-	-	-	-	-	1.0E-04	-
			Carbon Regeneration Kiln (4.001)	-	Wet Scrubber (WS-001)	-	-	-	-	-	-
			Smelting Furnace (TU4.003)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	8,000	2,000 acfm	90	-	-
			Electrowinning Circuit (TU4.004)	-	-	-	-	-	-	-	-
			Pregnant Tank (TU4.005)	-	-	-	-	-	-	-	-
			Barren Tank (4.006)	-	-	-	-	-	-	-	-
Coeur Rochester, Inc	AP1044-2242	6/18/2021	Mercury Retort (TU4.002)	Mercury Condenser (CO-001)	Carbon Canister (CC-001)	Carbon Canister (CC--002)	400 (CC-001)	85 acfm	90	1.0E-04	Combined limit for TU4.002 and TU4.003
			Mercury Retort (TU4.003)				400 (CC-002)				
Florida Canyon Mining, Inc	AP1041-2256	2/1/2021	Mercury Retort 700 (TU4.004)	Mercury Condenser (CO-001)	Carbon Filter Columns with Sulfur-Impregnated Carbon (CF-001)	Carbon Filter Columns with Sulfur-Impregnated Carbon (CF-002)	225 (CF-001)	17 dscfm	100	1.0E-04	CF-001 and CF-002 operate in parallel
			Mercury Retort 500 (TU4.005)				225 (CF-002)			1.0E-04	
GRP Pan, LLC	AP1041-3302	8/17/2016	Mercury Retort - Throughput (TU4.002)	Mercury Condenser System	Carbon Filter System (CF-002)	-	2,400	80 acfm	120	1.0E-04	-
Hycroft Resources & Development, LLC	AP1041-2255	7/1/2021	Mercury Retort #1 (TU4.001)	Mercury Condenser (MC-001)	Sulfur-Impregnated Carbon Bed (CA-001)	-	550	25 dscfm	40	7.0E-04	-
			Mercury Retort #2 (TU4.003)	Mercury Condenser (MC-002)	Particulate Settling Chamber Demister	Sulfur-Impregnated Carbon Adsorption Bed (CA-003)	550 (CA-003)	25 dscfm	75	1.0E-04	-
			Mercury Retort #3 (TU4.004)	Mercury Condensers (MC-003) & (MC-004)	Mist Eliminator (AC-001) & Chiller (C-001)	Carbon Filter Columns (CF-004) & (CF-005)	100, each	35.5 dscfm	70	1.0E-04	Parallel carbon columns
			Mercury Retort #4 (TU4.005)	Mercury Condensers (MC-005) & (MC-006)	Mist Eliminator (AC-002) & Chiller (C-002)	Carbon Filter Columns (CF-006) & (CF-007)	100, each	35.5 dscfm	70	1.0E-04	Parallel carbon columns
			Mercury Retort #5 (TU4.006)	Mercury Condensers (MC-007) & (MC-008)	Mist Eliminator (AC-003)& Chiller (C-003)	Carbon Filter Columns (CF-008) & (CF-009)	100, each	35.5 dscfm	70	1.0E-04	Parallel carbon columns
Jerritt Canyon Gold LLC	AP1041-2217	7/13/2022	Mercury Retort (TU4.008)	Chilled Condenser System (C-001)	Carbon Pot (MS-006)	Static HEPA Filter	13,200	4,248 dscfm	250	1.0E-04	-
			Induction Furnace (TU4.009)	-	-	Sulfur-Impregnated Carbon Bed (SIC-001)	-	-	-	-	-
KG Mining (Bald Mountain) Inc	AP1041-3927	7/15/2021	Retort (TU4.005)	Condenser (CO-002)	Carbon Filter (CF-003)	-	850	50 dscfm	200	1.0E-04	-
Klondex Aurora Mine, Inc	AP1041-2248	5/29/2019	Mercury Retort #1 (TU4.004)	Mercury Condenser (MC-001)	-	-	-	-	-	-	-
			Mercury Retort #2 (TU4.005)	-	-	-	-	-	-	-	-
			Pregnant Tank (TU4.002)	-	Carbon Deep Bed Scrubber (CA-001)	-	5,500	1,071 dscfm	190	1.0E-04	Combined limit for System 01B (TU4.004, TU4.005, TU4.002, TU4.003, and TU4.006)
			Barren Tank (4.003)	-	-	-	-	-	-	-	-
			Electrowinning Cell (TU4.006)	-	-	-	-	-	-	-	-
Klondex Midas Operations - Ken Snyder Mine	AP1041-2253	5/6/2019	Mercury Retort A (TU4.003)	Cooling Jackets and Condenser (CO-001)	Chiller (CH-001) After Cooler (AC-001)	Carbon Columns (CC-001)	161	40 acfm	75	5.0E-03	-
			Mercury Retort Furnace (TU4.005)	Mercury Condensers (MC-003) & (MC-004)	Chiller (CH-001) & Mist Eliminator (AC-001	Carbon Filter Columns (CF-004) & (CF-005)	100, each	30 dscfm	100	5.0E-03	Parallel carbon columns
Marigold Mining Company	AP1041-2254	1/27/2022	Mercury Retort (TU4.002)	Mercury Condenser (CO-001)	-	-	-	-	-	-	-
			Tilting Crucible Furnace (TU4.003)	-	-	-	-	-	-	-	-
			Electrowinning Cells (2 Cells) (TU4.004)	-	Carbon Adsorption Unit (CA-002)	-	5,000	3,000 dscfm	95	5.0E-03	Combined limit for TU4.002 and TU4.004 - TU4.006 or TU4.003 and TU4.004 - TU4.006
			Pregnant Tank (TU4.005)	-	-	-	-	-	-	-	-
			Barren Tank (TU4.006)	-	-	-	-	-	-	-	-
McEwen Mining, Inc	AP1041-3801	9/24/2020	Mercury Retort (Electric) (TU4.006)	Condenser (MC-001) (With aftercooler)	Carbon Filter (CF-002)	-	200	28 dscfm	85	1.0E-04	-
Nevada Gold Mines, LLC - Cortez	AP1041-2220	2/1/2021	Retort #1 (TU4.010)	Mercury Condenser System (MC-001)	-	-	-	-	-	1.0E-04	-
			Retort #2 (TU4.011)	-	-	Sulfur-Impregnated Carbon Adsorption Bed (CA-001)	3,300	3,205 dscfm	110	1.0E-04	-
			Refinery Induction Furnace #1 (TU4.003)	-	Baghouse (BH-001)	-	-	-	-	-	-
			Refinery Induction Furnace #2 (TU4.004)	-	-	-	-	-	-	-	-
Nevada Gold Mines LLC - Gold Quarry Operations	AP1041-2219	4/23/2025	Mercury Retort 100 (TU4.029)	Mercury Condenser (MC-001) & (MC-002)	Mist Eliminator (AC-001)	Sulfur-Impregnated Carbon Filters (CF-006) & (CF	100, each	31.2 dscfm	125	1.0E-04	Parallel carbon filters
			Mercury Retort 200 (TU4.030)	Mercury Condenser (MC-003) & (MC-004)	Mist Eliminator (AC-002)	Sulfur-Impregnated Carbon Filters (CF-008) & (CF	100, each	31.2 dscfm	125	1.0E-04	Parallel carbon filters
			Mercury Retort 300 (TU4.031)	Mercury Condenser (MC-005) & (MC-006)	Mist Eliminator (AC-003)	Sulfur-Impregnated Carbon Filters (CF-010) & (CF	100, each	31.2 dscfm	125	1.0E-04	Parallel carbon filters
Nevada Gold Mines LLC - Goldstrike Mine	AP1041-2221	5/5/2025	Mercury Retort #1 (TU4.019)	Chilled Contact Condenser System	SO2 Scrubber	Carbon Filter (CA-003)	2,400	400 dscfm	180	1.0E-04	-
			Mercury Retort #2 (TU4.020)							1.0E-04	-
			Mercury Retort #3 (TU4.021)							1.0E-04	-
			Mercury Retort #4 (TU4.025)							1.0E-04	-
Nevada Gold Mines LLC - Twin Creeks Mine	AP1041-2218	11/14/2023	Juniper Mercury Retort A (TU4.004)	Mercury Condenser (MC-001) & (MC-002)	Mist Eliminator (AC-001)	Carbon Filters (CF-001) & (CF-002) Carbon Bed (CF-014)	206, each 4,263 (CF-014)	100 dscfm	160	1.0E-04	Parallel carbon filters
			Juniper Mercury Retort B (TU4.005)	Mercury Condenser (MC-003) & (MC-004)	Mist Eliminator (AC-002)	Carbon Filters (CF-003) & (CF-004) Carbon Bed (CF-015)	206, each 4,263 (CF-015)	100 dscfm	160	1.0E-04	Parallel carbon filters
Newmont Mining Corporation, Phoenix Mine	AP1041-2247	8/13/2018	Electric Mercury Retort (TU4.002)	Chiller (CH-001)	Two Stage Mercury Condenser (MC-001)	Sulfur Impregnated Carbon Adsorption Column (CA-001)	90	9 dscfm	100	2.9E-03	-
Rawhide Mining, LLC	AP1041-2245	12/21/2021	Mercury Retort (S2.004) (TU4.004)	Mercury Condensers (CO-003)	Carbon Filter (CF-003)	-	388	35 dscfm	145	1.0E-04	-
Round Mountain Gold Corporation - Smoky Valley Mine	AP1041-2250	3/7/2024	Retort (TU4.010)	Mercury Condenser with chiller (MC-002)	Carbon Deep Bed Scrubber (CA-005)	-	200	16 dscfm	150	1.15E-04	-
			Retort (TU4.013)	Mercury Condenser with chiller (MC-003)	Carbon Deep Bed Scrubber (CA-008)	-	100	23 dscfm	100	1.0E-04	-
Walker Lane Minerals Corporation	AP1041-3895	11/17/2017	Mercury Retort (TU4.004)	Condenser (CO-001)	-	-	-	-	-	1.0E-04	-
			Pregnant Tank (TU4.001)	-	-	-	-	-	-	-	-
			Barren Tank (TU4.002)	-	-	Deep Bed Carbon Scrubber (DBCS-001)	5,000	2,760 dscfm	140	-	-
			Electrowinning Cells (TU4.003)	-	-	-	-	-	-	-	-
			Carbon Regeneration Kiln (4.005)	-	Wet Scrubber (WS-001)	-	-	-	-	-	-
WK Allied Hasbrouck, LLC Three Hills Mine Project	AP1041-3669	6/25/2019	Retort (Electric) (TU4.001)	Mercury Condenser (MC-001) & (MC-002)	Mist Eliminator (AC-001)	Carbon Filter Columns (CF-001) & (CF-002)	30, each	37 dscfm	90	1.0E-04	-

As shown in Table 3-1, the mercury controls installed for retorts include condensers followed by carbon adsorbers.

3.3.1.1.1 Condensers

As shown in Table 3-1, all the existing retorts employ a condenser as the primary mercury control technology. For these retorts, the vaporized mercury in the retort exhaust stream passes through a condenser, which cools the gas and causes the mercury to condense. The condensed mercury is then bled from the condenser into a collection vessel. The species of mercury collected from the condensers at precious metal mining, processing, and refining facilities in Nevada is elemental.

The two most common types of condensers are surface and contact condensers. Surface condensers cool gas streams by circulating water (or other cooling medium) through an enclosed water jacket surrounding the exhaust system or through a shell-and-tube type heat exchanger. Contact condensers cool gas streams by spraying cooled water into the gas stream. The following correlation exists for both types of condensers: the colder the circulating water, the colder the exhaust gas, and, for a constant inlet loading of mercury, the more efficient the removal of mercury from the gas stream (EPA 2002).

3.3.1.1.2 Carbon Adsorption

Carbon adsorption filters use activated carbon particles to adsorb mercury from the gas stream. Adsorption occurs when gas molecules are passed through a bed of solid particles (activated carbon). The gas molecules migrate from the gas stream to the surface of the solids, where they are held by physical attraction (EPA 2002). Carbon impregnated with elemental sulfur increases the adsorption efficiency due to the sulfur–mercury reaction that forms mercury sulfide, a stable mercury compound with a low vapor pressure (Booz et al. 2001).

Carbon filters control all types of mercury: particulate-bound, oxidized, and elemental. The mercury in the gas stream is adsorbed to the carbon and collected as carbon loaded with mercury. Once the carbon reaches adsorptive capacity, it is replaced, and the spent carbon is reclaimed. The carbon filter's mercury content is monitored to ensure that the mercury loading does not exceed the value recommended by the manufacturer. The typical carbon loading capacity is approximately 20 percent (or more) mercury by weight (SION n.d.) (Klett et al. 2002). Carbon mercury loading can be monitored directly, or the mercury concentration in the exhaust at the outlet of the carbon filter can be monitored to ensure the effectiveness of the carbon adsorber.

Some factors that can affect carbon filter adsorption efficiency include residence time of the gas in the carbon filter, carbon particle size, and exhaust stream moisture content. Longer residence times and smaller carbon particle sizes increase the mercury removal efficiency of the carbon filter (Booz et al. 2001). According to Scotia International of Nevada (SION), *"Some moisture in the gas stream, and therefore in the carbon, catalyzes the mercury removal reaction. It is anticipated that as long as no free water is being released from the carbon, the moisture maximum would be 45%. Release of moisture from the carbon, would indicate that the gas stream is condensing within the carbon, which*

has the potential to inhibit the mercury removal reaction. The carbon is delivered with a nominal moisture of 5% (this value can vary by the ambient humidity of the area of usage)" (SION 2021).

In short, mercury removal may be inhibited when carbon is physically wet with water (where moisture exceeds 45 percent).

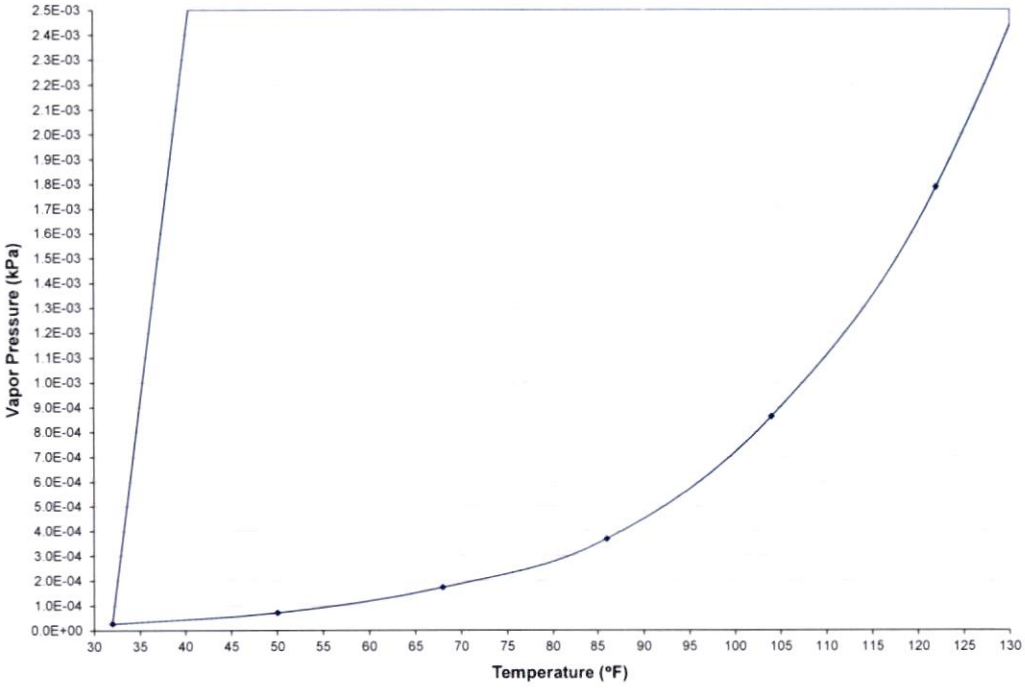
3.3.1.1.3 Work Practices

In addition to the controls listed in Table 3-1, most of the precious metal mining facilities in Nevada incorporate several different work practices into their processes to reduce mercury emissions. These work practices include inspecting the exhaust capture system, monitoring the condenser temperature, and replacing the carbon prior to exceeding the recommended mercury loading levels.

A retort is placed under a vacuum during heating, which ensures that 100 percent of the off-gas is routed through the mercury control units on the retort. The mercury that is condensed in the condenser is collected as a co-product. With surface condensers, the mercury is bled from the system directly into a collection vessel. With contact condensers, the mercury is separated from the process water with a mercury trap, where the mercury, which is heavier than water and immiscible in water, settles to the bottom of the trap and is collected.

The condenser efficiency can be increased by circulating chilled water. The chilled circulating water reduces the temperature of the off-gas and causes increased condensation of mercury from the gas stream. This relationship is determined by the mercury saturation pressure curve, which is shown in Figure 3-2.

Figure 3-2. Mercury Vapor Pressure Versus Temperature Curve[1]



[1] (Taylor and Francis Group 2005)

To ensure sufficient control efficiency by a carbon filter, the carbon filter media is replaced prior to exceeding maximum mercury loading as recommended by the manufacturer. This can be accomplished by:

- replacing the carbon on a schedule that ensures the recommended mercury loading is not exceeded, based on worst-case mercury loading data;
- monitoring the loading of mercury on the carbon directly by carbon analyses;
- monitoring the mercury levels in the exhaust from the carbon filter; or
- a combination of the above work/monitoring practices.

Due to the fact that retorting is itself a method to reduce or eliminate mercury emissions from downstream processes (e.g., the melting furnace), there are no measures that reduce the volume of mercury emissions from the retort through process changes or substitution of materials.

3.3.1.2 Mercury Emissions

NMCP permits for existing retorts were downloaded from the NDEP Public Document Search website to obtain a list of the existing mercury emission limits. This information is summarized in Table 3-1 of Section 3.3.1.1. The NvMACT emission limits range from the General Industry NvMACT limit for retorts of 1.0E-04 grains per dry standard cubic foot (gr/dscf) to the True-Up/True-Down (TUTD) interim limit of 5.0E-03 gr/dscf (NDEP 2016).

NMCP compliance tests for existing retorts were downloaded from the NDEP Public Document Search website to obtain the actual mercury emissions data for retorts utilizing NvMACT controls. This information is summarized in Table 3-2 for years 2018 through 2025. As shown in Table 3-2, all stack test results are below the TUTD interim limit of 5.0E-03 gr/dscf and many of the stack test results are also below the General Industry NvMACT limit for retorts of 1.0E-04 gr/dscf.

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Borealis Mining Company LLC	Mercury Retort (TU4.002)	10/16/2018	7.28E-07	1.0E-04	2.21E-06	354	455	72.5
	Mercury Retort (TU4.002)	6/11/2019	5.10E-06	1.0E-04	1.93E-05	437	594	92.4
	Mercury Retort (TU4.002)	8/11/2020	1.48E-06	1.0E-04	6.34E-06	500	668	73.2
	Mercury Retort (TU4.002)	8/31/2021	5.52E-06	1.0E-04	1.46E-05	309	435	96.8
	Mercury Retort (TU4.002)	10/18/2022	1.90E-06	1.0E-04	8.40E-06	516	679	73.8
	Mercury Retort (TU4.002)	8/2/2023	8.00E-06	1.0E-04	3.40E-05	499	677	82.6
	Mercury Retort (TU4.002)	10/22/2024	1.88E-06	1.0E-04	5.40E-06	338	455	81.8
Coeur Rochester, Inc.	Mercury Retort (TU4.002) Mercury Retort (TU4.003)	2/13/2018	2.55E-05	1.0E-04	1.35E-05	62	78	59.1
	Mercury Retort (TU4.002) Mercury Retort (TU4.003)	2/19/2019	3.43E-05	1.0E-04	1.93E-05	65	83	45.4
	Mercury Retort (TU4.002) Mercury Retort (TU4.003)	2/18/2020	2.62E-05	1.0E-04	1.44E-05	64	84	58.4
	Mercury Retort (TU4.002) Mercury Retort (TU4.003)	3/9/2023	2.74E-03	1.0E-04	1.80E-03	77	97	56.9
Florida Canyon Mining, Inc.	Mercury Retort 700 (TU4.004)	10/8/2018	1.30E-05	1.0E-04	2.50E-06	22	28	69.4
	Mercury Retort 500 (TU4.005)	10/11/2018	1.42E-06	1.0E-04	2.06E-07	17	20	50.4
	Mercury Retort 700 (TU4.004)	12/14/2020	3.57E-05	1.0E-04	5.15E-06	17	20	61.6
	Mercury Retort 500 (TU4.005)	12/15/2020	3.55E-06	1.0E-04	6.27E-07	21	24	48.4
	Mercury Retort 700 (TU4.004)	4/6/2021	2.38E-05	1.0E-04	3.91E-06	19	24	82.6
	Mercury Retort 500 (TU4.005)	4/7/2021	1.49E-05	1.0E-04	2.52E-06	20	25	77.6
	Mercury Retort 500 (TU4.005)	1/19/2022	3.98E-04	1.0E-04	1.19E-04	33	not available	72.1
	Mercury Retort 700 (TU4.004)	1/20/2022	1.31E-04	1.0E-04	3.61E-05	32	not available	55.4
	Mercury Retort 500 (TU4.005)	7/18/2022	9.28E-04	1.0E-04	1.51E-04	19	not available	88.0
	Mercury Retort 700 (TU4.004)	7/20/2022	3.45E-04	1.0E-04	7.53E-05	26	not available	89.5
	Mercury Retort 500 (TU4.005)	11/16/2022	2.77E-07	1.0E-04	5.54E-08	23	27	64.4
	Mercury Retort 700 (TU4.004)	11/18/2022	1.69E-07	1.0E-04	3.39E-08	23	27	52.8
	Mercury Retort 500 (TU4.005)	5/16/2023	2.54E-04	1.0E-04	4.74E-05	22	26	83.2
	Mercury Retort 700 (TU4.004)	1/30/2024	7.56E-07	1.0E-04	3.00E-06	453	557	86.3
	Mercury Retort 500 (TU4.005)	6/25/2024	8.20E-07	1.0E-04	3.00E-06	439	592	123.0
GRP Pan, LLC	Mercury Retort - Throughput (TU4.002)	11/14/2017	3.03E-05	1.0E-04	3.34E-06	13	16	44.0
	Mercury Retort - Throughput (TU4.002)	12/18/2018	1.47E-07	1.0E-04	1.18E-08	9	11	47.8
	Mercury Retort - Throughput (TU4.002)	11/18/2019	2.00E-06	1.0E-04	1.30E-07	8	9	50.3
	Mercury Retort - Throughput (TU4.002)	11/10/2020	3.80E-05	1.0E-04	3.60E-06	11	13	42.1
	Mercury Retort - Throughput (TU4.002)	12/13/2021	5.89E-07	1.0E-04	5.00E-08	10	not available	37.6
	Mercury Retort - Throughput (TU4.002)	11/14/2022	3.00E-07	1.0E-04	2.70E-08	10	12	37.0
	Mercury Retort - Throughput (TU4.002)	9/18/2023	7.64E-08	1.0E-04	9.59E-09	15	not available	70.4
	Mercury Retort - Throughput (TU4.002)	9/30/2024	4.36E-07	1.0E-04	7.78E-08	21	27	74.7
	Mercury Retort - Throughput (TU4.002)	10/20/2025	2.93E-07	1.0E-04	4.53E-08	18	not available	51.0
Hycroft Resources & Development, LLC	Mercury Retort #1 (TU4.001)	3/12/2019	3.07E-05	7.0E-04	7.84E-06	30	40	102.4
	Mercury Retort #2 (TU4.003)	6/26/2019	1.49E-06	1.0E-04	7.30E-07	57	82	108.1
	Mercury Retort #1 (TU4.001)	6/11/2020	2.87E-05	7.0E-04	not available	31	not available	112.9
	Mercury Retort #2 (TU4.003)	6/10/2020	3.22E-05	1.0E-04	not available	62	not available	105.0
	Mercury Retort #1 (TU4.001)	8/24/2021	2.23E-05	7.0E-04	6.82E-06	36	not available	100.4
		Shutdown in 2022						
Jerritt Canyon Gold LLC	Mercury Retort (TU4.008)	8/15/2018	3.20E-05	5.0E-05	7.98E-04	2,913	3,820	88.4
	Mercury Retort (TU4.008)	7/30/2019	1.39E-06	5.0E-05	2.94E-05	2,478	3,234	92.6
	Mercury Retort (TU4.008)	7/27/2020	4.37E-06	5.0E-05	1.27E-04	3,384	4,396	82.3
	Mercury Retort (TU4.008)	9/21/2020	2.50E-06	5.0E-05	6.56E-05	3,058	3,951	79.4
	Mercury Retort (TU4.008)	6/14/2021	4.80E-06	5.0E-05	not available	3,069	not available	85.7
	Mercury Retort (TU4.008)	6/20/2022	7.92E-07	1.0E-04	2.10E-05	3,097	not available	70.7
	Mercury Retort (TU4.008)	8/16/2023	7.93E-07	1.0E-04	not available	2,643	not available	94.4
Klondex Aurora Mine, Inc.	Mercury Retort #1 (TU4.004) Mercury Retort #2 (TU4.005) Pregnant Tank (TU4.002) Barren Tank (4.003) Electrowinning Cell (TU4.006)	9/26/2018	2.70E-07	1.0E-04	5.10E-06	2,169	3,384	138.0
	Mercury Retort #1 (TU4.004) Mercury Retort #2 (TU4.005) Pregnant Tank (TU4.002) Barren Tank (4.003) Electrowinning Cell (TU4.006)	10/2/2019	1.40E-06	1.0E-04	2.90E-05	2,421	3,434	86.9
		'Temporarily' stopped for economic reasons						
Klondex Midas Operations - Ken Snyder Mine	Mercury Retort A (TU4.003)	3/6/2018	1.95E-05	5.0E-03	7.29E-06	44	not available	58.7
	Mercury Retort Furnace (TU4.005)	3/7/2018	1.64E-05	5.0E-03	5.45E-06	38	not available	64.0
	Mercury Retort Furnace (TU4.005)	3/19/2019	3.09E-06	5.0E-03	1.10E-06	42	52	58.0
	Mercury Retort A (TU4.003)	9/10/2019	1.90E-06	5.0E-03	4.81E-07	30	37	76.0
	Mercury Retort Furnace (TU4.005)	9/11/2019	3.68E-06	5.0E-03	1.03E-06	33	41	65.9
	Mercury Retort Furnace (TU4.005)	'Temporarily' stopped for economic reasons						

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Marigold Mining Company	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	6/11/2019	8.80E-07	5.0E-03	3.64E-06	481	726	142.2
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/25/2020	2.20E-06	5.0E-03	5.90E-06	309	492	141.6
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/20/2021	2.20E-07	5.0E-03	4.40E-07	235	442	152.3
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/19/2022	7.60E-06	5.00E-03	1.90E-05	297	488	150.10
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/20/2022	3.30E-05	5.00E-03	3.50E-04	1,235	1863	154.90
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/21/2022	4.80E-06	5.00E-03	1.10E-05	262	473	156.80
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/11/2023	2.30E-03	5.00E-03	7.20E-03	378	543	135.60
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/11/2023	1.80E-03	5.00E-03	5.40E-03	370	529	135.50
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	5/14/2024	5.81E-06	5.00E-03	1.68E-05	330	465	125.15
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	9/10/2024	1.34E-06	5.00E-03	4.11E-06	358	462	145.56
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	6/3/2025	8.20E-06	5.00E-03	2.36E-05	339	547	153.10
	Mercury Retort (TU4.002) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/5/2025	2.10E-06	5.00E-03	6.29E-06	350	514	128.29
McEwen Mining, Inc.	Mercury Retort (Electric) (TU4.006)	4/21/2020	5.29E-06	5.0E-03	8.18E-07	18	26	126.9
	Mercury Retort (Electric) (TU4.006)	10/13/2020	4.93E-06	5.0E-03	7.10E-07	17	24	133.4
	Mercury Retort (Electric) (TU4.006)	11/9/2021	2.51E-06	5.0E-03	3.69E-07	17	26	160.9
	Mercury Retort (Electric) (TU4.006)	5/10/2022	2.30E-06	5.0E-03	3.50E-07	18	27	150.3
	Mercury Retort (Electric) (TU4.006)	11/29/2022	1.70E-06	5.0E-03	2.00E-07	14	21	148.6
	Mercury Retort (Electric) (TU4.006)	1/16/2024	1.21E-06	1.0E-04	4.43E-07	43	not available	153.4
	Mercury Retort (Electric) (TU4.006)	7/16/2024	2.03E-05	1.0E-04	5.42E-06	31	not available	194.2
	Mercury Retort (Electric) (TU4.006)	10/30/2024	1.35E-06	1.0E-04	5.82E-07	50	78	168.4
	Mercury Retort (Electric) (TU4.006)	6/10/2025	4.00E-06	1.0E-04	1.19E-06	35	54	179.4
Nevada Gold Mines, LLC - Cortez	Retort #1 (TU4.010)	7/17/2018	7.46E-06	1.0E-04	1.17E-04	1,826	2,292	95.5
	Retort #2 (TU4.011)	7/24/2018	1.14E-06	1.0E-04	1.98E-05	2,035	2,573	95.6
	Retort #2 (TU4.011)	11/7/2018	5.70E-07	1.0E-04	9.12E-06	1,865	2,254	64.9
	Retort #1 (TU4.010)	8/29/2019	3.29E-06	1.0E-04	4.57E-05	1,622	not available	106.2
	Retort #2 (TU4.011)	8/20/2019	3.43E-05	1.0E-04	4.98E-04	1,694	not available	109.3
	Retort #1 (TU4.010)	8/18/2020	3.60E-06	1.0E-04	5.20E-05	1,653	2,125	101.7
	Retort #2 (TU4.011)	8/19/2020	3.20E-06	1.0E-04	4.50E-05	1,657	2,134	101.8
	Retort #1 (TU4.010)	8/30/2021	1.36E-06	1.0E-04	2.01E-05	1,720	2,125	100.0
	Retort #2 (TU4.011)	8/23/2021	1.15E-07	1.0E-04	1.67E-06	1,690	not available	101.3
	Retort #1 (TU4.010)	8/30/2022	1.95E-05	1.0E-04	2.91E-04	1,733	not available	102.1
	Retort #2 (TU4.011)	8/22/2022	4.15E-06	1.0E-03	6.42E-05	1,801	not available	97.9
	Retort #1 (TU4.010)	8/28/2023	9.00E-06	1.0E-04	1.90E-04	2,490	2,995	93.2
	Retort #2 (TU4.011)	8/21/2023	3.80E-06	1.0E-04	8.40E-05	2,548	3,117	92.6
	Retort #1 (TU4.010)	8/27/2024	1.68E-06	1.0E-04	2.80E-05	1,999	2,498	87.1
	Retort #2 (TU4.011)	8/26/2024	2.02E-06	1.0E-04	3.40E-05	1,973	2,379	68.5
	Retort #1 (TU4.010)	11/20/2025	8.81E-07	1.0E-04	1.93E-05	2,566	3,102	64.1
	Retort #2 (TU4.011)	11/18/2025	5.71E-07	1.0E-04	1.23E-05	2,529	3,155	70.2

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Nevada Gold Mines LLC - Gold Quarry Operations	Mercury Retort 100 (TU4.029)	9/23/2019	4.89E-07	1.0E-04	4.81E-08	11	14	73.5
	Mercury Retort 200 (TU4.030)	9/23/2019	7.96E-07	1.0E-04	1.10E-07	16	21	81.4
	Mercury Retort 300 (TU4.031)	9/25/2019	1.55E-06	1.0E-04	1.89E-07	14	18	77.9
	Mercury Retort 100 (TU4.029)	9/14/2020	3.56E-07	1.0E-04	4.96E-08	16	21	87.0
	Mercury Retort 200 (TU4.030)	9/16/2020	9.35E-07	1.0E-04	6.35E-08	8	10	87.6
	Mercury Retort 300 (TU4.031)	9/14/2020	5.23E-07	1.0E-04	1.07E-07	24	31	90.2
	Mercury Retort 100 (TU4.029)	9/20/2021	9.94E-07	1.0E-04	8.13E-08	10	not available	651.9
	Mercury Retort 200 (TU4.030)	9/15/2021	4.46E-07	1.0E-04	3.44E-08	9	not available	655.0
	Mercury Retort 300 (TU4.031)	9/22/2021	2.39E-07	1.0E-04	4.05E-08	20	not available	82.3
	Mercury Retort 100 (TU4.029)	10/17/2022	3.06E-07	1.0E-04	3.34E-08	13	16	73.9
	Mercury Retort 200 (TU4.030)	10/19/2022	1.14E-04	1.0E-04	8.35E-06	8	10	75.1
	Mercury Retort 300 (TU4.031)	10/26/2022	6.04E-07	1.0E-04	7.13E-08	14	16.9	64.6
	Mercury Retort 200 (TU4.030)	1/11/2023	5.66E-05	1.0E-04	7.63E-06	15	18	52.8
	Mercury Retort 100 (TU4.029)	10/9/2023	7.15E-07	1.0E-04	8.25E-08	13	not available	66.5
	Mercury Retort 300 (TU4.031)	10/16/2023	5.78E-07	1.0E-04	8.49E-08	17	not available	68.0
	Mercury Retort 100 (TU4.029)	10/7/2024	2.06E-06	1.0E-04	2.26E-07	13	not available	83.2
	Mercury Retort 200 (TU4.030)	10/10/2024	8.60E-07	1.0E-04	1.37E-07	19	not available	83.4
	Mercury Retort 300 (TU4.031)	10/8/2024	1.17E-06	1.0E-04	1.18E-07	12	not available	80.0
Nevada Gold Mines LLC - Goldstrike Mine	Mercury Retort #1 (TU4.019)	5/15/2018	1.32E-06	1.0E-04	1.66E-06	57	70	65.2
	Mercury Retort #2 (TU4.020)	5/16/2018	9.11E-06	1.0E-04	1.10E-05	54	69	86.8
	Mercury Retort #3 (TU4.021)	5/17/2018	1.14E-05	1.0E-04	1.37E-05	54	69	74.3
	Mercury Retort #4 (TU4.025)	5/18/2018	5.28E-06	1.0E-04	6.21E-06	53	69	84.4
	Mercury Retort #1 (TU4.019)	7/12/2019	1.60E-05	1.0E-04	1.20E-05	89	119	112.2
	Mercury Retort #2 (TU4.020)	7/11/2019	1.48E-05	1.0E-04	1.17E-05	93	126	103.1
	Mercury Retort #3 (TU4.021)	7/13/2019	1.04E-05	1.0E-04	7.92E-06	90	118	108.0
	Mercury Retort #4 (TU4.025)	7/9/2019	1.52E-05	1.0E-04	1.49E-05	117	149	90.8
	Mercury Retort #1 (TU4.019)	8/11/2020	5.40E-06	1.0E-04	2.20E-06	48	62	90.2
	Mercury Retort #2 (TU4.020)	8/12/2020	3.60E-06	1.0E-04	1.50E-06	50	63	83.0
	Mercury Retort #3 (TU4.021)	8/13/2020	3.50E-06	1.0E-04	1.50E-06	50	65	86.3
	Mercury Retort #4 (TU4.025)	8/14/2020	1.70E-06	1.0E-04	7.20E-07	49	62	84.3
	Mercury Retort #1 (TU4.019)	10/19/2021	2.00E-07	1.0E-04	8.90E-08	51	63	62.4
	Mercury Retort #2 (TU4.020)	10/20/2021	4.60E-08	1.0E-04	1.80E-08	47	58	68.0
	Mercury Retort #3 (TU4.021)	10/21/2021	6.90E-08	1.0E-04	2.80E-08	47	59	74.4
	Mercury Retort #4 (TU4.025)	10/22/2021	9.50E-08	1.0E-04	4.00E-08	50	62	68.4
	Mercury Retort #1 (TU4.019)	9/17/2022	5.40E-06	1.0E-04	2.50E-06	54	68	83.7
	Mercury Retort #2 (TU4.020)	9/16/2022	2.10E-05	1.0E-04	9.20E-06	52	65	83.5
	Mercury Retort #3 (TU4.021)	9/15/2022	4.80E-06	1.0E-04	2.20E-06	54	66	70.8
	Mercury Retort #4 (TU4.025)	9/13/2022	5.20E-06	1.0E-04	2.40E-06	53	65	68.0
	Mercury Retort #1 (TU4.019)	9/12/2023	6.70E-06	1.0E-04	3.60E-06	64	80	76.6
	Mercury Retort #2 (TU4.020)	9/13/2023	6.30E-06	1.0E-04	3.20E-06	58	74	75.3
	Mercury Retort #3 (TU4.021)	9/14/2023	4.40E-06	1.0E-04	1.90E-06	48	62	69.7
	Mercury Retort #4 (TU4.025)	9/15/2023	4.40E-06	1.0E-04	1.80E-06	47	60	74.0
	Mercury Retort #1 (TU4.019)	6/10/2024	1.33E-06	1.0E-04	6.42E-07	56	73	90.5
	Mercury Retort #2 (TU4.020)	6/11/2024	1.25E-06	1.0E-04	1.11E-06	104	134	91.8
	Mercury Retort #3 (TU4.021)	6/12/2024	1.31E-06	1.0E-04	9.41E-07	84	110	94.5
	Mercury Retort #4 (TU4.025)	6/13/2024	1.32E-06	1.0E-04	9.30E-07	82	106	90.0
	Mercury Retort #1 (TU4.019)	7/21/2025	1.29E-06	1.0E-04	1.08E-05	976	1,290	99.4
	Mercury Retort #2 (TU4.020)	7/22/2025	9.32E-07	1.0E-04	2.60E-06	324	425	97.7
	Mercury Retort #3 (TU4.021)	7/23/2025	1.42E-06	1.0E-04	5.20E-06	428	559	97.1
	Mercury Retort #4 (TU4.025)	7/24/2025	1.12E-06	1.0E-04	2.73E-06	285	373	99.2
Nevada Gold Mines LLC - Twin Creeks Mine	Juniper Mercury Retort A (TU4.004)	5/7/2018	1.75E-04	1.0E-04	1.62E-05	11	14	81.3
	Juniper Mercury Retort B (TU4.005)	5/7/2018	1.25E-05	1.0E-04	1.19E-06	11	14	80.1
	Juniper Mercury Retort A (TU4.004)	9/25/2018	1.64E-05	1.0E-04	1.23E-06	9	12	90.3
	Juniper Mercury Retort A (TU4.004)	5/7/2019	4.53E-05	1.0E-04	5.56E-06	15	20	87.8
	Juniper Mercury Retort B (TU4.005)	5/7/2019	1.49E-03	1.0E-04	2.07E-04	16	21	80.8
	Juniper Mercury Retort B (TU4.005)	12/12/2019	4.50E-05	1.0E-04	6.40E-06	17	19	48.7
	Juniper Mercury Retort B (TU4.005)	10/26/2020	2.09E-04	1.0E-04	not available	12	not available	49.4
	Juniper Mercury Retort B (TU4.005)	12/29/2020	2.50E-04	1.0E-04	2.40E-05	11	14	79.4
	Juniper Mercury Retort A (TU4.004)	4/13/2021	8.23E-05	1.0E-04	1.37E-05	19	not available	63.1
	Juniper Mercury Retort B (TU4.005)	4/14/2021	9.48E-06	1.0E-04	1.78E-05	22	not available	75.6
	Juniper Mercury Retort A (TU4.004)	4/20/2022	3.84E-07	1.0E-04	not available	125	not available	52.0
	Juniper Mercury Retort B (TU4.005)	4/21/2022	2.95E-07	1.0E-04	not available	136	not available	42.3
	Juniper Mercury Retort A (TU4.004)	5/11/2023	4.70E-07	1.0E-04	4.90E-07	122	149	73.0
	Juniper Mercury Retort B (TU4.005)	5/18/2023	9.00E-07	1.0E-04	9.60E-07	126	156	79.8
	Juniper Mercury Retort B (TU4.005)	4/23/2024	4.38E-07	1.0E-04	4.48E-07	116	144	66.2
	Juniper Mercury Retort A (TU4.004)	5/13/2025	6.72E-06	1.0E-04	7.40E-06	128	153	54.8
	Juniper Mercury Retort B (TU4.005)	5/15/2025	1.86E-06	1.0E-04	2.00E-06	123	150	70.9
Newmont Mining Corporation, Phoenix Mine	Electric Mercury Retort (TU4.002)	5/15/2018	1.88E-05	5.0E-03	1.83E-06	11	14	75.9
	Electric Mercury Retort (TU4.002)	10/24/2018	9.87E-04	2.9E-03	5.48E-05	6	8	71.5
	Electric Mercury Retort (TU4.002)	2019+ tests are not available, MOPTC was 'cancelled'						
Rawhide Mining, LLC	Mercury Retort (S2.004) (TU4.004)	12/4/2018	1.70E-06	1.0E-04	5.18E-07	35	40	37.6
	Mercury Retort (S2.004) (TU4.004)	10/1/2019	9.38E-05	1.0E-04	2.59E-05	32	42	82.6
	Mercury Retort (S2.004) (TU4.004)	12/10/2020	1.33E-05	1.0E-04	3.20E-06	28	33	57.2
	Mercury Retort (S2.004) (TU4.004)	11/15/2021	1.70E-06	1.0E-04	3.50E-07	24	28	61.1
	Mercury Retort (S2.004) (TU4.004)	8/5/2022	1.51E-04	1.0E-04	not available	19	not available	78.2
	Mercury Retort (S2.004) (TU4.004)	8/15/2023	8.60E-06	1.0E-04	2.93E-05	42	not available	94.6
		Shutdown in 2023						

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Stack Temp. (F)
Round Mountain	Retort (TU4.010)	4/16/2018	3.67E-07	1.15E-04	2.81E-08	9	11	55.9
Gold Corporation -	Retort (TU4.010)	10/16/2018	3.40E-06	1.15E-04	3.00E-07	10	13	61.0
Smoky Valley Mine	Retort (TU4.010)	4/23/2019	4.90E-06	1.15E-04	3.70E-07	9	12	76.4
Common Operation	Retort (TU4.010)	5/12/2020	8.20E-07	1.15E-04	7.50E-08	11	14	70.0
	Retort (TU4.010)	8/6/2021	4.80E-07	1.15E-04	4.30E-08	11	14	71.3
	Retort (TU4.010)	9/29/2022	9.00E-06	1.15E-04	2.80E-06	36	48	65.1
	Retort (TU4.010)	9/24/2023	4.39E-05	1.15E-04	6.40E-06	17	21	78.8
	Retort (TU4.010)	11/29/2023	1.70E-05	1.15E-04	7.40E-06	50	62	53.0
	Retort (TU4.013)	11/29/2023	1.70E-05	1.0E-04	7.40E-06	65	80	57.7
	Retort (TU4.013)	2/6/2024	3.04E-06	1.0E-04	3.90E-06	147	not available	35.7
	Retort (TU4.010)	8/12/2024	3.76E-06	1.15E-04	1.40E-06	42	55	73.0
	Retort (TU4.013)	8/6/2024	2.90E-06	1.0E-04	1.30E-06	51	67	77.7
	Retort (TU4.010)	7/7/2025	9.68E-05	1.15E-04	2.90E-05	35	46	79.1
	Retort (TU4.013)	7/8/2025	2.60E-06	1.0E-04	1.10E-06	49	66	88.0
Walker Lane Minerals Corporation	Mercury Retort (TU4.004) Pregnant Tank (TU4.001) Barren Tank (TU4.002) Electrowinning Cells (TU4.003) Carbon Regeneration Kiln (4.005)	3/3/2020	3.48E-08	1.0E-04	4.67E-07	54	not available	108.3
	Mercury Retort (TU4.004) Pregnant Tank (TU4.001) Barren Tank (TU4.002) Electrowinning Cells (TU4.003) Carbon Regeneration Kiln (4.005)	4/26/2021	4.29E-07	1.0E-04	2.87E-06	844	not available	104.0
	Mercury Retort (TU4.004)	5/19/2022	7.79E-07	1.0E-04	6.73E-06	1,009	1,391	111.3

3.3.1.3 Mercury Control Costs

The cost of existing carbon filters and condensers listed in Table 3-1 were estimated in current dollars using technical documents from the EPA Clean Air Technology Center and economies of scale (for the condenser). These documents provide the capital costs, operational and maintenance (O&M) costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rates listed in Table 3-1, 30 scfm is typical for the exhaust flow of a single retort. The retort control costs for this typical flow rate are summarized in Table 3-3.

Table 3-3. Existing Similar Thermal Units: Control Costs

Control	Exhaust Flow (scfm)	Capital Cost ($)	O&M Cost ($/ yr)	Annualized Cost ($/ yr)
Condenser	30	5,500	2,300	3,100
Carbon Filter	30	5,000	not available	not available

(EPA 2003cs) (EPA 1999) (M.A.Tribe, R.L.W.Alpine 1985)
scfm = standard cubic feet per minute; yr = year

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements

The main non-air-quality health and environmental impact caused by mercury control technologies for retorts is the reclamation of the carbon loaded with mercury from carbon filters. Once the carbon reaches adsorptive capacity, it is replaced with fresh carbon and the loaded carbon is reclaimed. In addition, shipping the used carbon to a reclamation facility has non-air-quality health, environmental, and energy impacts. Also, the use of condensers and carbon filters would cause increased energy consumption due to the additional fan and pump power requirements and the energy required to cool the circulating water in the condenser.

3.3.2 Part II – Other Controls and/or Work Practices

Part II of the NvMACT analysis examines other control options and/or work practices not currently employed with the existing retorts described in Part I – Existing Similar Thermal Units.

3.3.2.1 Other Mercury Control Options

In addition to the mercury control technologies employed with existing retorts, the following mercury control options are examined below:

1. Boliden-Norzink Process
2. Activated Carbon Injection
3. Selenium Scrubber
4. Selenium Filter
5. Baghouse

3.3.2.1.1 Boliden-Norzink Process

In the Boliden-Norzink process, a mercuric chloride ($HgCl_2$) solution reacts with elemental mercury in the off-gas to form a mercurous chloride (HgCl) precipitate known as calomel, which then settles and is recovered. This reaction occurs in a packed column. Once the solid is removed, the wash solution can be recirculated. A portion of the precipitate can be used to regenerate the mercuric chloride solution using chlorine gas (Booz et al. 2001). The rest of the calomel is sent off-site for reclamation. The Boliden-Norzink process uses the following reaction:

$$HgCl_{2(sol'n)} + Hg_{(gas)} \rightarrow 2HgCl_{(solid)}$$

Boliden-Norzink scrubbers are installed on the Nevada Gold Mines LLC – Goldstrike (Goldstrike), Jerritt Canyon Gold, LLC (Jerritt Canyon), and Nevada Gold Mines LLC - Gold Quarry Operations (Gold Quarry) roasters. These roasters volatilize large amounts of mercury and in turn produce large amounts of mercury co-product in the form of calomel. The calomel production at Goldstrike, Jerritt Canyon, and Gold Quarry averages 195,340 pounds, 7,640 pounds, and 9,120 pounds, respectively (Barrick 2018).

A Boliden-Norzink scrubber has not been applied to any existing retorts at precious metal mining facilities in Nevada. There is no basis for assessing its performance in such an application, given the dissimilarities between the retort (and its characteristic emission stream) and the units/emission streams where Boliden-Norzink scrubbers have been applied. In addition, this technology requires a significant capital investment and produces wastewater (process water containing chloride ions) and solid waste (calomel). The capital costs of the Boliden-Norzink scrubbers installed at Goldstrike and Gold Quarry are $4.7 million and $3.2 million, respectively (Barrick 2018).

Based on the Boliden-Norzink process cost and environmental impacts, and the low amount of mercury emitted from retorts, Boliden-Norzink scrubbers are not representative of NvMACT for retorts.

3.3.2.1.2 Activated Carbon Injection

Activated carbon injection is similar to activated carbon filters in that activated carbon particles are used to adsorb mercury from the off-gas stream. In this process, the carbon particles are injected directly into the off-gas stream to adsorb mercury. They are then collected in downstream particulate controls, such as baghouses, wet scrubbers, or wet ESPs. Carbon injection is typically used in the power plant industry, where particulate control technologies have already been installed to clean fly-ash (and injected activated carbon) from the off-gas stream.

This process has not been applied to existing retorts at precious metal mining facilities in Nevada, and there is no basis for assessing its performance in such an application. In addition, the control efficiency of carbon injection is typically lower than that of carbon filters. Therefore,

the most appropriate activated carbon technology application for retorts is a carbon adsorption filter.

3.3.2.1.3 Selenium Scrubber

Selenium scrubbers use selenium or a selenium compound within a scrubber to react with elemental mercury in the off-gas to form mercuric selenide (HgSe). HgSe has a lower vapor pressure than other common mercury compounds, which allows for mercury capture. The HgSe is removed in a sludge separation circuit, which requires a thickener and HgSe reclamation. Sulfuric acid, at concentrations between 10 and 60 percent, is used as the wash solution for the process.

Selenium scrubbers are appropriate for gas streams with high mercury loading. The outlet concentrations from this process are typically higher than the concentrations achieved from the Boliden-Norzink process discussed in Section 3.3.2.1.1. Selenium scrubbers are not widely used due to their low removal efficiency and expensive reagent and reclamation requirements. Therefore, this option is not considered an effective mercury control method for retorts.

3.3.2.1.4 Selenium Filter

Selenium filters are similar to selenium scrubbers in that they use selenium to react with the elemental mercury in the off-gas stream to form mercuric selenide. Selenium filters use a selenium-impregnated porous carrier structure, housed in a cylindrical tower. The selenium filter's maximum operating temperature is approximately 250°F. The filters require a dry gas stream because moisture tends to degrade the filter media. The typical filter's carrying capacity is between 10 and 15 percent mercury by weight.

Selenium filters have been installed in only a few places in the world, and primarily in Sweden, and no operating data from these applications are available. Selenium filters are expensive to produce and to regenerate. There is no basis to believe that selenium filters would provide a better alternative to activated carbon filters. In addition, there is some concern that the selenium filters cause selenium air emissions. Therefore, this option is not considered an effective mercury control method for retorts.

3.3.2.1.5 Baghouse

Baghouses, also called fabric filters, collect particulates by passing the off-gas through filters where the particulates collect on the fabric surface. Baghouses control particulate mercury, but they do not control gaseous elemental mercury (Booz et al. 2001). Therefore, this option is not considered an effective mercury control method for retorts where the primary form of mercury emissions is elemental mercury.

3.3.2.2 Other Work Practices

All viable work practices for reducing mercury emissions have already been addressed in Part I – Existing Similar Thermal Units. Thus, there are no other work practices, process changes, or material substitutions that can be instituted to reduce mercury emissions from retorts.

3.3.3 Part III - Proposed NvMACT

Per NAC 445B.3681.6.(a), the applicant must propose "*standards, methods of control or other limitations to be applied to the thermal unit for the reduction of mercury emissions that the applicant deems sufficient for the Director to determine to be NvMACT for the thermal unit that emits mercury.*"

The NvMACT proposed in this section follows the criteria required by the Director pursuant to NAC 445B.3683. All items considered in this NvMACT analysis are checked in the criteria list provided below:

NAC 445B.3683 Review of and action on application for new or modified thermal unit that emits mercury.

☒ 2.*(b) Make a determination of NvMACT for the thermal unit that emits mercury in which the Director shall consider the following for each thermal unit that emits mercury:*

☒ *(1) The maximum degree of reduction of mercury emissions that is achievable for the thermal unit after considering:*

(I) The cost of achieving such a reduction; and

(II) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal unit that emits mercury to implement the NvMACT.

☒ *(2) The measures that reduce the volume or eliminate mercury emissions through process changes, substitution of materials or any other modifications.*

☒ *(3) The enclosure of systems or processes to eliminate mercury emissions.*

☒ *(4) The collection, capture or treatment of mercury emissions.*

☒ *(5) The design, equipment, work practice or operational standards of the thermal unit that emits mercury, including, without limitation, the requirements for training and certification of operators of the thermal unit that emits mercury.*

☒ *(6) The differences in the age, remaining operating life and configurations of similar thermal units that emit mercury. The Director may also consider the differences in the concentration of mercury in the ore, size and any other relevant factors of the similar thermal units that emit mercury.*

3.3.3.1 Proposed Controls and Work Practices

Based on the existing control technologies and work practices described in Part I and the additional control technology options described in Part II, Goldcorp proposes the following control equipment, work practices, and capture system as NvMACT for the proposed retort:

Control equipment:

- Condenser
- Carbon Bed

Work practices:

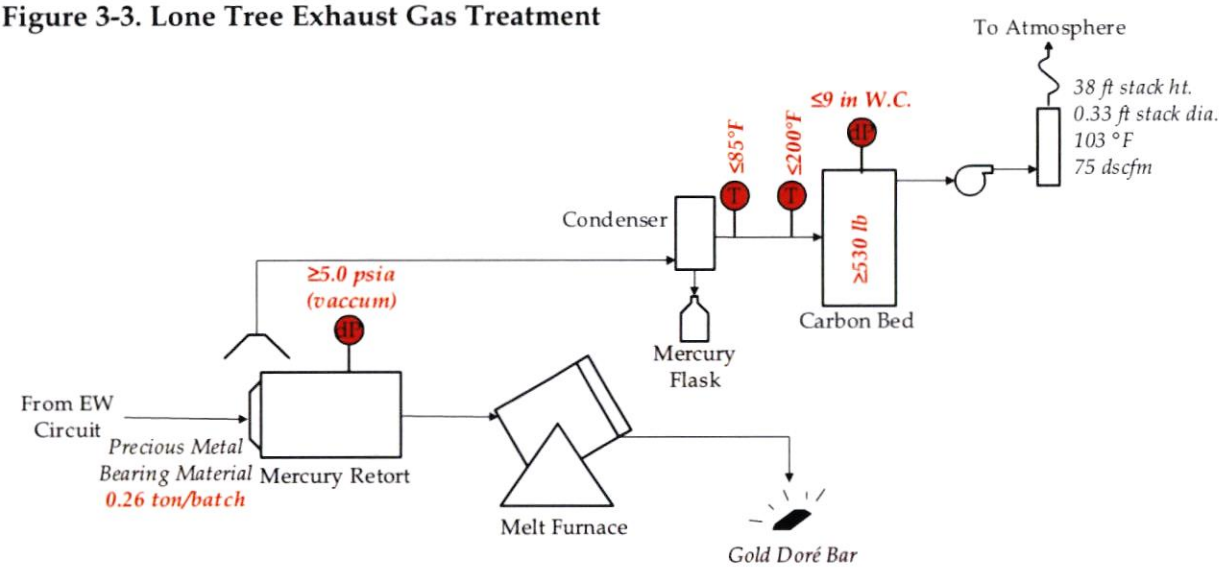
- During heating, the retort vacuum pressure will be maintained at or above 5 pounds per square inch absolute (psia).
- The retort will automatically shut off via interlock if the retort vacuum pressure is less than 5 psia.
- The exhaust temperature at the condenser outlet will be maintained at or below 85 degrees Fahrenheit (°F).
- The retort will automatically shut off via interlock if the condenser outlet exhaust temperature exceeds 105°F.
- Condensed mercury from the condensers will be collected monthly.
- The carbon bed will contain at least 530 pounds of sulfur-impregnated carbon.
- The gas temperature entering the carbon bed will not exceed 200°F.
- The differential pressure across the carbon bed will not exceed 9 inches of water column (in WC).
- The carbon in the carbon bed shall be monitored and replaced prior to exceeding 20 percent mercury by weight.

Capture system:

The exhaust from the retort will be pulled through the control system by a vacuum pump. This pump will create a negative pressure through the retort to ensure 100 percent capture of the exhaust gas.

A flow diagram of the proposed NvMACT mercury control system is provided in Figure 3-3.

Figure 3-3. Lone Tree Exhaust Gas Treatment



The proposed retort will be designed to process 0.26 tons of precious metal bearing material per batch. In the proposed control system, the exhaust from the retort first passes through a condenser to cool the exhaust stream and condense elemental mercury. The condenser circulating water is cooled by a chiller. The exhaust temperature exiting the condenser will be maintained at or below 85°F. Following the condenser, the exhaust stream will pass through a carbon bed for final mercury removal.

The carbon bed will hold 530 pounds of sulfur-impregnated carbon. The bed is designed for an exhaust flow rate of approximately 75 dry standard cubic feet per minute (dscfm) with a residence time of 14.1 seconds (Hatch 2025). The loading capacity of the carbon is 20 percent mercury by weight.

Table 3-4 provides the carbon bed design analysis using NDEP's NvMACT Specific Case-by-Case Worksheet for deep bed systems.

Table 3-4. Carbon Bed Design Analysis

Description	Calculated Value	[Unit]	Symbol	Equations
Volume of bed	**17.7**	ft^3	VB	VB=MC/CD
Total quantity of carbon	**530**	lbs	MC	Capacity of carbon bed
Carbon Hg capacity	**20**	%	CP	Scotia - 15% to 40%
Carbon density	**30**	lbs/ft^3	CD	NDEP default value
Velocity	**N/A**	ft/min	V	$V = Q/SA_{bed}$
Flow rate	**75**	DSCFM	Q	Exhaust flow rate
Mercury loading	**0.0083**	lb/hr	L	Calculated from saturated mercury concentration estimation
Residence time	**14.1**	sec	T	T=((MC/CD)/Q)*60
Pressure drop	**9**	in H_2O	ΔP	(Hatch 2025)
Hg saturation (hours)	**12,836**	hr	S_h	Sh=MC*(CP/100)*(1/L)
Permit hours per year	**8,760**	hr/yr	HY	
Hg saturation (years)	**1.47**	yr	S_y	$S_y=S_h/HY$

As shown by Table 3-4, the volume of carbon is sufficient to provide adequate residence time (≥1 second based on the dry standard flow rate) and the total weight of carbon is sufficient for the expected mercury loading rate (mercury saturation is approximately 1.5 years). Based on this analysis, the proposed retort control system meets NvMACT.

3.3.3.2 Proposed Mercury Emission Limit

As shown in Table 3-1 of Section 3.3.1.1, the NvMACT mercury emission limits for existing retorts range from the General Industry NvMACT limit of 1.0E-04 gr/dscf to the TUTD interim limit of 5.0E-03 gr/dscf. Goldcorp proposes the General Industry NvMACT Limit of 1.0E-04 gr/dscf for the proposed retort.

3.3.3.3 Cost of Controls

The cost of the proposed retort condenser and carbon bed were estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital costs, O&M costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rate of 75 dscfm, the estimated retort control costs are summarized in Table 3-5.

Table 3-5. Lone Tree Retort Control Costs

Control	Exhaust Flow (dscfm)	Capital Cost ($)	O&M Cost ($/ yr)	Annualized Cost ($/ yr)
Condenser	75	13,800	5,700	7,800
Carbon Bed	75	12,600	not available	not available

(EPA 2003cs) (EPA 1999) (M.A.Tribe, R.L.W.Alpine 1985)

REFERENCES

Barrick. 2018. "Barrick Goldstrike Mines Inc., MOPTC Phase II, AP1041-2221, Revised NvMACT Analysis and Application Forms, Roasters." Barrick Goldstrike Mines, Inc. (Barrick), September 19. Accessed August 25, 2021. DOC ID 19487 - https://documentviewerpublic.ndep.nv.gov/Common/login.aspx.

Booz et al. 2001. "Mercury Mass Balance and Emission Factor Estimates for Gold Ore Processing Facilities (Draft)." Report Prepared for U.S. EPA Region 9 by Booz Allen & Hamilton Inc., January 14.

EPA. 1999. "Technical Bulletin - Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA 456/F-99-004." United States Environmental Protection Agency (EPA), May.

—. 2002. "EPA Air Pollution Control Cost Manual, 6th Edition." EPA Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA/452/B-02-001, January.

—. 2003cs. "Air Pollution Control Technology Fact Sheet - Condensation Scrubber." *EPA-452/F-03-010.* United States Environmental Protection Agency (EPA). Accessed August 4, 2022. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1008OGF.PDF.

Hatch. 2025. "i-80 Gold Corp - Lone Tree Restart Permitting Inputs Sheet." *Document Number: H367753-0000-843-216-0001.* Hatch, November 7.

Klett et al. 2002. "The Cost of Mercury Removal in an IGCC Plant. Final Report." Michael G. Klett, Russell C. Maxwell, and Michael D. Rutkowski. Parsons Infrastructure and Technology Group Inc. Report prepared for The United States Department of Energy National Energy Technology Laboratory., September.

M.A.Tribe, R.L.W.Alpine. 1985. "SCALE ECONOMIES AND THE "'0.6 RULE"." *Engineering Costs and Production Economics.* Elsevier Science Publishers B.V., Amsterdam, September 23. Accessed August 23, 2022. https://www.sciencedirect.com/science/article/pii/0167188X86900534.

NDEP. 2016. "Nevada Mercury Control Program Permitting Guidance, General Industry NvMACT Determinations (Draft)." Nevada Division of Environmental Protection (NDEP), February 29.

SION. 2021. "Trip Report to Rawhide Mine to Review the Operation of Melting Furnace Mercury Scrubber." Scotia International of Nevada (SION), July 26.

—. n.d. "Coal Based Activated Carbon Impregnated with Sulfur." *Product Bulletin COL-IS 60.* Scotia International of Nevada, Inc. (SION).

Taylor and Francis Group. 2005. "CRC Handbook of Chemistry and Physics." 86th Edition.

NvMACT Analysis for the Furnace

FURNACE NVMACT ANALYSIS - TABLE OF CONTENTS

3.0 NvMACT Analysis - Furnace 109
3.1 Introduction 109
3.2 Process Description 109
3.3 NvMACT Analysis 110
3.3.1 Part I – Existing Similar Thermal Units 110
3.3.1.1 Mercury Controls 110
3.3.1.1.1 Baghouse 112
3.3.1.1.2 Wet Scrubber 113
3.3.1.1.3 Wet Electrostatic Precipitator 114
3.3.1.1.4 Carbon Adsorption 115
3.3.1.1.5 Work Practices 116
3.3.1.2 Mercury Emissions 116
3.3.1.3 Mercury Control Costs 121
3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements 121
3.3.2 Part II – Other Controls and/or Work Practices 121
3.3.2.1 Other Mercury Control Options 121
3.3.2.1.1 Boliden-Norzink Process 122
3.3.2.1.2 Activated Carbon Injection 122
3.3.2.1.3 Selenium Scrubber 123
3.3.2.1.4 Selenium Filter 123
3.3.2.1.5 Condenser 123
3.3.2.2 Other Work Practices 124
3.3.3 Part III - Proposed NvMACT 124
3.3.3.1 Proposed Controls and Work Practices 125
3.3.3.2 Proposed Mercury Emission Limit 127
3.3.3.3 Cost of Controls 127
References 128

Tables

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits 111

Table 3-2. Existing Similar Thermal Units: Compliance Test Results 117

Table 3-3. Existing Similar Thermal Units: Control Costs 121

Table 3-4. Carbon Bed Design Analysis 127

Table 3-5. Lone Tree Furnace Control Costs 127

Figures

Figure 3-1. Furnace Process Flow Diagram 109

Figure 3-2.Typical Pulse-Jet Baghouse 112

Figure 3-3. Typical Rectangular Throat Venturi Scrubber, Spray Tower Scrubber, and Plate Tower Scrubber 113

Figure 3-4. Typical Flat-Plate Modular Wet ESP 115

Figure 3-5. Mercury Saturation Pressure Curve 124

Figure 3-6. Lone Tree Exhaust Gas Treatment 126

3.0 NvMACT ANALYSIS - FURNACE

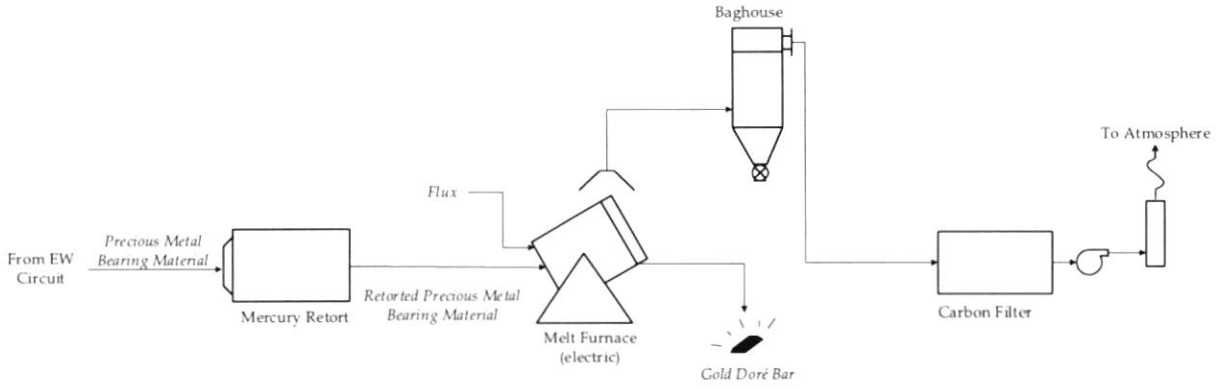
3.1 Introduction

Goldcorp DEE LLC (Goldcorp) proposes to install and operate a melt furnace (furnace) at the Lone Tree Mine (Lone Tree). Per Nevada Administrative Code (NAC) 445B.3681.6, a Nevada Maximum Achievable Control Technology (NvMACT) analysis is required for new thermal units that emit mercury, as a part of a Mercury Operating Permit to Construct (MOPTC) application. The NvMACT analysis provided herein addresses all the applicable requirements of NAC 445B.3681.6.

3.2 Process Description

As part of the refining process, retorted precious metal bearing material is mixed with fluxes and fed to the furnace for melting into doré bars. Impurities from the melt are skimmed off as slag. The proposed furnace at Lone Tree will be electrically heated. The exhaust stream from the furnace will be ducted through a baghouse, then through a carbon bed, before being released into the atmosphere. A process flow diagram is provided in Figure 3-1.

Figure 3-1. Furnace Process Flow Diagram



3.3 NvMACT Analysis

3.3.1 Part I – Existing Similar Thermal Units

Part I of the NvMACT analysis provides a list of similar existing thermal units used for precious metal refining and describes the controls and work practices used to reduce mercury emissions. All information required by NAC 445B.3681, as described below, is provided herein:

NAC 445B.3681 New or modified thermal unit that emits mercury: Contents of required application.

☒ *6.(b) Sets forth a list of similar thermal units that emit mercury which are used for precious metal mining that includes, without limitation:*

- ☒ *(1) Any methods or technologies to control mercury emissions which are associated with the thermal units that emit mercury;*
- ☒ *(2) The level of mercury emissions associated with each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(3) The design for each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(4) Costs associated with reductions of mercury emissions as a result of each method or technology to control mercury emissions from the thermal units that emit mercury;*
- ☒ *(5) Costs associated with energy for each method or technology to control mercury emissions from the thermal units that emit mercury; and*
- ☒ *(6) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal units that emit mercury.*

3.3.1.1 Mercury Controls

The Nevada Mercury Control Program (NMCP) permits for existing furnaces were downloaded from the Nevada Division of Environmental Protection (NDEP) Public Document Search website to obtain a list of the existing furnace mercury controls. This information is summarized in Table 3-1.

Table 3-1. Existing Similar Thermal Units: NvMACT Controls and Permitted Emissions Limits

Facility Name	Permit No.	Date	Source	Control1	Control2	Control3	Carbon (lb)	Stack Flow	Stack Temp	Limit (gr/dscf)	Limit Notes
Borealis Mining Company LLC	AP1041-2228	2/22/2013	Smelting Furnace (TU4.003)	Wet Scrubber (WS-001)						5.0E-05	
			Carbon Regeneration Kiln (TU4.001)							-	
			Mercury Retort (TU4.002)	Mercury Condenser (MC-001)	Deep Bed Carbon Scrubber (DBCS-001)		8,000	2,000 acfm	120	-	
			Electrowinning Circuit (TU4.004)	-						-	
			Pregnant Tank (TU4.005)	-						-	
			Barren Tank (TU4.006)	-						-	
Coeur Rochester, Inc.	AP1044-2242	6/18/2021	Reverberatory Furnace (TU4.001)	Wet ESP (WESP-01)	Carbon Filter System (CF-001)		5,888	9,600 dscfm	150	1.64E-04	
Florida Canyon Mining, Inc.	AP1041-2256	2/1/2021	Tilting Crucible Furnace (TU4.001)	Baghouse (BH-001)	Carbon Adsorption Vessel (DS-001)		26,500	10,000 acfm	120	1.0E-05	
GRP Pan, LLC	AP1041-3302	8/17/2016	Melt Furnace (TU4.003)	Baghouse (DC-001)	Carbon Filter (CF-003)		13,200	5,200 acfm	270	1.0E-05	
Hycroft Resources & Development, LLC	AP1041-2255	7/1/2021	Smelting Furnace #1 (TU4.002)	Baghouse (BH-001)	Sulfur Impregnated Carbon Bed (CA-002)		21,600	5,000 dscfm	80	1.0E-05	
			Smelting Furnace #2 (TU4.007)	Baghouse (BH-002)	Sulfur Impregnated Carbon Bed (CF-		14,400	8,965 dscfm	172	1.0E-05	
			Smelting Furnace #3 (TU4.008)	Baghouse (BH-003)	Sulfur Impregnated Carbon Filter (CF-011)		14,400	8,965 dscfm	172	1.0E-05	
Jerritt Canyon Gold LLC	AP1041-2217	7/13/2022	Induction Furnace (TU4.009)	Baghouse (BG-002)	-	Carbon Bed (SIC-001)	13,200	4,248 dscfm	130	1.0E-05	
			Mercury Retort (TU4.008)	-	Carbon Pot (MS-006)					-	
KG Mining (Bald Mountain) Inc.	AP1041-3927	7/15/2021	Induction Furnace (TU4.006)	Baghouse (BH-001)	Carbon Filter (CF-004)		16,000	5,000 dscfm	300	5.0E-03	
Klondex Aurora Mine, Inc.	AP1041-2248	5/29/2019	Dore Furnace (TU4.007)	Baghouse (BH-001)							Combined limit for TU4.002, TU4.003, TU4.006, and TU4.007
			Pregnant Tank (TU4.002)	-	Carbon Deep Bed Scrubber (CA-001)		5,500	1,071 dscfm	200	1.0E-05	
			Barren Tank (TU4.003)	-							
			Electrowinning Cells (TU4.006)	-							
Klondex Midas Operations - Ken Snyder Mine	AP1041-2253	5/6/2019	Refinery Furnace #1 (TU4.001)	Baghouse (BH-001)	Venturi Scrubber with Cyclone (WS-001)	Carbon Filters (CF-001, 2)	3,700 (CF-001) 1,550 (CF-002)	10,700 dscfm	120	5.0E-03 5.0E-03	
			Refinery Furnace #2 (TU4.002)								
Marigold Mining Company	AP1041-2254	1/27/2022	Tilting Crucible Furnace (TU4.003)	-							
			Electrowinning Cells (2 Cells) (TU4.004)	-							Combined limit for TU4.003 - TU4.006
			Pregnant Tank (TU4.005)	-	Carbon Adsorption Unit (CA-002)		5,000	3,000 dscfm	100	5.0E-03	
			Barren Tank (TU4.006)								
			Mercury Retort (TU4.002)	Mercury Condenser (CO-001)						-	-
McEwen Mining, Inc.	AP1041-3801	9/24/2020	Melting Furnace (Electric) (TU4.007)	Baghouse (BH-001)	Carbon Filter (CF-003)		11,200	2,569 dscfm	100	1.2E-04	
Nevada Gold Mines LLC - Cortez	AP1041-2220	2/1/2021	Induction Furnace #1 (TU4.003)	Baghouse (BH-001)						1.0E-05	Combined limit for TU4.003 and TU4.004
			Induction Furnace #2 (TU4.004)		Sulfur-Impregnated Carbon Adsorption Bed (CA-001)		3,300	3,205 dscfm	120		
			Retort #1 (TU4.010)	Mercury Condenser System (MC-001)						-	
			Retort #2 (TU4.011)							-	
Nevada Gold Mines LLC - Gold Quarry Operations	AP1041-2219	4/23/2025	Electric Induction Furnace (TU4.024)	Baghouse (BH-001)	Carbon Filter Pack (500-DC-012)		4,123	16,000 dscfm	90	6.3E-04	Combined limit for TU4.024 - TU4.026
			Electric Induction/Pour Furnace								
			Bar Melt Furnace (TU4.026)	-							
Nevada Gold Mines LLC - Goldstrike Mine	AP1041-2221	5/5/2025	East Melting Furnace (TU4.022)	Baghouse (BH-001)	Carbon Bed (CA-004)		6,600	9,100 dscfm	140	7.3E-04	Combined limit for TU4.022 - TU4.024
			West Melting Furnace (TU4.023)								
			Electrowinning Cells (TU4.024)								
Nevada Gold Mines LLC - Twin Creeks Mine	AP1041-2218	11/14/2023	Juniper Mill Furnace 1 (TU4.001)	Baghouse (DC-004)	Carbon Filter (CF-006)		4,500	15,625 dscfm	100	1.0E-05	
			Juniper Mill Furnace 2 (TU4.002)							1.0E-05	
Rawhide Mining, LLC	AP1041-2245	12/21/2021	Refinery Induction Furnace (TU4.003)	Baghouse (BH-001)	Carbon Filter (CF-004)		1,755	2,400 acfm	90	5.0E-03	
Round Mountain Gold Corporation - Smoky Valley Mine Common	AP1041-2250	3/7/2024	Electric Induction Furnace (TU4.005)	Baghouse (BH-002)	Carbon Deep Bed Scrubber (CA-002)		11,000	3,500 dscfm	300	1.0E-05	
			Smelting Furnace (TU4.011)	Baghouse (BH-001)	Carbon Deep Bed Scrubber (CA-006)		14,000	3,500 dscfm	150	1.05E-05	
WK-Allied Hasbrouck, LLC Three Hills Mine Project	AP1041-3669	6/25/2019	Smelting Furnace (TU4.002)	Venturi Scrubber (VS-001)						1.0E-05	
			Carbon Regeneration Kiln (TU4.003)	Venturi Scrubber (VS-002)						-	
			Electrowinning Cell #1 (TU4.004)	-	Carbon Bed Vapor Pac (CB-001)		18,000	7,650 dscfm	115	-	
			Electrowinning Cell #2 (TU4.005)	-						-	
			Eluant Tank (TU4.006)	-						-	
			Barren Solution Return Tank (TU4.007)	-						-	

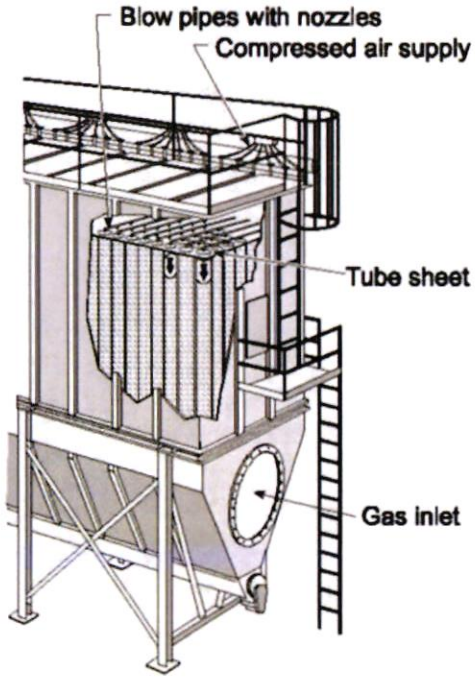
As shown in Table 3-1, the mercury controls installed for furnaces include baghouses, wet scrubbers, and/or wet electrostatic precipitators (ESPs) upstream of carbon filters.

3.3.1.1.1 Baghouse

Baghouses, also called fabric filters, have at least one isolated compartment that contains rows of fabric bags. Typically, the exhaust flows up along the surface of the bags, then flows radially through the fabric (EPA 2002). The particles in the gas stream collect on the upstream face of the bags. The layer of dust that collects on the fabric surface increases the particulate control efficiency of the bags because the dust forms a barrier with tortuous pores that trap particles as they travel through the dust layer (EPA 2002). Baghouses can handle exhaust temperatures up to approximately 500°F (EPA 2002).

Baghouses are cleaned periodically to remove the accumulated dust. Several cleaning mechanisms may be used to remove caked particles from the bags. The four most common are shaking, reverse-air, pulse-jet, and sonic. Baghouses installed on furnaces most commonly use the pulse-jet cleaning method, which uses a high-pressure jet of air (compressed-air-induced pulse) to remove dust from the bag (NCSU 1995). A diagram of a typical pulse-jet baghouse is provided in Figure 3-2.

Figure 3-2.Typical Pulse-Jet Baghouse



Off-gas is either pushed or pulled through the baghouse by a fan. When the gas is pushed through the baghouse, the collector is called a positive pressure baghouse. When the fan is downstream of the baghouse, the gas is pulled through the baghouse and the collector is called a negative pressure baghouse (NCSU 1995).

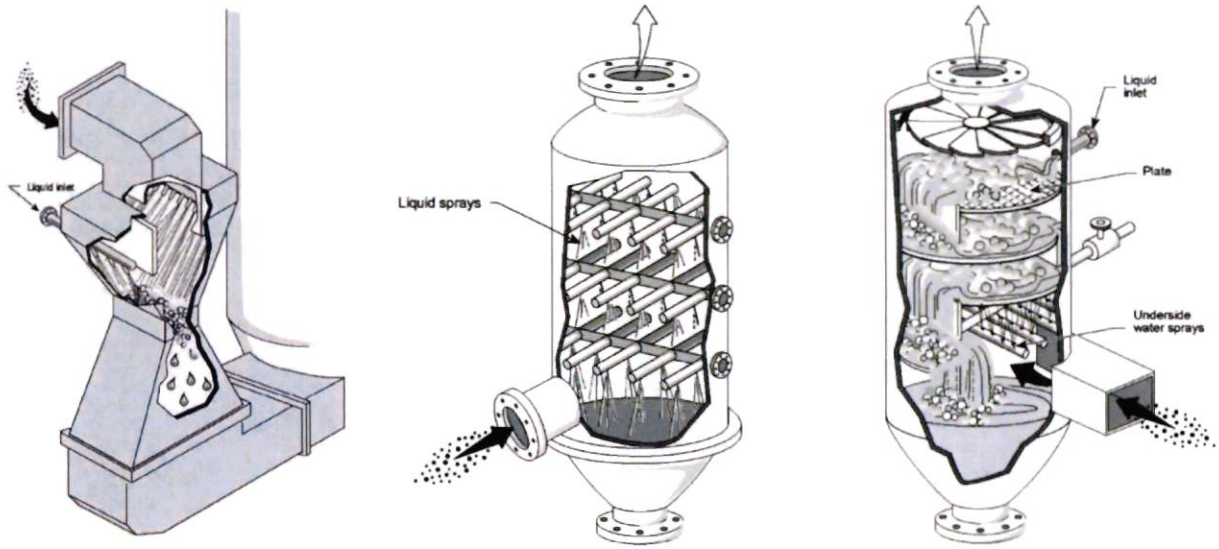
As the gas passes through the baghouse, there is a drop in pressure. Monitoring pressure drop provides a means of detecting changes in the operation of the baghouse that could lead to increased emissions. A pressure drop change can indicate insufficient cleaning cycles, damaged cleaning equipment, bag blinding, broken or loose bags, or sudden airflow changes.

An important design parameter for baghouses is the air-to-cloth ratio, which is the cubic feet per minute of gas penetrating one square foot of fabric (EPA 2002). Air-to-cloth ratios differ depending on baghouse type; however, in general, lower air-to-cloth ratios result in higher control efficiencies (NCSU 1995). Baghouses control particulate mercury, but they do not control elemental or oxidized mercury.

3.3.1.1.2 Wet Scrubber

Common types of wet scrubbers include venturi, spray tower, and impingement plate wet scrubbers. These wet scrubbers are shown in Figure 3-3.

Figure 3-3. Typical Rectangular Throat Venturi Scrubber, Spray Tower Scrubber, and Plate Tower Scrubber[1]



Wet scrubbers control particulates, including particulate mercury, through impaction, diffusion, interception, and/or adsorption of the pollutant onto droplets of liquid (EPA 2002). Wet scrubbers may control oxidized mercury (Rong Yan, et al. 2004), as this form of mercury is soluble in the scrubber water, as well as elemental mercury if the scrubber's exhaust temperature is below the mercury saturation temperature. However, for furnace exhausts, the concentration of mercury in the exhaust stream is too low for mercury condensation. See Section 3.3.2.1.5 for additional discussion regarding condensers for furnaces.

---

[1] (NCSU 1998b)

Venturi scrubbers use a converging-then-diverging flow channel, in which the cross-sectional area of the channel decreases, then increases, along the length of the channel. The narrowest area is called the throat. As the exhaust gas enters the venturi scrubber, the decrease in area causes the gas velocity and turbulence to increase. The scrubbing water is injected either slightly upstream of or directly into the throat. As the scrubbing solution is injected, the turbulence in the throat causes it to atomize, improving gas–liquid contact (EPA 2002). After passing through the throat, the gas-liquid mixture decelerates and causes additional particle-droplet impacts and droplet agglomeration. Before the gas exits the scrubber, the liquid droplets are separated from the gas in an entrainment section (EPA 2002).

As the gas passes through the venturi scrubber, there is a drop in pressure. For venturi scrubbers in general, the greater the pressure drop, the higher the particulate control efficiency. The liquid-to-gas ratio also affects venturi scrubber efficiency. Sufficient liquid must be injected into the scrubber to allow for coverage over the throat area and to create sufficient collection targets. After an optimal point, adding excess liquid to a scrubber does not increase the particulate control efficiency. The liquid-to-gas ratio for wet scrubbers typically ranges from 4 to 20 gallons per 1,000 actual cubic feet (NCSU 1998b).

Spray tower wet scrubbers are constructed very simply, consisting of empty cylindrical vessels made of steel or plastic and nozzles that spray liquid into the vessels. As shown in Figure 3-3, the exhaust stream enters at the bottom and flows upward, while liquid is sprayed downward from one or more levels (NCSU 1998b).

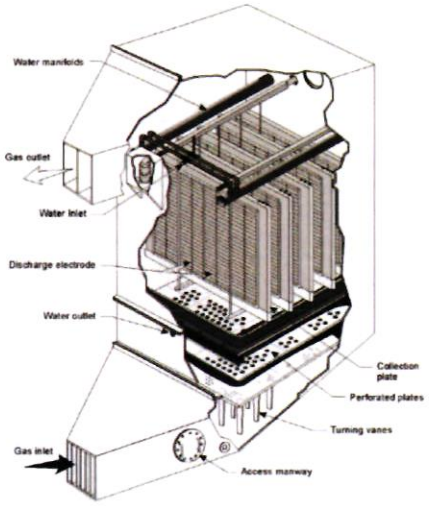
An impingement plate wet scrubber is a vertical column with one or more plates (trays) mounted horizontally inside. As shown in Figure 3-3, the exhaust stream enters at the bottom and flows upward, passing through openings in the plates. Liquid enters at the top of the tower, traveling across each plate to a downcomer, through which it reaches either the next plate below or the bottom of the tower. Pollutant collection occurs on each plate as the gas stream contacts and then atomizes the liquid flowing over each plate. Plate towers are very effective in removing gaseous pollutants (if soluble in the scrubbing solution) and can be used simultaneously for particle removal (NCSU 1998b).

3.3.1.1.3 Wet Electrostatic Precipitator

Wet ESPs use electrostatic charges to move particulates from a gas stream onto a collection surface. Electrodes maintained at a high voltage create the electric field. For typical wet ESPs, voltages are in the range of 20,000 to 100,000 volts (EPA 2002). Wet ESPs are operated at the highest voltage possible without excessive sparking.

Wash water is used to clean the particulates from the collection plates (Booz et al. 2001). Wet ESPs are designed for saturated gas streams and have a maximum operating temperature of 170 to 190°F. Wet ESPs effectively control particulates, including particulate mercury; however, they do not effectively control gaseous oxidized or elemental mercury (Booz et al. 2001). A diagram of a typical flat-plate modular wet ESP is provided as Figure 3-4.

Figure 3-4. Typical Flat-Plate Modular Wet ESP[2]



3.3.1.1.4 Carbon Adsorption

Carbon adsorption filters use activated carbon particles to adsorb mercury from the gas stream. Adsorption occurs when gas molecules are passed through a bed of solid particles (activated carbon). The gas molecules migrate from the gas stream to the surface of the solids, where they are held by physical attraction (EPA 2002). Carbon impregnated with elemental sulfur increases the adsorption efficiency due to the sulfur–mercury reaction that forms mercury sulfide, a stable mercury compound with a low vapor pressure (Booz et al. 2001).

Carbon filters control all types of mercury: particulate-bound, oxidized, and elemental. The mercury in the gas stream is adsorbed to the carbon and collected as carbon loaded with mercury. Once the carbon reaches adsorptive capacity, it is replaced, and the spent carbon is reclaimed. The carbon filter's mercury content is monitored to ensure that the mercury loading does not exceed the value recommended by the manufacturer. The typical carbon loading capacity is approximately 20 percent (or more) mercury by weight (SION n.d.) (Klett et al. 2002). Carbon mercury loading can be monitored directly, or the mercury concentration in the exhaust at the outlet of the carbon filter can be monitored to ensure the effectiveness of the carbon adsorber.

Some factors that can affect carbon filter adsorption efficiency include residence time of the gas in the carbon filter, carbon particle size, and exhaust stream moisture content. Longer residence times and smaller carbon particle sizes increase the mercury removal efficiency of the carbon filter (Booz et al. 2001). According to Scotia International of Nevada (SION), *"Some moisture in the gas stream, and therefore in the carbon, catalyzes the mercury removal reaction. It is anticipated that as long as no free water is being released from the carbon, the moisture maximum would be 45%. Release of moisture from the carbon, would indicate that the gas stream is condensing within the carbon, which has the potential to inhibit the mercury removal reaction. The carbon is delivered with a nominal moisture of 5% (this value can vary by the ambient humidity of the area of usage)"* (SION 2021).

---

[2] (NCSU 1998a)

In short, mercury removal may be inhibited when carbon is physically wet with water (where moisture exceeds 45 percent).

3.3.1.1.5 Work Practices

In addition to the controls listed in Table 3-1, most of the precious metal mining facilities in Nevada incorporate several different work practices into their processes to reduce mercury emissions. These work practices include inspecting the exhaust capture system, retorting material prior to processing in the furnace, and replacing the carbon prior to exceeding the recommended mercury loading levels.

The exhaust from the furnace must be captured and conveyed to the control system and then to a stack before being released into the atmosphere. The equipment for the ventilation system consists of hoods, ductwork, fans, and a stack. The hoods and ductwork are inspected periodically to ensure proper emissions capture.

Retorting the precious metal bearing material prior to furnace melting can significantly reduce mercury emissions from the furnace. This work practice is currently being employed at most mines in Nevada.

To ensure sufficient control efficiency by a carbon filter, the carbon filter media is replaced prior to exceeding maximum mercury loading as recommended by the manufacturer. This can be accomplished by:

- replacing the carbon on a schedule that ensures the recommended mercury loading is not exceeded, based on worst-case mercury loading data;
- monitoring the loading of mercury on the carbon directly by carbon analyses;
- monitoring the mercury levels in the exhaust from the carbon filter; or
- a combination of the above work/monitoring practices.

3.3.1.2 Mercury Emissions

NMCP permits for existing furnaces were downloaded from the NDEP Public Document Search website to obtain a list of the existing mercury emission limits. This information is summarized in Table 3-1 of Section 3.3.1.1. The NvMACT emission limits range from the General Industry NvMACT limit for furnaces of 1.0E-05 grains per dry standard cubic foot (gr/dscf) to the True-Up/True-Down (TUTD) interim limit of 5.0E-03 gr/dscf (NDEP 2016).

NMCP compliance tests for existing furnaces were downloaded from the NDEP Public Document Search website to obtain the actual mercury emissions data for furnaces utilizing NvMACT controls. This information is summarized in Table 3-2 for years 2018 through 2025. As shown in Table 3-2, all stack test results are below the TUTD interim limit of 5.0E-03 gr/dscf and many of the stack test results are also below the General Industry NvMACT limit for furnaces of 1.0E-05 gr/dscf.

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	Test Limit	lb/hr	Flow (dscfm)	Flow (acfm)	Temp. (F)
Borealis Mining Company LLC	Smelting Furnace (TU4.003)	10/18/2018	3.63E-07	5.0E-05	1.11E-06	357	457	68.5
	Smelting Furnace (TU4.003)	6/12/2019	4.89E-06	5.0E-05	1.82E-05	436	603	96.2
	Smelting Furnace (TU4.003)	8/12/2020	1.68E-06	5.0E-05	7.28E-06	505	672	74.1
	Smelting Furnace (TU4.003)	9/1/2021	9.31E-07	5.0E-05	3.47E-06	434	599	94.2
	Smelting Furnace (TU4.003)	10/19/2022	2.10E-06	5.0E-05	8.70E-06	477	591	86.9
	Smelting Furnace (TU4.003)	8/3/2023	6.11E-06	5.0E-05	2.60E-05	511	680	76.7
	Smelting Furnace (TU4.003)	10/23/2024	4.66E-06	5.0E-05	1.40E-05	343	461	77.7
Coeur Rochester, Inc.	Reverberatory Furnace (TU4.001)	2/14/2018	1.84E-05	1.6E-04	8.08E-04	5,138	7,220	110.0
	Reverberatory Furnace (TU4.001)	2/20/2019	3.43E-05	1.6E-04	1.80E-03	6,121	8,576	107.8
	Reverberatory Furnace (TU4.001)	2/19/2020	2.12E-05	1.6E-04	1.07E-03	5,907	8,563	132.4
	Reverberatory Furnace (TU4.001)	3/9/2023	2.71E-04	1.6E-04	7.80E-03	3,309	4,256	72.0
Florida Canyon Mining, Inc.	Tilting Crucible Furnace (TU4.001)	10/9/2018	9.85E-07	not available	1.00E-04	11,911	14,252	65.8
	Tilting Crucible Furnace (TU4.001)	12/16/2020	2.61E-06	1.0E-05	2.77E-04	12,393	14,189	45.1
	Tilting Crucible Furnace (TU4.001)	4/8/2021	3.60E-06	1.0E-05	3.70E-04	12,016	14,375	63.2
	Tilting Crucible Furnace (TU4.001)	1/19/2022	1.45E-05	1.0E-05	5.77E-04	4,597	not available	65.9
	Tilting Crucible Furnace (TU4.001)	7/19/2022	7.84E-06	1.0E-05	2.75E-04	4,097	not available	106.0
	Tilting Crucible Furnace (TU4.001)	5/17/2023	8.42E-07	1.0E-05	3.40E-05	4,017	5,834	93.3
	Tilting Crucible Furnace (TU4.001)	6/26/2024	3.63E-07	1.0E-05	1.33E-05	4,229	5,310	100.7
GRP Pan, LLC	Melt Furnace (TU4.003)	12/19/2018	5.76E-07	1.0E-05	1.03E-05	2,071	not available	110.9
	Melt Furnace (TU4.003)	11/19/2019	1.50E-06	1.0E-05	2.60E-05	2,077	not available	107.1
	Melt Furnace (TU4.003)	11/11/2020	3.90E-05	1.0E-05	6.60E-04	1,988	not available	116.0
	Melt Furnace (TU4.003)	2/9/2021	2.80E-07	1.0E-05	4.80E-06	2,019	not available	99.2
	Melt Furnace (TU4.003)	12/14/2021	4.16E-07	1.0E-05	8.00E-06	2,247	not available	106.1
	Melt Furnace (TU4.003)	11/15/2022	2.40E-07	1.0E-05	5.00E-06	2,378	3,037	84.5
	Melt Furnace (TU4.003)	9/19/2023	4.55E-07	1.0E-05	2.47E-06	634	not available	106.8
	Melt Furnace (TU4.003)	10/1/2024	2.94E-07	1.0E-05	1.67E-06	665	922	115.8
	Melt Furnace (TU4.003)	10/21/2025	9.42E-08	1.0E-05	2.46E-06	3,050	not available	85.4
Hycroft Resources & Development, LLC	Smelting Furnace #1 (TU4.002)	3/14/2019	1.86E-04	5.0E-06	6.84E-03	4,283	5,848	139.0
	Smelting Furnace #1 (TU4.002)	6/26/2019	7.06E-07	5.0E-06	3.02E-05	4,973	7,535	205.8
	Smelting Furnace #1 (TU4.002)	6/12/2020	6.96E-07	1.0E-05	2.86E-05	4,791	not available	159.0
	Smelting Furnace #1 (TU4.002)	8/25/2021	5.89E-07	1.0E-05	2.31E-05	4,591	not available	133.2
		Shutdown in 2022						
Jerritt Canyon Gold LLC	Induction Furnace (TU4.009)	8/22/2018	6.02E-05	5.0E-06	1.61E-03	3,119	4,124	97.2
	Induction Furnace (TU4.009)	8/1/2019	1.29E-06	5.0E-06	3.48E-05	3,173	4,269	112.4
	Induction Furnace (TU4.009)	7/29/2020	1.28E-05	5.0E-06	3.90E-04	3,549	4,808	105.8
	Induction Furnace (TU4.009)	9/23/2020	1.02E-05	5.0E-06	1.87E-04	2,143	2,835	95.2
	Induction Furnace (TU4.009)	3/3/2021	6.50E-06	5.0E-06	1.83E-04	3,299	4,440	85.1
	Induction Furnace (TU4.009)	6/16/2021	4.93E-06	5.0E-06	not available	3,694	not available	94.3
	Induction Furnace (TU4.009)	6/22/2022	1.65E-06	1.0E-05	4.13E-05	2,927	not available	84.7
	Induction Furnace (TU4.009)	8/16/2023	4.54E-07	1.0E-05	not available	2,357	not available	102.6
Klondex Aurora Mine, Inc.	Dore Furnace (TU4.007) Pregnant Tank (TU4.002) Barren Tank (TU4.003) Electrowinning Cells (TU4.006)	9/27/2018	1.16E-06	1.0E-05	2.20E-05	2,218	not available	139.1
	Dore Furnace (TU4.007) Pregnant Tank (TU4.002) Barren Tank (TU4.003) Electrowinning Cells (TU4.006)	10/3/2019	7.70E-07	1.0E-05	1.70E-05	2,508	not available	87.9
	Pregnant Tank (TU4.002) Barren Tank (TU4.003) Electrowinning Cells (TU4.006) Dore Furnace (TU4.007)	'Temporarily' stopped for economic reasons						
Klondex Midas Operations - Ken Snyder Mine	Refinery Furnace #1 (TU4.001)	3/8/2018	2.45E-06	5.0E-03	1.31E-04	5,965	not available	108.7
	Refinery Furnace #2 (TU4.002)	3/9/2018	3.43E-06	5.0E-03	1.60E-04	5,475	not available	105.7
	Refinery Furnace #1 (TU4.001)	3/22/2019	6.01E-06	5.0E-03	2.40E-04	4,788	not available	120.0
	Refinery Furnace #2 (TU4.002)	3/21/2019	8.34E-06	5.0E-03	3.20E-04	4,512	not available	124.8
	Refinery Furnace #1 (TU4.001)	9/12/2019	1.80E-06	5.0E-03	7.20E-05	4,860	not available	109.5
	Refinery Furnace #2 (TU4.002)	9/11/2019	6.50E-06	5.0E-03	2.60E-04	4,725	not available	112.5
	Refinery Furnace #1 (TU4.001) Refinery Furnace #2 (TU4.002)	'Temporarily' stopped for economic reasons						

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	**Test Limit**	lb/hr	Flow (dscfm)	Flow (acfm)	Temp. (F)
Marigold Mining Company	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	5/23/2018	2.40E-05	5.0E-03	2.70E-04	1,339	not available	142.0
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	6/12/2019	6.70E-06	5.0E-03	7.75E-05	1,350	not available	159.6
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/26/2020	7.90E-06	5.0E-03	8.40E-05	1,232	not available	146.6
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/21/2021	2.00E-07	5.0E-03	2.00E-06	1,168	not available	157.3
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/20/2022	3.34E-05	5.0E-03	not available	1,236	not available	154.9
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	7/12/2023	2.40E-04	5.00E-03	2.70E-03	1,305	not available	149.60
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	5/14/2024	5.80E-06	5.00E-03	1.68E-05	330	not available	125.15
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	5/15/2024	2.23E-05	5.00E-03	1.81E-04	956	not available	134.13
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	9/11/2024	9.85E-06	5.00E-03	4.58E-05	560	809	136.06
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	6/4/2025	1.29E-05	5.00E-03	3.89E-05	353	547	144.00
	Tilting Crucible Furnace (TU4.003) Electrowinning Cells (2 Cells) (TU4.004) Pregnant Tank (TU4.005) Barren Tank (TU4.006)	8/6/2025	6.43E-06	5.00E-03	1.97E-05	359	527	123.94
McEwen Mining, Inc.	Melting Furnace (Electric) (TU4.007)	4/22/2020	9.04E-05	5.0E-03	3.12E-03	4,025	5,218	81.0
	Melting Furnace (Electric) (TU4.007)	10/14/2020	4.36E-05	5.0E-03	1.50E-03	4,011	5,334	90.0
	Melting Furnace (Electric) (TU4.007)	4/21/2021	3.94E-05	5.0E-03	1.50E-03	4,417	5,888	79.5
	Melting Furnace (Electric) (TU4.007)	5/11/2022	1.30E-05	5.0E-03	4.70E-04	4,252	5,455	63.2
	Melting Furnace (Electric) (TU4.007)	11/30/2022	8.30E-06	5.0E-03	3.60E-04	5,068	6,468	63.0
	Melting Furnace (Electric) (TU4.007)	1/17/2024	1.06E-05	1.2E-04	2.72E-04	2,994	not available	70.0
	Melting Furnace (Electric) (TU4.007)	7/17/2024	3.80E-05	1.2E-04	8.49E-04	2,570	not	105.96
	Melting Furnace (Electric) (TU4.007)	6/11/2025	3.40E-05	1.2E-04	9.70E-04	3,296	4,486	99.13
Nevada Gold Mines LLC - Cortez	Induction Furnace #1 (TU4.003)	7/18/2018	1.34E-05	1.0E-05	2.26E-04	1,966	2,540	110.4
	Induction Furnace #2 (TU4.004)	7/25/2018	4.74E-06	1.0E-05	8.23E-05	2,024	2,583	99.0
	Induction Furnace #1 (TU4.003)	11/6/2018	2.68E-06	1.0E-05	3.97E-05	1,726	2,129	76.4
	Induction Furnace #2 (TU4.004)	11/8/2018	8.57E-06	1.0E-05	1.25E-04	1,703	2,053	66.3
	Induction Furnace #1 (TU4.003)	8/30/2019	1.10E-05	1.0E-05	1.59E-04	1,703	not available	102.5
	Induction Furnace #2 (TU4.004)	8/21/2019	1.16E-05	1.0E-05	1.65E-04	1,659	not available	107.9
	Induction Furnace #1 (TU4.003)	11/22/2019	5.40E-06	1.0E-05	8.20E-05	1,768	not available	71.3
	Induction Furnace #2 (TU4.004)	11/21/2019	6.30E-06	1.0E-05	9.30E-05	1,722	not available	73.2
	Induction Furnace #1 (TU4.003)	8/26/2020	2.20E-06	1.0E-05	2.80E-05	1,512	not available	98.7
	Induction Furnace #2 (TU4.004)	8/25/2020	2.70E-06	1.0E-05	3.50E-05	1,540	not available	98.7
	Induction Furnace #1 (TU4.003)	8/31/2021	5.56E-07	1.0E-05	7.90E-06	1,646	not available	96.7
	Induction Furnace #2 (TU4.004)	8/24/2021	9.62E-08	1.0E-05	1.39E-06	1,690	not available	94.7
	Induction Furnace #1 (TU4.003)	8/31/2022	2.59E-06	1.0E-05	3.97E-05	1,788	not available	105.0
	Induction Furnace #2 (TU4.004)	8/23/2022	1.65E-06	1.0E-05	2.49E-05	1,766	not available	101.3
	Induction Furnace #1 (TU4.003)	8/29/2023	5.60E-06	1.0E-05	1.20E-04	2,506	3,014	91.5
	Induction Furnace #2 (TU4.004)	8/22/2023	4.30E-06	1.0E-05	1.00E-04	2,766	3,365	93.3
	Induction Furnace #1 (TU4.003)	8/28/2024	1.15E-06	1.0E-05	1.90E-05	1,979	2,494	90.7
	Induction Furnace #2 (TU4.004)	8/20/2024	1.17E-06	1.0E-05	2.70E-05	2,648	3,344	92.6
	Induction Furnace #1 (TU4.003)	11/26/2025	8.73E-06	1.0E-05	1.89E-04	2,543	3,106	67.8
	Induction Furnace #2 (TU4.004)	11/19/2025	2.41E-07	1.0E-05	5.00E-06	2,331	2,935	76.1

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	**Test Limit**	lb/hr	Flow (dscfm)	Flow (acfm)	Temp. (F)
Nevada Gold Mines LLC - Gold Quarry Operations	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	3/20/2018	8.74E-05	5.0E-03	4.28E-03	5,659	not available	85.6
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	4/2/2019, 4/4/2019	9.20E-06	5.0E-03	4.63E-04	5,896	not available	66.0
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	9/24/2019	3.44E-04	5.0E-03	1.47E-02	4,995	not available	66.3
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	4/16/2020, 4/21/2020	4.34E-04	5.0E-03	2.68E-02	7,180	not available	71.0
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	9/15/2020	4.18E-04	5.0E-03	3.74E-02	10,470	not available	75.9
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	3/9/2021, 3/11/2021	3.32E-05	5.0E-03	1.44E-03	5,088	not available	73.5
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	10/12/2021	2.75E-04	5.0E-03	1.42E-02	6,034	not available	65.50
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	10/18/2022	3.24E-06	5.0E-03	1.32E-04	4,672	5,872	73.1
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	10/17/2023 - 10/24/2023	2.45E-05	5.0E-03	1.34E-03	6,357	not available	63.6
	Electric Induction Furnace (TU4.024) Electric Induction/Pour Furnace Bar Melt Furnace (TU4.026)	10/14/2024	2.29E-04	6.20E-04	1.39E-02	6,970	not available	69.00
Nevada Gold Mines LLC - Goldstrike Mine	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	9/11/2018	6.40E-04	5.0E-03	2.50E-02	4,588	6,577	111.0
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	10/14/2019	1.60E-04	5.0E-03	7.10E-03	5,076	6,516	66.0
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	8/18/2020	1.00E-04	7.3E-04	3.40E-03	3,976	5,691	110.8
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	9/10/2021	8.30E-06	7.3E-04	3.00E-04	4,205	6,283	116.3
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	9/21/2022	1.00E-04	7.3E-04	3.90E-03	4,441	6,157	103.1
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	11/14/2023	4.60E-05	7.3E-04	1.60E-03	4,181	5,924	115.2
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	11/19/2024	6.32E-05	7.3E-04	2.72E-03	5,008	6,906	102.4
	East Melting Furnace (TU4.022) West Melting Furnace (TU4.023) Electrowinning Cells (TU4.024)	9/23/2025	2.41E-05	7.3E-04	9.25E-04	4,468	6,475	117.0
Nevada Gold Mines LLC - Twin Creeks Mine	Juniper Mill Furnace 1 (TU4.001)	5/8/2018	1.31E-06	1.0E-05	1.66E-04	14,781	not available	77.2
	Juniper Mill Furnace 2 (TU4.002)	5/9/2018	1.32E-04	1.0E-05	1.68E-02	14,786	not available	78.6
	Juniper Mill Furnace 1 (TU4.001)	5/8/2019	3.94E-06	1.0E-05	5.04E-04	14,649	not available	70.4
	Juniper Mill Furnace 2 (TU4.002)	5/9/2019	1.81E-06	1.0E-05	2.28E-04	14,585	not available	66.9
	Juniper Mill Furnace 1 (TU4.001)	6/9/2020	1.10E-04	1.0E-05	not available	14,521	not available	79.1
	Juniper Mill Furnace 2 (TU4.002)	6/10/2020	2.90E-05	1.0E-05	not available	14,013	not available	83.9
	Juniper Mill Furnace 1 (TU4.001)	9/16/2020	6.32E-06	1.0E-05	not available	18,603	not available	73.9
	Juniper Mill Furnace 2 (TU4.002)	9/15/2020	1.66E-06	1.0E-05	not available	19,054	not available	77.3
	Juniper Mill Furnace 1 (TU4.001)	10/20/2022	2.00E-06	1.0E-05	2.50E-04	15,101	18,268	73.2
	Juniper Mill Furnace 2 (TU4.002)	10/19/2022	8.50E-06	1.0E-05	1.10E-03	14,849	17,978	77 .0
	Juniper Mill Furnace 1 (TU4.001)	5/9/2023	3.30E-07	1.0E-05	4.00E-05	14,395	17,546	72.7
	Juniper Mill Furnace 2 (TU4.002)	5/10/2023	2.60E-07	1.0E-05	3.20E-05	14,362	17,708	74.9
	Juniper Mill Furnace 2 (TU4.002)	4/24/2024	3.69E-04	1.0E-05	not available	14,576	not available	67.1
	Juniper Mill Furnace 2 (TU4.002)	6/19/2024	7.46E-07	1.0E-05	not available	16,112	not available	74.9
	Juniper Mill Furnace 1 (TU4.001)	5/14/2025	4.13E-06	1.0E-05	5.30E-04	15,003	18,185	65.5
	Juniper Mill Furnace 2 (TU4.002)	5/16/2025	7.50E-06	1.0E-05	9.30E-04	14,524	17,486	63.7

Table 3-2. Existing Similar Thermal Units: Compliance Test Results

Facility Name	Source	Test Date	gr/dscf	**Test Limit**	lb/hr	Flow (dscfm)	Flow (acfm)	Temp. (F)
Rawhide Mining, LLC	Refinery Induction Furnace (TU4.003)	12/5/2018	1.33E-05	1.0E-05	2.42E-04	2,126	2,456	50.0
	Refinery Induction Furnace (TU4.003)	4/25/2019	5.56E-06	1.0E-05	9.30E-05	1,949	2,516	100.9
	Refinery Induction Furnace (TU4.003)	10/2/2019	1.67E-04	1.0E-05	2.42E-03	1,686	2,103	84.9
	Refinery Induction Furnace (TU4.003)	12/9/2020	2.67E-05	1.0E-05	2.18E-04	953	1,142	68.4
	Refinery Induction Furnace (TU4.003)	5/12/2021	2.51E-04	1.0E-05	1.91E-03	887	1,113	91.1
	Refinery Induction Furnace (TU4.003)	8/4/2022	1.30E-05	1.0E-05	not available	935	not available	94.2
	Refinery Induction Furnace (TU4.003)	2/8/2023	8.93E-05	5.0E-03	1.11E-03	1,445	1,685	59.0
	Refinery Induction Furnace (TU4.003)	8/16/2023	1.76E-04		1.54E-03	1,013	not available	105.7
		Shutdown in 2023						
Round Mountain Gold Corporation - Smoky Valley Mine Common Operation	Electric Induction Furnace (TU4.005)	4/12/2018	1.10E-04	5.4E-04	1.63E-03	1,724	not available	110.7
	Smelting Furnace (TU4.011)	4/18/2018	2.31E-07	1.1E-05	3.95E-06	2,000	not available	75.1
	Smelting Furnace (TU4.011)	10/17/2018	2.23E-06	1.1E-05	3.07E-05	1,582	not available	84.7
	Electric Induction Furnace (TU4.005)	4/18/2019	1.50E-04	5.4E-04	2.30E-03	1,876	not available	86.4
	Smelting Furnace (TU4.011)	4/24/2019	9.04E-07	1.1E-05	9.40E-06	1,242	not available	93.6
	Electric Induction Furnace (TU4.005)	5/7/2020	5.10E-07	1.0E-05	1.50E-05	3,433	4,458	90.8
	Smelting Furnace (TU4.011)	5/11/2020	5.60E-05	1.1E-05	1.50E-03	3,053	3,999	92.3
	Smelting Furnace (TU4.011)	8/4/2021	7.40E-07	1.1E-05	1.90E-05	3,043	4,130	94.2
	Electric Induction Furnace (TU4.005)	8/9/2021	6.30E-06	1.0E-05	1.60E-04	3,022	3,966	85.4
	Smelting Furnace (TU4.011)	9/29/2022	9.00E-06	1.1E-05	9.20E-05	2,129	2,755	82.0
	Electric Induction Furnace (TU4.005)	10/6/2022	7.20E-05	1.0E-05	2.10E-03	3,405	4,436	64.5
	Electric Induction Furnace (TU4.005)	1/5/2023	5.72E-06	1.0E-05	L63E-04	3,334	4,396	86.0
	Smelting Furnace (TU4.011)	9/21/2023	1.35E-06	1.1E-05	3.20E-05	2,711	3,459	65.6
	Electric Induction Furnace (TU4.005)	9/25/2023	1.87E-06	1.0E-05	6.10E-05	3,794	4,846	71.1
	Electric Induction Furnace (TU4.005)	8/5/2024	4.10E-06	1.0E-05	1.30E-04	3,748	5,175	106.7
	Smelting Furnace (TU4.011)	8/14/2024	2.59E-06	1.1E-05	6.40E-05	2,824	3,791	97.5
	Smelting Furnace (TU4.011)	10/30/2024	2.19E-06	1.1E-05	5.67E-05	3,052	3,773	59.1
	Electric Induction Furnace (TU4.005)	7/7/2025	3.40E-06	1.0E-05	1.12E-04	3,748	4,937	80.3
	Smelting Furnace (TU4.011)	7/9/2025	1.24E-06	1.1E-05	3.00E-05	2,951	3,776	79.0
Walker Lane Minerals Corporation	Melting Furnace (TU4.006)	3/5/2020	6.85E-07	1.0E-05	1.08E-05	1,840	not available	136.9
	Melting Furnace (TU4.006)	4/27/2021	1.87E-05	1.0E-05	2.60E-04	1,620	not available	95.2
	Melting Furnace (TU4.006)	5/17/2022	9.89E-06	1.0E-05	1.42E-04	1,644	2,261	129.0

3.3.1.3 Mercury Control Costs

The cost of existing furnace baghouses, wet scrubbers, wet ESPs, and carbon filters listed in Table 3-1 were estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital costs, operational and maintenance (O&M) costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rates listed in Table 3-1, the estimated furnace control costs are summarized in Table 3-3.

Table 3-3. Existing Similar Thermal Units: Control Costs

Control	Exhaust Flow (scfm)	Capital Cost ($1,000)	O&M Cost ($1,000/ yr)	Annualized Cost ($1,000/ yr)
Baghouse	1,071 to 16,000	31 to 458	28 to 415	43 to 644
Venturi Wet Scrubber	2,000 to 10,700	42 to 225	223 to 1,191	356 to 1,903
ESP	9,600	516	387	481
Carbon Filter	1,071 to 16,000	113 to 1,683	not available	not available

(EPA 2003bh) (EPA 2003vs) (EPA 2003es) (EPA 1999)
scfm = dry standard cubic feet per minute; yr = year

3.3.1.4 Non-Air Quality Health and Environmental Impacts and Energy Requirements

The main non-air quality health and environmental impact caused by mercury control technologies for furnaces is the reclamation of carbon loaded with mercury from carbon filters. Once the carbon reaches adsorptive capacity, it is replaced with fresh carbon and the loaded carbon is reclaimed. Reclaiming the used carbon at a reclamation facility has non-air quality health, environmental, and energy impacts.

Carbon filters, baghouses, wet scrubbers, and wet ESPs require increased energy consumption due to the use of exhaust fans, water pumps, and the power requirements of ESPs. Wet scrubbers and wet ESPs use water as a scrubbing solution or to clean the collection plates and the discharge of this water has environmental impacts.

3.3.2 Part II - Other Controls and/or Work Practices

Part II of the NvMACT analysis examines other control options and/or work practices not currently employed with the existing furnaces described in Part I - Existing Similar Thermal Units.

3.3.2.1 Other Mercury Control Options

In addition to the mercury control technologies employed with existing furnaces, the following mercury control options are examined below:

1. Boliden-Norzink Process
2. Activated Carbon Injection

3. Selenium Scrubber
4. Selenium Filter
5. Condenser

3.3.2.1.1 Boliden-Norzink Process

In the Boliden-Norzink process, a mercuric chloride ($HgCl_2$) solution reacts with elemental mercury in the off-gas to form a mercurous chloride (HgCl) precipitate known as calomel, which then settles and is recovered. This reaction occurs in a packed column. Once the solid is removed, the wash solution can be recirculated. A portion of the precipitate can be used to regenerate the mercuric chloride solution using chlorine gas (Booz et al. 2001). The rest of the calomel is sent off-site for reclamation. The Boliden-Norzink process uses the following reaction:

$$HgCl_{2(sol'n)} + Hg_{(gas)} \rightarrow 2HgCl_{(solid)}$$

Boliden-Norzink scrubbers are installed on the Nevada Gold Mines LLC – Goldstrike (Goldstrike), Jerritt Canyon Gold, LLC (Jerritt Canyon), and Nevada Gold Mines LLC - Gold Quarry Operations (Gold Quarry) roasters. These roasters volatize large amounts of mercury and in turn produce large amounts of mercury co-product in the form of calomel. The calomel production at Goldstrike, Jerritt Canyon, and Gold Quarry averages 195,340 pounds, 7,640 pounds, and 9,120 pounds, respectively (Barrick 2018).

A Boliden-Norzink scrubber has not been applied to any existing furnace at precious metal mining facilities in Nevada. There is no basis for assessing its performance in such an application, given the dissimilarities between the furnace (and its characteristic emission stream) and the units/emission streams where Boliden-Norzink scrubbers have been applied. In addition, this technology requires a significant capital investment and produces wastewater (process water containing chloride ions) and solid waste (calomel). The capital costs of the Boliden-Norzink scrubbers installed at Goldstrike and Gold Quarry are $4.7 million and $3.2 million, respectively (Barrick 2018).

Based on the Boliden-Norzink process cost and environmental impacts, and the low amount of mercury emitted from furnaces, Boliden-Norzink scrubbers are not representative of NvMACT for furnaces.

3.3.2.1.2 Activated Carbon Injection

Activated carbon injection is similar to activated carbon filters in that activated carbon particles are used to adsorb mercury from the off-gas stream. In this process, the carbon particles are injected directly into the off-gas stream to adsorb mercury. They are then collected in downstream particulate controls, such as baghouses, wet scrubbers, or wet ESPs. Carbon injection is typically used in the power plant industry, where particulate control technologies have already been installed to clean fly-ash (and injected activated carbon) from the off-gas stream.

This process has not been applied to existing furnaces at precious metal mining facilities in Nevada, and there is no basis for assessing its performance in such an application. In addition, the control efficiency of carbon injection is typically lower than that of carbon filters. Therefore, the most appropriate activated carbon technology application for furnaces is a carbon adsorption filter.

3.3.2.1.3 Selenium Scrubber

Selenium scrubbers use selenium or a selenium compound within a scrubber to react with elemental mercury in the off-gas to form mercuric selenide (HgSe). HgSe has a lower vapor pressure than other common mercury compounds, which allows for mercury capture. The HgSe is removed in a sludge separation circuit, which requires a thickener and HgSe reclamation. Sulfuric acid, at concentrations between 10 and 60 percent, is used as the wash solution for the process.

Selenium scrubbers are appropriate for gas streams with high mercury loading. The outlet concentrations from this process are typically higher than the concentrations achieved from the Boliden-Norzink process discussed in Section 3.3.2.1.1. Selenium scrubbers are not widely used due to their low removal efficiency and expensive reagent and reclamation requirements. Therefore, this option is not considered an effective mercury control method for furnaces.

3.3.2.1.4 Selenium Filter

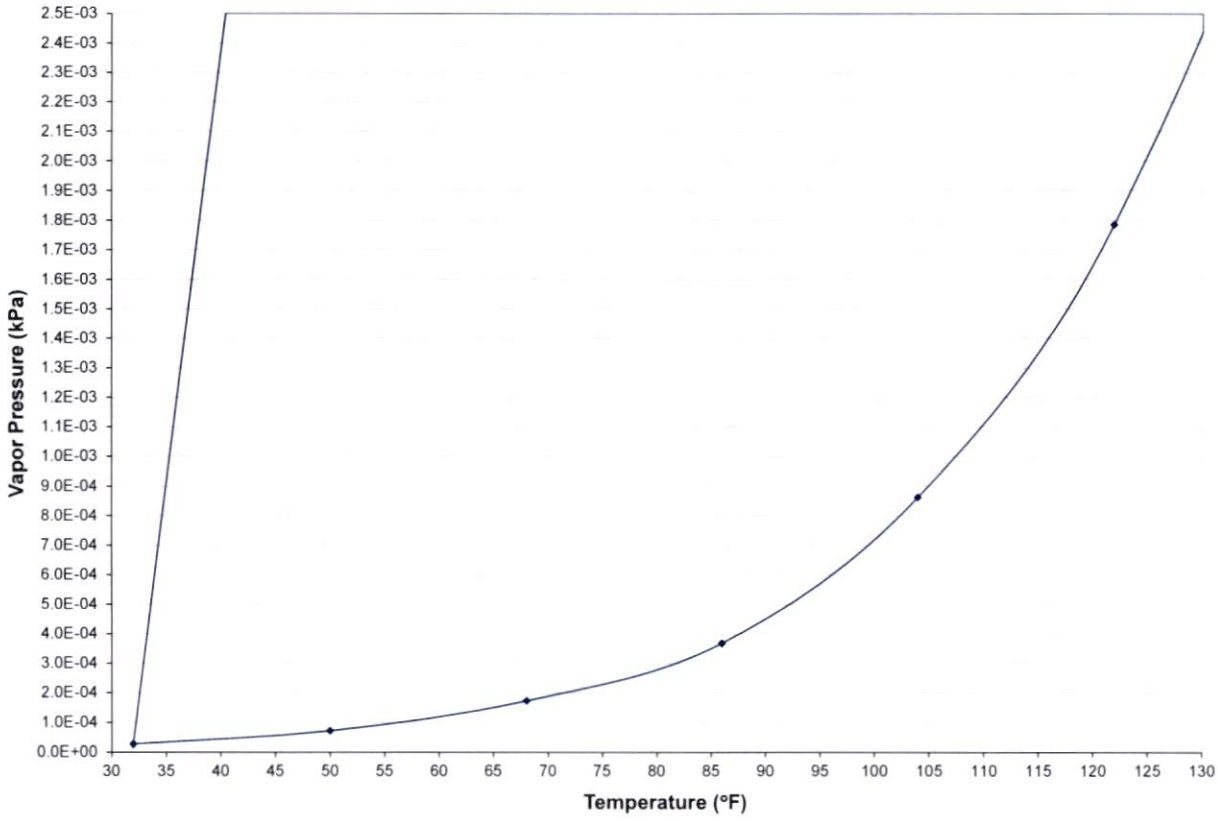
Selenium filters are similar to selenium scrubbers in that they use selenium to react with the elemental mercury in the off-gas stream to form mercuric selenide. Selenium filters use a selenium-impregnated porous carrier structure, housed in a cylindrical tower. The selenium filter's maximum operating temperature is approximately 250°F. The filters require a dry gas stream because moisture tends to degrade the filter media. The typical filter's carrying capacity is between 10 and 15 percent mercury by weight.

Selenium filters have been installed in only a few places in the world, and primarily in Sweden, and no operating data from these applications are available. Selenium filters are expensive to produce and to regenerate. There is no basis to believe that selenium filters would provide a better alternative to activated carbon filters. In addition, there is some concern that the selenium filters cause selenium air emissions. Therefore, this option is not considered an effective mercury control method for furnaces.

3.3.2.1.5 Condenser

Condensers control mercury by cooling a gas stream containing mercury vapor below the mercury vapor saturation point. When the gas temperatures fall below the saturation point, mercury condensation occurs. Chilled water is circulated through the condenser to achieve lower gas stream temperatures. The required condensation temperature is determined by the mercury saturation pressure curve shown in Figure 3-5. The condensed mercury is collected as a co-product.

Figure 3-5. Mercury Saturation Pressure Curve[3]



The two most common types of condensers are surface and contact condensers. Surface condensers cool gas streams by circulating water (or other cooling medium) through an enclosed water jacket surrounding the exhaust system or through a shell-and-tube type heat exchanger. Contact condensers cool gas streams by spraying cooled water into the gas stream. The following correlation exists for both types of condensers: the colder the circulating water, the colder the exhaust gas, and, for a constant inlet loading of mercury, the more efficient the removal of mercury from the gas stream (EPA 2002). Given the low concentration of mercury in furnace exhaust, condensers are not a viable NvMACT control option for furnaces.

3.3.2.2 Other Work Practices

All viable work practices for reducing mercury emissions have already been addressed in Part I – Existing Similar Thermal Units. Thus, there are no other work practices, process changes, or material substitutions that can be instituted to reduce mercury emissions from furnaces.

3.3.3 Part III - Proposed NvMACT

Per NAC 445B.3681.6.(a), the applicant must propose "*standards, methods of control or other limitations to be applied to the thermal unit for the reduction of mercury emissions that the applicant deems sufficient for the Director to determine to be NvMACT for the thermal unit that emits mercury.*"

---

[3] (Taylor and Francis Group 2005)

The NvMACT proposed in this section follows the criteria required by the Director pursuant to NAC 445B.3683. All items considered in this NvMACT analysis are checked in the criteria list provided below:

NAC 445B.3683 Review of and action on application for new or modified thermal unit that emits mercury.

☒ *2.(b) Make a determination of NvMACT for the thermal unit that emits mercury in which the Director shall consider the following for each thermal unit that emits mercury:*

☒ *(1) The maximum degree of reduction of mercury emissions that is achievable for the thermal unit after considering:*

(I) The cost of achieving such a reduction; and

(II) Consistent with section 112(d)(2) of the Act, any nonair quality health and environmental impacts and energy requirements for each method or technology to control mercury emissions from the thermal unit that emits mercury to implement the NvMACT.

☒ *(2) The measures that reduce the volume or eliminate mercury emissions through process changes, substitution of materials or any other modifications.*

☒ *(3) The enclosure of systems or processes to eliminate mercury emissions.*

☒ *(4) The collection, capture or treatment of mercury emissions.*

☒ *(5) The design, equipment, work practice or operational standards of the thermal unit that emits mercury, including, without limitation, the requirements for training and certification of operators of the thermal unit that emits mercury.*

☒ *(6) The differences in the age, remaining operating life and configurations of similar thermal units that emit mercury. The Director may also consider the differences in the concentration of mercury in the ore, size and any other relevant factors of the similar thermal units that emit mercury.*

3.3.3.1 Proposed Controls and Work Practices

Based on the existing control technologies and work practices described in Part I and the additional control technology options described in Part II, Goldcorp proposes the following control equipment, work practices, and capture system as NvMACT for the proposed furnace:

Control equipment:

- Baghouse
- Carbon Bed

Work practices:

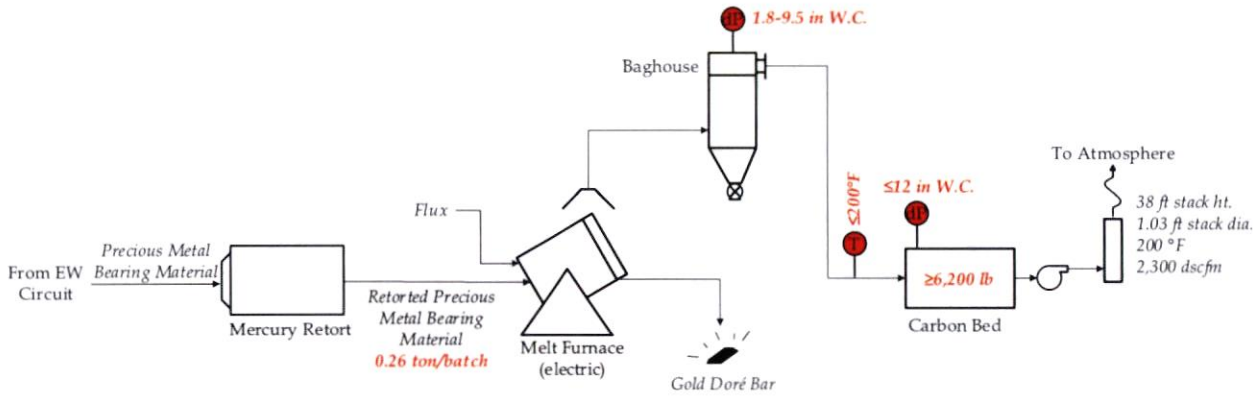
- The furnace will process only retorted precious metal bearing material.
- The differential pressure (DP) across the baghouse shall be maintained between 1.8 and 9.5 inches of water column (in. W.C.).
- The carbon bed will contain at least 6,200 pounds of sulfur-impregnated carbon.
- The gas temperature entering the carbon bed will not exceed 200 degrees Fahrenheit (°F).
- The differential pressure across the carbon bed will not exceed 12 in. W.C.
- The carbon in the carbon bed shall be monitored and replaced prior to exceeding 20 percent mercury by weight.

Capture System:

The exhaust from the furnace will be pulled through the control system by an exhaust fan. The system will be designed so that all emissions from the furnace are captured and ducted through the baghouse and carbon filter.

A flow diagram of the proposed NvMACT mercury control system is provided in Figure 3-6.

Figure 3-6. Lone Tree Exhaust Gas Treatment



The proposed furnace at Lone Tree will be designed to process 0.26 tons of retorted precious metal bearing material per batch. In the proposed control system, the exhaust from the furnace will be ducted to a baghouse for particulate removal. A carbon bed will be installed downstream of the baghouse to control mercury emissions.

The carbon bed will hold 6,200 pounds of sulfur-impregnated carbon. The bed is designed for an exhaust flow rate of approximately 2,300 dry standard cubic feet per minute (dscfm) with a residence time of 5.4 seconds (Hatch 2025). The loading capacity of the carbon is 20 percent mercury by weight.

Table 3-4 provides the carbon bed design analysis using NDEP's NvMACT Specific Case-by-Case Worksheet for deep bed systems.

Table 3-4. Carbon Bed Design Analysis

Description	Calculated Value	[Unit]	Symbol	Equations
Volume of bed	**207**	ft^3	VB	VB=MC/CD
Total quantity of carbon	**6,200**	lbs	MC	Capacity of carbon bed
Carbon Hg capacity	**20**	%	CP	Scotia - 15% to 40%
Carbon density	**30**	lbs/ft^3	CD	NDEP default value
Velocity	**N/A**	ft/min	V	$V = Q/SA_{bed}$
Flow rate	**2,300**	DSCFM	Q	Exhaust flow rate
Mercury loading	**0.010**	lb/hr	L	Calculated based on 98% control
Residence time	**5.4**	sec	T	T=((MC/CD)/Q)*60
Pressure drop	**12**	in H_2O	ΔP	(Hatch 2025)
Hg saturation (hours)	**125,797**	hr	S_h	Sh=MC*(CP/100)*(1/L)
Permit hours per year	**8,760**	hr/yr	HY	
Hg saturation (years)	**14.36**	yr	S_y	$S_y=S_h/HY$

As shown by Table 3-4, the volume of carbon is sufficient to provide adequate residence time (≥1 second based on the dry standard flow rate) and the total weight of carbon is sufficient for the expected mercury loading rate (mercury saturation is approximately 14 years). Based on this analysis, the proposed furnace control system meets NvMACT.

3.3.3.2 Proposed Mercury Emission Limit

As shown in Table 3-1 of Section 3.3.1.1, the NvMACT mercury emission limits for existing gold furnaces range from the General Industry limit of 1.0E-05 gr/dscf to the TUTD interim limit of 5.0E-03 gr/dscf. Goldcorp is proposing to conduct TUTD testing to establish the final NvMACT mercury emission limit for the furnace. During the TUTD testing period, Goldcorp is proposing the NvMACT interim mercury emission limit of 5.0E-03 gr/dscf.

3.3.3.3 Cost of Controls

The costs of the proposed furnace baghouse and carbon filter were estimated in current dollars using technical documents from the EPA Clean Air Technology Center. These documents provide the capital costs, O&M costs, and annualized costs as functions of exhaust flow rate. Based on the exhaust flow rate of 2,300 dscfm, the estimated control costs are summarized in Table 3-5.

Table 3-5. Lone Tree Furnace Control Costs

Control	Exhaust Flow (dscfm)	Capital Cost ($1,000)	O&M Cost ($1,000 / yr)	Annualized Cost ($1,000 / yr)
Baghouse	2,300	66	60	93
Carbon Bed	2,300	242	not available	not available

(EPA 2003bh) (EPA 1999)

REFERENCES

Barrick. 2018. "Barrick Goldstrike Mines Inc., MOPTC Phase II, AP1041-2221, Revised NvMACT Analysis and Application Forms, Roasters." Barrick Goldstrike Mines, Inc. (Barrick), September 19. Accessed August 25, 2021. DOC ID 19487 - https://documentviewerpublic.ndep.nv.gov/Common/login.aspx.

Booz et al. 2001. "Mercury Mass Balance and Emission Factor Estimates for Gold Ore Processing Facilities (Draft)." Report Prepared for U.S. EPA Region 9 by Booz Allen & Hamilton Inc., January 14.

EPA. 1999. "Technical Bulletin - Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA 456/F-99-004." United States Environmental Protection Agency (EPA), May.

—. 2002. "EPA Air Pollution Control Cost Manual, 6th Edition." EPA Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA/452/B-02-001, January.

—. 2003bh. "Air Pollution Control Technology Fact Sheet, Fabric Filter - Pulse-Jet Cleaned Type (also referred to as Baghouses)." *EPA-452/F-03-025.* United States Environmental Protection Agency (EPA). Accessed August 23, 2021. https://www.epa.gov/catc/clean-air-technology-center-products#factsheets.

—. 2003es. "Wet Electrostatic Precipitator (ESP)- Wire-Plate Type." *EPA-452/F-03-030.* United States Environmental Protection Agency (EPA). Accessed August 23, 2021. https://www.epa.gov/catc/clean-air-technology-center-products#factsheets.

—. 2003vs. "Air Pollution Control Technology Fact Sheet - Venturi Scrubber." *EPA-452/F-03-017.* United States Environmental Protection Agency (EPA). Accessed August 23, 2021. https://www.epa.gov/catc/clean-air-technology-center-products#factsheets.

Hatch. 2025. "i-80 Gold Corp - Lone Tree Restart Permitting Inputs Sheet." *Document Number: H367753-0000-843-216-0001.* Hatch, November 7.

Klett et al. 2002. "The Cost of Mercury Removal in an IGCC Plant. Final Report." Michael G. Klett, Russell C. Maxwell, and Michael D. Rutkowski. Parsons Infrastructure and Technology Group Inc. Report prepared for The United States Department of Energy National Energy Technology Laboratory., September.

NCSU. 1998a. "Electrostatic Precipitator Operation." *APTI Course SI:412B, Second Edition.* U.S. Environmental Protection Agency (EPA) Air Pollutaion Training Institute (APTI).

—. 1998b. "Wet Scrubber System Operation Review." *APTI SI:412C, Second Edition.* U.S. Environmental Protection Agency (EPA) Air Pollution Training Institute (APTI).

NDEP. 2016. "Nevada Mercury Control Program Permitting Guidance, General Industry NvMACT Determinations (Draft)." Nevada Division of Environmental Protection (NDEP), February 29.

Rong Yan, et al. 2004. "Bench-scale experimental evaluation of carbon performance on mercury vapour adsorption." Fuel. Vol. 83, No. 17-18.

SION. 2021. "Trip Report to Rawhide Mine to Review the Operation of Melting Furnace Mercury Scrubber." Scotia International of Nevada (SION), July 26.

—. n.d. "Coal Based Activated Carbon Impregnated with Sulfur." *Product Bulletin COL-IS 60.* Scotia International of Nevada, Inc. (SION).

Taylor and Francis Group. 2005. "CRC Handbook of Chemistry and Physics." 86th Edition.

Appendix 4

Request for de minimis Emissions Determination

Thermal Mercury Emitting Unit

Not Applicable

Appendix 5

APPLICATION CERTIFICATION

The responsible official must sign and date the application certification found in Appendix 5. ***If the application is signed by a person other than the responsible official, as defined in NAC 445B.156, the application will be returned as incomplete.***

Note: According to NAC 445B.156, **Responsible Official** means:

1. For a corporation:
   (a) A president;
   (b) A vice president in charge of a principal business function;
   (c) A secretary;
   (d) A treasurer; or
   (e) An authorized representative of such a person who is responsible for the overall operation of the facility and who is designated in writing by the officer of the corporation and approved in advance by the director.
2. For a partnership or sole proprietorship: a general partner or the proprietor, respectively.
3. For a municipality or a state, federal or other public agency: a ranking elected official or a principal executive officer, including, for a federal agency, a chief executive officer who has responsibility for the overall operations of a principal geographic unit of the agency.
4. For an affected source: the designated representative or his alternate, as defined in 42 U.S. C. § 7651 a (26).

PLEASE NOTE THE FOLLOWING REQUIREMENTS WHICH APPLY TO PERMIT APPLICANTS DURING THE APPLICATION PROCESS:

A. A permit applicant must submit supplementary facts or corrected information upon discovery [NAC 445B.297.1(b)].

B. A permit applicant is required to provide any additional information which the Director requests in writing within the time specified in the Director's request [NAC 445B.297.1(c)].

C. Submission of fraudulent data or other information may result in prosecution for an alleged criminal offense (NRS 445B.470).

CERTIFICATION: I certify that, based on information and belief formed after reasonable inquiry, the statements contained in this application are true, accurate and complete.

Signature of Responsible Official

Mark Miller, VP, Environmental & Permitting
Print or Type Name **and** Title

03/05/2026
Date