US Magnesium LLC
238 North 2200 West - Salt Lake City, UT 84116-2921
801/532-2043 - 800/262-9624 - FACSIMILE 801/534-1407

Via Electronic Mail and Certified Mail

January 31, 2023

Mr. Bryce Bird, Director
Division of Air Quality
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144820
Salt Lake City, Utah 84114

Subject: Submittal of Updated RACT Analysis In Response to the Order regarding Information Request and Stack Testing Order Under Sections 19-2-120 and 19-2-107(2)(a)(i), (2)(b)(iii), and (2)(b)(ix) of the Utah Code, DAQ-038-22

Dear Mr. Bird:

Pursuant to emails and phone conversations with Ana Williams through November 29, 2022, US Magnesium LLC (USM) is submitting the attached RACT analysis, prepared by Trinity Consultants, as an update to the RACT analysis that was originally submitted May 20, 2022. As was stated during conversations with the agency, the original RACT analysis did not properly take into account the operating conditions off the Boron process, which lowered the capital costs of the equipment chosen for the analysis. The attached analysis, which takes into account those conditions, better summarizes the costs associated with the various control technologies.

If there are questions regarding the attached please feel free to contact me at (801) 532-1522 ext. 1355.

Sincerely,

Jeffrey L. Mensinger
Environmental Manager
US Magnesium LLC

Attachment

Cc (Electronic only):
Jon Black, DAQ
Harold Burge, DAQ
Ana Williams, DAQ
Mike Zody, PB&L
Kristine Davies, Trinity Consultants

OZONE MODERATE NONATTAINMENT SIP

RACT Analysis

US Magnesium LLC

Prepared By:

TRINITY CONSULTANTS
4525 Wasatch Boulevard, Suite 200
Salt Lake City, UT 84124
801-272-3000

January 2023

Project 234502.0002

TABLE OF CONTENTS

1. INTRODUCTION

On May 1, 2018 the U.S. Environmental Protection Agency (EPA) notified the Utah Division of Air Quality (UDAQ) that the Northern Wasatch Front would be designated as Marginal Nonattainment for the 8-hour ozone standard and this classification was bumped up to Moderate on November 7, 2022. The Ozone Implementation Rule requires that the State Implementation Plan (SIP) associated with this redesignation include Reasonable Available Control Technology (RACT) measures for all major sources.[1] US Magnesium LLC (US Magnesium) has the potential to emit more than 70 tons or more per year of volatile organic compounds (VOC) which is an ozone precursor, thus US Magnesium is considered a major source.[2]

US Magnesium LLC (US Magnesium), located at 12819 North Rowley Road in North Skull Valley, Utah, received an Information Request and Stack Testing Order (the Order) dated April 20, 2022 from the Utah Division of Air Quality (UDAQ). The letter requested that US Magnesium submit a RACT analysis for all emission units emitting volatile organic compounds (VOCs) located at the facility. On May 3, 2022, US Magnesium submitted a request for clarification and modification of the scope of the Order. UDAQ responded to the request from US Magnesium on May 11, 2022 with a modification of the Order, stating that the US Magnesium only needed to address VOC emissions from the Boron Plant, which accounts for almost 98 percent of all VOC emissions from the site. On May 20, 2022 GeoStrata Engineering and Geosciences (GeoStrata) submitted a VOC RACT analysis on behalf of US Magnesium. US Magnesium has been involved in discussions and negotiations with UDAQ since the May 20th submittal. UDAQ has agreed to limiting the RACT analysis to the evaporation from the spent strip water and revising estimated emissions to 165 tons per year based on the water flow rate and organic concentration of the water into the spent strip water pond.[3] UDAQ also agreed to accept a revised VOC RACT analysis if submitted no later than January 31, 2023. Therefore, included in this submittal is an abbreviated VOC RACT analysis covering only the VOC evaporation from the spent strip water and the two control technologies originally included in the cost effectiveness analysis.

All correspondence regarding this submission should be addressed to:

Mr. Jeffrey Mensinger
US Magnesium LLC
Environmental Manager
12819 N Rowley Road
N Skull Valley, UT 84029
Email: jmensinger@usmagnesium.com

[1] Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area State Implementation Plan Requirements, 83 Fed. Reg. 62,998 (Dec. 6, 2018)

[2] The major source threshold was lowered to 70 tpy with the implementation of the PM2.5 Serious Nonattainment SIP

[3] Email from Ms. Ana Williams dated November 21, 2022.

2. PROCESS DESCRIPTION AND EMISSIONS CALCULATIONS

2.1 Description of Process

The Boron Plant VOC emissions are a result of the removal of boron in the concentrated Great Salt Lake (GSL) brine by use of solvent extraction prior to further processing in the magnesium production process. The brine passes through a solvent extraction step where a long chain alcohol in a kerosene carrier is used to remove the naturally occurring boron from the solution. The active reagent used is currently decanol [$C_{10}H_{19}OH$]. This impurity (boron) that is "surface active" on the surface of molten magnesium must be removed as it adversely affects the magnesium purity of the final product. US Magnesium has provided the following from their Standard Operating Procedure:

> *Boron is removed from the DLS brine (desulfated brine) which is mixed with organic solvent consisting of iso-decanol and kerosene in four extraction vessels and allowed to separate. The deboronated brine is pumped to a storage pond (brine feed to spray dryers) and the spent solvent is regenerated by mixing with a dilute hydrochloric acid solution in four stripping vessels that recover the boron back into an aqueous phase and regenerate the organic phase (decanol/kerosene blend) for reuse in the extraction circuit. The regenerated organic phase is pumped to the regenerated organic (R.O.) storage tank and the spent strip water (hydrochloric acid solution) drains through the wastewater piping system to the wastewater pond.*

2.2 Emission Calculations

Potential emissions from the spent strip water were calculated assuming a maximum water flow rate of 150 gallons per minute and a maximum organic content of 0.05 percent. The calculations assume 8,760 hours per year of operation.

$$\text{Annual VOC Emissions}\left(\frac{\text{tons}}{\text{yr}}\right)$$
$$= \text{Water Flow Rate}\left(\frac{\text{gal}}{\text{min}}\right) \text{ x } 60\left(\frac{\text{min}}{\text{hr}}\right) \text{ x } 8.34\left(\frac{\text{lbs}}{\text{gal}}\right) \text{ x } 8{,}760\left(\frac{\text{hrs}}{\text{yr}}\right) \text{ x Organic Weight\% x }\left(\frac{\text{ton}}{2000\text{ lb}}\right)$$

The VOC content of the deboronated brine was calculated assuming a maximum water flow rate of 180 gallons per minute (gpm) and 0.06 percent by weight organic content using the same equation as the spent strip water. This is equivalent to 237 tons per year (tpy) of VOC sent through for processing through the melt reactor. As previously discussed with UDAQ, the melt reactor is operated at a very high temperature (>1,300 degrees Fahrenheit). Therefore, there is inherent VOC process control within this process, and the VOC emissions from the deboronated brine are considered negligible (i.e., they are combusted in the process).

3. RACT ANALYSIS BACKGROUND

As discussed in Section 1 of this report, US Magnesium previously submitted a RACT analysis and has had several discussions with UDAQ regarding emissions to include in the analysis as well as control technologies that are technically feasible. Therefore, this RACT analysis does not include a full analysis in accordance with the EPA's top-down Best Available Control Technology (BACT) approach. Rather, the analysis concentrates on the last two steps of the top-down process described below. Namely, the analysis includes only Step 4 – Evaluate Remaining Control Technologies on Economic, Energy, and Environmental Feasibility and Step 5 – Select RACT.

3.1 RACT Methodology

In a memorandum dated December 1, 1987, the EPA stated its preference for a "top-down" BACT analysis.[4] Guidance provided by UDAQ for this RACT analysis states that this approach is to be utilized. The 1987 guidance states that after determining if any New Source Performance Standard (NSPS) is applicable, the first step in this approach is to determine, for the emission unit in question, the most stringent control available for a similar or identical source or source category. If it can be shown that this level of control is technically, environmentally, or economically infeasible for the unit in question, then the next most stringent level of control is determined and similarly evaluated. This process continues until the control technology level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections. Presented below are the five basic steps of the top-down approach, as identified by the EPA.

Steps 1-3 of the top-down process where controls that are technically feasible are ranked by control effectiveness have not been included with this analysis as they have previously been submitted to UDAQ for the US Magnesium. Rather, this submittal responds to questions from the agency and updates the emissions methodology and calculations as well as the calculations related to the cost effectiveness evaluation in Step 4 of the top-down approach to RACT. The analysis also includes proposed emission rates that US Magnesium proposes as RACT for VOC emissions from the Boron Plant. A description of Steps 4 and 5 is included in the following sections.

3.1.1 Step 4 – Evaluate Remaining Control Technologies on Economic, Energy, and Environmental Feasibility

Beginning with the most effective control option in the ranking, detailed economic, energy, and environmental impact evaluations are performed. If a control option is determined to be economically feasible without adverse energy or environmental impacts, it is not necessary to evaluate the remaining options with lower control effectiveness.

The economic evaluation centers on the cost effectiveness of the control option. Costs of installing and operating control technologies are estimated and annualized following the methodologies outlined in the EPA's *OAQPS Control Cost Manual* (CCM) and other industry resources.[5] Note that the analysis is not whether controls are affordable, but whether the expenditure is effective.

---

[4] U.S. EPA, Office of Air and Radiation. Memorandum from J.C. Potter to the Regional Administrators. Washington, D.C. December 1, 1987.

[5] Office of Air Quality Planning and Standards (OAQPS), *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA 452-02-001 (http://www.epa.gov/ttn/catc/products.html#cccinfo), Daniel C. Mussatti & William M. Vatavuk, January 2002.

3.1.2 Step 5 – Select RACT

In the final step, one pollutant-specific control option is proposed as RACT for each emission unit under review based on evaluations from the previous step.

4. RACT ANALYSIS – SPENT STRIP WATER

This section provides information on the cost analysis and selection of RACT for VOC emissions from the spent strip water.

4.1 Step 4 – Evaluate Remaining Control Technologies on Economic, Energy, and Environmental Feasibility

Appendix A provides the cost analysis for the two technologies that were included in the original RACT analysis for the spent strip water. The cost analysis has been updated from the original submittal as the EPA Cost Control Manual (CCM) was used in the analysis. Specifically, the following costs were added:

- Sales tax (actual tax rate including state and local taxes)
- Freight (default from CCM)
- Indirect Operating Costs (default from CCM)
  - Overhead
  - Administrative Charges
  - Property Taxes
  - Insurance

In addition, the interest rate used in the capital recovery factor (CRF) equation was updated to seven percent, using the default factor from the CCM, which is the standard value used in BACT analyses.

The first technology that is addressed is the steam stripper with a regenerative thermal oxidizer (RTO) in series and is ranked as the highest level of control for the two options included in the cost analysis. The steam stripper/RTO can achieve up to 98 percent control efficiency for both the extraction solvent (decanol) and the carrier (kerosene). As detailed in the control cost analysis in Appendix A, it would cost $31,399 per ton of VOC removed to install and operate this series of control devices. US Magnesium considers the cost per ton of VOC removed to be not cost effective. Therefore, a cost analysis for the next available control technology, an air stripper with RTO in series, is also included in Appendix A. The air stripper/RTO can achieve up to 99 percent control efficiency for decanol, but only five percent control efficiency for kerosene. As detailed in the control cost analysis in Appendix A, it would cost $34,034 per ton of VOC removed to install and operate this series of control devices. As with the steam stripper/RTO control train, US Magnesium considers the cost per ton of VOC removed to be not cost effective.

4.2 Step 5 – Select RACT

Since neither of the available control devices are considered cost effective, US Magnesium proposes a RACT limit of 165 tpy and 901 pounds per day of VOC for the Boron Plant spent strip water process.

APPENDIX A. COST ANALYSIS

RACT Cost Analysis for Air Stripper and RTO System

Capital Cost Summary		
DIRECT COSTS		
Purchased Equipment Costs		
Air Stripper and RTO Equipment[1]		**$1,980,998**
Instrumentation (included in equipment cost)		$0
Sales Tax (6.6% of RTO Equipment)		$130,746
Freight (5.0% of RTO Equipment)		$99,050
Purchased Equipment Cost (PEC)	**PEC =**	**$2,210,794**
Direct Installation Costs[1]		
Foundation and Supports (8.0% of PEC)		
Handling and Erection (14.0% of PEC)		
Electrical (4.0% of PEC)		
Ductwork and Piping (2.0% of PEC)		
Insulation (1.0% of PEC)		
Painting (1.0% of PEC)		
Direct Installation Cost (DIC)	**DIC =**	**$0**
TOTAL DIRECT COST (DC = PEC + DIC)	**DC =**	**$2,210,794**
INDIRECT COSTS[1]		
Engineering (10.0% of PEC)		
Construction and Field Expenses (5.0% of PEC)		
Contractor Fees (10.0% of PEC)		
Start-up (2.0% of PEC)		
Performance Test (1.0% of PEC)		
Contingencies (CF(DC + IC))		
TOTAL INDIRECT COST (IC)	**IC =**	**$0**
TOTAL CAPITAL INVESTMENT (TCI = DC + IC)	**TCI =**	**$2,210,794**

1. Air stripper and RTO capital costs provided by QED and Anguil in original cost analysis dated May 20,2022. All direct and indirect installation costs included in the quote; therefore, additional default values from EPA cost manual are not included.

RACT Cost Analysis for Air Stripper and RTO System

Annual Cost Summary		
DIRECT ANNUAL OPERATING COSTS		
Operating Labor		
Operator (0.5 hr/shift, 3 shifts/day, 365 days/year, $60/hr)		$32,850
Supervisor (15% of Operator)		$4,928
Maintenance		
Labor (0.5 hr/shift, 3 shifts/day, 365 days/year, $60/hr)		$32,850
Materials (100% of Maintenance Labor)		$32,850
Utilities		
Electricity		$107,923
Propane		$765,902
TOTAL DIRECT COSTS OF ANNUAL OPERATIONS (D(	DC =	**$977,302**
INDIRECT OPERATING COSTS		
Overhead (60% of Total Labor and Maintenance Material Costs)		$62,086.50
Administrative Charges (2% of TCI)		$44,215.88
Property Taxes (1% of TCI)		$22,107.94
Insurance (1% of TCI)		$22,107.94
Capital Recovery (CRF x TCI)[3]		
20 years @ 7.0% interest CRF = 0.0944		$208,683
TOTAL ANNUALIZED INDIRECT COSTS (IC)	IC =	**$359,202**
TOTAL ANNUALIZED COST (TAC = DC + IC)	TAC=	**$1,336,504**
COST EFFECTIVENESS SUMMARY		
Annual Control Cost		**$1,336,504**
VOC Emissions Captured and Routed to Control (tpy)[3]		**165.00**
Pollutant to be removed (tpy)[4]		**39.27**
CONTROL COST EFFECTIVENESS ($/ton)		**$34,034**

2. Based on estimated equipment lifetime of 20 years for RTO.
3. Emissions per email from UDAQ on 11/21/2022.

RACT Cost Analysis for Steam Stripper and RTO System

Capital Cost Summary		
DIRECT COSTS		
Purchased Equipment Costs		
Air Stripper and RTO Equipment[1]		**$3,359,885**
Instrumentation (included in equipment cost)		$0
Sales Tax (6.6% of RTO Equipment)		$221,752
Freight (5.0% of RTO Equipment)		$167,994
Purchased Equipment Cost (PEC)	**PEC =**	**$3,749,632**
Direct Installation Costs[1]		
Foundation and Supports (8.0% of PEC)		
Handling and Erection (14.0% of PEC)		
Electrical (4.0% of PEC)		
Ductwork and Piping (2.0% of PEC)		
Insulation (1.0% of PEC)		
Painting (1.0% of PEC)		
Direct Installation Cost (DIC)	**DIC =**	**$0**
TOTAL DIRECT COST (DC = PEC + DIC)	**DC =**	**$3,749,632**
INDIRECT COSTS[1]		
Engineering (10.0% of PEC)		
Construction and Field Expenses (5.0% of PEC)		
Contractor Fees (10.0% of PEC)		
Start-up (2.0% of PEC)		
Performance Test (1.0% of PEC)		
Contingencies (CF(DC + IC))		
TOTAL INDIRECT COST (IC)	**IC =**	**$0**
TOTAL CAPITAL INVESTMENT (TCI = DC + IC)	**TCI =**	**$3,749,632**

1. Air stripper and RTO capital costs provided by QED and Anguil in original cost analysis dated May 20,2022. All direct and indirect installation costs included in the quote; therefore, additional default values from EPA cost manual are not included.

RACT Cost Analysis for Steam Stripper and RTO System

Annual Cost Summary		
DIRECT ANNUAL OPERATING COSTS		
Operating Labor		
Operator (0.5 hr/shift, 3 shifts/day, 365 days/year, $60/hr)		$32,850
Supervisor (15% of Operator)		$4,928
Maintenance		
Labor (0.5 hr/shift, 3 shifts/day, 365 days/year, $60/hr)		$32,850
Materials (100% of Maintenance Labor)		$32,850
Utilities		
Electricity		$578,160
Propane		$3,829,508
TOTAL DIRECT COSTS OF ANNUAL OPERATIONS (D(	**DC =**	**$4,511,146**
INDIRECT OPERATING COSTS		
Overhead (60% of Total Labor and Maintenance Material Costs)		**$62,086.50**
Administrative Charges (2% of TCI)		**$74,992.63**
Property Taxes (1% of TCI)		**$37,496.32**
Insurance (1% of TCI)		**$37,496.32**
Capital Recovery (CRF x TCI)[2]		
20 years @ 7.0% interest CRF = 0.0944		**$353,939**
TOTAL ANNUALIZED INDIRECT COSTS (IC)	**IC =**	**$566,010**
TOTAL ANNUALIZED COST (TAC = DC + IC)	**TAC=**	**$5,077,156**
COST EFFECTIVENESS SUMMARY		
Annual Control Cost		**$5,077,156**
VOC Emissions Captured and Routed to Control (tpy)[3]		**165.00**
Pollutant to be removed (tpy)[4]		**161.70**
CONTROL COST EFFECTIVENESS ($/ton)		**$31,399**

2. Based on estimated equipment lifetime of 15 years for RTO.
3. Emissions per email from UDAQ on 11/21/2022.