McWANE DUCTILE | IRON STRONG

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April 28, 2017

Bryce Bird, Director
Utah Department of Environmental Quality
Division of Air Quality
PO Box 144820
195 North 1950 West
Salt Lake City, Utah 84114-4820

Re: Request for BACT Analysis

Dear Mr. Bird:

McWane Ductile – Utah (MDU) received a letter from the Utah Division of Air Quality (UDAQ) dated January 23, 2017 regarding serious nonattainment area state implementation plan (SIP) control strategy requirements. In this letter, the UDAQ requested that MDU prepare and submit a Best Available Controls (BACM/BACT) analysis in support of UDAQ's development of a serious area attainment control plan. Enclosed you will find the BACT analysis completed for this facility. If you have any questions concerning the information provided, please contact Holly Hurst at (801) 623-4224 or at holly.hurst@mcwaneductile.com.

Respectfully,

D. A. Hiest

David Hiestand

Vice President / General Manager
McWane Ductile – Utah

$PM_{2.5}$ SERIOUS NONATTAINMENT SIP BACM/BACT ANALYSIS

McWane Ductile
Provo, Utah

MCWANE
DUCTILE

Prepared For:

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April 2017

Project 174502.0012

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1. EXECUTIVE SUMMARY

The Utah Division of Air Quality (UDAQ) is required to submit a Serious Area Attainment Control Plan as specified with 40 CFR 51, Subpart Z (Federal register (FR) Vol 81, No 164, August 24, 2016) in accordance with the $PM_{2.5}$ serious nonattainment re-designation issued by Environmental Protection Agency (EPA) on December 16, 2016.[1] This rule requires UDAQ to identify, adopt, and implement Best Available Control Measures or Technologies (BACM/BACT) for major sources of direct $PM_{2.5}$ and $PM_{2.5}$ precursors (sulfur dioxide (SO_2), nitrogen oxide (NO_X), volatile organic compounds (VOCs), and ammonia (NH_3)).

As the McWane Ductile, Provo Utah (MDU) Facility has the potential to emit more than 70 tons or more per year of $PM_{2.5}$ and/or $PM_{2.5}$ precursors, MDU is considered a major source. UDAQ has requested that each major source prepare a BACM/BACT Analysis which includes the following information:

- Detailed analysis of all applicable control measures and techniques (BACM/BACT Analysis);
- Evaluation of Most Stringent Measures (MSM);
- Startup and Shutdown (where appropriate);
- Evaluation of emission limits; and
- Evaluation of emissions monitoring.

The UDAQ must complete the State Implementation Plan (SIP) process by the end of July 2017 so it can be reviewed and approved for public comment by the Air Quality Board (AQB) in September 2017 and finalized in December 2017 for submittal to the Environmental Protection Agency (EPA) by December 31, 2017.[2] As such, MDU is submitting this BACM/BACT analysis in order to meet DAQ's submission deadline of April 30, 2017 as requested in the letter received January, 23 2017.

[1] Federal Register Vol. 81, No. 164, August 24, 2016, pp. 58151

[2] 40 CFR 51.1003 Attainment Plan Submittal Requirements

2.1. DESCRIPTION OF FACILITY

First constructed in 1926, McWane Ductile, Utah (MDU), produces various sizes of ductile iron products that are used in water distribution and infrastructure systems. MDU's Standard Industrial Classification (SIC) code is 3321, and its North American Industry Classification System (NAICS) code is 331511 for ductile cast iron foundries. MDU, located at 2550 South Industrial Parkway in Provo, Utah is in Utah County at the following Universal Transverse Mercator (UTM) coordinates.

- Zone 12
- 1984 World Geodetic System
- Easting: 446,300 meters
- Northing: 4,449,800 meters

All correspondence regarding this submission should be addressed to:

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Activities at the facility include melting, core preparation, casting, annealing, lining, coating, and special lining operations. Initially, scrap metal is melted in a cupola, sulfur content is reduced via a desulfurization process, and magnesium alloy is added to the molten metal to form ductile iron. The magnesium alloy changes the microstructure by causing the carbon in the iron to assume a nodular shape and as a result is far stronger than normal gray iron. A centrifugal casting machine is used in the casting process. Following casting, the pipe enters an annealing process to relieve internal stresses and refine chemical structure. After cooling, finishing operations include grinding, shot blasting, lining and painting.

2.2. PERMITTING BACKGROUND

MDU is currently operating as a stationary source under an approval order (AO) from the UDAQ dated January 12, 2016, (DAQE-AN107940032-16) and Title V Operating Permit Number 4900017003, last revised May 05, 2016, (expiring May 5, 2021).

The most recent AO update incorporates a new zinc thermal spray system. The new system uses an electrical arc and compressed air to apply a zinc coating to ductile iron pipe for increased corrosion resistance. The process is controlled with a high-efficiency baghouse for removal of particulates, which was established as BACT. Additionally, MDU submitted a request to correct the designation of the diesel-fired emergency generator listed in the existing AO under condition II.A.23.

The Sand Core Silo and the Sand Coating process are mentioned in the Title V permit, but are not evaluated in this document because the processes are no longer performed at MDU.

MDU's Title V permitting history has been summarized in Table 2-1 below.

Table 2-1. Permitting History

Permit/Activity	Date Issued	Recorded Changes
Title V renewal application (Project #OPP0107940009)	05/05/2016	Changes: Incorporate changes approved under AO DAQE-AN107940032-16 to include a new emission unit zinc thermal spray process and its associated limitation. Also incorporate changes approved under AO DAQEAN107940031-15: (1) Removing special linings oven; (2) Including three existing and one new small natural gas-fired emergency generators; (3) Changing the method to calculate the seal coat removed; (4) Removing annual metal HAP limit; and (5) Including NESHAP ZZZZ and NSPS JJJJ requirements.
Title V renewal application	10/04/2010	Additions: CAM and NESHAP Subpart ZZZZZ are included in the renewal permit.
Title V administrative amendment – enhanced AO **(Project #OPP017940005)**	12/7/2007	Changes: Incorporate changes approved under AO DAQE-AN011970019-07; Re-expressing NO_X emission from cupola on a pounds per hour basis; Adding 12-month rolling NO_X limit on cupola; and Removing methyl ethyl ketone limitation from HAP.
Title V administrative amendment **(Project # OPP0107940003)**	11/11/2005	Changes: Incorporate changes approved under AO DAQE-AN0794012-05, for decreasing the CO permit limit to more accurately reflect potential emissions.
Title V administrative amendment **(Project # OPP0107940002)**	03/05/2004	Changes: Incorporate changes approved under AO DAQE-AN0794009-04 dated March 3, 2004, for increasing NO_X limit at cupola.
Title V initial application **(Project # OPP0107940001)**	04/10/2003	

Emission sources and their relative emissions on site are detailed in Table 2-2.

Table 2-2. Site Wide Emission Summary

Source/Source Type	Current Emission Estimates (% of Total Emissions)				
	$PM_{2.5}$	NO_X	SO_2	VOC	NH_3
Charge Handling	11%	0%	0%	0%	0%
Scrap Cutting (Torch)	1%	0%	0%	0%	0%
Tuyere Injection	0%	0%	0%	0%	0%
Cupola	40%	51%	97%	4%	90%
Slag Conveyor	0%	0%	0%	0%	0%
Desulfurization & Inoculation Treatment	6%	0%	0%	0%	0%
Centrifugal Casting	4%	0%	0%	2%	3%
Pipe Cleaning	3%	0%	0%	0%	0%
Annealing Oven	3%	13%	1%	1%	3%
Coating Removal	0%	0%	0%	0%	0%
Pipe Cut-Off	0%	0%	0%	0%	0%
Pipe Grinding (Spigot, Bell)	0%	0%	0%	0%	0%
Cement Lining (Cement Silo)	0%	0%	0%	0%	0%
Cement Lining (Sand Silo)	0%	0%	0%	0%	0%
Zinc Coater	5%	0%	0%	0%	0%
Pipe Painting	12%	0%	0%	86%	0%
Pipe Stenciling and Striping	0%	0%	0%	1%	0%
Specialty Lining Shotblast	2%	0%	0%	0%	0%
Shell Core Making	0%	0%	0%	4%	0%
Lime Transload	0%	0%	0%	0%	0%
Finishing Heaters A	0%	0%	0%	0%	0%
Finishing Heaters B	0%	0%	0%	0%	0%
Finishing Heaters C	0%	0%	0%	0%	0%
Other Nat Gas	3%	29%	1%	1%	3%
Finishing Cement Handling	0%	0%	0%	0%	0%
Finishing Sand Handling	0%	0%	0%	0%	0%
Recuperator Emergency Generator	0%	4%	1%	0%	0%
DeLavaud Emergency Generator	0%	3%	1%	0%	0%
Oven Control Emergency Generator	0%	0%	0%	0%	0%
Sp Lining Storage Emergency Generator	0%	0%	0%	0%	0%
Main Office IT Emergency Generator	0%	0%	0%	0%	0%
Works Office IT Emergency Generator	0%	0%	0%	0%	0%
Enviroblend Silo	0%	0%	0%	0%	0%
Welding	5%	0%	0%	0%	0%
Degreaser (Parts Washers)	0%	0%	0%	1%	0%
Plant Roads and Parking Areas	1%	0%	0%	0%	0%
Unpaved Roadways	0%	0%	0%	0%	0%

Source/Source Type	Current Emission Estimates (% of Total Emissions)				
	$PM_{2.5}$	NO_X	SO_2	VOC	NH_3
Coke Storage Pile	0%	0%	0%	0%	0%
Landfill	1%	0%	0%	0%	0%

3. BEST AVAILABLE CONTROL MEASURES

MDU previously submitted a Reasonably Available Control Technology (RACT) evaluation in February 2013, with supplemental information and/or responses to UDAQ in August and October 2013. The 2013 RACT analysis and MDU's current SIP requirements as documented in UDAQ's Moderate Non-Attainment SIP have been achieved by MDU.[3] The 2013 RACT analysis serves as a baseline for the BACM/BACT analysis documented herein.[4] A BACM/BACT analysis has been conducted for each source addressed in Approval Order No. DAQE-AN107940032-16 and Title V permit #4900017003 in the following sections. Where appropriate, MDU has addressed startup and shutdown emissions for each source as part of the BACM/BACT analysis. MDU has organized the BACM/BACT analysis by emission unit group and addressed $PM_{2.5}$ and each $PM_{2.5}$ precursor in this analysis in a format that is in accordance with U.S. EPA's top-down BACT procedures.

3.1. BACM/BACT METHODOLOGY

In a memorandum dated December 1, 1987, the United States Environmental Protection Agency (U.S. EPA) stated its preference for a "top-down" BACT analysis.[5] 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 BACT level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections. Presented below are the five basic steps of a top-down BACT review as identified by the U.S. EPA.

3.1.1. Step 1 - Identify All Control Technologies

Available control technologies are identified for each emission unit in question. The following methods are used to identify potential technologies:

1. Researching the RACT/BACT/Lowest Achievable Emission Rate (LAER) Clearinghouse (RBLC) database;
2. Surveying regulatory agency emission limit requirements;
3. Drawing from previous engineering experience;
4. Surveying air pollution control equipment vendor emission limit guarantees, and/or
5. Surveying available literature.

[3] MDU's Source Specific Emission Limitations are documented in Section H.13 Source Specific Emission Limitations in Provo – UT $PM_{2.5}$ Nonattainment Area, UDAQ's Moderate SIP, December 3, 2014.

[4] Prior RACT analysis is required to be the baseline consideration for Serious Nonattainment SIP BACM/BACT analysis based on UDAQs Letter dated January 23, 2017.

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

3.1.2. Step 2 - Eliminate Technically Infeasible Options

The second step in the BACT analysis is to eliminate any technically infeasible control technologies. Each control technology for each pollutant is considered, and those that are clearly technically infeasible are eliminated. U.S. EPA states the following with regard to technical feasibility:[6]

> *A demonstration of technical infeasibility should be clearly documented and should show, based on physical, chemical, and engineering principles, that technical difficulties would preclude the successful use of the control option on the emissions unit under review.*

3.1.3. Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Once technically infeasible options are removed from consideration, the remaining options are ranked based on their control effectiveness. If there is only one remaining option or if all of the remaining technologies could achieve equivalent control efficiencies, ranking based on control efficiency is not required.

In a retroactive BACT analysis, this step differs from the equivalent step in the NSR BACT process in that the baseline from which control effectiveness is evaluated is the current emission rate, and not a hypothetical "uncontrolled" level.

3.1.4. Step 4 - Evaluate Most Effective Controls and Document Results

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 U.S. EPA's *OAQPS Control Cost Manual* (CCM) and other industry resources.[7] Note that the analysis is not whether controls are affordable, but whether the monetary expenditure is effective.

3.1.5. Step 5 - Select BACT

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

The U.S. EPA has consistently interpreted the statutory and regulatory BACT definitions as containing two core requirements that the agency believes must be met by any BACT determination, regardless of whether the "top-down" approach is used. First, the BACT analysis must include consideration of the most stringent available control technologies, i.e., those which provide the "maximum degree of emissions reduction." Second, any

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[6] U.S. EPA, New Source Review Workshop Manual (Draft): Prevention of Significant Deterioration and Nonattainment Area Permitting, October 1990.

[7] 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.

decision to require a lesser degree of emissions reduction must be justified by an objective analysis of "energy, environmental, and economic impacts."[8]

The UDAQ NOI Guide also details the requirement to achieve BACT as required in the State of Utah permitting process. The proposed BACT must be based on the most effective engineering techniques and control equipment to minimize emissions of air contaminants into the outside environment from its process.

3.1.6. Most Stringent Measures

The MSM analysis is a separate determination from BACT. The MSM analysis identifies any permanent and enforceable control measure that achieves the most stringent emissions reductions, in direct $PM_{2.5}$ emissions and/or emissions of $PM_{2.5}$ precursors, from among those control measures which are:

- Included in the SIP for any other National Ambient Air Quality Standard (NAAQS); or
- Have been achieved in practice in any state; and
- Can feasibly be implemented in the relevant $PM_{2.5}$ NAAQS nonattainment area.[9]

If the area cannot meet the $PM_{2.5}$ standard by December 31, 2019, through modeled prediction or actual ambient monitoring, the control measure required will rise to the MSMs identified.

3.2. CUPOLA

The purpose of the Cupola is to melt raw materials, such as scrap metal, to produce cast iron. The cupola is a large, hollow, vertical cylinder of steel with refractory lining in the melt zone area. The cupola is blasted with heated air (1,000 deg. F) at varying rates (10,000 to 22,000 CFM) to control the melt rate. The sides of the cupola are water cooled to protect the cupola from internal temperatures of approximately 5,000 deg. F. Exhaust gases from the cupola are collected and passed through the recuperator and then a baghouse.

Hinged doors at the bottom allow the cupola to be emptied when not in use. When in use, the bottom doors are closed, and a bed of sand is placed on the furnace bottom over the doors. The cupola is charged from the top with scrap metal, alloying materials, flux, carbon additives, and coke as fuel. These materials are melted together in the cupola. Flux (limestone) combines with impurities to form slag, which rises to the surface and is separated from the molten iron. The vast majority of emissions occur during melting, during which forced air flow is circulated in the cupola to provide oxygen. The air entrains combustion emissions and particulate formed during melting, and the exhaust air is routed through a recuperator and then through a baghouse for particulate matter emission controls. Melted material remaining in the cupola at the end of a melt cycle are "tapped" (i.e., unloaded).

In 2003, a new gas handling system was installed. The system recycles heat from the cupola off-gases by preheating incoming combustion air in the recupoator. Natural gas low-NOx burners, totaling 24 MMBtu's/hr, are used in the recuperator CO burner system to combust CO and VOCs in the exhaust gas.[10] The cupola exhaust gas is then used to preheat the incoming blast air in an air-to-air heat exchanger. The exhaust gases leaving this

[8] Ibid.

[9] 40 CFR 51.1000 – Definitions - Provisions for Implementation of $PM_{2.5}$ National Ambient Air Quality Standards

[10] The Cupola is listed under Section II.A.2 of the January 12, 2016 Approval Order.

heat exchanger are further cooled using an air-to-oil heat exchanger. Finally, gases are routed through a baghouse that reduces PM emissions.

The cupola starts up early each morning. The cupola is charged with a bed of coke, scrap and other process material. Once the material is charged, the cupola lid is lowered and the bed of coke is ignited. After a period to ensure the coke bed is properly ignited, the cupola lid is raised to continue charging additional material. During this initial period of charging, a rapid thermal expansion may occur as a result of the buildup of CO in the emission control ductwork. This may result in a very short period of uncontrolled emissions (20-30 seconds) as the rapid thermal expansion propagates back up the ductwork towards the cupola. In accordance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart ZZZZZ, the NESHAP for Iron and Steel Foundries Area Sources, MDU follows an operation and maintenance (O&M) plan to ensure emissions during the startup period are minimized with management practices. The collection efficiency of the baghouse is reduced during this short period due to flow and backpressure issues.

The cupola also typically shuts down each afternoon. Tuyeres inject hot blast air into the cupola to force the residual molten iron and slag through a tap hole at the bottom of the cupola. During tap out, emissions may be blown out the bottom of the cupola along with the residual material rather than being collected by the baghouse offtake at the top of the cupola due to backpressure and flow. During periods of shutdown MDU follow's the operation and maintenance plan. This shutdown process takes approximately 10 minutes. Industry standards do not have available emission controls for periods of startup and shutdown published. While emissions may be higher during these short startup and shutdown periods, overall emissions from the cupola are primarily due to normal operations. Due to the short time period, lack of industry known control options, and concern with backpressure/flow for any add on control systems, emissions are not reviewed further for startup and shutdown operations.

3.2.1. $PM_{2.5}$

$PM_{2.5}$ emissions are generated from combustion as well as metal fumes from molten metal in the cupola.

Cupola $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- Baghouse/Fabric Filter
- Wet Scrubber
- Electrostatic Precipitator (ESP)
- High-Efficiency Cyclone

Cupola $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

All control technologies are technically feasible. This section specifically addresses filterable $PM_{2.5}$. The condensable fraction is represented with the other precursors (NO_X, SO_2, VOCs, and NH_3). A description of each technology is as follows:

Baghouse/Fabric Filter

A fabric filter unit (or baghouse) consists of one or more compartments containing rows of fabric bags. Particle-laden gases pass along the surface of the bags then through the fabric. Particles are retained on the upstream face of the bags and the cleaned gas stream is vented to the atmosphere. Fabric filters collect particles with sizes ranging from submicron to several hundred microns in diameter. Fabric filters are used for medium and low gas flow streams with high particulate concentrations. The typical baghouse has control efficiency between 95% and 99.9%.[11]

ESPs

A dry electrostatic precipitator (ESP) is a particle control device that uses electrical forces to move the particles out of the gas stream onto collector plates. This process is accomplished by the charging of particles in the gas stream using positively or negatively charged electrodes. The particles are then collected as they are attracted to oppositely opposed electrodes. Once the particles are collected on the plates, they are removed by knocking them loose from the plates, allowing the collected layer of particles to fall down into a hopper. Dry ESPs are used to capture coarse particles at high concentrations. Small particles at low concentrations are not effectively collected by an ESP.

ESPs are used infrequently for cupola emission control. They are also less effective than a baghouse or fabric filter.[12] ESP controls can reach 99.9% of general PM control, though EPA notes that "In general, the most difficult particles to collect are those with aerodynamic diameters between 0.1 and 1.0 μm."[13]

Wet scrubbers

A wet gas scrubber is an air pollution control device that removes $PM_{2.5}$ from stationary point sources waste streams. $PM_{2.5}$ is primarily removed through the impaction, diffusion, interception, and/or absorption of the pollutant onto droplets of liquid. Wet scrubbers have some advantages over ESPs and baghouses in that they are particularly useful in removing PM with the following characteristics:

- Sticky and/or hygroscopic materials;
- Combustible, corrosive or explosive materials;
- Particles that are difficult to remove in dry form;
- PM in the presence of soluble gases; and
- PM in gas stream with high moisture content.

Condensation wet scrubbers and Venturi scrubbers can attain collection efficiencies of greater than 99% for fine PM.[14] Packed-bed wet scrubbers can typically not attain better than 95% for PM in general (EPA's fact sheet does not comment on whether 95% can be attained specifically for fine PM).[15]

Cyclones

A cyclone separator (cyclone) operates on the principle of centrifugal separation. The exhaust enters the inlet and spirals around towards the outlet. As the particles proceed through the cyclone, the heavier material hits the

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[11] From EPA Air Pollution Control Technology Fact Sheet for baghouses: https://www3.epa.gov/ttnchie1/mkb/documents/ff-pulse.pdf (EPA-452/F-03-025)

[12] This analysis was researched in MDU's 2013 RACT submittal for Pacific States Cast Iron Pipe Company (PSCIPCO).

[13] From EPA Air Pollution Control Technology Fact Sheet for ESPs: https://www3.epa.gov/ttncatc1/dir1/fdespwpi.pdf (EPA-452/F-03-027)

[14] From EPA Air Pollution Control Technology Fact Sheet for condensation scrubbers: https://www3.epa.gov/ttnchie1/mkb/documents/fcondnse.pdf (EPA-452/F-03-010). Also see EPA Air Pollution Control Technology Fact Sheet for Venturi scrubbers: https://www3.epa.gov/ttncatc1/dir1/fventuri.pdf (EPA-452/F-03-017).

[15] From EPA Air Pollution Control Technology Fact Sheet for packed-bed scrubbers: https://www3.epa.gov/ttncatc1/dir1/fpack.pdf (EPA-452/F-03-015)

outside wall and drops out where it is collected. The cleaned gas escapes through an inner tube. Cyclones are generally used to reduce dust loading and collect large particles.

A high-efficiency cyclone designed specifically for $PM_{2.5}$ removal is likely to achieve between 20% and 70% removal.[16]

Cupola $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Table 3-1. Summary for Cupola $PM_{2.5}$ Emission Control

Control Technologies	Rank	Percent Control
Baghouse/Fabric Filter	1	99.9%
ESP	2	99.9%
Wet Scrubber	3	70-99%[17]
High-Efficiency Cyclone	4	20-70%

Cupola $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

The cupola is equipped with a baghouse, the highest ranking control technology listed in Step 3; therefore, no evaluation of economic, energy, or environmental effectiveness is required.

Cupola $PM_{2.5}$ Step 5 - BACT

BACT for $PM_{2.5}$ emissions from the Cupola is baghouse filtration.

Cupola $PM_{2.5}$ Most Stringent Measures

The MSM would be identical to BACT.

3.2.2. NO_X

The Cupola has a NO_X emission rate limit of 33 pounds per hour (lb/hr).[18]

Cupola NO_X Step 1 - Identify All Control Technologies

Control technologies for NO_X were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

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[16] From EPA Air Pollution Control Technology Fact Sheet for cyclones: https://www3.epa.gov/ttncatc1/dir1/fcyclon.pdf (EPA-452/F-03-005)

[17] EPA Costs Control Manual, EPA/452/B-02-001, Wet scrubbers for particulate control, July, 15 2002. Venturi removal efficiencies range from 70% to 99% for particles larger than 1 µm in diameter and greater than 50% for submicron particles.

[18] Title V Condition II.B.2.b.1

- Selective Catalytic Reduction (SCR)
- Urea Injection / Selective Non-Catalytic reduction (SNCR)
- Low-NO_X Burners (LNB) (on Afterburners)
- Good Combustion Practices
- Use of Natural Gas (on Afterburners)

Cupola NO_X Step 2 - Eliminate Technically Infeasible Options

SCR

SCR has been applied to stationary source, fossil fuel-fired, combustion units for emission control since the early 1970s. It has been applied to large (>250 MMBtu/hr) utility and industrial boilers, process heaters, and combined cycle gas turbines. There has been limited application of SCR to other combustion devices and processes such as simple cycle gas turbines, stationary reciprocating internal combustion engines, nitric acid plants, and steel mill annealing furnaces. SCR can be applied as a stand-alone NO_X control or with other technologies such as combustion controls. The reagent reacts selectively with the flue gas NO_X within a specific temperature range and in the presence of the catalyst and oxygen to reduce the NO_X into molecular nitrogen (N_2) and water vapor (H_2O).[19] The optimum operating temperature is dependent on the type of catalyst and the flue gas composition. Generally, the optimum temperature ranges from 480°F to 800°F.[20] In practice, SCR systems operate at efficiencies in the range of 70% to 90%.[21]

SNCR

MDU previously attempted implementing an SNCR / urea injection system on the cupola source and encountered technical challenges and conclusively considers it technically infeasible.

In 2005, an experimental Approval Order was requested and obtained in order to test a urea injection system on the cupola. The unit was operated in the second half of 2005. A stack test report was provided to UDAQ on January 20, 2006. The test demonstrated NO_X reductions were extremely variable, even at high urea injection rates. The variability was anticipated to be a result of absorption of ammonia onto PM present in the flue gas, rendering it unavailable for NO_X reduction. Anticipated control efficiency had been 80%, but the efficiency achieved in practice was approximately 23%, which was inconsistent with its design control efficiency and chemical use rate. SNCR was deemed infeasible and is no longer in use. Furthermore, cost figures submitted in an August 7, 2013 RACT supplemental letter to UDAQ, estimated $93,000 cost per ton of NO_X control.

Therefore, for the purposes of this BACT analysis, SNCR is considered technically infeasible.

LNB on Afterburners

LNB technology uses advanced burner design to reduce NO_X formation through the restriction of oxygen, flame temperature, and/or residence time. There are two general types of LNB: staged fuel and staged air burners. In a stage fuel LNB, the combustion zone is separated into two regions. The first region is a lean combustion region where a fraction of the fuel is supplied with the total quantity of combustion air. Combustion in this zone takes place at substantially lower temperatures than a standard burner. In the second combustion region, the

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[19] OAQPS, *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/424/B-02-001 (http://www.epa.gov/ttn/catc/dir1/c_allchs.pdf); January 2002

[20] OAQPS, *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/424/B-02-001 (http://www.epa.gov/ttn/catc/dir1/c_allchs.pdf); January 2002

[21] Ibid

remaining fuel is injected and combusted with left over oxygen from the first region. A staged air burner begins with full fuel but only partial combustion air, and then adds the remaining combustion air in the second combustion region. These techniques reduce the formation of thermal NO_X. This control technology is already in place on the afterburners.

Good Combustion Practices

Good combustion practices help achieve current emission rate limit of 33 lb/hr of NO_X from the cupola. MDU follows manufacturer's instructions and internal operation and maintenance plans to ensure proper combustion practices are applied. Good combustion practices may include, startup/shutdown procedures, monitoring of backpressure, excess oxygen, and coke size and sulfur content.

Cupola NO_X Step 3 - Rank Remaining Control Technologies by Effectiveness

Table 3-2. Summary for Cupola NO_X Emission Control

Control Technologies	Rank	Percent Control
Selective Catalytic Reduction (SCR)	1	70-90%
Good Combustion Practices	3	Intrinsic
Low-NO_X Burners (LNB) (on Afterburners)	4	Intrinsic
Use of Natural Gas (on Afterburners)	5	Intrinsic

Cupola NO_X Step 4 - Evaluate Most Effective Controls and Document Results

There are no economic, energy, or environmental obstacles to implementing the feasible control technologies, except for SCR, which is economically infeasible. Good combustion practices at the cupola, as well as LNB and natural gas use on the afterburners, are already in use to reduce NO_X.

SCR

SCR is not considered economically feasible at a control cost per ton of roughly $41,564.

A cost per ton estimate can be produced using the EPA Control Cost Manual (CCM) for SCR (Chapter 2).[22] The methods apply primarily to units that fire coal, oil, and natural gas, while the cupola is fired on coke with natural gas afterburners. To estimate the cost, the exhaust flow rate of 101,919 acfm at 239 °F is converted to an order-of-magnitude equivalent heat rate of coal of 175 MMBtu/hr. Detailed calculations may be found in Appendix A.

[22] U.S. EPA, "Chapter 2. Selective Catalytic Reduction," *Control Cost Manual* (May 2016), https://www3.epa.gov/ttn/ecas/docs/SCRCostManualchapter7thEdition_2016.pdf

Cupola NO_X Step 5 - Select BACT

BACT for NO_X emissions from the cupola is considered to be good combustion practices, with LNB and natural gas use at the afterburners.

Cupola NO_X Most Stringent Measures

MSM is identical to BACT, in this instance.

3.2.3. SO_2

Cupola SO_2 Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- Lime Scrubber or Dry Alkaline Injection Scrubber
- Limits on Coke Fuel Sulfur Content

Cupola SO_2 Step 2 - Eliminate Technically Infeasible Options

Lime Scrubber or Dry Alkaline Injection Scrubber

Control efficiencies for lime injection and dry injection scrubbing range from 50% to 98%.[23] Based on the RBLC search above, there are eight cupola units in the RBLC with lime injection and dry injection scrubber emission limits, and five of these limits are set to 0.22 lb per ton of iron processed. Two others are 19.8 lb/hr limits on 90 ton/hr cupolas, equating to 0.22 pounds per ton (lb/ton), while the last limit is 9 lb/hr on a 25 ton/hr cupola, equating to 0.36 lb/ton.

Limits on Coke Fuel Sulfur Content

Limits on coke fuel sulfur content are an effective means of controlling SO_2 emissions as coke sulfur content can be reduced. MDU's current permit allowable emissions for the cupola are 0.23 lb/ton. Actual emissions are lower.

Cupola SO_2 Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Table 3-3. Summary for Cupola SO_2 Emission Control

Control Technologies	Rank	Emission Control
Lime Scrubber or Dry Alkaline Injection Scrubber	1	0.22 lb/ton
Limits on Coke Fuel Sulfur Content	2	0.23 lb/ton

[23] From EPA Air Pollution Control Technology Fact Sheet for wet/dry/spray dry scrubbers for SO_2 control: https://www3.epa.gov/ttncatc1/dir1/ffdg.pdf (EPA-452/F-03-034).

Cupola SO_2 Step 4 - Evaluate Most Effective Controls and Document Results

The current fuel sulfur content meets a permit allowable emission factor of 0.23 lb/ton. A scrubber would offer very little additional marginal control. Therefore, it is assumed that the control cost per ton of a scrubber add-on control would be extremely high.

Cupola SO_2 Step 5 - Select BACT

BACT for SO_2 emissions is current operating practices that meet the current permit allowable emissions of 0.23 lb SO_2/ton of iron processed.

Cupola SO_2 Most Stringent Measures

MSM is identical to BACT, in this instance.

3.2.4. VOC

Gas combustion is the primary source of VOC emissions in the Cupola.

Cupola VOC Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- Afterburner
- Regenerative Thermal Oxidation (RTO)
- Catalytic Oxidation (CatOx)
- Recuperative Thermal Oxidizer (RCTO)
- Good Combustion Practices
- Use of Natural Gas (on Afterburners)

Cupola VOC Step 2 - Eliminate Technically Infeasible Options

Three of the above end-of-pipe controls are technically infeasible: RTO; CatOx; and recuperative incineration. Each of these technologies includes an additional combustion source which would add more VOC rather than further reducing VOC. Combustion would also increase NO_X, $PM_{2.5}$, and SO_2.

Afterburner

In a simple thermal oxidizer (TO) or afterburner, the flue gas is reheated in the presence of sufficient oxygen to oxidize the VOC present in the flue gas. A typical afterburner is a flare and is not equipped with any heat recovery device. The afterburner currently serving the process is designed to combust excess CO, and will destroy VOCs as it has a minimal residence time of 0.3 seconds.

Regenerative Thermal Oxidizer

A RTO is equipped with ceramic heat recovery media (stoneware) that has large surface area for heat transfer and can be stable to 2,300°F. Operating temperatures of the RTO system typically range from 1,500°F to 1,800°F with a retention time of approximately one second. The combustion chamber of the RTO is surrounded by multiple integral heat recovery chambers, each of which sequentially switches back and forth from being a predryer to a heat recovery chamber. In this fashion, energy is absorbed from the gas exhausted from the unit and stored in the heat exchange media to preheat the next cycle of incoming gas.

The process stack exhaust stream associated with the cupola is well below 1,500°F after the gas passes through the recuperator. Because gas combustion is the only source of VOC emissions from the cupola and an RTO includes additional combustion which would add VOC, NO_X, $PM_{2.5}$, and SO_2, this technology was not considered further. Additionally, if the RTO was placed upstream of the baghouse, the RTO would foul due to dust in the flue gas.

Catalytic Oxidation

CatOx allows complete oxidation to take place at a faster rate and a lower temperature than is possible with thermal oxidation. Oxidation efficiency depends on exhaust flow rate and composition. Residence time required for oxidation to take place at the active sites of the catalyst may not be achieved if exhaust flow rates exceed design specifications. Also, sulfur and other compounds may foul the catalyst, leading to decreased efficiency. In a typical CatOx, the gas stream is passed through a flame area and then through a catalyst bed at a velocity in the range of 10 to 30 feet per second (fps). CatOx typically operate at a narrow temperature range of approximately 600°F to 1,100°F. A CatOx will require additional fuel to heat the gas stream to at least 600°F which will generate additional emissions. Additionally, if the CatOx was upstream of the baghouse, the CatOx would be fouled due to dust in the flue gas. Therefore, the catalytic oxidation is considered technically infeasible.

Recuperative Thermal Oxidizer

A RCTO is more thermally efficient than simple thermal oxidization but less efficient than an RTO. The thermal efficiency is improved through the use of either a shell-and-tube or a plate-and-frame type heat exchanger in which heat from the treated flue gas is transferred or recirculated to the untreated flue gas. Up to 65 to 70% heat recovery is common. However, a RCTO is not feasible for VOC control for the cupola process due to additional fuel costs, increased natural gas consumption, and increase in emissions of concern. The RCTO is not considered further. Additionally, if the RCTO was upstream of the baghouse, the RCTO would be fouled due to dust in the flue gas.

Good Combustion Practices

The use of good combustion practices usually includes the following components: (1) proper fuel mixing in the combustion zone; (2) high temperatures and low oxygen levels in primary zone; (3) Overall excess oxygen levels high enough to complete combustion while maximizing boiler efficiency, and (4) sufficient residence time to complete combustion. Good combustion practices are accomplished through following industry recommended practices.

Use of Natural Gas

Natural gas is an inherently cleaner burning fuel that is ubiquitous in the US and can be produced domestically. The afterburners use natural gas currently.

Cupola VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The remaining control technologies ranked by effectiveness are afterburner, good combustion practices, and use of natural gas.

Table 3-4. Summary for Cupola VOC Emission Control

Control Technologies	Rank	Emission Control
Afterburner	N/A	0.07 lb/ton
Regenerative Thermal Oxidation	N/A	No additional control
Catalytic Oxidation	N/A	No additional control
Recuperative Thermal Oxidizer	N/A	No additional control
Good Combustion Practices	N/A	Intrinsic
Use of Natural Gas (on Afterburners)	N/A	Intrinsic

Cupola VOC Step 4 - Evaluate Most Effective Controls and Document Results

As good combustion practices and use of natural gas are intrinsic to the process, no economic, energy, or environmental analysis was conducted.

Cupola VOC Step 5 - Select BACT

BACT for the cupola is the use of the current afterburner design with natural gas and good combustion practices.

Cupola VOC Most Stringent Measures

MSM is the same technology as BACT, in this instance.

3.2.1. Ammonia (NH_3)

MDU found ammonia emission factors for uncontrolled boilers on EPA's WebFIRE database.[24] The emission factors cited within this document are from the 1994 version of EPA's AP-42 Chapter 1.4. In 1998, this chapter was updated and ammonia emissions were removed from the list of emission factors associated with external combustion sources fueled by natural gas such as the recuporator burners. Similarly, the NH_3 emitted from the cupola is anticipated to be minimal. Historical reporting of ammonia emissions are based on worst case derived emission factors from the SNCR study. Ammonia emissions have been reported in error as the facility does not have an SNCR, therefore, no ammonia emissions are expected from the current operation. As such, MDU assumes there are minimal ammonia emissions associated with the cupola and has not considered these emissions further for BACT.

[24] Database accessed April 12, 2017.

3.3. DESULFURIZATION UNIT AND INOCULATION TREATMENT

The desulfurization unit is used to control the sulfur content of iron produced. High levels of sulfur can change the iron product properties undesirably, (e.g., by increasing brittleness). Lime is added to the molten iron to reduce sulfur content as it flows from the cupola to the ladle.

The desulfurization process generates emissions of PM as solids are volatilized when lime is added to the molten metal bath. MDU currently controls these emissions with a baghouse.

3.3.1. $PM_{2.5}$

Desulfurization and Inoculation Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Consideration of $PM_{2.5}$ in the following BACT analysis for desulfurization and Inoculation is for filterable $PM_{2.5}$ only. Control technologies include:

- High-Efficiency Cyclone
- Wet Scrubber
- Baghouse/Fabric Filter
- Electrostatic Precipitator (ESP)

Desulfurization and Inoculation Step 2 - Eliminate Technically Infeasible Options

All four control technologies identified above are technically feasible. MDU currently uses a baghouse to control emissions from the desulfurization unit and inoculation unit.

Desulfurization and Inoculation Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Table 3-5. Summary for Desulfurization and Inoculation $PM_{2.5}$ Emission Control

Control Technologies	Rank	Percent Control[25]
Baghouse/Fabric Filter	1	99.9%
ESP	2	99.9%
Wet Scrubber	3	95-99%
High-Efficiency Cyclone	4	20-70%

Desulfurization and Inoculation Step 4 - Evaluate Most Effective Controls and Document Results

MDU currently uses a baghouse to control emissions associated with desulfurization and inoculation. As detailed in MDUs previously submitted RACT review, emissions are controlled to 0.01 gr/dscf with the existing baghouse.

[25] The percent control is based on EPA's published date in Cost Control Manual or other EPA reference documents.

It is assumed that a newer baghouse may be able to achieve up to 0.001 gr/dscf.[26] With an annualized cost of \$44,311/tons of $PM_{2.5}$ removed, this add on control is considered economically infeasible.[27]

ESP and wet scrubber add on control technologies show similar achievable emission rates. However, this is not used in the cast iron foundries industry. Baghouses are the most effective add on control for this process; therefore, a baghouse is the only unit evaluated for cost.

A baghouse meeting the 0.01 gr/dscf is considered BACT for the desulfurization and inoculation process. No detailed energy or environmental impact evaluations are required. BACT for $PM_{2.5}$ emissions from the desulfurization unit and inoculation unit is the existing baghouse.

Desulfurization and Inoculation Step 5 - Select BACT

MDU's current baghouse is achieving BACT.

Desulfurization and Inoculation Most Stringent Measures

MSM is improving the baghouse system with higher control efficiency.[28]

3.4. ANNEALING OVEN

Ductile Iron Pipe from the casting machines is received at the annealing oven. The annealing oven is approximately 70 feet (ft) long, 25 ft wide, and 8 ft high. Either end of the annealing oven (25 x 8 ft area) is open to the atmosphere, (i.e. where the pipe is conveyed in and out of the oven). Additionally, to ensure operational conditions can be physically monitored and corrected, both sides of the oven (70 x 8 ft area) have windows that may be opened to view current operations. The exhaust (combustion byproducts) from the oven is emitted to the atmosphere from the openings on either end, the side windows, and a stack that exhausts from the front of the oven (heating zone).

The annealing oven is used to improve the ductility and reduce the brittleness of the pipe produced at the plant by controlling the pipe's temperatures before cooling. The oven consists of three primary zones: heating, cooling, and isotherm which the pipe products pass through to support the complete annealing process. In the heating zone, the pipe is heated to approximately 1,800°F. The pipe then passes through the cooling zone which reduces the pipe heat to 1,400°F. The pipe then moves through the isotherm zone which keeps the pipe at around 1,350°F, depending on the chemistry of each pipe. The heat input of the annealing oven is limited to 63.29 million British thermal units per hour (MMBtu/hr) and limits of 15.9 pounds per day (lb/day) of seal-coat removed in the oven and 1,850 pounds (lb) each rolling 12 months. [29]

Startup and shutdown emissions from the annealing oven are anticipated to be no greater than normal operation. The startup process is simply a matter of bringing the oven to operating temperature.

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[26] Note this is a very aggressive controlled emission rate for $PM_{2.5}$ from a baghouse. This controlled rate does not consider condensable emissions.

[27] February 2013 RACT submittal, Appendix E. This value was inflated to March 2017 values using a Bureau of Labor Statistics CPI Inflation Calculator.

[28] An improved control efficiency would be require testing, prior to committing to an emission rate.

[29] Title V Operating Permit #4900017003 Condition II.B.4.a-b

3.4.1. $PM_{2.5}$

According to EPA's AP-42, Section 1.4, because natural gas is a gaseous fuel, filterable $PM_{2.5}$ emissions are typically low. Particulate matter from natural gas combustion has been estimated to be less than one micrometer in size and has filterable and condensable fractions. Particulate matter in natural gas combustion is usually larger molecular weight hydrocarbons that are not fully combusted. Increased particulate matter emissions can result from poor air/fuel mixing or maintenance problems. For this analysis MDU is evaluating filterable $PM_{2.5}$ only. The condensable fraction is represented with the other precursors (NO_X, SO_2, VOCs, and NH_3).

Annealing Oven $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- High-Efficiency Cyclone;
- Baghouse/Fabric Filter;
- Wet Scrubber;
- Electrostatic Precipitator (ESP);
- Good Combustion Practices; and
- Use of Natural Gas.

Annealing Oven $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

High-Efficiency Cyclone, Baghouse/Fabric Filter, Electrostatic Precipitator

Each of these technologies are considered add on controls, which requires a collection system. Due to the annealing oven configuration, it would be difficult to capture emissions from the large entrance/exit of the oven (25 ft x 8 ft), and operations monitoring side windows. If any device was added to either end of the oven to pull the exhaust to an add-on control device this would alter the temperature across the annealing oven. The temperature is controlled throughout the annealing oven to ensure proper heat distribution is maintained in each of the oven's zones (i.e., heating, cooling, and isotherm) to achieve proper annealing. As a result, a complete redesign of the oven would be required and therefore an add-on control device is considered infeasible if applied to one of the ends of the oven.

An add-on control technology may be adapted on the stack located above the heating zone of the oven, but the temperature is approximately 1,700°F and would have to be cooled prior to entering the subject PM control devices. Additionally, $PM_{2.5}$ emissions associated with combustion from all burners in the oven is approximately 2 tpy. The removal of the condensable portion of $PM_{2.5}$ is very low, so overall emission reduction from an add-on $PM_{2.5}$ control device to the stack are expected to be minimal.

Finally, there are no cases of any of these technologies being used on an annealing oven documented.

Wet Scrubber

According to EPA's Air Pollution Control Technology Fact Sheet for Wet, Spray Dry, and Dry Scrubbers, wet scrubbers require an inlet gas temperature of 700 °F or less. As the exhaust temperature of the annealing oven is 1,700 °F, this control technology is considered infeasible.

Good Combustion Practices and Use of Natural Gas

The use of good combustion practices usually includes the following components: (1) proper fuel mixing in the combustion zone; (2) high temperatures and low oxygen levels in primary zone; (3) Overall excess oxygen levels high enough to complete combustion while maximizing boiler efficiency, and (4) sufficient residence time to complete combustion. Good combustion practices are accomplished through following manufacturer recommended practices. The use of natural gas has the lowest known $PM_{2.5}$ content of currently available combustible fuels.

Annealing Oven $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Of the remaining control technologies, good combustion practices and the use of natural gas are not in competition with one another, and both are currently in use.

Table 3-6. Summary for Annealing Oven $PM_{2.5}$ Emission Control

Control Technologies	Rank	Percent Control	Technically Feasible?
Good Combustion Practices	N/A	Intrinsic	Yes
High-Efficiency Cyclone	N/A	N/A	No
Baghouse/Fabric Filter	N/A	N/A	No
Wet Scrubber	N/A	N/A	No
Electrostatic Precipitator (ESP)	N/A	N/A	No
Use of Natural Gas	N/A	Intrinsic	Yes

Annealing Oven $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

MDU is currently implementing the only feasible controls available for $PM_{2.5}$ emissions. Therefore, no detailed economic energy, and environmental evaluation were conducted.

Annealing Oven $PM_{2.5}$ Step 5 - Select BACT

BACT for $PM_{2.5}$ emissions is good combustion practices and the use of natural gas. As shown in RBLC ID AR-140 and LA-0309 determinations made on 12/13/2016 and 03/03/2017 for annealing furnaces used at steel foundries, good combustion practices and use of natural gas are considered as BACT for this pollutant.

Annealing Oven $PM_{2.5}$ Most Stringent Measures

MSM is the same technology as BACT in this instance.

3.4.2. NO_X

NO_X will be formed during combustion from two major mechanisms: thermal NO_X and fuel NO_X. Since natural gas is relatively free of fuel-bound nitrogen, the contribution of this second mechanism to the formation of NO_X emissions in natural gas-fired equipment is minimal, leaving thermal NO_X as the main source of NO_X emissions.

Thermal NO_X formation is a function of residence time, oxygen level, and flame temperature, and can be minimized by controlling these elements in the design of the combustion equipment.

Annealing Oven NO_X Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- Low Temperature Oxidation (LoTOx);
- Selective Catalytic Reduction (SCR);
- Non-Selective Catalytic Reduction (NSCR);
- Selective Non-Catalytic Reduction (SNCR);
- Ultra Low NO_X Burner (ULNB); Flue Gas Recirculation (FGR), Low Excess Air (LEA);
- Exhaust Gas Recirculation (EGR);
- Low NO_X Injection Burner;
- Use of Natural Gas; and
- Good Combustion Practices.

Annealing Oven NO_X Step 2 - Eliminate Technically Infeasible Options

Low Temperature Oxidation

LoTOx™ technology, is a low-temperature oxidation process that employs ozone to oxidize NO_2 to higher oxides of nitrogen such as N_2O_5. However, NO is also converted to NO_2, which is NO_X. As such, this technology would need to be paired with SCR or SNCR for the gas stream from the annealing oven, which is expected to emit larger portions of NO than NO_2. The potential to increase total NO_X emissions makes this option technically infeasible. The high temperature of the annealing oven exhaust (1,700 °F) also makes this infeasible. LoTOx operates optimally at a temperature below 300 °F.[30]

In addition to the potential for the technology to increase regulated air pollutants or to emit pollutants not previously emitted, LoTOx is infeasible for the following reasons:

- The technology has not been used on this type of operation.
- Control efficiency range is low.
- Introduction of a wet scrubber would require additional resources including utilities and water.
- Caustic soda introduction would be necessary to neutralize nitric acid.
- Natural gas burners in the annealing oven are too small for commercially available LoTOx systems.

Selective Catalytic Reduction

SCR systems introduce a reducing agent such as ammonia or urea into the flue gas stream before a catalyst. The catalyst reduces the temperature needed to initiate the reaction between the reducing agent and NO_X to form nitrogen and water. A SCR can achieve NO_X reduction efficiencies between 70 and 90%.[31] SCR requires capture of the exhaust gases in order to be treated and controlled. Due to the annealing oven configuration, it would be difficult to capture emissions from the large entrance/exit of the oven (25 ft x 8 ft), and operations monitoring

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[30] Nicholas Confuorto and Jeffrey Sexton, "Wet Scrubbing-Based NO_X Control Using LoTOx Technology - First Commercial FCC Start-Up," *Digital Refining* (September 2007), http://www.digitalrefining.com/article/1000812,Wet_scrubbing_based_NOX_control_using_LoTOx_technology__first_commercial_FCC_start_up.html#.WO0eIPnythF

[31] Air Pollution Control Technology Fact Sheet, SCR, EPA-452/F-03-032.

side windows. If any device was added to either end of the oven to pull the exhaust to an add-on control device this would alter the temperature across the annealing oven. The temperature is controlled throughout the annealing oven to ensure proper heat distribution is maintained in each of the oven's zones (i.e., heating, cooling, and isotherm) to achieve proper annealing.

An add-on control technology may be adapted on the stack located above the heating zone of the oven. Based on the current design of the facility, there are physical space limitations for the addition of an add-on control technology as large as an SCR. Furthermore, an SCR would increase ammonia emissions from this source, another precursor to $PM_{2.5}$. Even though the addition of SCR on the stack will only reduce a portion of NO_X emissions from the annealing oven, and will emit additional ammonia, this technology is being considered for economic feasibility.

Non-Selective Catalytic Reduction

NSCR requires that the exhaust gases be captured in order to be treated and controlled. Gas capture from the annealing ovens is expected to be technically infeasible because the oven ends and the oven interior are open to the atmosphere as previously discussed in the SCR section. Capture from the stack associated with the heating zone of the oven may be feasible.

NSCR chemistry is not likely to be effective in the annealing ovens' exhaust stream due to the quantity of dilution air used. According to U.S. EPA's CAM Technical Guidance Document, Appendix B.16, NSCR is intended for use on exhaust streams with low oxygen content (less than 0.5 vol%).[32] The chemistry of NSCR reduces NO_X by oxidizing CO, H_2, and hydrocarbons. However, if O_2 is present, the CO, H_2, and hydrocarbons will preferably oxidize with the O_2 rather than the NO_X. Therefore, NSCR must use some of the CO, H_2, and hydrocarbons to oxidize all the O_2 before any NO_X control is possible. By design, the annealing oven operates with a large amount of dilution air, so the oxygen content of the exhaust gas is high; it is expected that the chemistry would not have enough CO, H_2, and hydrocarbons left over to reduce any NO_X. Therefore, NSCR is technically infeasible.

Selective Non-Catalytic Reduction

SNCR requires that the exhaust gases be captured in order to be treated and controlled. Gas capture from the annealing ovens is expected to be technically infeasible because the oven ends and the oven interior are open to the atmosphere as previously discussed. Capture from the stack associated with the heating zone of the oven may be feasible.

SNCR can achieve reduction levels ranging from 30% to 50%.[33] However, the SCNR is less effective at lower levels of uncontrolled NO_X. The NO_X levels required for an effective SNCR are 200-400 ppm.[34] Additionally, like SCR, SNCR also has ammonia slip emissions due to unreacted ammonia from the incomplete reaction of the NO_X and the reagent. This will result in emissions of ammonia.

Even though the SNCR will only reduce a portion of NO_X emissions from the annealing oven (since only a portion of emissions flow through the heating zone stack), it is being considered for economic feasibility.

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[32] U.S. EPA, "Technical Guidance Document: Compliance Assurance Monitoring" (April 2002), p. B-134.

[33] Air Pollution Control Technology Fact Sheet, SNCR, EPA-452/F-03-031.

[34] Ibid.

Ultra-Low NO_X Burners

ULNB represent the state of the art for low NO_X burner design. Various sources give different levels of expected performance from ULNBs. Some sources have achieved as low as 9 parts per million by volume (ppmv) NO_X (3% O_2) (0.011 pound per million British thermal units (lb/MMBtu)). The current configuration and design of the annealing ovens is represented by the AP-42 Section 1.4 combustion emission factor at 0.049 lb/MMBtu. To use ULNB attaining lower emissions than this factor, MDU would need to redesign the annealing oven's combustion system.

Safety issues have been identified with UNLB as these burners have been known to experience a "flame out" condition where the fuel valves remain open. The safety issue makes this technology infeasible.

Flue Gas Recirculation; Low Excess Air

As identified in correspondence with UDAQ, neither LEA nor FGR is feasible for emission control on the annealing oven because it requires a large amount of dilution air to operate.[35] The large flow of dilution air is infeasible to capture and reroute back into the annealing ovens. As a result, FGR and LEA are not being considered further.

Exhaust Gas Recirculation

With EGR, a portion of the exhaust gas is recirculated, diluting the oxygen in the incoming air stream. Peak temperature and pressure are reduced resulting in a decrease in NO_X.

EGR technology is appropriate for vertically-designed burners. MDU's annealing ovens are horizontal, wall-mounted burners. Due to the open-ended configuration of the annealing oven, a large amount of dilution air is present. The horizontal, open-ended configuration renders this control technology infeasible at the MDU facility.

Low-NO_X Injection Burner

Per BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017, this technology is not currently in use on comparable equipment. The annealing oven would require a redesign of the combustion system to use this control technology. However, it is being considered for economic feasibility.

Good Combustion Practices

Good combustion practices currently in use at MDU may include use of low emitting fuels, proper equipment design, and proper maintenance of equipment, house-keeping, and general operating practices following manufacture recommendations where appropriate. This technology is feasible.

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[35] Correspondence with UDAQ, March 20, 2015.

Annealing Oven NO_X Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Table 3-7. Summary for Annealing Oven NO_X Emission Control

Control Technologies	Rank	Controlled Rate
SCR	1	8.17 lb/MMscf[36]
Low NO_X Injection Burner	2	38.1 lb/MMscf
Alternative Low NO_X Burners	3	76.2 lb/MMscf[37]
Low NO_X Burner - Existing	4	81.7 lb/MMscf
Good Combustion Practices + Use of Natural Gas	N/A	Intrinsic

Annealing Oven NO_X Step 4 - Evaluate Most Effective Controls and Document Results

SCR

There are several technical considerations for the installation of an SCR including physical space and ammonia emissions. However, MDU has completed a cost analysis for the installation of an SCR on the stack over the heating zone. The stack only emits a portion of the natural gas combustion emissions associated the annealing oven. Therefore, for the cost analysis only one third of the emissions and one third of the annealing oven capacity was considered for 90% reduction in emissions. With this consideration, it would cost $66,126/ton of NO_X removed to install SCR. Considering the economic infeasibility and other potential technical issues, this technology is eliminated from further consideration.

Low-NO_X Injection

In October 31, 2013 RACT-related correspondence with UDAQ, MDU presented a cost assessment for a LNI system determining that the total annualized cost of installing this system was $367,700. In 2016 dollars scaled by the Chemical Engineering Plant Cost Index (CEPCI), this cost would be $340,700.[38] Given an expected emission factor of 38.1 lb/MMscf or 0.037 lb/MMBtu, and a current emission factor of 50 lb/MMscf or 0.049 lb/MMBtu, and a heat rate of 63.29 MMBtu/hr, the expected emission reduction from LNI would be 3.32 tons per year (tpy). Therefore, the control cost per ton is expected to be $102,600/ton.

There are no economic, energy, or environmental obstacles to implementing any of the remaining feasible control technologies.

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[36] Note, this level of control may only be applied to the heating zone stack, and therefore only a third of emissions from the annealing oven is expected to be able to meet this emission rate.

[37] Documented in PSCIPCO letter response to UDAQ on October 31, 2013 for Moderate $PM_{2.5}$ Non-attainment SIP.

[38] CEPCI values obtained from http://www.chemengonline.com/site/plant-cost-index/ on March 14, 2017. The average annual 2012 index was 584.6, while the average annual 2016 index was 541.7. The cost analysis submitted October 31, 2013, did not specify its year of index, but the values are assumed to be current, and it is noted that an annual 2013 value would not have been available until after the end of calendar year 2013.

Table 3-8. Summary for Annealing Oven NO_X Emission Control

Control Technologies	Technically Feasible?	Rank	Percent Control	Cost Effectiveness ($/ton)	BACT
SCR	Yes		90%	$66,126	No
Low NO_X Injection	Yes	N/A	53%	$102,600	No
Alternative Low NO_X Burners[39]	Yes	N/A	7%	$199,790	No
Good Combustion Practices + Natural Gas Usage	Yes - Currently In Use	N/A	N/A	In Use	Yes
Low-NO_X Burners	Yes - Currently In Use	N/A	N/A	In Use	Yes

Annealing Oven NO_X Step 5 - Select BACT

BACT for NO_X emissions from the annealing oven is good combustion practices and the use of natural gas.

Annealing Oven NO_X Most Stringent Measures

MSM is the same technology as BACT in this instance.

3.4.3. SO_2

Sulfur dioxide emissions result from the amount of sulfur in fuel and the combustion process.

Annealing Oven SO_2 Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- Use of Natural Gas
- Dry Scrubber
- Wet Scrubber
- Good Combustion Practices

Annealing Oven SO_2 Step 2 - Eliminate Technically Infeasible Options

Post-combustion devices such as wet or dry scrubbers are typically installed on coal-fired power plants that burn fuels with much higher sulfur contents. The SO_2 concentrations in the natural gas combustion exhaust gases from the annealing oven is too low for scrubbing technologies to work effectively or to be technically

[39] October 31, 2013 Letter to UDAQ Page 5 of 9. This value was inflated to March 2017 values using a Bureau of Labor Statistics CPI Inflation Calculator.

feasible and cost effective. These control technologies require much higher sulfur concentrations in the exhaust gases to be feasible as a control technology. Thus, post-combustion SO_2 control devices, such as wet and dry scrubbing have not been achieved in practice on natural gas furnaces. Since these controls are not technically feasible, they have been eliminated from further consideration for the annealing oven.

Use of Natural Gas

Use of low-sulfur natural gas is a control technique that has been achieved in practice and is technically feasible and will be further considered for BACT.

Good Combustion Practices

Good combustion practices currently in use at MDU may include use of low emitting fuels, proper equipment design, proper maintenance of equipment, house-keeping, and general operating practices following manufacture recommendations where appropriate. This technology is feasible.

Annealing Oven SO_2 Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Of the remaining control technologies, good combustion practices and the use of natural gas are not in competition with one another, and both are currently in use.

Table 3-9. Summary for Annealing Oven SO_2 Emission Control

Control Technologies	Rank	Percent Control	Feasible	BACT
Good Combustion Practices	N/A	Intrinsic	Yes	Yes
Use of Natural Gas	N/A	Intrinsic	Yes	Yes

Annealing Oven SO_2 Step 4 - Evaluate Most Effective Controls and Document Results

Since the highest ranked control in place for this gas stream, no detailed economic, energy, and environmental impact evaluations were conducted.

Annealing Oven SO_2 Step 5 - Select BACT

BACT for SO_2 emissions is good combustion practices and the use of natural gas.

Annealing Oven SO_2 Most Stringent Measures

MSM is the same technology as BACT in this case.

3.4.4. VOC

Annealing Oven VOC Step 1 - Identify All Control Technologies

Control technologies were identified via a BAAQMD, SJVAPCD, and SCAQMD regulatory review as well as an RBLC search on similar equipment conducted on March 21, 2017. Control technologies include:

- Regenerative Thermal Oxidation
- Recuperative Incinerator
- Catalytic Oxidation
- Use of Natural Gas
- Good Combustion Practices

Annealing Oven VOC Step 2 - Eliminate Technically Infeasible Options

The annealing oven has low concentrations of VOCs. Add-on controls become technically infeasible as the exhaust concentrations are less than what can be achieved through add-on controls.

Regenerative Thermal Oxidation

Using an incinerator or oxidizer to control VOC requires that the exhaust gases be captured in order to be treated and controlled. Gas capture from the annealing oven is \technically infeasible because the oven ends and the oven interior are open to atmosphere.

VOC loading of the inlet stream due to natural gas combustion is 5.5 lb/MMscf or 0.0054 lb/MMBtu. Converting to ppmv using EPA Method 19,

$$\left(\frac{0.0054\ lb\ VOC\ exhaust}{MMBtu\ gas\ fired}\right)\left(\frac{MMBtu\ gas\ fired}{8{,}710\ dscf\ exhaust}\right)\left\{\left(\frac{dscf\ ppm}{0.0000001194\ lb\ as\ NO_2}\right)\left(\frac{46.01\ lb\ as\ NO_2}{44.1\ lb\ as\ propane}\right)\right\}\left(\frac{20.9-3}{20.9}\right)$$

$$= 4.63\ ppmv\ VOC\ as\ propane\ at\ 3\%\ O_2$$

According to EPA's Air Pollution Control Technology Fact Sheet for Thermal Incinerators, emissions control for low-VOC-inlet incinerators can and have been used effectively at inlet loadings as low as 100 ppmv or less (EPA, 1995) . This value is greater than the trace VOC caused by natural gas combustion, so it is expected that treating the VOC by incineration is infeasible.

Recuperative Incinerator

Using an incinerator or oxidizer to control VOC requires that the exhaust gases be captured in order to be treated and controlled. Gas capture from the annealing ovens is expected to be technically infeasible because the oven ends and the oven interior are open to atmosphere.

According to EPA's Air Pollution Control Technology Fact Sheet for Thermal Incinerators, emissions control for low-VOC-inlet incinerators can and have been used effectively at inlet loadings as low as 100 ppmv or less (EPA, 1995) . This value is greater than the trace VOC caused by natural gas combustion, so it is expected that treating the VOC by incineration is infeasible.

Catalytic Oxidation

According to EPA's Air Pollution Control Technology Fact Sheet for Catalytic Incinerators, the maximum design exhaust temperature for the catalyst is 1,250 °F. As the exhaust temperature of the annealing oven is 1,700 °F, this technology is considered technologically infeasible.

Using an incinerator or oxidizer to control VOC requires that the exhaust gases be captured in order to be treated and controlled. Gas capture from the annealing ovens is expected to be technically infeasible because the oven ends and interior are open to the atmosphere.

Annealing Oven VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Of the remaining control technologies, good combustion practices and the use of natural gas are not in competition with one another, and both are currently in use.

Table 3-10. Summary of Annealing Oven VOC Emission Control

Control Technologies	Rank	Percent Control	Feasible	BACT
Good Combustion Practices	N/A	Intrinsic	Yes	Yes
Use of Natural Gas	N/A	Intrinsic	Yes	Yes

Annealing Oven VOC Step 4 - Evaluate Most Effective Controls and Document Results

There are no economic, energy, or environmental obstacles to implementing either of the two feasible control technologies.

Annealing Oven VOC Step 5 - Select BACT

BACT for VOC emissions is good combustion practices and the use of natural gas.

Annealing Oven VOC Most Stringent Measures

MSM is the same technology as BACT in this instance.

3.4.5. Ammonia (NH_3)

MDU found ammonia emission factors for uncontrolled boilers on EPA's WebFIRE database.[40] The emission factors cited within this document are from the 1994 version of EPA's AP-42 Chapter 1.4. In 1998, this chapter was updated and ammonia emissions were removed from the list of emission factors associated with external combustion sources fueled by natural gas. As such, MDU assumes there are minimal ammonia emissions associated with the annealing oven and has not considered these emissions further for BACT.

3.5. FINISHING HEATERS

Following the annealing process, MDU has three natural gas fired finishing heaters.

The three finishing heaters include:

- 2.25 MMBtu/hr Pipe Curing Heater;
- 1.94 MMBtu/hr Pipe Drying Heater;
- 2.0 MMBtu/hr Pipe Curing Heater.

With a combined capacity of only 6.19 MMBtu/hr, these heaters dry and cure the coated products. The heaters appear in section II.A.9 of the facility's January 12, 2016 approval order.

[40] Database accessed April 12, 2017.

Startup and shutdown emissions from the finishing heaters are anticipated to be no greater than normal operation as it's a matter of just bringing the heaters to operating temperature.

3.5.1. $PM_{2.5}$

Finishing Heaters Combustion $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies for $PM_{2.5}$ from units of this size are as follows:

- Good Combustion Practices;
- Use of Natural Gas.

Each of the small heaters combusts natural gas. Related natural gas combustion emissions are anticipated to be minimal.

Finishing Heaters Combustion $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Both of these technologies are technically feasible; in fact both are currently effectively used for the finishing heaters.

Natural Gas Combustion

Natural gas is an inherently cleaner burning fuel that is ubiquitous in the US and can be produced domestically.

Good Combustion Practices

Good combustion practices include following manufacturer recommendations for operation and maintenance.

Finishing Heaters Combustion $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Both of these technologies offer intrinsic emission reductions from combustion. Since the technologies do not compete, both technologies can be used at the same units simultaneously.

The impact of using natural gas can be evaluated based on the difference in mass emission per heat production (lb/MMBtu).

Table 3-11. Fuel Oil and Natural Gas $PM_{2.5}$ Emissions

Fuel Type	Emission Factor	HHV	Emission Factor (lb/MMBtu)
Natural Gas	7.6 lb/MMscf	1,020 Btu/scf	= 7.4×10^{-3}
No. 2 Fuel Oil	3.3 lb/Mgal (filt. + cond.)	140 MMBtu/Mgal	= 23×10^{-3}

Finishing Heaters Combustion $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document

Results

Because both control technologies are currently in use at all three heaters, the incremental cost of implementation is zero.

Finishing Heaters Combustion $PM_{2.5}$ Step 5 - Select BACT

BACT for $PM_{2.5}$ is good combustion practices and the use of natural gas.

Finishing Heaters Combustion $PM_{2.5}$ Most Stringent Measures

MSM is the same technology as BACT in this instance.

3.5.2. NO_X

Finishing Heaters Combustion NO_X Step 1 - Identify All Control Technologies

Control technologies for NO_X from units of this size are as follows:

- Good Combustion Practices;
- Low-NO_X Burners;
- Flue Gas Recirculation.

Finishing Heaters Combustion NO_X Step 2 - Eliminate Technically Infeasible Options

Flue Gas Recirculation

The exhaust from the heaters is emitted inside a building in a fugitive nature. In order to recirculate these gases, it would be necessary to collect the gases and route them into the heater inlets. It is not technically feasible to recirculating the exhaust gases to a heat exchanger as is done with FGR.

All Other Technologies

Both good combustion practices and low NO_X burners are technically feasible. Both technologies are currently in use on the finishing heaters.

Finishing Heaters Combustion NO_X Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Of the two feasible control technologies, both can be implemented simultaneously on all three heaters.

Table 3-12. Summary for Finish Heater NO_X Emission Control

Control Technologies	Feasible	Rank	Percent Control	Cost Effectiveness ($/ton)	BACT
Good Combustion Practices	Yes - Currently In Use	N/A	N/A	In Use	Yes
Low-NO_X Burners	Yes - Currently In Use	N/A	N/A	In Use	Yes

Finishing Heaters Combustion NO_X Step 4 - Evaluate Most Effective Controls and Document Results

Since both good combustion practices and low-NO_X burners are currently in use on the finish heaters, no detailed economic, energy, and environmental impact evaluations were conducted.

Finishing Heaters Combustion NO_X Step 5 - Select BACT

BACT for NO_X is good combustion practices and the use of low NO_X burners.

Finishing Heaters Combustion NO_X Most Stringent Measures

MSM is a combination of the two control technologies identified here.

3.5.3. SO_2

SO_2 emissions are due to natural gas combustion. Emissions associated with the finishing heaters are less than one tpy.

Finishing Heaters Combustion SO_2 Step 1 - Identify All Control Technologies

Control technologies for SO_2 from units of this size are as follows:

- Good Combustion Practices;
- Use of Natural Gas.

Pipeline quality natural gas has a low sulfur content. Use of a fuel containing low sulfur content is considered a control technology.

Finishing Heaters Combustion SO_2 Step 2 - Eliminate Technically Infeasible Options

These technologies are technically feasible; in fact both are currently effectively used for the finishing heaters.

Finishing Heaters Combustion SO_2 Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Both of these technologies offer intrinsic emission reductions from combustion. Since the technologies do not compete, both technologies can be used at the same units simultaneously. The percent reduction of emissions from using natural gas depends on the sulfur content of local natural gas and other fuels, e.g., liquefied petroleum gases or distillate oil. Natural gas is expected to be the lower-sulfur fuel.

Table 3-13. Summary for Finishing Heaters SO_2 Emission Control

Control Technologies	Feasible	Rank	Percent Control	Cost Effectiveness ($/ton)	BACT
Good Combustion Practices	Yes - Currently In Use	N/A	N/A	In Use	Yes
Use of Natural Gas	Yes - Currently In Use	N/A	N/A	In Use	Yes

Finishing Heaters Combustion SO_2 Step 4 - Evaluate Most Effective Controls and Document Results

Since both control technologies are currently in use for the three heaters, no detailed economic, energy, and environmental impact evaluations were conducted.

Finishing Heaters Combustion SO_2 Step 5 - Select BACT

BACT for SO_2 is good combustion practices and the use of natural gas.

Finishing Heaters Combustion SO_2 Most Stringent Measures

MSM is a combination of the two control technologies identified here.

3.5.4. VOC

Finishing Heaters Combustion VOC Step 1 - Identify All Control Technologies

Control technologies for VOC from units of this size are as follows:

- Good Combustion Practices;
- Use of Natural Gas.

Finishing Heaters Combustion VOC Step 2 - Eliminate Technically Infeasible Options

These technologies are technically feasible; in fact both are currently effectively used for the Finish Heaters.

Finishing Heaters Combustion VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Both of these technologies offer intrinsic emission reductions from combustion. Since the technologies do not compete, both technologies can be used at the same units simultaneously.

Table 3-14. Summary for Finish Heater VOC Emission Control

Control Technologies	Feasible	Rank	Percent Control	Cost Effectiveness ($/ton)	BACT
Good Combustion Practices	Yes - Currently In Use	N/A	N/A	In Use	Yes
Use of Natural Gas	Yes - Currently In Use	N/A	N/A	In Use	Yes

Finishing Heaters Combustion VOC Step 4 - Evaluate Most Effective Controls and Document Results

Since both control technologies are currently in use on the three heaters, no detailed economic, energy, and environmental impact evaluations were conducted.

Finishing Heaters Combustion VOC Step 5 - Select BACT

BACT for VOC is good combustion practices and the use of natural gas. Since the heaters are using natural gas as a fuel, under normal conditions the VOC emissions will be minimal.

Finishing Heaters Combustion VOC Most Stringent Measures

MSM is a combination of the two control technologies identified here.

3.5.5. Ammonia (NH_3)

MDU found ammonia emission factors for uncontrolled boilers on EPA's WebFIRE database.[41] The emission factors cited within this document are from the 1994 version of EPA's AP-42 Chapter 1.4. In 1998, this chapter was updated and ammonia emissions were removed from the list of emission factors associated with external combustion sources fueled by natural gas. As such, MDU assumes there are minimal ammonia emissions associated with the finishing heaters and has not considered these emissions further for BACT.

3.6. WELDING

MDU carries out welding operations as part of the "miscellaneous equipment" listed under Section II.A.21 of the Approval Order issued January 12, 2016. Welding operations are sources of $PM_{2.5}$ emissions. Approximately 6% of product is welded. Note, welding of ductile iron is not often conducted outside the ductile iron pipe industry. Therefore, standard practices for this material are not specifically outlined in the manufacturer's specifications.

3.6.1. $PM_{2.5}$

Particulate matter is generated by the welding process itself. Elemental composition of the welding fumes is based on the type of electrode and work piece composition. Welding emissions are estimated at approximately 3.5 tpy of $PM_{2.5}$.

Welding $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies identified for $PM_{2.5}$ emissions from welding operations are as follows:

- Management Practices; and
- Capture and Collection Systems.

Welding $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

All options are considered technically feasible.

Management Practices

Management practices should minimize $PM_{2.5}$ emissions while maintaining welding quality and using engineering judgement. Management practices may include one or more of the following practices[42]:

[41] Database accessed April 12, 2017.

[42] 40 CFR Part 63.11516(f)

- Operate all equipment per manufacturer's instructions,
- Reduce fume generation rates,
- Reduce fume generation capabilities,
- Use of welding fillers, shielding carrier gases, or materials with reduced fume generation,
- Optimize welding process variable to reduce the amount of fume generated, and
- Fume capture and control discussed below.

Capture and Collection Systems

AP-42 lists capture systems which may include welding booths, hoods, torch fume extractors, flexible ducts and portable ducts. Collection/control systems may include high efficiency filters, ESPs, scrubbers, and activated carbon filters.[43]

Welding $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The two options presented are not mutually exclusive. Capture and collection can reduce emissions with good management practices employed. When reviewing these options independently, a capture and collection system would provide higher overall control than management practices.

Welding $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

There are no energy or environmental obstacles to implementing either of the two feasible control technologies. A baghouse is considered the capture and control system with the lowest achievable emission rate. A cost per ton estimate can be produced using the EPA's CCM for a baghouse or filter. To estimate the cost, the flowrate was estimated to 5,000 scfm. Using a baghouse, costs are estimated as $24,025/ton of pollutant removed. Detailed calculations are provided in Appendix A.

Welding $PM_{2.5}$ Step 5 - Select BACT

Fugitive emissions from welding processes are subject to R307-309-46 and to best management practices of minimizing emissions, by welding indoors if at all possible. BACT for welding is to follow manufacturer-recommended practices.

Table 3-15. Summary for Welding $PM_{2.5}$ Emission Control

Control Technologies	Technically Feasible?	Rank	Percent Control	Cost Effectiveness ($/ton)	BACT
Capture & Control	Yes	1	99%	$24,025	No
Management Practices	Yes - Currently In Use	2	N/A	In Use	Yes

[43] EPA AP-42 Chapter 12.19

Welding $PM_{2.5}$ Most Stringent Measures

Capture and control may be MSM in this instance.[44]

3.7. MATERIAL HANDLING AND FUGITIVE PARTICULATE

The following sources of fugitive PM and materials handling PM are grouped into three groups for BACT analysis, and each source in each group is similar enough to the others that the same suite of control technologies is considered available. The three groups are as follows:

Materials Handling - Emission Collected at Pickup Points

- Finishing Cement Handling
- Finishing Sand Handling
- Silos (Cement, Sand, Lime, Enviroblend)

Materials Handling – Emissions Not Collected

- Slag Conveyor
- Scrap Cutting (Torch)
- Tuyere Injection to Cupola (Drop Point)
- Scrap (Plate/Structural, Returns, Shred) Handling[45]
- Limestone Handling
- Ferro Silica Material Handling[46]
- Coke/Anode Handling[47]
- Lime Handling[48]

Roads and Landfill

- Paved Plant Roads and Parking Areas
- Unpaved Roadways
- Industrial Waste Landfill

3.7.1. $PM_{2.5}$ - Collected Material Handling

Collected Material Handling $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies identified for $PM_{2.5}$ emissions from material handling operations are as follows, based on March 21, 2017 review of relevant entries in EPA's RACT/BACT/LAER Clearinghouse (RBLC):

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[44] McWane will need to contact vendors to evaluate capture and control further to verify that this option is technically feasible.

[45] These are large pieces of scrap metal with little to no ability to become airborne.

[46] Relatively heavy material, very little dust observed resulting from handling.

[47] Anodes are good sized and little to no dust has been observed from handling operations. Some dust is generated from rail unloading which occurs 2 times per week.

[48] Primarily an enclosed process with little to no emission generating potential.

- Watering and Material Moisture Content
- Cyclone
- Wet Scrubber
- Baghouse / Fabric Filter
- Electrostatic Precipitator (ESP)
- Enclosures

Collected Material Handling $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Watering and Material Moisture Content; Wet Scrubbers

Control technology involving water contact with the materials is infeasible for all of the materials sources because the moisture content of all handled materials must be minimized for process control and employee safety.

Electrostatic Precipitator

This control technology is infeasible for all of the material handling sources. ESP is a proven technology for reducing combustion emissions, but it is much less effective when controlling intermittent or sporadic emission sources such as the sources identified above. Furthermore, it is expected that the space requirement for an ESP is prohibitive when controlling material handing emissions.

Baghouse, Cyclone

Baghouses and cyclones are both systems which remove PM from captured air containing fugitive material landing emissions. If the emissions are picked up and routed to a control system, either a baghouse or a cyclone is feasible. MDU currently uses a baghouse to reduce PM emissions from material handling collected at pickup points.

Enclosures

Enclosures are feasible for the material handling emission points described in this section.

Collected Material Handling $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

- Baghouses: The typical baghouse has control efficiency between 95% and 99.9%.[49]
- Cyclones: A high-efficiency cyclone designed specifically for $PM_{2.5}$ removal is likely to achieve between 20% and 70% removal.[50]
- Enclosures: According to EPA publications, an enclosure can achieve up to 100% capture efficiency if the enclosure is total and permanent, but even a 100%-efficient enclosure is only as efficient as the control device to which it routes.[51] For partial enclosures, this BACT analysis does not take credit for any enclosure control better than the pickup-point control systems (baghouses, cyclones) named above.

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[49] From EPA Air Pollution Control Technology Fact Sheet for baghouses: https://www3.epa.gov/ttnchie1/mkb/documents/ff-pulse.pdf (EPA-452/F-03-025)

[50] From EPA Air Pollution Control Technology Fact Sheet for cyclones: https://www3.epa.gov/ttncatc1/dir1/fcyclon.pdf (EPA-452/F-03-005)

[51] From EPA Air Pollution Control Technology Fact Sheet for permanent total enclosures: https://www3.epa.gov/ttncatc1/dir1/fpte.pdf (EPA-452/F-03-033)

Table 3-16 - Summary of $PM_{2.5}$ for Material Handling

Control Technologies	Rank	Percent Control	Feasible	BACT
Baghouse	1	95 - 99.9%	Yes – For Captured Sources	Yes – For Captured Sources
High-Efficiency Cyclone	2	20 - 70%	Yes – For Captured Sources	No
Partial Enclosure	3	Low	Yes	Yes – For Uncaptured Fugitive Sources

Collected Material Handling $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

While a cyclone and enclosure controls are technically feasible control options for collected material handling sources, the control efficiency for these technologies are less than the baghouse currently installed for the processes.

The highest ranking controls (i.e., baghouse and partial enclosures) for material handling are currently in use, there is not a need to conduct further detailed economic, energy, and environmental impact evaluations.

Collected Material Handling $PM_{2.5}$ Step 5 - Select BACT

BACT for fugitive PM emissions which have collection points are the existing baghouses that have an estimated control efficiency of 99%.

- The cement, sand, reagent and lime material handling systems are controlled from the point where the material is received, to when the material is in its final product container. Material is pneumatically transferred from trucks to silos, which are controlled by baghouses. As the material is transferred from the silos, it is either conveyed into enclosed containers or controlled at the drop point.

Collected Material Handling $PM_{2.5}$ Most Stringent Measures

For collected material handling sources, MSM is the same technology as BACT (i.e., baghouse) in this case.

3.7.2. $PM_{2.5}$ - Non-Collected Material Handling

Non-Collected Material Handling $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies identified for $PM_{2.5}$ emissions from material handling operations are as follows, based on March 21, 2017 review of relevant entries in EPA's RACT/BACT/LAER Clearinghouse (RBLC):

- Watering and Material Moisture Content
- Cyclone
- Wet Scrubber

- Baghouse / Fabric Filter
- Electrostatic Precipitator (ESP)
- Management/Operation Practices
- Enclosures

Non-Collected Material Handling $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

The identified items for this section are further subdivided for ease of this evaluation.

- Scrap Cutting (Torch)
- Tuyere Injection to Cupola (Drop Point)
- Lime Handling
- Limestone Handling
- FerroSilica Material Handling
- Slag Conveyor
- Scrap (Plate/Structural, Returns, Shred) Handling
- Coke/Anode Handling

Watering and Material Moisture Content; Wet Scrubbers

Control technology involving water contact with the materials is infeasible for all of the raw materials sources because the moisture content of all handled materials must be minimized for process control, employee safety.

Electrostatic Precipitator

This control technology is infeasible for all of the material handling sources. ESP is a proven technology for reducing combustion emissions, but it is much less effective when controlling intermittent or sporadic emission sources such as the sources identified above. Furthermore, it is expected that the space requirement for an ESP is prohibitive when controlling material handing emissions.

Baghouse, Cyclone

Baghouses and cyclones are both systems which remove PM from captured air containing fugitive material handling emissions. If the emissions are picked up and routed to a control system, such as conveyor drop points, either a baghouse or a cyclone is feasible. However, for material handling emissions which cannot be captured and routed to a central control point, such scrap cutting, or initial material (limestone, scrap, ferrosilica, coke/anodes) neither a baghouse nor a cyclone is considered feasible.

Enclosures

Enclosure effectiveness is highly dependent upon if the activity is such that it is readily enclosed and does not need to occur outside of the enclosure. A few of the above sources utilize this method currently.

- Lime Handling – Currently occurs under cover.
- Limestone Handling – Conveyor load and drop points and conveyor itself are under cover.
- Ferro Silica Handling – Conveyor load and drop points and conveyor itself are under cover.
- Slag Conveyor – Conveyor load and majority of conveyor are under cover. Slag is solid and fractures/shatters upon drop point.
- Coke/Anode Handling - Conveyor load and drop points and conveyor itself are under cover.

Enclosures are feasible for the material handling emission points described above.

Management/Operation Practices

Management practices of material movement should minimize $PM_{2.5}$ emissions. These include, but not limited to minimizing material drop heights; proper operation of equipment (torch scrap cutting) and having the scrap reasonably free of foreign matter, minimizing the use of dust generating materials in type and size, etc.

Non-Collected Material Handling $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

- Baghouses: The typical baghouse has control efficiency between 95% and 99.9%.[52]
- Cyclones: A high-efficiency cyclone designed specifically for $PM_{2.5}$ removal is likely to achieve between 20% and 70% removal.[53]
- Enclosures: According to EPA publications, an enclosure can achieve up to 100% capture efficiency if the enclosure is total and permanent, but even a 100%-efficient enclosure is only as efficient as the control device to which it routes.[54] For partial enclosures, this BACT analysis does not take credit for any enclosure control better than the pickup-point control systems (baghouses, cyclones) named above.

Table 3-17. Summary of $PM_{2.5}$ for Material Handling

Control Technologies	Rank	Percent Control	Feasible	BACT
Baghouse	1	95 - 99.9%	Yes – For Capturable Sources	Yes – For Capturable Sources
High-Efficiency Cyclone	2	20 - 70%	Yes – For Capturable Sources	No
Partial Enclosure	3	Low	Yes – For Consistent Activity Locations	Yes – For Uncaptured Fugitive Sources
Management/Operation Practices	4	Low	Yes	Yes

[52] From EPA Air Pollution Control Technology Fact Sheet for baghouses: https://www3.epa.gov/ttnchie1/mkb/documents/ff-pulse.pdf (EPA-452/F-03-025)

[53] From EPA Air Pollution Control Technology Fact Sheet for cyclones: https://www3.epa.gov/ttncatc1/dir1/fcyclon.pdf (EPA-452/F-03-005)

[54] From EPA Air Pollution Control Technology Fact Sheet for permanent total enclosures: https://www3.epa.gov/ttncatc1/dir1/fpte.pdf (EPA-452/F-03-033)

Non-Collected Material Handling $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

Baghouse and cyclone controls are technically feasible control options for collected material handling sources. However, not all emissions can be collected and the control efficiency for these technologies may be less than the partial enclosure control currently in use.

A partial enclosure is an effective control option as it is already installed for the following areas:

- Tuyere Injection to Cupola[55]
- Lime Handling[56]
- Limestone Handling[57]
- FerroSilica Material Handling[58]
- Slag Conveyor
- Scrap (Plate/Structural, Returns, Shred) Handling
- Coke/Anode Handling (Partial)

Emissions from Tuyere Injection, Lime Handling, Limestone Handling, and FerroSilica Handling are between 100-200 lbs/year per operation. Additional controls were not considered further for these sources due to the minimal impact on total emissions.

Coke and anode handling (coke) $PM_{2.5}$ emissions are only partially controlled through partial enclosures. The current method of offloading coke is through an elevated rail car dropping the material through bottom doors onto the ground. A partial enclosure for this operation is estimated to be $100,000 - $300,000 depending on complexity of design. Since emissions are less than 1 ton/year, the cost per ton of removal exceeds $100,000. Therefore, partial enclosure is not considered further. Installing a dump hopper for railroad cars to below grade is not an option due to a high water table in the area (water may be found as close as thirty inches below grade). The frequency of this activity is approximately twice a week lasting about two hours per episode. This operation occurs during daylight hours for worker safety.

Scrap cutting occurs at various areas throughout the facility and the size of scrap to cut and then retrieve exceed typical enclosure sizes. Management or operational practices of scrap cutting and handling minimize $PM_{2.5}$ emissions. Management and operational practices of scrap cutting and handling include, but are not limited to minimizing material drop heights; proper operation of equipment and having the scrap reasonably free of foreign matter, minimizing the use of dust generating materials in type and size, etc.

Non-Collected Material Handling $PM_{2.5}$ Step 5 - Select BACT

Partial Enclosure

- Charge handling operations are completed under partial enclosure.

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[55] Emissions of 200 lbs/year estimated.

[56] Displaced air is filtered through a fabric filter when filling the cubic yard containers via gravity. Emissions of

[57] Emissions of 100 lbs/year estimated.

[58] Emissions of 130 lbs/year estimated.

- Lime Handling – Currently occurs under cover.
- Limestone Handling – Conveyor load and drop points and conveyor itself are under cover.
- Ferro Silica Handling – Conveyor load and drop points and conveyor itself are under cover.
- Slag Conveyor – Conveyor load and majority of conveyor are under cover. Slag is solid and fractures/shatters upon drop point.
- Coke/Anode– Conveyor load and drop points and conveyor itself are under cover.

> MDU receives large pieces of scrap metal at the facility which sometimes need to be cut prior to being used as a raw material. The large scrap metal pieces are cut via torch cutting but emissions are not captured at a collection point.

> The tuyere injection process involves injection of carbon and silicon into the cupola. Fugitive emissions are generated from the unloading of this material from supersacks. The fugitive emissions are not captured at a collection point, but are contained in an enclosed area.

Management or operational practices

> Scrap cutting operational practices include having the scrap reasonably free of foreign matter.

> Coke is received at the facility from elevated rail cars which empty the coke via a belly dump onto the concrete pad below the rail car. The concrete is partially enclosed by adjacent buildings, equipment and the rail road track pillars. Drop height is minimized to the extent possible. The size of the coke is approximately 10-12 inches in diameter, which helps to minimize fugitive emissions. From the pile under the railroad tracks, coke is trammed via loader to a hopper where a covered conveyor takes it for charging into the cupola.

Non-Collected Material Handling $PM_{2.5}$ Most Stringent Measures

For collected material handling sources, MSM is the same technology as BACT

3.7.3. $PM_{2.5}$ - Roads/Landfill

There are four main roads at the MDU facility, three paved and one unpaved. In addition, there are paved and unpaved product storage areas and minor access roads. Fugitive dust from unloading and storage of bulk materials, material conveyances, landfill operations and movement of dry cement waste may be deposited on plant roads during production activities. Vehicular traffic in these areas may then disturb dust deposited on plant roads.

Roads/Landfill $PM_{2.5}$ Step 1 - Identify All Control Technologies

Control technologies identified for $PM_{2.5}$ emissions from roads are as follows, based on March 21, 2017 review of relevant entries in EPA's RACT/BACT/LAER Clearinghouse (RBLC):

> Watering and Material Moisture Content
> Road Paving (Applicable to Unpaved Roads Only)
> Street Sweeping (Applicable to Paved Roads Only)
> Silt Content Reduction (Applicable to Unpaved Roads Only)
> Reduced Speed (Applicable to Unpaved Roads Only)

Roads/Landfill $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

All of the above technologies are technically feasible with exception of sweeping unpaved roads.

Roads/Landfill $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

For these technologies applied to unpaved roads, any grouping of silt content reduction, and speed reduction can be applied together, and they are not competitive.

Road paving converts an unpaved road to a paved road, rendering the unpaved road technologies inapplicable. Street sweeping on paved roads reduces silt content that could become fugitive dust.

Watering and material moisture increases can be applied regardless of whether the road is paved or unpaved, and regardless of other technologies.

Control efficiencies are available for certain technologies:

1. Watering and Material Moisture Content: 80-95% control at the immediate point of application, but can drop off sharply as road dries, per AP-42 Figure 13.2.2-2.
2. Reduced Speed: 44% reduction if below 25 mph, per Western Regional Air Partnership (WRAP) Fugitive Dust Handbook.

Variable control technologies include:

- Silt Content Reduction: Varies with current, uncontrolled road conditions, per AP-42 13.2.2.
- Street Sweeping: Highly variable, depends on current road conditions, per AP-42 Section 13.2.1.4.
- Road Paving: Depends on paved road final conditions and current unpaved road conditions.

Roads/Landfill $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

Since the highest available controls include implementing road watering, speed reduction and silt content reduction on unpaved roads, and street sweeping for paved roads, no detailed economic, energy, and environmental impact evaluations were conducted.

It is generally assumed that it is not economically feasible to pave an unpaved road for the purpose of PM emission control.

Roads/Landfill Roads $PM_{2.5}$ Step 5 - Select BACT

BACT for unpaved roads is speed reduction, watering, and silt content reduction. Vehicle speed is currently limited to 15 mph on all plant roads. All facility roads are posted with visible speed limit signs. Unpaved roads or storage areas at the MDU are watered as needed and if vehicle travel causes persistent visible emissions of fugitive dust. The frequency of application is dependent on precipitation and road activity. Additionally, iron slag may be placed on the unpaved roads to reduce silt concentration when the need arises.

BACT for paved roads is street sweeping and watering. Fugitive dust from paved areas at the MDU is controlled with a street sweeper. The street sweeper utilizes a dry dust vacuum system in conjunction with an optional water spray and wire brush system to remove dust and debris from paved road surfaces.

BACT for the onsite industrial waste landfill is watering and the addition of cover material. Water is applied via a water truck to the working area of the landfill prior to maintenance activities for dust suppression. Inactive areas of the landfill are covered by iron slag, which has been approved as a final cover material under the facility's Class IIIb Landfill Permit. Landfill cover may also be supplemented with dry pre-characterized pond tailings. Fugitive dust from active areas of the landfill is controlled with a sprinkler system as described above.

Roads/Landfill Roads $PM_{2.5}$ Most Stringent Measures

MSM for unpaved roads would be paving, which would have the largest reduction in fugitive emissions, however this would not be a practical solution for large areas or roads that are not used on a regular basis. Therefore, MSM for paved roads is the same technology as BACT in this case.

3.8. PIPE CLEANING

Pipes are cleaned to remove the sand core used during casting prior to annealing. Much of the sand core is removed in the casting area where the ends of the pipe are cleaned manually as part of the quality assurance process. Residual sand is removed used compressed air at a blowout station just prior to the annealing oven. Emissions from the blowout station are routed through a cyclone that vents outside. The process generates less than two tons per year of $PM_{2.5}$ emissions. Pipe cleaning operations are included in "miscellaneous equipment" listed in Section II.A.21 of the January 12, 2016 Approval Order.

3.8.1. $PM_{2.5}$

Pipe Cleaning $PM_{2.5}$ Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Other Fugitive Dust Sources (process type 99.190);[59] and
- EPA's Air Pollution Technology Fact Sheets.

Control technologies include:

- High-Efficiency Cyclone
- Wet Electrostatic Precipitator (ESP)
- Wet Scrubber
- Baghouse/Fabric Filter

Pipe Cleaning $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Baghouse

Baghouses remove particulates by collecting particulates on the filter bag as the exhaust stream passes through the baghouse. Baghouses typically cannot withstand high exhaust temperatures (greater than 500 °F). Fabric filters have been considered effective for medium and low gas flow streams with high particulate concentrations. Baghouses have been shown to obtain a particulate collection efficiency up to 99.5% for PM_{10}, and up to 99% capture for $PM_{2.5}$. Emissions from pipe cleaning are released throughout the year which results in a steady, low concentration exhaust stream.

Wet Scrubber

A wet gas scrubber is an air pollution control device that removes PM and acid gases from waste streams from stationary point sources. PM and acid gases are primarily removed through the impaction, diffusion,

[59] Accessed March 3, 2017.

interception and/or absorption of the pollutant onto droplets of liquid. Wet scrubbers have some advantages over ESPs and baghouses in that they are particularly useful in removing PM with the following characteristics:

- Sticky and/or hygroscopic materials;
- Combustible, corrosive or explosive materials;
- Particles that are difficult to remove in dry form;
- PM in the presence of soluble gases; and
- PM in gas stream with high moisture content.

Collection efficiencies for wet scrubbers vary with the particle size distribution of the waste gas stream. In general, collection efficiency decreases as the PM size decreases.[60] High efficiency wet scrubbers have been shown to achieve 99% capture for PM_{10}, but only up to 90% capture for $PM_{2.5}$. While a wet gas scrubber is considered technically feasible, it is not more effective than the cyclone-baghouse combination control system proposed to be installed onsite. Therefore, the wet scrubber was not further considered for BACT.

Wet ESP

As part of this analysis, the possibility of using a Wet Electrostatic Precipitator (ESP) was also reviewed. Wet ESP technology removes particulates by electrically charging the particles and collecting the charged particles on plates. The collected particulate is washed off the plates and collected in hoppers at the bottom of the ESP. High efficiency ESPs have been shown to achieve control of particulates up to 99.5% for PM_{10}, and up to 95% capture for $PM_{2.5}$.

The major constituent of sand is silicon dioxide (SiO_2), due to the chemical structure of this molecule it is difficult to induce the electrical charge required to capture particulate matter composed of this material. Without the ability to create an electrical charge this control technology is not technically feasible.

Cyclone

Cyclones use centrifugal force and inertia to remove particles from a gas stream. The inertia of the particles resists the change in direction of the gas and they move outward under the influence of centrifugal force until they strike the walls of the cyclone. At this point, the particles are caught in a thin laminar layer of air next to the cyclone wall and are carried downward by gravity where they are collected in hoppers. Cyclones are capable of removing in excess of 90%of the larger diameter (> 30 μm) PM. However, their efficiency decreases with smaller particles. Cyclones are generally used to reduce dust loading and collect large particles. A cyclone has a control efficiency of 20-70%. MDU currently uses a cyclone to reduce PM emissions from this source.

Pipe Cleaning $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The control technologies under consideration are ranked as follows in order of most effective to least effective for control of PM_{10}, and $PM_{2.5}$:

[60] U.S. Environmental Protection Agency, Chapter 2, Particulate Matter Controls

Table 3-18. Summary of Pipe Cleaning $PM_{2.5}$ Emission Control

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Baghouse with fabric filter	99% - 99.5%
	Wet scrubber	90%-99%
	Existing cyclone	20-70%

Pipe Cleaning $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

MDU is proposing to install a new baghouse to the exhaust of the existing cyclone. This additional control measure will result in an overall control efficiency that is estimated to be greater than 99%.

Pipe Cleaning $PM_{2.5}$ Step 5 - Select BACT

BACT for $PM_{2.5}$ emissions is installation of a baghouse with fabric filter, MDU is proposing to install a new baghouse to the exhaust of the existing cyclone with installation completed by December 31, 2018.

Pipe Cleaning $PM_{2.5}$ Most Stringent Measures

MSM for pipe cleaning is the same technology as BACT.

3.9. SPECIALTY LINING SHOTBLAST

Before the specialty lining can be applied, the inside of the pipe is shot blasted to prepare a clean surface for the application of the coating. This operation is completed in an enclosed hood and the dust from the shot blast is collected to a baghouse outside the special linings building. Emissions from this process are estimated to be less than 2 tons per year.

3.9.1. $PM_{2.5}$

Shotblast PM2.5 Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Other Fugitive Dust Sources (process type 99.190);[61] and
- EPA's Air Pollution Technology Fact Sheets.

Control technologies include:

[61] Accessed March 3, 2017.

- Baghouse/Fabric Filter
- Wet Electrostatic Precipitator (ESP)
- Wet Scrubber
- High-Efficiency Cyclone

Shotblast $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Baghouse

Baghouses remove particulates by collecting particulates on the filter bag as the exhaust stream passes through the baghouse. Baghouses typically cannot withstand high exhaust temperatures (greater than 500 °F). Fabric filters have been considered effective for medium and low gas flow streams with high particulate concentrations. Baghouses have been shown to obtain a particulate collection efficiency up to 99.5% for PM_{10}, and up to 99% capture for $PM_{2.5}$. Emissions from pipe cleaning are released throughout the year which results in a steady, low concentration exhaust stream. A baghouse is currently installed to control emissions from this process.

Wet Electrostatic Precipitator

As part of this analysis, the possibility of using a Wet Electrostatic Precipitator (ESP) was also reviewed. Wet ESP technology removes particulates by electrically charging the particles and collecting the charged particles on plates. The collected particulate is washed off the plates and collected in hoppers at the bottom of the ESP. High efficiency ESPs have been shown to achieve control of particulates up to 99.5% for PM_{10}, and up to 95% capture for $PM_{2.5}$.

While a wet ESP is technically feasible, the control efficiency for this technology is less than the baghouse currently installed for the process; therefore, a wet ESP has not been further evaluated.

Wet Scrubber

A wet gas scrubber is an air pollution control device that removes PM and acid gases from waste streams from stationary point sources. PM and acid gases are primarily removed through the impaction, diffusion, interception and/or absorption of the pollutant onto droplets of liquid. Wet scrubbers have some advantages over ESPs and baghouses in that they are particularly useful in removing PM with the following characteristics:

- Sticky and/or hygroscopic materials;
- Combustible, corrosive or explosive materials;
- Particles that are difficult to remove in dry form;
- PM in the presence of soluble gases; and
- PM in gas stream with high moisture content.

Collection efficiencies for wet scrubbers vary with the particle size distribution of the waste gas stream. In general, collection efficiency decreases as the PM size decreases.[62] High efficiency wet scrubbers have been shown to achieve 99% capture for PM_{10}, but only up to 90% capture for $PM_{2.5}$. While a wet scrubber is technically feasible, the control efficiency for this technology is less than the baghouse currently installed for the process; therefore, a wet scrubber has not been further evaluated.

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[62] U.S. Environmental Protection Agency, Chapter 2, Particulate Matter Controls

Cyclone

Cyclones use centrifugal force and inertia to remove particles from a gas stream. The inertia of the particles resists the change in direction of the gas and they move outward under the influence of centrifugal force until they strike the walls of the cyclone. At this point, the particles are caught in a thin laminar layer of air next to the cyclone wall and are carried downward by gravity where they are collected in hoppers. Cyclones are capable of removing in excess of 90% of the larger diameter (> 30 μm) PM. However, their efficiency decreases with smaller particles and has an anticipated control efficiency of 20-70%. Cyclones are generally used to reduce dust loading and collect large particles. While a cyclone is technically feasible, the control efficacy for this technology is less than the baghouse currently installed for the process; therefore, a cyclone has not been further evaluated.

Shotblast $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The control technologies under consideration are ranked as follows in order of most effective to least effective for control of PM_{10}, and $PM_{2.5}$:

Table 3-19. Summary for Shotblast $PM_{2.5}$ Emission Control

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Baghouse with fabric filter	99% - 99.5%
	Wet electrostatic precipitator	95% - 99.5%
	Wet scrubber	90%-99%
	Cyclone	20%-70%

Shotblast $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

While wet ESP, wet scrubber, and cyclone controls are technically feasible control options, the control efficiency for these technologies are less than the baghouse currently installed for the process.

Shotblast $PM_{2.5}$ Step 5 - Select BACT

BACT for $PM_{2.5}$ emissions is the existing baghouse that has an estimated control efficiency of 99%.

Shotblast $PM_{2.5}$ Most Stringent Measures

MSM is the same technology as BACT in this case.

3.10. CASTING

Gray iron in the holding ladle is poured into a treating ladle containing cooling iron, magnesium-ferrosilicon and ferrosilicon to convert the gray iron to ductile iron. The ductile iron is then transferred to a preheated casting ladle. A core is placed into the bell end of the casting machine mold and the iron is poured in the spinning mold through a trough which runs the full length of the mold. The iron enters the trough from a casting machine ladle which is filled from the back-up ladle. After the iron has solidified and the pipe is extracted from the mold, the pipe is sent to the annealing, furnace. The desulfurization baghouse currently provides some control of emissions from this process. The casting process emits 2.77 tpy of $PM_{2.5}$ emissions.

3.10.1. $PM_{2.5}$

Casting $PM_{2.5}$ Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's Air Pollution Technology Fact Sheets; and
- TCEQ BACT Guidelines for the Iron and Steel Industry.

Control technologies include:

- Baghouse/Fabric Filter
- Wet Electrostatic Precipitator (ESP)
- Wet Scrubber
- Cyclone
- Good Operating Practices

Casting $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Baghouse

Baghouses remove particulates by collecting particulates on the filter bag as the exhaust stream passes through the baghouse. Baghouses typically cannot withstand high exhaust temperatures (greater than 500 °F). Fabric filters have been considered effective for medium and low gas flow streams with high particulate concentrations. Baghouses have been shown to obtain a particulate collection efficiency up to 99.5% for PM_{10}, and up to 99% capture for $PM_{2.5}$. Emissions from casting are released throughout the year which results in a steady, low concentration exhaust stream. The desulfurization baghouse currently provides some control of emissions from this process. Based on information provided by other McWane facilities, it is estimated that the baghouse would need to handle a 550,000 – 600,000 acfm flow rate, making this an expensive choice.

Wet ESP

As part of this analysis, the possibility of using a Wet Electrostatic Precipitator (ESP) was also reviewed. Wet ESP technology removes particulates by electrically charging the particles and collecting the charged particles on plates. The collected particulate is washed off the plates and collected in hoppers at the bottom of the ESP. High efficiency ESPs have been shown to achieve control of particulates up to 99.5% for PM_{10}, and up to 95% capture for $PM_{2.5}$.

Wet Scrubber

A wet gas scrubber is an air pollution control device that removes PM and acid gases from waste streams from stationary point sources. PM and acid gases are primarily removed through the impaction, diffusion, interception and/or absorption of the pollutant onto droplets of liquid. Wet scrubbers have some advantages over ESPs and baghouses in that they are particularly useful in removing PM with the following characteristics:

- Sticky and/or hygroscopic materials;
- Combustible, corrosive or explosive materials;
- Particles that are difficult to remove in dry form;
- PM in the presence of soluble gases; and
- PM in gas stream with high moisture content.

Collection efficiencies for wet scrubbers vary with the particle size distribution of the waste gas stream. In general, collection efficiency decreases as the PM size decreases.[63] High efficiency wet scrubbers have been shown to achieve 99% capture for PM_{10}, but only up to 90% capture for $PM_{2.5}$.

Cyclone

Cyclones use centrifugal force and inertia to remove particles from a gas stream. The inertia of the particles resists the change in direction of the gas and they move outward under the influence of centrifugal force until they strike the walls of the cyclone. At this point, the particles are caught in a thin laminar layer of air next to the cyclone wall and are carried downward by gravity where they are collected in hoppers. Cyclones are capable of removing in excess of 90 percent of the larger diameter (> 30 μm) PM. However, their efficiency decreases with smaller particles. Cyclones are generally used to reduce dust loading and collect large particles.

Good Operating Practices

Particulate matter emissions from casting and molding can be controlled to a degree by the casting equipment design and methods. A violent cast with excessive hot metal turbulence tends to create greater quantities of fume than does a smooth, controlled cast. MDU currently operates in accordance with these practices.

Casting $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The control technologies under consideration are ranked as follows in order of most effective to least effective for control of PM_{10}, and $PM_{2.5}$:

Table 3-20. Summary of Casting $PM_{2.5}$ Emission Control

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Baghouse with fabric filter	99% - 99.5%
	Wet electrostatic precipitator	95% - 99.5%
	Wet scrubber	90%-99%
	Cyclone	90%
	Good Operating Practices	NA

[63] U.S. Environmental Protection Agency, Chapter 2, Particulate Matter Controls

Casting $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

While wet ESP, wet scrubber, and cyclone controls are technically feasible control options, the control efficiency for these technologies create additional impacts on the environment and operating issues for the facility.

Casting $PM_{2.5}$ Step 4 - Evaluate Most Effective Controls and Document Results

A cost analysis can be found for a new baghouse in Appendix A. Since there is a large airflow requirement and the potential emissions are 2.77 tons/year, a new baghouse is cost prohibitive (in the $604,788/ton range).

Casting $PM_{2.5}$ Step 5 - Select BACT

BACT for $PM_{2.5}$ emissions is the partial capture by the ladle baghouse that has an estimated control efficiency of 99%, and good operating practices.

Casting $PM_{2.5}$ Most Stringent Measures

MSM is the same technology as BACT in this case.

3.11. COATING OPERATIONS

MDU has three processes associated with coating operations as addressed in its Title V permit and approval order (AO) which include: 1) Pipe coating, 2) Specialty Lining Painter, and 3) Pole Coating. These three lines are similar in nature to industrial coating operations; although, they are located in different areas across the facility and have different customer purposes and specifications. As a result, the coating operations have been addressed separately in this report.

The bulk of cast iron pipe proceeds to paint coating operations to apply a protective coating on the cast iron pipe to minimize corrosion and meet customer specifications. Since 2005 MDU has been using a coating with a VOC content of 6% (0.51 lbs/gallon), which is reduced from nearly 100% VOCs in the past. The pipe coating is asphaltic in nature as a heavy hydrocarbon. The coating's specification is dictated by its customers based on viscosity.

Pipe coating is applied inside a paint booth. The exterior of the pipe is coated with a fixed nozzle and the interior of the pipe with a lance traveling inside the pipe. The nozzles are high volume low pressure (HVLP) nozzles which minimize overspray. Upon the completion of coating, pipes are cured inside the bay for up to 48 hours prior to being moved to the yard for storage.

Specialty Lining and Pole Coating are not conducted in a spray booth, but are conducted within enclosed buildings. Specialty lining coating is applied on the exterior with a roller and on the interior by a lance. Pole Coating is applied to the bottom exterior portion of the pole using an airless spray gun with a transfer efficiency equivalent to a HVLP spray system. Coating is not applied to the interior of the pole.

The above three coating operations are conducted in three buildings that are separated more than 600 feet from each other. Given the air volume requirements that will be discussed below, the distance between the three operations and the possible differing operating schedules for the three operations require controls to be considered separately.

Pipe stenciling and striping also generate fugitive emissions of VOC; however, the emissions are negligible compared to the coating processes mentioned above. Addition of controls would have a negligible decrease in emissions. For this reason, they are not addressed further in this document.

3.11.1. $PM_{2.5}$ - Pipe Coating

A review of previous BACT analyses, the California Air Resources Board, EPA's RACT/BACT/LAER (RBLC) Clearinghouse, and other state databases was performed to identify possible $PM_{2.5}$ control technologies that are available on the market and have been proven in practice for surface coating. These control technologies are discussed below.

Pipe Coating $PM_{2.5}$ Step 1 - Identify All Available Control Technologies

Pollution control technologies were evaluated for control of $PM_{2.5}$ from painting activities. These add-on control technologies include:

- Electrostatic precipitators,
- Wet scrubbers;
- Dry particulate filter systems; and
- High transfer efficiency application techniques.

Pipe Coating $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Control Options

Wet ESP

An electrostatic precipitator (ESP) removes particles from a gas stream by using electrical energy to charge particles either positively or negatively. The charged particles are then attracted to collector plates carrying the opposite charge. The collected particles may be removed from the collector plates as dry material (dry ESPs), or they may be washed from the plates with water (wet ESPs). ESPs are capable of collection efficiencies greater than 99 percent. Dry and wet electrostatic precipitators were determined to be technically infeasible due to their difficulty in controlling sticky particles from spray booths and their inability to control variable operations. In addition, ESP's were not identified in the literature or databases as a means of controlling PM from spray booth operations. Thus, this control technology was eliminated from further consideration.

Wet Scrubber

Wet scrubbers are used primarily for particulate control, including particulate in the PM_{10} and $PM_{2.5}$ size range. Wet scrubbers are PM control devices that rely on direct and irreversible contact of a liquid (droplets, foam, or bubbles) with the PM. The liquid with the collected PM is then easily collected. Wet scrubbers have important advantages when compared to other PM collection devices. They can collect flammable and explosive dusts safely, absorb gaseous pollutants, and collect mists. However, there are also some disadvantages associated with wet scrubbers, namely, wet scrubbers can lead to water and solid waste pollution problems. They generate a waste sludge which is typically defined as hazardous. Additionally, with coating technologies the solubility of the material being collected needs to be considered. Since the particulate to be controlled is not readily soluble in water, this technology was eliminated from further consideration.

Good Operating Practice

Once a coating is applied, the part is allowed to air-dry. Any overspray (particulate) is controlled in a paint booth, through application, and/or exhausted through filter media.

High Transfer Efficiency Application Techniques

The coatings will be applied using a HVLP spray nozzle fixed within the booth for the exterior of the pipe and a lance for the interior of the pipe. Therefore, minimal particulate emissions escaping from the process.

Pipe Coating $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Wet scrubber, overspray filter, and high transfer efficiency application techniques as presented above have been ranked based on control efficiencies documented as being achieved in practice.

Table 3-21. Summary of Pipe Coating $PM_{2.5}$ Emission Control

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Good Operating Practices	Intrinsic
	High transfer efficiency application techniques	Intrinsic

Pipe Coating $PM_{2.5}$ Step 4 - Evaluate Remaining Control Options

The coatings will continue to be applied using high-volume, low-pressure (HVLP) spray guns or similar application techniques with equivalent transfer efficiency. Good operating practices includes the use of dry filtration systems is currently in use, MDU will continue utilize a dry filtration system in the paint booth.

Since the two above control technologies are currently being implemented, no detailed economic, energy, and environmental impact evaluations were conducted.

Pipe Coating $PM_{2.5}$ Step 5 - Select BACT

Exhaust from the spray booth is equipped with a dry filter to control particulate emissions generated during the spray application of coatings. The use of a HVLP spray guns (or similar applications techniques with equivalent transfer efficiency) will continue to be used.

Pipe Coating $PM_{2.5}$ Most Stringent Measures

MSM is consistent with BACT in this instance.

3.11.2. $PM_{2.5}$ - Specialty Lining

Specialty Lining $PM_{2.5}$ Step 1 - Identify All Available Control Technologies

Pollution control technologies were evaluated for control of $PM_{2.5}$ from painting. These add-on control technologies include:

- Electrostatic precipitators,
- Wet scrubbers;
- Dry particulate filter systems; and
- High transfer efficiency application techniques.

Specialty Lining $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Control Options

Wet ESP

Similar to pipe coating ESP's were not identified in the literature or databases as a means of controlling PM from coating operations. Thus, this control technology was eliminated from further consideration.

Wet Scrubber

There are disadvantages associated with wet scrubbers, namely, wet scrubbers can lead to water and solid waste pollution problems. They generate a waste sludge which is typically defined as hazardous. Additionally, installation of a wet scrubber is not a practical method of control due to the low and/or non-existent $PM_{2.5}$ emissions. Therefore, wet scrubber has been eliminated from further consideration.

Good Operating Practices

Once a coating is applied, the part is allowed to air-dry.

High Transfer Efficiency Application Techniques

The coatings are applied using a HVLP lance for the interior of the pipe and a roller for the exterior of the pipe.

Specialty Lining $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The potential control technologies presented above have been ranked based on control efficiencies documented as being achieved in practice.

Table 3-22. Summary of Specialty Lining $PM_{2.5}$ Emission Control

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Good Operating Practices	Intrinsic
	High transfer efficiency application techniques	Intrinsic

Specialty Lining $PM_{2.5}$ Step 4 - Evaluate Remaining Control Options

The coatings will continue to be applied using HVLP (or similar technique) for the interior of the pipe and a roller for the exterior. The use of minimizing overspray reduces $PM_{2.5}$ filterable particles as a good management practice. Additionally, the Sacramento Metropolitan Air Quality Management District (SMAQMD) establishes no control for fine particulate matter ($PM_{2.5}$).[64]

Since the two above control technologies are currently being implemented, no detailed economic, energy, and environmental impact evaluations were conducted.

Specialty Lining $PM_{2.5}$ Step 5 - Select BACT

The coatings will be applied using HVLP lance for the interior of the pipe (or similar application technique with equivalent transfer efficiency) and a roller for the exterior of the pipe. Therefore, minimal particulate emissions escape from the process. Since the two above control technologies have equivalent control efficiencies. The use of these control measures is considered BACT.

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[64] SMAQMD BACT Determination number 124 &125, Coating, Stripping, and Solvent Cleaning Miscellaneous Metal Parts and Products. http://www.airquality.org/StationarySources/Documents/BACT124-125-PaintSprayBooth-MiscMetalParts.pdf

Specialty Lining $PM_{2.5}$ Most Stringent Measures (MSM)

Since we are proposing a dry filtration system, MSM is BACT.

3.11.3. $PM_{2.5}$ - Pole Coating

Pole Coating $PM_{2.5}$ Step 1 - Identify All Available Control Technologies

Pollution control technologies were evaluated for control of $PM_{2.5}$ from painting activities. These add-on control technologies include:

- Electrostatic precipitators,
- Wet scrubbers;
- Dry particulate filter systems; and
- High transfer efficiency application techniques.

Pole Coating $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Control Options

Wet ESP

Similar to pipe coating ESP's were not identified in the literature or databases as a means of controlling PM from spray booth operations. Thus, this control technology was eliminated from further consideration.

Wet Scrubber

There are disadvantages associated with wet scrubbers, namely, wet scrubbers can lead to water and solid waste pollution problems. They generate a waste sludge which is typically defined as hazardous. Additionally, installation of a wet scrubber is not a practical method of control due to the low and/or non-existent $PM_{2.5}$ emissions. Therefore, wet scrubber has been eliminated from further consideration.

Good Operating Practices

Once a coating is applied, the part is allowed to air-dry.

High Transfer Efficiency Application Techniques

The coatings are applied using an airless spray gun with a transfer efficiency equivalent to a HVLP spray system for the exterior of the pole.

Pole Coating $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The potential control technologies presented above have been ranked based on control efficiencies documented as being achieved in practice.

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Good Operating Practices	Intrinsic
	High transfer efficiency application techniques	Intrinsic

Pole Coating $PM_{2.5}$ Step 4 - Evaluate Remaining Control Options

The coatings will continue to be applied using an airless spray gun with a transfer efficiency equivalent to a HVLP spray system for the exterior of the pole. The use of minimizing overspray reduces $PM_{2.5}$ filterable particles as a good management practice. Additionally, the Sacramento Metropolitan Air Quality Management District (SMAQMD) establishes no control for fine particulate matter ($PM_{2.5}$).[65]

Since the two above control technologies are currently being implemented, no detailed economic, energy, and environmental impact evaluations were conducted.

Pole Coating $PM_{2.5}$ Step 5 - Select BACT

The coatings will be applied using an airless spray gun with a transfer efficiency equivalent to a HVLP spray system for the exterior of the pole Therefore, minimal particulate emissions escape from the process. The use of these control measure is considered BACT.

Pole Coating $PM_{2.5}$ Most Stringent Measures (MSM)

MSM is consistent with BACT in this instance.

3.11.4. VOC - Pipe Coating

Pipe Coating VOC Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Volatile Organic Liquid Storage (process type 42.009);[66]
- EPA's Air Pollution Technology Fact Sheets;
- NSPS Kb – Standards of Performance for Volatile Liquid Storage Vessels;
- NESHAP G – Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater;
- NESHAP WW – Storage Vessels (Tanks) – Control Level 2;
- SCAQMD LAER/BACT Determinations;
- SJVAPCD BACT Clearinghouse;
- BAAQMD BACT/TBACT Workbook; and
- Permits available online.

Several add-on control technologies were identified to reduce VOC emissions from painting activities. These add-on control technologies include:

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[65] SMAQMD BACT Determination number 124 &125, Coating, Stripping, and Solvent Cleaning Miscellaneous Metal Parts and Products. http://www.airquality.org/StationarySources/Documents/BACT124-125-PaintSprayBooth-MiscMetalParts.pdf

[66] Database accessed March 3, 2017.

- Regenerative thermal oxidizer,
- Thermal oxidizer,
- Regenerative thermal oxidizer with concentrator,
- Carbon adsorption,
- Low-VOC coatings,
- HLVP coating gun, and
- Best management practices.

Pipe Coating VOC Step 2 - Eliminate Technically Infeasible Control Options

Control technologies identified in Step 1 have been demonstrated and achieved in practice; however, the asphaltic properties of the material used at MDU would plug the equipment and ductwork.

Volume Concentrators

Volume concentrators are designed specifically for the control of low-concentration VOC or HAP gas streams. These devices raise the concentration of VOC/HAP vapor to allow more economical treatment of the concentrated compound in the exhaust gas. The most common volume concentrator is a rotary carousel system. In this unit, one sector of the carousel is being used for adsorption while another sector is being regenerated (or desorbed) with hot gas. As the carousel turns, each section alternately adsorbs VOC and HAP from the waste gas and is then regenerated. The adsorbent can be a zeolite, a mixture of zeolite and activated carbon, a mixture of zeolite and polymer adsorbents, or activated carbon or polymer adsorbent beds followed by zeolite beds downstream. A concentration ratio of well above 1,000:1 can often be obtained in a volume concentrator. (Permissible concentration ratios may be limited by flammability considerations.) Of course, the flowrate of the regeneration gas is correspondingly lowered. This higher-concentration/lower-flowrate regeneration gas can then be treated in various ways, including thermal oxidation.

Volume concentrators can achieve 90% to 98% removal efficiency, depending on the number of rotors in series and the inlet VOC/HAP concentration. However, as mentioned earlier, the asphaltic properties of the materials involved would plug equipment and ductwork causing too frequent process interruptions. Therefore, the volume concentrator is considered infeasible.

Carbon Adsorption

Carbon adsorption uses a filter bank of canisters that contain activated carbon which adsorbs the VOC emissions as the emissions pass through before being released to the atmosphere. Carbon adsorption units work best with lower-temperature operations. At MDU, the exhaust stream properties would cause equipment and ductwork to plug causing frequent process interruptions; therefore, carbon adsorption is infeasible.

Thermal Oxidation (RTO, RCO, and TO)

Thermal oxidation add-on controls including, Regenerative Thermal Oxidizer (RTO), Recuperative Thermal Oxidizer, Simple Thermal Oxidizer or Afterburner (TO) are evaluated together due to the configuration of the building and the pipe coating process. Pipes are painted one after the other in a continuous flow and then stored in a large building for up to 48 hours to ensure proper curing. Because of this configuration, as well as the need to ensure the pipe can be moved with heavy equipment, providing a localized exhaust to capture and transport VOC emissions to the control device is not possible. Rather than just stating that sufficient capture of these emissions are impossible, principles of USEPA Method 204 for Total Enclosures were used to provide a basis for establishing an air volume that would sufficiently capture VOC emissions during the coating and subsequent curing operations.

Method 204 requirements include:

a. Any Natural Draft Opening (NDO) shall be at least four equivalent opening diameters from each VOC emitting point
b. Any exhaust point from the enclosure shall be at least four equivalent duct or hood diameters from each natural draft opening.
c. The total area of all NDO shall not exceed 5 percent of the surface area of the enclosure's four walls, floor, and ceiling.
d. The average facial velocity (FV) of air through all NDO shall be at least 3,600 m/hr (200 fpm). The direction of air flow through all NDO's shall be into the enclosure.
e. All access doors and windows whose areas are not included in c. above and are not included in the calculation in d. shall be closed during routine operation

The estimated cost to modify the Pipe Coating structure to accommodate Method 204 design principles, adding ventilation, relocating electrical and hydraulic services in addition to building out the existing storage area to accommodate pipe curing is $2,500,000 based on the October 2013 analysis. Therefore it is eliminated further from analysis.

HVLP, Low VOC, and Best Management Practices

High-efficiency application methods include the use of high volume, low pressure (HVLP) spray guns, electrostatic application, airless spray guns, air-assisted airless spray guns, or equivalent technologies. The use of HVLP coating guns is also considered a Best Management Practice to prevent or reduce the discharge of pollutants to the air soil, or water. Use of a water-based low VOC coating may be a viable option for high VOC solvent-based coatings. Work practices include keeping VOC containing coatings and solvents in closed, air tight containers, preventing unnecessary emissions of VOC.

Other Best Management Practices include the use of paint booths to capture overspray, capture of hazardous chemicals and wastewater, and the proper handling for hazardous materials and regulated wastes managed by MDU.

Pipe Coating VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The feasible control technologies presented above have been ranked based on control efficiencies documented as being achieved in practice. HVLP, Low VOC, and Best Practices were ranked #1 as shown in the table in Step 5.

Table 3-23. Summary of Pipe Coating VOC Emission Control

Control Technologies	Rank	Percent Control	BACT
HVLP, Low VOC, and Best Management Practices	1	NA	Yes

HVLP, Low VOC, and Best Management Practices

The bulk of the production proceeds to pipe coating where a low VOC coating (approximately 0.51 pounds of VOC per gallon of coating) is applied to the interior and exterior of the pipe with a lance and a nozzle, respectively. Over 95% of the pipe by weight was processed through pipe coating (again the coating operation using the lower VOC content coating).

Pipe Coating VOC Step 4 - Evaluate Remaining Control Options

MDU has properly designed and operated painting facilities. Work activities are conducted in a manner consistent with the requirements of applicable laws and best management practices minimizing impact to the environment. HVLP spray nozzles, or other spray methods with equivalent transfer efficiency, will be utilized for applying coating. Work practices include keeping VOC containing coatings and solvents in closed, air tight containers, preventing unnecessary emissions of VOC.

Pipe Coating VOC Step 5 - Select BACT

Because of the properties of the exhaust stream and the process materials, MDU will continue to implement low VOC content materials as long as they meet customer specifications, HVLP spray nozzles, and best management practices to ensure BACT.

Pipe Coating VOC Most Stringent Measures

MSM is equivalent to BACT in this instance.

3.11.5. VOC - Specialty Lining

Specialty Lining Painter VOC Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Volatile Organic Liquid Storage (process type 42.009);[67]
- EPA's Air Pollution Technology Fact Sheets;
- NSPS Kb – Standards of Performance for Volatile Liquid Storage Vessels;
- NESHAP G – Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater;
- NESHAP WW – Storage Vessels (Tanks) – Control Level 2;
- SCAQMD LAER/BACT Determinations;
- SJVAPCD BACT Clearinghouse;
- BAAQMD BACT/TBACT Workbook; and
- Permits available online.

Several add-on control technologies were identified to reduce VOC emissions from painting activities. These add-on control technologies include:

[67] Database accessed March 3, 2017.

- Regenerative thermal oxidizer,
- Carbon adsorption,
- Thermal oxidizer,
- Regenerative thermal oxidizer with concentrator, and
- Low-VOC coatings,
- HLVP coating gun, and
- Best management practices.

Specialty Lining Painter VOC Step 2 - Eliminate Technically Infeasible Control Options

Similar to Pipe Coating control technologies identified in Step 1 have been demonstrated and achieved in practice; however, the properties of the material used in the specialty lining process would plug the equipment and ductwork associated with thermal oxidizers, concentrators and carbon absorption.

The remaining control options include: HVLP, Low VOC, and Best Management Practices.

Specialty Lining Painter VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Table 3-24. Summary for Specialty Lining Painter VOC Emission Control

Control Technologies	Rank	Percent Control	BACT
HVLP, Low VOC, and Best Management Practices	1	NA	Yes

The potential control technologies presented above have been ranked based on control efficiencies documented as being achieved in practice. HVLP, Low VOC, and Best Practices were ranked #1 as shown in the table in Step 5.

Specialty Lining Painter Step 4 - Evaluate Remaining Control Options

Specialty lining coating is limited by customer specifications, so VOCs are minimized as much as possible based on available materials. MDU currently implements through proper design and operation of the painting facilities and the conduct of work activities in a manner that is consistent with the requirements of applicable laws and best management practices to prevent pollution to the environment. Specifically, specialty lining is limited to 18 hours per day.[68] HVLP spray nozzles will be utilized for applying coating. Additionally use of a roller for the coating application on the outside the pipe minimizes carryover.

Specialty Lining Painter VOC Step 5 - Select BACT

In addition to implementing HVLP and BMPs, specialty lining is only used for specific customer requirements and because of the properties of the exhaust stream and the process materials, MDU will implement Low VOC content materials where able, HVLP gun, and best management practices to ensure BACT.

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[68] Title V Condition, II.B.10.a

Specialty Lining VOC Most Stringent Measures

MSM is equivalent to BACT.

3.11.6. VOC - Pole Coating

Pole Coating VOC Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Volatile Organic Liquid Storage (process type 42.009);[69]
- EPA's Air Pollution Technology Fact Sheets;
- NSPS Kb – Standards of Performance for Volatile Liquid Storage Vessels;
- NESHAP G – Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater;
- NESHAP WW – Storage Vessels (Tanks) – Control Level 2;
- SCAQMD LAER/BACT Determinations;
- SJVAPCD BACT Clearinghouse;
- BAAQMD BACT/TBACT Workbook; and
- Permits available online.

Several add-on control technologies were identified to reduce VOC emissions from painting activities. These add-on control technologies include:

- Regenerative thermal oxidizer,
- Carbon adsorption,
- Thermal oxidizer,
- Regenerative thermal oxidizer with concentrator, and
- Low-VOC coatings,
- HLVP coating gun, and
- Best management practices.

Pole Coating VOC Step 2 - Eliminate Technically Infeasible Control Options

Similar to Pipe Coating control technologies identified in Step 1 have been demonstrated and achieved in practice; however, the properties of the material used at MDU would plug the equipment and ductwork associated with thermal oxidizers, concentrators and carbon absorption.

The remaining control options include: HVLP, Low VOC, and Best Management Practices.

Pole Coating VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The potential control technologies presented above have been ranked based on control efficiencies documented as being achieved in practice. HVLP, Low VOC, and Best Practices were ranked #1 as shown in the table in Step 5.

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[69] Database accessed March 3, 2017.

Table 3-25. Summary of Pole Coating VOC Emission Control

Control Technologies	Rank	Percent Control	BACT
HVLP, Low VOC, and Best Management Practices	1	NA	Yes

Pole Coating VOC Step 4 - Evaluate Remaining Control Options

Pole coating is limited by customer specifications, so VOCs are minimized as much as possible based on available materials. MDU currently uses an airless spray gun with a transfer efficiency equivalent to an HVLP spray system to apply coating.

Pole Coating VOC Step 5 - Select BACT

Because of the properties of the exhaust stream and process materials, MDU will implement Low VOC Content materials where able, HVLP nozzles or equivalent and best management practices to ensure BACT. Application with a roller will also be maintained to minimize any carryover.

Pole Coating VOC Most Stringent Measures

MSM is equivalent to BACT in this instance.

3.12. BACT ANALYSIS FOR ZINC COATING

Arc spray equipment is used to apply a thin layer of elemental zinc to the surface of a limited number of ductile iron pipe to increase corrosion resistance. Arc spray (sometimes referred to as twin wire arc spray) is a process that uses an electric arc to melt twin zinc wires. The molten metal is then atomized with compressed air to create a spray stream that applies the coating to the pipe. The application of a zinc layer for added corrosion protection is driven by the market as an optional feature in addition to the standard cement and asphalt paint linings applied to the majority of pipe produced at the facility. Pipe to be coated with zinc will be diverted from the process line prior to cement lining. The zinc coating is applied, and the pipe returned to the process line for subsequent cement and asphalt lining.

Emissions from the zinc thermal spray system are routed to a Farr GS-72 baghouse with an estimated removal efficiency of 99.9%.

3.12.1. $PM_{2.5}$

Zinc Coating $PM_{2.5}$ Step 1 - Identify All Control Technologies

A review of previous BACT analyses, the California Air Resources Board, EPA's RACT/BACT/LAER (RBLC) Clearinghouse, and other state databases was performed to identify possible $PM_{2.5}$ control technologies that are available on the market and have been proven in practice for surface coating operations. These control technologies are discussed below.

- Baghouse with dry fabric filter;
- Electrostatic precipitation; and
- Water curtain.

Zinc Coating $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Baghouse with Dry Fabric Filter

Baghouses remove particulates by collecting particulates on the filter bag as the exhaust stream passes through the baghouse. Baghouses typically cannot withstand high exhaust temperatures (greater than 500 °F). Fabric filters have been considered effective for medium and low gas flow streams with high particulate concentrations. Baghouses have been shown to obtain a particulate collection efficiency up to 99.5% for PM_{10}, and up to 99% capture for $PM_{2.5}$. Emissions from the zinc thermal spray system are currently routed to a Farr GS-72 baghouse with an estimated removal efficiency of 99.9%.

Wet ESP

As part of this analysis, the possibility of using a Wet Electrostatic Precipitator (ESP) was also reviewed. Wet ESP technology removes particulates by electrically charging the particles and collecting the charged particles on plates. The collected particulate is washed off the plates and collected in hoppers at the bottom of the ESP. High efficiency ESPs have been shown to achieve control of particulates up to 99.5% for PM_{10}, and up to 95% capture for $PM_{2.5}$.

Water Curtain

Water curtains (in water wash spray booths) is a type of control device that draws the exhaust stream through a continuous curtain of moving water to scrub out suspended PM. Water curtains are used to remove overspray particles from a spray booth exhaust. In water wash spray booths, most of the insoluble material is collected as sludge, but some of this material is dispersed in the water along with the soluble overspray components. The paint sludge is eventually collected from the pit for further treatment and reclamation or disposal. A properly running and well maintained water wash spray booth can exceed 95% particulate capture efficiency. If not properly maintained, the efficiency may drop to under 90% for $PM_{2.5}$.

Zinc Coating $PM_{2.5}$ Step 3 - Rank Remaining Control Technologies by Control Effectiveness

The control technologies under consideration are ranked as follows in order of most effective to least effective for control of $PM_{2.5}$:

Table 3-26. Summary of Zinc Coating $PM_{2.5}$ Emission Control

Pollutant	Control Technologies	Approximate Control Efficiency
$PM_{2.5}$	Existing baghouse with dry fabric filter	99.9%
	Wet ESP	95% - 99.5%
	Water curtain in water spray booth	90% - 95%

Zinc Coating $PM_{2.5}$ Step 4 - Evaluate Remaining Control Options

While wet ESP and water curtain controls are technically feasible control options, the control efficiency for these technologies are less than the baghouse currently installed for the process. In addition, the generation of a sludge has added undesirable environmental affects, requiring further treatment of the waste prior to disposal, therefore a water curtain has not been further evaluated.

On December 9, 2004, the Air Resources Board approved the adoption of a regulation called the "Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying". This regulation applies to thermal spraying operations throughout the State of California (e.g., flame spraying, twin-wire electric arc spraying, plasma spraying, and high-velocity oxy-fuel (HVOF) spraying.) The Thermal Spraying regulation only applies to thermal spraying processes that use materials containing chromium, chromium compounds, nickel, or nickel compounds and would not apply to the MDU zinc coating process. However, the regulation does require new thermal spraying units to have the maximum level of control, which has been identified as a control efficiency of 99.97% and suggests the use of High Efficiency Particulate Air (HEPA) filter with an enclosure and ventilation system.

The use of HEPA filters is specifically identified in this regulation since the targeted pollutants are toxic metal pollutants and not overall particulate control. This requirement does not apply to this analysis since only direct $PM_{2.5}$ is being evaluated for this analysis.

Zinc Coating $PM_{2.5}$ Step 5 - Select BACT

Based upon the results of this analysis, the existing baghouse with dry fabric filter is considered to be BACT for the zinc coating process.

Zinc Coating $PM_{2.5}$ Most Stringent Measures

MSM is the same as BACT in this instance.

3.13. FUEL STORAGE TANK EMISSIONS

MDU has a 15,000 gallon diesel and a 1,000 gallon gasoline, fixed roof, storage tank. Fugitive VOC emissions from these tanks are minimal. We were unable to find controls specific to a diesel storage of this size. As such, diesel storage was not evaluated further. The remainder of this discussion applies to the gasoline tank.

3.13.1. VOC

Emissions from fixed roof storage tanks result from displacement of headspace vapor during filling operations (working losses) and from diurnal temperature and heating variations (breathing losses). VOC emissions from the storage tanks at MDU are likely to be minimal as tanks are not refilled frequently.

Fuel Storage VOC Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Volatile Organic Liquid Storage (process type 42.009);[70]
- EPA's Air Pollution Technology Fact Sheets;
- NSPS Kb – Standards of Performance for Volatile Liquid Storage Vessels;
- NESHAP G – Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater;
- NESHAP WW – Storage Vessels (Tanks) – Control Level 2;
- SCAQMD LAER/BACT Determinations;
- SJVAPCD BACT Clearinghouse;
- BAAQMD BACT/TBACT Workbook; and
- Permits available online.

The technologies identified as possible VOC reduction technologies for Storage Tanks are shown in the table below.

Pollutant	Control Technologies
VOC	Internal Floating Roof
	Vapor Recovery System
	Wet Scrubber
	Pressure/Vacuum Valve Settings
	Carbon Filtration System
	Simple Thermal Oxidizer

Fuel Storage VOC Step 2 - Eliminate Technically Infeasible Options

Internal Floating Roof

An internal floating roof, as identified in RBLC, is for tanks with a much larger capacity than the tank located at the MDU Plant. Internal floating roofs are typically installed on tanks greater than 1,000 barrels (bbls) (42,000 gallons). Due to the size of the gasoline tank, an internal or external floating roof is technically infeasible. Thus, this option has been eliminated from further consideration as BACT.

Vapor Recovery System

Vapor recovery through carbon adsorption, vapor balance, or refrigerated condenser provides control of emissions by collecting the vented material for recycle or reuse. In the San Joaquin Valley Air Pollution Control District, Vapor Recovery is required for gasoline transfer tanks of a certain size.[71] Despite the California Rule, Vapor Recovery is not considered practical for a 1,000 gallon tank, and Vapor Recovery is not listed as BACT for tanks under 12,740 gallons/year[72]. Thus, this option has been eliminated from further consideration as BACT.

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[70] Database accessed March 3, 2017.

[71] SJAPCD Rule 4622 Gasoline Transfer into Motor Vehicle Fuel Tanks Condition 5.1.

[72] SJVAOCD's searchable BACT database, Gasoline Storage and Dispensing Facility, equipment rating 12,740 gallons/year.

Wet Scrubber

Absorption through a packed-bed tower wet scrubber is used for raw material and/or product recovery technique in separation and purification of gaseous streams containing high concentrations of VOCs, especially water soluble compounds such as methanol, ethanol, isopropanol, butanol, acetone, and formaldehyde. However, as an emission control technique, it is much more commonly employed for controlling inorganic gases than for VOC. Removal efficiencies for gas absorbers vary for each pollutant-solvent system with the type of absorber used. The suitability of gas absorption as a pollution control method is generally dependent on the following factors: 1) availability of the solvent; 2) required removal efficiency; 3) pollutant concentration inlet vapor; 4) capacity required for handling waste gases; and 5) recovery value of the pollutants or the disposal cost of unrecoverable solvent. This technology is not in use for any diesel or gasoline tanks of similar size and is therefore removed from consideration from these tanks.

Carbon Filtration System

Adsorption may be used on a low or medium concentrated gaseous stream to remove VOCs. During adsorption, a gaseous molecule will be attracted to the solid material in the filtration system. This control technology is shown in the RBLC being used for a corrosion inhibitor tank of unknown size. Since these tanks are small, this system is not considered further.

Simple Thermal Oxidizer

In a simple TO or afterburner, the flue gas is reheated in the presence of sufficient oxygen to oxidize the VOC present in the flue gas. A typical TO is a flare and is not equipped with any heat recovery device. This technology was identified for sources through RBLC and SCAQMD with large throughputs and several tanks co-located. Additionally, this control technology would require a combustion source increasing VOC, NO_X, and $PM_{2.5}$ from the facility. This technology is not considered further since it is not a proven control technology for sources of this size.

Pressure/Vacuum Valve Settings

Setting the pressure or vacuum valve to 10% of the maximum allowable tank working pressure is considered BACT within SJVAPCD for tanks with a capacity of less than 20,000 gallons. Setting up the pressure settings in this manner allows notification if the tank is leaking, reducing emissions of VOCs. This technology is feasible but as storage tanks are a minor source of emissions at MDU and considered an insignificant source, it is not being considered further.

Fuel Storage VOC Steps 3 - 5 - Select BACT

Due to the insignificant emissions, MDU is currently implementing BACT for these tanks.

Fuel Storage VOC Most Stringent Measures

Add-on pressure/vacuum valve qualifies as a most stringent measure.

3.14. VOC FUGITIVES

This section includes the BACT evaluation for VOC fugitive emission sources including pipe stenciling, pipe striping, and parts degreaser. Cumulatively these sources produce less than 4 tpy of VOC emissions.

3.14.1. VOC

MDU reviewed EPA's Alternative Control Technology Paper "Control Techniques for Volatile Organic Compound Emissions from Stationary Sources" published in December of 1992 to determine appropriate control technologies. MDU has also included additional control technologies specific to painting and degreasing operations cited in the TCEQ BACT Guidelines and the BAAQMD BACT/TBACT Workbook.

VOC Fugitives Step 1 - Identify All Control Technologies

VOC emissions can be reduced via three approaches: alternative chemical properties, good housekeeping practices and add on control technologies. Alternative chemical properties would prevent VOC emissions through a reduced potential for the material to evaporate. Good housekeeping measures ensure that VOC containing materials are not permitted to evaporate unnecessarily and used in excess of process needs. Add on controls would be accomplished through the use of control techniques that oxidize, combust or otherwise change VOC emissions produced from a process into less harmful pollutants or a less harmful form of the pollutant.

VOC Fugitives Step 2 - Eliminate Technically Infeasible Options

Alternative Chemical Properties

One common method of preventing VOC emissions is to use materials which reduce the potential for a process to release VOC emissions which generally requires using alternative materials with chemical properties that are less likely to result in VOC emissions. Chemical properties that are likely to result in low VOC emissions include materials with a low VOC content, and low vapor pressure. The materials used in these processes have been carefully selected based on their chemical properties; therefore, changing the chemical properties to reduce emissions may not be technically feasible in all cases. The degreaser used by MDU has a low vapor pressure throughout the plant. The solvent used in coating operations at MDU also has a low vapor pressure with exception of poles coating or specialty lining where a stronger solvent is required.

Good Housekeeping Practices

Good housekeeping practices include but may not be limited to maximum transfer efficiency, covered containers, sufficient freeboard, spill cleanup procedures, limited use and development of a management plan. MDU adheres to the practices found in UDAQ's miscellaneous metal parts coating rule for good housekeeping practices.[73]

Add on Controls

Any control system that destroys VOC emissions from a process has two fundamental components. The first is the containment or capture system, which is a single device or group of devices whose function is to collect the pollutant vapors and direct them into a duct leading to a control device. The second component is the control device, which reduces the quantity of the pollutant emitted to the atmosphere.[74]

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[73] Degreaser and solvent cleaning operations rule Utah Administrative Code (UAC) R307-335

[74] EPA's Alternative Control Technology Paper "Control Techniques for Volatile Organic Compound Emissions from Stationary Sources" published in December of 1992.

The fugitive sources described in this section are small sources located throughout the facility. Creating a capture system that spans this large area is technically infeasible; therefore, no destructive control techniques have been further evaluated.

VOC Fugitives Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Alternative chemical properties (1st) and good housekeeping practices (2nd) are technically feasible. MDU currently implements both control measures for fugitive VOCs.

VOC Fugitives Step 4 - Evaluate Most Effective Controls and Document Results

As the highest ranked control measures are already being implemented no economic, energy, or environmental analysis was conducted.

VOC Fugitives Step 5 - Select BACT

VOC fugitive emissions meet the requirements in UDAQ's requirements.

VOC Fugitives Most Stringent Measures

MSM is equivalent to BACT in this instance.

3.15. DIESEL-FIRED DELAVAUD EMERGENCY GENERATOR

The DeLavaud generator's purpose is to supply power to the overhead crane during a power outage. Operation of the crane is necessary during an emergency shutdown to empty the ladles of molten iron and thereby protect employees and prevent major equipment damage. The generator currently onsite was installed in 1977 and has a maximum power output 190 hp.

3.15.1. $PM_{2.5}$, NO_X, SO_2 and VOC

Delavaud Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Diesel Generators (process type 17.210 Small Internal Combustion Engines [<500 Hp] – Fuel Oil);75
- EPA's Air Pollution Technology Fact Sheets; and
- South Coast Air Quality Management District Example Permits.

Available control technologies for emergency generators includes the following:

[75] Database accessed March 3, 2017.

- Limited Hours of Operation;
- Good Combustion Practices;
- Use of a Tier Certified Engine
- Engine Design
- Diesel Particulate Filter
- Ultra Low Sulfur Fuel
- Diesel Oxidation Catalyst
- Selective Catalyst Reduction (SCR)

Delavaud Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 2 - Eliminate Technically Infeasible Options

Limited Hours of Operation

One of the apparent opportunities to control the emissions of all pollutants released from emergency generator engines is to limit the hours of operation for the equipment. Due to the designation of this equipment as emergency equipment, only 100 hours of operation for maintenance and testing are permitted per NESHAP Subpart ZZZZ.[76] MDU complies with NESHAP Subpart ZZZZ requirements and minimizes operation time for maintenance and testing.

Good Combustion Practices

Good combustion practices refer to the operation of engines at high combustion efficiency, which reduces the products of incomplete combustion. Good combustion practices for newer engines are often provided by the manufacturer. The existing emergency generator is sufficiently old enough that recommended good combustion practices are not available from the manufacturer. However, MDU operates and maintains the existing engine in accordance with best industry practices.

Use of a Tier Certified Engines

EPA noted that non-road engines were a significant source of emissions and began adopting emission standards for these emission units in 1994. Today engines are required to meet certain emission limits, or tier ratings, based on the size and model year. Emission standards for these engines have progressively gotten more stringent over time and are an indicator of good combustion design. A Tier 3 emission rating provides the lowest possible emissions for emergency generators.[77,78] The DeLavaud emergency engine was installed in 1977 and predates EPA emission requirements. MDU proposes to replace this emergency generator to ensure the engine continues to function as designed and reduce emissions from this source. The engine will meet intermediate Tier 3 emission standards.

Diesel Particulate Filters

This simple technology is placed in the exhaust pathway to prevent the release of particulate and may be coated with a catalyst to further capture hydrocarbon emissions.

According to EPA's Response to Public Comments on Notice of Reconsideration of NESHAP for RICE and NSPS for Stationary ICE, "Diesel particulate filters are also proven, commercially available technology for retrofit

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[76] 40 CFR 63.6640(f)(3)

[77] EPA Nonroad Compression-Ignition Engines: Exhaust Emission Standards, March 2016

[78] 40 CFR 89.122, 40 CFR 1039.101, 40 CFR 1039.102, 40 CFR 1039 Subpart F, 40 CFR 86 Subpart I, and 40 CFR 1065

applications to stationary engines...and are capable of reducing diesel PM by 90 percent or more."[79] Additionally the CA ARB was able to determine that this technology was technically feasible for emergency and prime engines through obtaining several vendor quotes. [80]

However, EPA remained concerned with the installation of a catalyzed particulate filter, citing technical issues including the fact that many older engines are not electronically controlled, PM emissions are often too high for efficient operation and, in some cases, engine exhaust temperatures are not high enough for filter substrate regeneration.[81]

While a catalytic diesel particulate filter is not considered to be technically feasible, consideration of a simple particulate filter will be evaluated.

Ultra Low Sulfur Diesel

Ultra low sulfur diesel contains less than 0.0015% (15 ppm) sulfur by weight. The reduced sulfur content reduces the potential for SOx emissions. Additionally, the low sulfur content results in a lower potential for aggregation of sulfur containing compounds and thus reduces $PM_{2.5}$ emissions. MDU uses ultra-low sulfur fuel for the emergency engines on-site.

Diesel Oxidation Catalyst (DOC)

A diesel oxidation catalysts utilizes a catalyst such as platinum or palladium to further oxidize the engine's exhaust, which includes hydrocarbons (HC), e.g., VOC, to carbon dioxide (CO_2) and water. Use of a diesel oxidation catalyst can result in approximately 90 percent reduction in HC/VOC emissions.[82] In addition to controlling HC/VOC a DOC also has the potential to control PM by 30 percent (based on the concentration of soluble organics) and CO by 50 percent if low sulfur diesel fuel is used.[83]

The use of a diesel oxidation catalyst reduces the effective power output of RICE and results in a solid waste stream. However, for the purposes of identifying technical feasibility, no formal consideration of these adverse energy and environmental impacts is presented. A diesel oxidation catalyst is considered technically feasible and is further considered for BACT.

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79 Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

80 Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

81 Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

82 U.S. EPA, *Alternative Control Techniques Document: Stationary Diesel Engines*, March 5, 2010, p. 41. (https://www.epa.gov/sites/production/files/2014-02/documents/3_2010_diesel_eng_alternativecontrol.pdf)

83 Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

Selective catalytic reduction (SCR)

Selective catalytic reduction systems introduce a liquid reducing agent such as ammonia or urea into the flue gas stream before a catalyst. The catalyst reduces the temperature needed to initiate the reaction between the reducing agent and NO_X to form nitrogen and water.

For SCR systems to function effectively, exhaust temperatures must be high enough (200°C to 500°C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 20 to 30 minutes after engine start up, especially during maintenance and testing. There are also complications controlling the excess ammonia (ammonia slip) from SCR use. Since SCR is anticipated to have a relatively low combustion efficiency during maintenance and testing, SCR is not considered technically feasible for emergency units.

Delavaud Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Effective control technologies for diesel engines include the limited hours of operation, good combustion practices, use of tier certified engines, use of high efficiency engines, diesel particulate filters, ultra-low sulfur diesel, and diesel oxidation catalysts. All control technologies considered effective are currently implemented or will be implemented with the purchase of a new DeLavaud generator with the exception of diesel particulate filters and diesel oxidation catalysts. Both technologies result in significant emission reductions and are further evaluated to determine the economic feasibility of implementation.

Delavaud Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 4 - Evaluate Most Effective Controls and Document Results

When reviewing the implementation and costs associated with installing diesel oxidation catalyst controls for an emergency-use or intermittent-use engines MDU found that "[b]ecause these engines are typically used only a few number of hours per year...[s]uch engines rarely if ever use the [diesel oxidation catalyst] type of emission controls."[84] Additionally, in its 2010 MACT/GACT evaluation for engines, EPA concluded for emergency engines: "Because these engines are typically used only a few number of hours per year [(27 hours per year per NFPA codes)], the costs of emission control are not warranted when compared to the emission reductions that would be achieved."[85] Based on EPA's assessment and the fact that the RBLC contains no records of diesel oxidation catalyst installation on emergency-use or nonroad engines, installation of a diesel oxidation catalyst is eliminated from consideration as BACT.

EPA gathered cost estimates for installing a diesel particulate filter when reviewing NESAHP ZZZZ and NSPS IIII, and determined the costs to be excessive.[86] EPA determined that the cost per ton of PM reduced from engines between 300 and 600 HP was close to $260,000 and more than $700,000 for engines above 750 HP when

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[84] U.S. EPA, Memorandum: *Response to Public Comments on Proposed National Emission Standards for Hazardous Air Pollutants for Existing Stationary Reciprocating Internal Combustion Engines Located at Area Sources of Hazardous Air Pollutant Emissions or Have a Site Rating Less Than or Equal to 500 Brake HP Located at Major Sources of Hazardous Air Pollutant Emissions*, August 10, 2010, p. 172-173. (EPA-HQ-OAR-2008-0708)

[85] Ibid.

[86] Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

installed at the time of manufacturing.[87] EPA concluded that the installation of a diesel particulate filter was only required for the operation of non-emergency engines as documented in NESHAP Subpart ZZZZ; therefore this technology is not further considered.[88]

Delavaud Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 5 - Select BACT

MDU will purchase a replacement DeLavaud emergency generator that is well designed, efficient and reliable. This will include a low emission guarantee (Tier 3) and a high efficiency rating (typically achieved through a turbocharger). The DeLavaud emergency generator will be operated and maintained in accordance with good combustion practices and combust only ultra-low sulfur diesel.[89] The hours of operation are restricted to 100 hours for maintenance and testing per year in accordance with 40 CFR 60, Subpart IIII. As a result, the replacement DeLavaud generator will meet BACT.

Delavaud Generator $PM_{2.5}$, NO_X, SO_2, VOC Most Stringent Measures

Requiring the replacement engine to meet final Tier 3 standards would be considered a most stringent measure.

3.16. DIESEL-FIRED RECUPERATOR EMERGENCY GENERATOR

MDU operates a recuperator in conjunction with the cupola in order to maximize heat recovery from the flue. The recuperator is temperature controlled through an oil heat exchanger. The recuperator emergency generator prevents the immediate shutdown of the oil heat exchanger in a power outage to protect employee safety and prevents major equipment damage. The generator currently onsite was installed in 2002 and has a maximum power output of 550 hp.

3.16.1. $PM_{2.5}$, NO_X, SO_2 and VOC

Recuperator Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 1 - Identify All Control Technologies

The following sources were reviewed to identify available control technologies:

- EPA's RBLC Database for Diesel Generators (process type 17.110 Large Internal Combustion Engines [>500 Hp] – Fuel Oil);[90]
- EPA's Air Pollution Technology Fact Sheets; and
- South Coast Air Quality Management District Example Permits.

Available control technologies for emergency generators include the following:

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[87] Memorandum from Tanya Parise, Alpha-Gamma Technologies to Jaime Pagán, EPA. Cost per Ton for NSPS for Stationary CI ICE. EPA-HQ-OAR-2005-0029-0276. May 12, 2006.

[88] 40 CFR 63.6625(g)

[89] McWane of Utah Approval Order, AN103540025-13, Condition II.B.1.d.

[90] Database accessed March 3, 2017.

- Limited Hours of Operation;
- Good Combustion Practices;
- Use of a Tier Certified Engine
- Engine Design
- Diesel Particulate Filter
- Ultra Low Sulfur Fuel
- Diesel Oxidation Catalyst
- Selective Catalyst Reduction (SCR)

Recuperator Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 2 - Eliminate Technically Infeasible Options

Limited Hours of Operation

One of the apparent opportunities to control the emissions of all pollutants released from emergency generator engines is to limit the hours of operation for the equipment. Due to the designation of this equipment as emergency equipment, only 100 hours of operation for maintenance and testing are permitted per NESHAP Subpart ZZZZ.[91] MDU complies with NESHAP Subpart ZZZZ requirements and minimizes operation time for emergency engines to maintenance and testing.

Good Combustion Practices

Good combustion practices refer to the operation of engines at high combustion efficiency, which reduces the products of incomplete combustion. The manufacturer has provided operation and maintenance manuals that detail the required methods to achieve the highest levels of combustion efficiency. MDU operates and maintains this engine in accordance with the manufacture provided instructions and best industry practices.

Use of a Tier Certified Engines

EPA noted that non-road engines were a significant source of emissions and began adopting emission standards for these emission units in 1994. Today engines are required to meet certain emission limits, or tier ratings, based on the size and model year. Emission standards for these engines have progressively gotten more stringent over time and are an indicator of good combustion design. A Tier 3 emission rating provides the lowest possible emissions for emergency generators.[92,93] The recuperator emergency engine was installed in 2002 and was manufactured to meet Tier II emission standards, which was considered BACT at the time of installation.

Diesel Particulate Filters

This simple technology is placed in the exhaust pathway to prevent the release of particulate and may be coated with a catalyst to further capture hydrocarbon emissions.

According to EPA's Response to Public Comments on Notice of Reconsideration of NESHAP for RICE and NSPS for Stationary ICE, "Diesel particulate filters are also proven, commercially available technology for retrofit

[91] 40 CFR 63.6640(f)(3)

[92] EPA Nonroad Compression-Ignition Engines: Exhaust Emission Standards, March 2016

[93] 40 CFR 89.122, 40 CFR 1039.101, 40 CFR 1039.102, 40 CFR 1039 Subpart F, 40 CFR 86 Subpart I, and 40 CFR 1065

applications to stationary engines...and are capable of reducing diesel PM by 90 percent or more."[94] Additionally the CA ARB was able to determine that this technology was technically feasible for emergency and prime engines through obtaining several vendor quotes. [95]

However EPA remained concerned with the installation of a catalyzed particulate filter, citing technical issues including the fact that many older engines are not electronically controlled, PM emissions are often too high for efficient operation and, in some cases, engine exhaust temperatures are not high enough for filter substrate regeneration.[96]

While a catalytic diesel particulate filter is not considered to be technically feasible, consideration of a simple particulate filter will be evaluated.

Ultra Low Sulfur Diesel

Ultra low sulfur diesel contains less than 0.0015 % sulfur by weight. The reduced sulfur content reduces the potential for SOx emissions. Additionally the low sulfur content results in a lower potential for aggregation of sulfur containing compounds and thus reduces $PM_{2.5}$ emissions. MDU uses ultra-low sulfur fuel for the emergency engines on-site.

Diesel Oxidation Catalyst (DOC)

A diesel oxidation catalysts utilizes a catalyst such as platinum or palladium to further oxidize the engine's exhaust, which includes hydrocarbons (HC), e.g., VOC, to carbon dioxide (CO_2) and water. Use of a diesel oxidation catalyst can result in approximately 90 percent reduction in HC/VOC emissions.[97] In addition to controlling HC/VOC a DOC also has the potential to control PM by 30 percent (based on the concentration of soluble organics) and CO by 50 percent if low sulfur diesel fuel is used.[98]

The use of a diesel oxidation catalyst reduces the effective power output of RICE and results in a solid waste stream. However, for the purposes of identifying technical feasibility, no formal consideration of these adverse energy and environmental impacts is presented. A diesel oxidation catalyst is considered technically feasible and is further considered for BACT.

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[94] Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

[95] Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

[96] Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

[97] U.S. EPA, *Alternative Control Techniques Document: Stationary Diesel Engines*, March 5, 2010, p. 41. (https://www.epa.gov/sites/production/files/2014-02/documents/3_2010_diesel_eng_alternativecontrol.pdf)

[98] Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

Selective Catalytic Reduction

Selective catalytic reduction systems introduce a liquid reducing agent such as ammonia or urea into the flue gas stream before a catalyst. The catalyst reduces the temperature needed to initiate the reaction between the reducing agent and NO_X to form nitrogen and water.

For SCR systems to function effectively, exhaust temperatures must be high enough (200°C to 500°C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 20 to 30 minutes after engine start up, especially during maintenance and testing. There are also complications controlling the excess ammonia (ammonia slip) from SCR use. Since SCR is anticipated to have a relatively low combustion efficiency during maintenance and testing, SCR is not considered technically feasible for emergency units.

Recuperator Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Effective control technologies for the recuperator diesel engine include limited hours of operation, good combustion practices, use of tier certified engines, diesel particulate filters, ultra-low sulfur diesel, and diesel oxidation catalysts. All control technologies considered effective have been implemented with the exception of diesel particulate filters and diesel oxidation catalysts. Both technologies result in significant emission reductions and are further evaluated to determine the economic feasibility of implementation.

Recuperator Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 4 - Evaluate Most Effective Controls and Document Results

When reviewing the implementation and costs associated with installing diesel oxidation catalyst controls for an emergency-use or intermittent-use engines MDU found that "[b]ecause these engines are typically used only a few number of hours per year...[s]uch engines rarely if ever use the [diesel oxidation catalyst] type of emission controls."[99] Additionally, in its 2010 MACT/GACT evaluation for engines, EPA concluded for emergency engines: "Because these engines are typically used only a few number of hours per year [(27 hours per year per NFPA codes)], the costs of emission control are not warranted when compared to the emission reductions that would be achieved."[100] Based on EPA's assessment and the fact that the RBLC contains no records of diesel oxidation catalyst installation on emergency-use or nonroad engines, installation of a diesel oxidation catalyst is eliminated from consideration as BACT.

EPA gathered cost estimates for installing a diesel particulate filter when reviewing NESAHP ZZZZ and NSPS IIII, and determined the costs to be excessive.[101] EPA determined that the cost per ton of PM reduced from engines between 300 and 600 HP was close to $260,000 and more than $700,000 for engines above 750 HP when installed at the time of manufacturing.[102] EPA concluded that the installation of a diesel particulate filter was

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[99] U.S. EPA, Memorandum: *Response to Public Comments on Proposed National Emission Standards for Hazardous Air Pollutants for Existing Stationary Reciprocating Internal Combustion Engines Located at Area Sources of Hazardous Air Pollutant Emissions or Have a Site Rating Less Than or Equal to 500 Brake HP Located at Major Sources of Hazardous Air Pollutant Emissions,* August 10, 2010, p. 172-173. (EPA-HQ-OAR-2008-0708)

[100] Ibid.

[101] Response to Public Comments on Notice of Reconsideration of National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Internal Combustion Engines, EPA Docket EPA-HQ-OAR-2008-0708, June 16, 2014

[102] Memorandum from Tanya Parise, Alpha-Gamma Technologies to Jaime Pagán, EPA. Cost per Ton for NSPS for

only required for the operation non-emergency engines as documented in NESHAP Subpart ZZZZ, therefore this technology is not further considered.[103]

Recuperator Generator $PM_{2.5}$, NO_X, SO_2, VOC Step 5 - Select BACT

The recuperator emergency generator is well designed, efficient and reliable, including a Tier II emission rating. Additionally, the recuperator emergency generator will be operated and maintained in accordance with good combustion practices and combust only ultra-low sulfur diesel.[104] The hours of operation are restricted to 100 hours for maintenance and testing per year in accordance with 40 CFR 63, Subpart ZZZZ. As a result, the Recuperator emergency generator meets BACT.

Recuperator Generator $PM_{2.5}$, NO_X, SO_2, VOC Most Stringent Measures

MSM is equivalent to BACT in this instance.

3.17. NATURAL GAS-FIRED EMERGENCY GENERATORS

MDU utilizes four (4) natural gas-fired emergency generators to maintain critical systems during an emergency. Specific information pertaining to the natural gas-fired emergency generators and their respective building locations are summarized in the table below.

Table 3-27. Natural Gas-Fired Emergency Engine Manufacture Dates

Building Number	Manufacture Date
Works Office	2015
Main Office	2004
Oven Control	1980/90s
Specialty Lining	2000

3.17.1. $PM_{2.5}$, NO_x, SO_2 and VOC

Natural Gas-Fired Emergency Generators $PM_{2.5}$, NO_X, SO_2, VOC Step 1 - Identify All Control Technologies

The following sources were reviewed to identify available control technologies:

Stationary CI ICE. EPA-HQ-OAR-2005-0029-0276. May 12, 2006.

[103] 40 CFR 63.6625(g)

[104] Title V Condition II.B.1.f.

- South Coast Air Quality Management District;
- Bay Area Quality Management District;
- San Joaquin Valley Air Pollution Control District;
- Texas Commission on Environmental Quality BACT Requirements;
- EPA's RBLC Database for Natural Gas Generators (process type 17.230 Small Internal Combustion Engines [<500 Hp] – Natural Gas);105 and
- EPA's Air Pollution Technology Fact Sheets.

Available control technologies for natural gas-fired emergency generator engines includes the following:

- Limited Hours of Operation
- Routine Maintenance
- Good Combustion Practices
- Use of Natural Gas
- Lean Burn Technology
- Selective Catalyst Reduction (SCR)

The following step evaluates the technical feasibility of each of these options.

Natural Gas-Fired Emergency Generators $PM_{2.5}$, NO_X, SO_2, VOC Step 2 - Eliminate Technically Infeasible Options

Limited Hours of Operation

One of the apparent opportunities to control the emissions of all pollutants released from natural gas-fired emergency generator engines is to limit the hours of operation for the equipment. Under NSPS Subpart JJJJ and RICE NESHAP[106], only 100 hours of operation for maintenance and testing are allowed for generators designated as emergency. MDU will comply with the federal requirements and minimize operation time for maintenance and testing.

Routine Maintenance

Routine maintenance ensures the engines are working properly and as efficiently as possible, which, in turn, helps reduce emissions. For spark ignition internal combustion engines, such as those utilized by the MDU, RICE NESHAP[107] requires sources to:

- Change oil and filters every 500 hours of operation or annually, whichever comes first;
- Inspect spark plugs every 1,000 hours of operation or annually, whichever comes first, and replace as necessary; and
- Inspect all hoses and belts every 500 hours of operation or annually, whichever comes first, and replace as necessary.

The MDU will comply with the routine maintenance specified in RICE NESHAP and summarized herein.

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[105] Database accessed April 13, 2017.

[106] 40 CFR 60.4243(d)(2) and 40 CFR 63.6640(f), respectively

[107] 40 CFR 63.6603(a)

Good Combustion Practices

Good combustion practices refer to the operation of engines at high combustion efficiency, which reduces the products of incomplete combustion. The natural gas-fired emergency generator engines installed at the MDU are designed to achieve maximum combustion efficiency. Where available, the manufacturer has provided operation and maintenance manuals that detail the required methods to achieve the highest levels of combustion efficiency for each unit. The MDU operates and maintains these generator engines in accordance with the manufacture provided instructions, where available, and best industry practices.

Use of Natural Gas

Natural gas is the cleanest fossil fuel and is a highly efficient form of energy. It is composed mainly of methane and its combustion results in less particulate matter, NO_x, and SO_2 in comparison to other fossil fuels. MDU uses natural gas for these four emergency engines.

Lean Burn Technology

With lean burn combustion technology excess air is introduced into the engine along with the fuel. In lean burn engines the air:fuel ratio may be as lean as 65:1 by mass. Excess air, in turn, reduces the temperature of the combustion process and combusts more of the fuel which ultimately results in fewer hydrocarbons being emitted. The four natural gas-fired emergency generator engines at MDU utilize lean burn technology.

Selective catalytic reduction

Selective catalytic reduction (SCR) systems introduce a liquid reducing agent such as ammonia or urea into the flue gas stream prior to a catalyst. The catalyst then reduces the temperature needed to initiate the reaction between the reducing agent and NO_x to form nitrogen and water.

For SCR systems to function effectively, exhaust temperatures must be high enough (200°C to 500°C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 20 to 30 minutes after engine start up, especially during maintenance and testing. There are also complications controlling the excess ammonia (ammonia slip) from SCR use. Since SCR is anticipated to have a relatively low combustion efficiency during maintenance and testing due to short periods of operation and frequent starts/stops, implementing a SCR technology for emergency units is challenging, and not infeasible.

Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Effective control technologies for natural gas-fired engines include the limited hours of operation, routine maintenance, good combustion practices, use of natural gas, and lean burn technology. All control technologies considered effective are currently implemented or will be implemented at the MDU, with the exception of SCR technology, which is evaluated further in Step 4 below to determine the economic feasibility of implementation.

Step 4 - Evaluate Most Effective Controls and Document Results

In the 2010 MACT/GACT evaluation for engines, EPA concluded for emergency engines: "Because these engines are typically used only a few number of hours per year [(27 hours per year per NFPA codes)], the costs of emission control are not warranted when compared to the emission reductions that would be achieved."[108] Based on EPA's assessment and the fact that the RBLC contains no records of SCR installation on emergency-use or nonroad engines, installation of a SCR system is eliminated from consideration as BACT.

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[108] Ibid.

Table 3-28. Summary for Natural Gas-Fired Emergency Generator Pollutants - $PM_{2.5}$, NO_X, SO_2 and VOC

Control Technologies	Feasibility	BACT
Limited Hours of Operation	Yes	Yes
Good Combustion Practices	Yes	Yes
Use of Natural Gas	Yes	Yes

Natural Gas Generator Step 5 - Select BACT

The MDU natural gas-fired emergency generator engines will be operated and maintained in accordance with good combustion practices, which will include routine maintenance being performed on the units in accordance with the RICE NESHAP requirements, combust only natural gas, and utilize lean burn technology. The hours of operation will be limited to 100 hours for maintenance and testing per year in accordance with NSPS Subpart JJJJ and RICE NESHAP. As a result, the MDU engines will meet BACT.

Natural Gas Generator $PM_{2.5}$, NO_X, SO_2, VOC Most Stringent Measures

MSM is the same as BACT in this instance.

3.18. COOLING TOWERS

There are eight (8) cooling towers in use at MDU to support plant processes.

3.18.1. $PM_{2.5}$

Particulate matter is emitted from wet cooling towers because the water circulating in the tower contains small amounts of dissolved solids (e.g., calcium, magnesium, etc.) that crystallize and form airborne particles as some of the water (i.e., drift) leaves the cooling tower through the induced draft fans and evaporates. However, advances in drift eliminator technology have greatly reduced the potential for cooling tower drift. This analysis addresses filterable $PM_{2.5}$ only.

Cooling Towers $PM_{2.5}$ Step 1 - Identify All Control Technologies

MDU has reviewed the following sources to ensure all available control technologies have been identified:

- EPA's RBLC Database for Cooling Towers (process type 99.009);[109]
- EPA's Air Pollution Technology Fact Sheets; and
- Permits available online.

Cooling Towers $PM_{2.5}$ Step 2 - Eliminate Technically Infeasible Options

Drift/Mist Eliminator

Drift/mist eliminators reduce the amount of particulate matter in entrained on the water droplets of that are released into the atmosphere of the exit stream of the cooling tower thereby reducing the drift of the cooling

[109] Database accessed March 3, 2017.

tower. A drift of 0.005%, as specified by the vendor, is being identified as BACT. One of the eight cooling towers in use at the facility (Cast Machine No. 7) is equipped with a drift eliminator that achieves a drift of 0.01%. The remainder of this section addresses the cooling tower for cast machine no. 7 only, as the remainder currently meet BACT.

Step 3 - Rank Remaining Control Technologies by Control Effectiveness

A drift eliminator that achieves a drift of 0.005%, is considered BACT.

Step 4 - Evaluate Most Effective Controls and Document Results

Technically feasible technology includes a drift eliminator on the cast machine no. 7 cooling tower. Based on established control efficiencies for these technologies, the drift eliminator is ranked as the control device providing the highest control efficiency (i.e., rank 1).

Since the highest ranked control has been accepted as BACT for seven of the eight emission sources, no detailed economic, energy, and environmental impact evaluations was conducted for these sources.

Due to the minimal emissions associated with the cooling tower serving Cast Machine No. 7 which achieves a drift of 0.01%, MDU has assumed that replacement of this unit would be economically infeasible.

Cooling Towers $PM_{2.5}$ Step 3-5 - Select BACT

The selected BACT for $PM_{2.5}$ emissions from the proposed gas stream is use of a drift eliminator that achieves a drift of 0.005%. Additionally, the cooling towers are engineered to minimize water evaporation and cool machines as necessary. The implementation of the drift eliminator technology, with a drift of 0.005%, with proper engineering control and design has been selected as BACT for proposed gas stream for the control of $PM_{2.5}$ emissions. The emissions from the Cast Machine No. 7 are 1.48 lb/yr for $PM_{2.5}$ and therefore replacement of the cooling tower to achieve the 0.005% would cut emissions in half and be cost prohibitive for an insignificant emission decrease.

Cooling Towers $PM_{2.5}$ Most Stringent Measures

MSM is the same as BACT in this instance.

3.19. MISCELLANEOUS EMISSION UNITS

In order to ensure that this BACM analysis is complete MDU would like to address the emissions released from the following units:

- Pipe Cut off
- Pipe Grinding
- Mold Grinding
- Mold Blast
- Mold Flux Fines Repair
- Machine Shop Grinding
- Blackening

The combined total emission rate for the units above is less than 0.5 tons per year of PM emissions. Additionally all emissions produced by these operations occur inside the buildings onsite which limits the dispersion potential of the emissions produces. Per a conversation with John Jenks, Environmental Engineer with UDAQ, a full BACM analysis does not need to be completed for these sources due to the minor nature of the emissions and location of release. MDU considers the completion of these activities in accordance with good operating practices and within buildings onsite to be BACT.

4.1. EMISSION SUMMARY

Table 4-1 provides emission limits during normal operation and startup, shutdown, and maintenance settings.

Table 4-1. Site Wide Emission Summary

Source/Source Type	Current Emission Estimates (tpy)				
	$PM_{2.5}$	NO_X	SO_2	VOC	NH_3
Total Emissions	**20.71**	**87.6**	**25.1**	**140.85**	

Table 5-1 provides a summary of monitoring conditions for the site that affect $PM_{2.5}$ or its precursors.

Table 5-1. Monitoring Conditions

Monitoring Condition	Frequency	Source(s) Covered	Permit Condition
Good air pollution control practices during startup, shutdown, and malfunction	As Necessary	Source-wide	#4900017003 Condition II.B.1.a.1
Fugitive dust monitoring as required by most recent fugitive dust plan	As Required by Plan	Source-wide	#4900017003 Condition II.B.1.c.1
Natural gas and diesel use	Monthly	Source-wide with exceptions[110]	#4900017003 Condition II.B.1.d.1
Visible emissions surveys and follow-up Method 9 Evaluations as necessary	Daily survey Method 9/203A if VE are observed	Source-wide	#4900017003 Condition II.B.1.e.1
Initial inspection of PM Control Device	Once upon installation	Source-wide	#4900017003 Condition II.B.1.g.1 and 40 CFR 63.10897
Inspections of ductwork and internal baghouse components	Ductwork – monthly Internals – every 6 months	Source-wide	#4900017003 Condition II.B.1.g.1 and 40 CFR 63.10897
Inspections of capture components	Monthly	Source-wide	#4900017003 Condition II.B.1.g.1 and 40 CFR 63.10897
Stack Testing	Every 2 years or as directed	Cupola	#4900017003 Condition II.B.2.b.1 Condition II.B.2.d.1
Calculation of rolling 12-month total NO_X	The 20th of each month	Cupola	#4900017003 Condition II.B.2.c.1
Calculation of production	Monthly – by the 20th for 12-month total Daily – for hourly production	Cupola	#4900017003 Condition II.B.2.e.1
Visible emissions surveys and follow-up Method 9 Evaluations as necessary	Daily survey Method 9 within 24 hours if VE are observed	Cupola baghouse	#4900017003 Condition II.B.2.f.1

[110] This does not apply to emergency generators or the cupola.

Monitoring Condition	Frequency	Source(s) Covered	Permit Condition
Visible emissions surveys and follow-up Method 203A Evaluations as necessary	Weekly survey Method 203A if VE are observed	Cupola reagent silo bin vent	#4900017003 Condition II.B.2.g.1
Visible emissions surveys and follow-up Method 203A Evaluations as necessary	Daily survey Method 203A if VE are observed	Desulfurization & Ductile System	#4900017003 Condition II.B.3.a.1
Quantify amount of seal-coat removed	Daily when in operation Totals by the 20th of each month	Annealing Oven	#4900017003 Condition II.B.4.a.1
Heat Input using hourly gas flow meter, vendor supplier records, or testing by MDU	Hourly	Annealing Oven	#4900017003 Condition II.B.4.b.1
Visible emissions surveys and follow-up Method 203A Evaluations as necessary	Weekly survey Within 24 hours, Method 203A if VE are observed	Cement Lining Silo	#4900017003 Condition II.B.8.a.1
Visible emissions surveys and follow-up Method 203A Evaluations as necessary	Weekly survey Within 24 hours, Method 203A if VE are observed	Cement Lining Sand Silo	#4900017003 Condition II.B.9.a.1
Hours of Operation	Daily	Special Lining	#4900017003 Condition II.B.10.a.1
Visible emissions surveys and follow-up Method 9 Evaluations as necessary	Daily survey Within 24 hours, Method 9 if VE are observed	Special Lining baghouse	#4900017003 Condition II.B.10.b.1
Records of paint and epoxy lining applied	Unspecified	Special Lining	#4900017003 Condition II.B.10.c.1
Visible emissions surveys and follow-up Method 203A Evaluations as necessary	Weekly survey Within 24 hours, Method 203A if VE are observed	Lime Silo	#4900017003 Condition II.B.11.a.1
Rolling 12-month total on VOC emissions	Monthly by the 20th	All sources with regulated VOC emissions	#4900017003 Condition II.B.12.a.1
Visible emissions surveys and follow-up Method 203A Evaluations as necessary	Daily survey Within 24 hours, Method 203A if VE are observed	Miscellaneous	#4900017003 Condition II.B.13.a.1

Monitoring Condition	Frequency	Source(s) Covered	Permit Condition
Visible emissions surveys and follow-up Method 9 Evaluations as necessary	Survey when operated more than 12 hours Method 9 if operated on consecutive days or if VE is observed	Emergency CI Engines	#4900017003 Condition II.B.14.a.1
Hours between oil & filter changes Inspections of air cleaner Hose Inspections	500 hours or annually 1000 hours or annually 500 hours or annually (whichever comes 1st)	Emergency CI Engines	#4900017003 Condition II.B.14.b.1 40 CFR 63 Subpart ZZZZ Table 2d
Hours of operation	According to O&M Plan	Emergency CI Engines	#4900017003 Condition II.B.14.c.1 40 CFR 63 Subpart ZZZZ Table 2d
Visible emissions surveys and follow-up Method 9 Evaluations as necessary	Survey when operated more than 12 hours Method 9 if operated on consecutive days or if VE is observed	Emergency SI Engines	#4900017003 Condition II.B.15.a.1
Hours between oil & filter changes Spark plug inspections Hose inspections	500 hours or annually whichever is 1st 1000 hours or annually and as necessary Every 500 hours or annually and as necessary	Emergency SI Engines	#4900017003 Condition II.B.15.b.1 40 CFR 63 Subpart ZZZZ Table 2d
Hours of operation	According to O&M Plan	Emergency SI Engines	#4900017003 Condition II.B.15.b.1
Requirements of O&M plan	According to O&M Plan	Emergency SI Engines	#4900017003 Condition II.B.16.a.1

Monitoring Condition	Frequency	Source(s) Covered	Permit Condition
Hours of operation using non-resettable hour meter	As necessary for specific engines[111]	Emergency SI Engines	#4900017003 Condition II.B.16.b.1
Amount of zinc wire used	Daily when in operation. Monthly totals shall be determined by the 20th of the month.	Zinc Thermal Spray	#4900017003 Condition II.B.17.a.1
Visible emissions surveys and follow-up Method 9 Evaluations as necessary	Daily when in operation. Within 24 hours, Method 9 if operated on consecutive days or if VE is observed	Zinc Thermal Spray	#4900017003 Condition II.B.17.b.1

MDU feels that these monitoring conditions will sufficiently ensure the site operates in compliance with all permits and potential SIP conditions.

[111] Specifically for SI ICE less than 130 HP, built after July 1, 2008 that do not meet the standards applicable to non-emergency engines.

6. PROPOSED SIP CONDITIONS

MDU would like to make the changes below to existing SIP conditions.

i. Emissions of VOC from the main finishing paint line shall not exceed 1 ton/day.

   A. Compliance with the above conditions shall be demonstrated as follows: VOC emissions at the main finishing paint line shall be determined by asphalt paint consumption. Asphalt paint consumption shall be monitored by liquid level monitoring sensors on the finishing paint line bulk tanks.

   B. For purposes of this section a day is defined as a period of 24-hours commencing at midnight and ending at the following midnight.

ii. The Annealing Oven furnaces are limited to 63.29 MMBtu/hr.

iii. Emissions from the desulfurization and ductile treatment system shall be routed through the operating baghouse prior to be emitted into the atmosphere.

iv. Emissions from the Special Lining Shotblast operations shall be routed through the operating baghouse prior to being emitted into the atmosphere.

APPENDIX A. COST ANALYSIS

APPENDIX A. COST ANALYSIS

BACT CONTROL COST EVALUATION

Technology: Selective Catalytic Reduction (SCR)
Application: Cupola
Pollutants: Oxides of Nitrogen (NOx)

Selective Catalytic Reduction (SCR)

Key Assumptions	Cupola		Notes
Process Information			
Uncontrolled Emissions (tpy)	52		McWane PTE 2017 workbook
(lb/hr)	33		McWane PTE 2017 workbook
Exhaust Flow (acfm)	101,919		McWane PTE 2017 workbook
Exhaust Temperature (°F)	239		McWane PTE 2017 workbook
exhaust)	169,135		Calculated value
SCR Inlet Temperature (°F)	700		EPA CCM recommended operating temp.
Base case fuel gas volumetric flow rate factor (Q_{fuel})	547		EPA CCM
Number of SCR Reactor Chambers	1		Default value
Heat Input (MMBtu/hr)	175		This heat input, in lignite coal, would produce the same quantity of exhaust gas as the coke charge of the cupola. Value calculated by MDU.
(lb/MMBtu)	0.1886		Calculated value
Control Efficiency (%)	90%		High value from EPA fact sheet
Ammonia Slip (ppm)	10.00		Highest acceptable value from EPA fact sheet
Catalyst Volume (ft^3)	394.4		Cost Control Manual equation 2.22. Fuel sulfur content assumed negligible.
SCR Height (ft)	17.0		Default value
Ammonia Reagent (lb/hr)	20.40		
Electrical Consumption (kWh/year)	858,480		
Gas Consumption (MMBtu/year)	15,330		
Water Consumption (Mgal/year)	0		
Utility Costs			
Electricity ($/kWh)	$	0.089	Average Utah prices
Natural Gas ($/MMBtu)	$	2.83	Average U.S. Prices (Jan 2017)
Water ($/Mgal)	$	33.45	Sandy Utah (2" Meter, July 2016)
Ammonia Reagent ($/lb)	$	0.48	
Labor Costs			
Operator ($/hour)	$	15.00	
Supervisor ($/hour)	$	20.00	
Maintenance ($/hour)	$	20.00	
Economic Factors			
Dollar Inflation (2002 to 2017)	1.3416		U.S. Consumer Price Index
Equipment Life Expectancy (Years)	10		
Interest Rate (%)	7.00%		Current Avg SBA Loan Rate
Capital Recovery Factor (CRF)	0.1424		

BACT CONTROL COST EVALUATION

Technology: Selective Catalytic Reduction (SCR)
Application: Cupola
Pollutants: Oxides of Nitrogen (NOx)

DIRECT COSTS

Capital Cost	Cupola	Notes
Purchased Equipment Costs		
Total Equipment Cost[1]	4,507,760	A
Instrumentation	450,776	0.10 × A
Sales Tax	270,466	0.06 × A
Freight	225,388	0.05 × A
Total Purchased Equipment Costs	*5,454,390*	*B = 1.18 × A*
Direct Installation Costs [2]		
Foundations and Supports	436,351	0.08 × B
Handling and Erection	763,615	0.14 × B
Electrical	218,176	0.04 × B
Piping	109,088	0.02 × B
Insulation	54,544	0.01 × B
Painting	54,544	0.01 × B
Site Preparation & Buildings	-	No estimate / Site specific
Additional duct work	-	No estimate / Site specific
Total Direct Installation Costs	*1,636,317*	*C = 0.30 × B*
Indirect Installation Costs [2]		
Engineering	545,439	0.10 × B
Construction and Field Expense	272,719	0.05 × B
Contractor Fees	545,439	0.10 × B
Start-up	109,088	0.02 × B
Performance Test	54,544	0.01 × B
Process Contingencies	163,632	0.03 × B
Total Indirect Installation Costs	*1,690,861*	*D = 0.31 × B*
Total Capital Investment ($)	**8,781,568**	**TCI = B + C + D**

BACT CONTROL COST EVALUATION

Technology: Selective Catalytic Reduction (SCR)
Application: Cupola
Pollutants: Oxides of Nitrogen (NOx)

ANNUAL COSTS

Operating Cost	Cupola	Notes
Direct Annual Costs [3]		
Operating Labor (0.5 hr, per 8-hr shift)	8,213	E
Supervisory Labor (15% operating labor)	1,232	F = 0.15 × E
Maintenance Labor (0.5 hr, per 8-hr shift)	10,950	G
Maintenance Materials	43,908	H = 0.005 x TCI
Electricity	76,405	I
Natural Gas	43,384	J
Water	0	K
Reagent	84,886	L
Catalyst Replacement (Cost x CRF for 3 yrs	36,075	M
Total Direct Annual Costs	*305,052*	*DAC = E +F+ G+ H+ I+ J +K+L+M*
Indirect Annual Costs [3]		
Overhead	38,581	N = 0.60 × (E + F + G + H)
Administrative Charges	175,631	O = 0.02 × TCI
Property Tax	87,816	P = 0.01 × TCI
Insurance	87,816	Q = 0.01 × TCI
Capital Recovery [4]	1,250,298	R
Total Indirect Annual Costs	*1,640,142*	*IDAC = N+O+P+Q+R*
Total Annual Cost ($)	**1,945,193**	*TAC = DAC + IDAC*
Pollutant Removed (tpy)	46.80	
Cost per ton of Pollutant Removed ($)	**41,564**	*$/ton = TAC / Pollutant Removed*

1. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, Draft June 2015, Section 4.2, Chapter 2 (Selective Catalytic Reduction), Table 2.1b
2. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, January 2002, Section 3.2, Chapter 2, Table 2.8 (assume same as catalytic incineration)
3. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, January 2002, Section 3.2, Chapter 2, Table 2.10 (assume same as catalytic incineration)
4. Capital Recovery factor calculated based on Equation 2.8a (Section 1, Chapter 2, page 2-21) and Table 1.13 (Section 2, Chapter 1, page 1-52) of U.S. EPA OAQPS, EPA Air Pollution Control Cost Manual (6th Edition), January 2002.

BACT CONTROL COST EVALUATION

Trinity Consultants

Technology:	Selective Catalytic Reduction (SCR)
Application:	Annealing Oven
Pollutants:	Oxides of Nitrogen (NOx)

Selective Catalytic Reduction (SCR)

Key Assumptions		Annealing Oven	Notes
Process Information			
Uncontrolled Emissions (tpy)		5	
Heat Input (MMBtu/hr)		21	
Control Efficiency (%)		90%	
Catalyst Volume (ft^3)		117.5	
SCR Height (ft)		17.0	
Ammonia Reagent (lb/hr)		2.46	
Electrical Consumption (kWh/year)		103,492	
Gas Consumption (MMBtu/year)		1,848	
Water Consumption (Mgal/year)		0	
Utility Costs			
Electricity ($/kWh)	$	0.089	Average Utah prices
Natural Gas ($/MMBtu)	$	2.83	Average U.S. Prices (Jan 2017)
Water ($/Mgal)	$	33.45	Sandy Utah (2" Meter, July 2016)
Ammonia Reagent ($/lb)	$	0.48	
Labor Costs			
Operator ($/hour)	$	15.00	
Supervisor ($/hour)	$	20.00	
Maintenance ($/hour)	$	20.00	
Economic Factors			
Dollar Inflation (2002 to 2017)		1.3416	U.S. Consumer Price Index
Equipment Life Expectancy (Years)		10	
Interest Rate (%)		7.00%	Current Avg SBA Loan Rate
Capital Recovery Factor (CRF)		0.1424	

BACT CONTROL COST EVALUATION

Trinity Consultants

Technology:	Selective Catalytic Reduction (SCR)
Application:	Annealing Oven
Pollutants:	Oxides of Nitrogen (NOx)

DIRECT COSTS

Capital Cost	Annealing Oven	Notes
Purchased Equipment Costs		
Total Equipment Cost[1]	543,421	A
Instrumentation	54,342	0.10 × A
Sales Tax	32,605	0.06 × A
Freight	27,171	0.05 × A
Total Purchased Equipment Costs	*657,540*	*B = 1.18 × A*
Direct Installation Costs [2]		
Foundations and Supports	52,603	0.08 × B
Handling and Erection	92,056	0.14 × B
Electrical	26,302	0.04 × B
Piping	13,151	0.02 × B
Insulation	6,575	0.01 × B
Painting	6,575	0.01 × B
Site Preparation & Buildings	-	No estimate / Site specific
Additional duct work	-	No estimate / Site specific
Total Direct Installation Costs	*197,262*	*C = 0.30 × B*
Indirect Installation Costs [2]		
Engineering	65,754	0.10 × B
Construction and Field Expense	32,877	0.05 × B
Contractor Fees	65,754	0.10 × B
Start-up	13,151	0.02 × B
Performance Test	6,575	0.01 × B
Process Contingencies	19,726	0.03 × B
Total Indirect Installation Costs	*203,837*	*D = 0.31 × B*
Total Capital Investment ($)	**1,058,639**	**TCI = B + C + D**

BACT CONTROL COST EVALUATION

Technology: Selective Catalytic Reduction (SCR)
Application: Annealing Oven
Pollutants: Oxides of Nitrogen (NOx)

ANNUAL COSTS

Operating Cost	Annealing Oven	Notes
Direct Annual Costs [3]		
Operating Labor (0.5 hr, per 8-hr shift)	8,213	E
Supervisory Labor (15% operating labor)	1,232	F = 0.15 × E
Maintenance Labor (0.5 hr, per 8-hr shift)	10,950	G
Maintenance Materials	5,293	H = 0.005 x TCI
Electricity	9,211	I
Natural Gas	5,230	J
Water	0	K
Reagent	10,233	L
Catalyst Replacement (Cost x CRF for 3 yrs	10,748	M
Total Direct Annual Costs	*61,109*	*DAC = E +F+ G+ H+ I+ J +K+L+M*
Indirect Annual Costs [3]		
Overhead	15,413	N = 0.60 × (E + F + G + H)
Administrative Charges	21,173	O = 0.02 × TCI
Property Tax	10,586	P = 0.01 × TCI
Insurance	10,586	Q = 0.01 × TCI
Capital Recovery [4]	150,726	R
Total Indirect Annual Costs	*208,484*	*IDAC = N+O+P+Q+R*
Total Annual Cost ($)	**269,594**	*TAC = DAC + IDAC*
Pollutant Removed (tpy)	4.08	
Cost per ton of Pollutant Removed ($)	**66,126**	*$/ton = TAC / Pollutant Removed*

1. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, Draft June 2015, Section 4.2, Chapter 2 (Selective Catalytic Reduction), Table 2.1b
2. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, January 2002, Section 3.2, Chapter 2, Table 2.8 (assume same as catalytic incineration)
3. U.S. EPA OAQPS, *EPA Air Pollution Control Cost Manual (6th Edition)*, January 2002, Section 3.2, Chapter 2, Table 2.10 (assume same as catalytic incineration)
4. Capital Recovery factor calculated based on Equation 2.8a (Section 1, Chapter 2, page 2-21) and Table 1.13 (Section 2, Chapter 1, page 1-52) of U.S. EPA OAQPS, EPA Air Pollution Control Cost Manual (6th Edition), January 2002.

BACT CONTROL COST EVALUATION

Technology:	Baghouse, Reverse Air
Application:	Welding
Pollutants:	Particulate Matter

Baghouse, Reverse Air

Key Assumptions	Welding	Notes
Process Information		
Uncontrolled Emissions (tpy)	3.57	
Exhaust Airflow (scfm)	5,000	
Capture Efficiency (%)	98%	
Control Efficiency (%)	99%	
Electrical Consumption (kWh/year)	80,631	
Gas-to-Cloth Ratio	3.0	Assume rock dust
Gross Cloth Area (ft^2)	1,667	
Utility Costs		
Electricity ($/kWh)	$ 0.089	Average Utah prices
Natural Gas ($/MMBtu)	$ 2.83	Average U.S. Prices (Jan 2017)
Water ($/Mgal)	$ 33.45	Sandy Utah (2" Meter, July 2016)
Sewer ($/Mgal)	$ 6.36	Salt Lake City, Class 6 User
Filter Bags ($/$ft^2$)	$ 2.04	Polypropylene Bags, Reverse Air
Labor Costs		
Operator ($/hour)	$ 15.00	
Supervisor ($/hour)	$ 20.00	
Maintenance ($/hour)	$ 20.00	
Economic Factors		
Dollar Inflation (2002 to 2017)	1.3416	U.S. Consumer Price Index
Equipment Life Expectancy (Years)	10	
Interest Rate (%)	7.00%	Current Avg SBA Loan Rate
Capital Recovery Factor (CRF)	0.1424	

BACT CONTROL COST EVALUATION

Technology:	Baghouse, Reverse Air
Application:	Welding
Pollutants:	Particulate Matter

DIRECT COSTS

Capital Cost	Welding	Notes
Purchased Equipment Costs		
Total Equipment Cost (includes bags)[1]	50,938	A
Instrumentation	5,094	0.10 × A
Sales Tax	1,528	0.03 × A
Freight	2,547	0.05 × A
Total Purchased Equipment Costs	*60,107*	*B = 1.18 × A*
Direct Installation Costs [2]		
Foundations and Supports	2,404	0.04 × B
Handling and Erection	30,054	0.50 × B
Electrical	4,809	0.08 × B
Piping	601	0.01 × B
Insulation	4,207	0.07 × B
Painting	2,404	0.04 × B
Site Preparation & Buildings	-	No estimate / Site specific
Additional duct work	-	No estimate / Site specific
Total Direct Installation Costs	*44,479*	*C = 0.85 × B*
Indirect Installation Costs [2]		
Engineering	6,011	0.10 × B
Construction and Field Expense	12,021	0.20 × B
Contractor Fees	6,011	0.10 × B
Start-up	601	0.01 × B
Performance Test	601	0.01 × B
Process Contingencies	1,803	0.03 × B
Total Indirect Installation Costs	*27,048*	*D = 0.31 × B*
Total Capital Investment ($)	**131,634**	**TCI = B + C + D**

Trinity Consultants

BACT CONTROL COST EVALUATION

Technology: Baghouse, Reverse Air
Application: Welding
Pollutants: Particulate Matter

ANNUAL COSTS

Operating Cost	Welding	Notes
Direct Annual Costs [3]		
Operating Labor (0.5 hr, per 8-hr shift)	8,213	E
Supervisory Labor (15% operating labor)	1,232	F = 0.15 × E
Maintenance Labor (0.5 hr, per 8-hr shift)	10,950	G
Maintenance Materials	10,950	H = G
Electricity	7,176	I
Bag Replacement (Cost x CRF for 2 yrs)	1,880	J
Total Direct Annual Costs	*40,400*	*DAC = E + F +G +H +I +J*
Indirect Annual Costs [3]		
Overhead	18,807	K = 0.60 × (E + F + G + H)
Administrative Charges	2,633	L = 0.02 × TCI
Property Tax	1,316	M = 0.01 × TCI
Insurance	1,316	N = 0.01 × TCI
Capital Recovery [4]	18,742	O
Total Indirect Annual Costs	*42,814*	*IDAC = K+L+M+N+O*
Total Annual Cost ($)	**83,214**	*TAC = DAC + IDAC*
Pollutant Removed (tpy)	3.46	
Cost per ton of Pollutant Removed ($)	**24,025**	*$/ton = TAC / Pollutant Removed*

1. EPA Air Pollution Control Cost Manual, Section 6, Chapter 1, Baghouses and Filters, Figure 1.11 and Table 1.8.
2. EPA Air Pollution Control Cost Manual, Section 6, Chapter 1, Baghouses and Filters, Table 1.9.
3. EPA Air Pollution Control Cost Manual, Section 6, Chapter 1, Baghouses and Filters, Table 1.11.
4. Capital Recovery factor calculated based on Equation 2.8a (Section 1, Chapter 2, page 2-21) and Table 1.13 (Section 2, Chapter 1, page 1-52) of U.S. EPA OAQPS, EPA Air Pollution Control Cost Manual (6th Edition), January 2002.

BACT CONTROL COST EVALUATION

Technology: Baghouse, Reverse Air
Application: Casting Baghouse
Pollutants: Particulate Matter

Baghouse, Reverse Air

Key Assumptions	Casting	Notes
Process Information		
Uncontrolled Emissions (tpy)	3	
Exhaust Airflow (scfm)	485,492	
Capture Efficiency (%)	95%	
Control Efficiency (%)	99%	
Electrical Consumption (kWh/year)	7,829,141	
Gas-to-Cloth Ratio	3.0	Assume rock dust
Gross Cloth Area (ft^2)	161,831	
Utility Costs		
Electricity ($/kWh)	$ 0.089	Average Utah prices
Natural Gas ($/MMBtu)	$ 2.83	Average U.S. Prices (Jan 2017)
Water ($/Mgal)	$ 33.45	Sandy Utah (2" Meter, July 2016)
Sewer ($/Mgal)	$ 6.36	Salt Lake City, Class 6 User
Filter Bags ($/$ft^2$)	$ 2.04	Polypropylene Bags, Reverse Air
Labor Costs		
Operator ($/hour)	$ 15.00	
Supervisor ($/hour)	$ 20.00	
Maintenance ($/hour)	$ 20.00	
Economic Factors		
Dollar Inflation (2002 to 2017)	1.3416	U.S. Consumer Price Index
Equipment Life Expectancy (Years)	10	
Interest Rate (%)	7.00%	Current Avg SBA Loan Rate
Capital Recovery Factor (CRF)	0.1424	

BACT CONTROL COST EVALUATION

Trinity Consultants

Technology: Baghouse, Reverse Air
Application: Casting Baghouse
Pollutants: Particulate Matter

DIRECT COSTS

Capital Cost	Casting	Notes
Purchased Equipment Costs		
Total Equipment Cost (includes bags)[1]	1,370,917	A
Instrumentation	137,092	0.10 × A
Sales Tax	41,128	0.03 × A
Freight	68,546	0.05 × A
Total Purchased Equipment Costs	*1,617,682*	*B = 1.18 × A*
Direct Installation Costs[2]		
Foundations and Supports	64,707	0.04 × B
Handling and Erection	808,841	0.50 × B
Electrical	129,415	0.08 × B
Piping	16,177	0.01 × B
Insulation	113,238	0.07 × B
Painting	64,707	0.04 × B
Site Preparation & Buildings	-	No estimate / Site specific
Additional duct work	-	No estimate / Site specific
Total Direct Installation Costs	*1,197,085*	*C = 0.85 × B*
Indirect Installation Costs[2]		
Engineering	161,768	0.10 × B
Construction and Field Expense	323,536	0.20 × B
Contractor Fees	161,768	0.10 × B
Start-up	16,177	0.01 × B
Performance Test	16,177	0.01 × B
Process Contingencies	48,530	0.03 × B
Total Indirect Installation Costs	*727,957*	*D = 0.31 × B*
Total Capital Investment ($)	**3,542,724**	**TCI = B + C + D**

BACT CONTROL COST EVALUATION

Technology:	Baghouse, Reverse Air
Application:	Casting Baghouse
Pollutants:	Particulate Matter

ANNUAL COSTS

Operating Cost	Casting	Notes
Direct Annual Costs [3]		
Operating Labor (0.5 hr, per 8-hr shift)	8,213	E
Supervisory Labor (15% operating labor)	1,232	F = 0.15 × E
Maintenance Labor (0.5 hr, per 8-hr shift)	10,950	G
Maintenance Materials	10,950	H = G
Electricity	696,794	I
Bag Replacement (Cost x CRF for 2 yrs)	182,528	J
Total Direct Annual Costs	*910,666*	*DAC = E + F +G +H +I +J*
Indirect Annual Costs [3]		
Overhead	18,807	K = 0.60 × (E + F + G + H)
Administrative Charges	70,854	L = 0.02 × TCI
Property Tax	35,427	M = 0.01 × TCI
Insurance	35,427	N = 0.01 × TCI
Capital Recovery [4]	504,404	O
Total Indirect Annual Costs	*664,920*	*IDAC = K+L+M+N+O*
Total Annual Cost ($)	**1,575,586**	*TAC = DAC + IDAC*
Pollutant Removed (tpy)	2.61	
Cost per ton of Pollutant Removed ($)	**604,788**	*$/ton = TAC / Pollutant Removed*

1. EPA Air Pollution Control Cost Manual, Section 6, Chapter 1, Baghouses and Filters, Figure 1.11 and Table 1.8
2. EPA Air Pollution Control Cost Manual, Section 6, Chapter 1, Baghouses and Filters, Table 1.9
3. EPA Air Pollution Control Cost Manual, Section 6, Chapter 1, Baghouses and Filters, Table 1.11
4. Capital Recovery factor calculated based on Equation 2.8a (Section 1, Chapter 2, page 2-21) and Table 1.13 (Section 2, Chapter 1, page 1-52) of U.S. EPA OAQPS, EPA Air Pollution Control Cost Manual (6th Edition), January 2002.