PM$_{2.5}$ SIP Evaluation Report: McWane Ductile – Utah

Provo/Orem Nonattainment Area

Utah Division of Air Quality

Major New Source Review Section

December 1, 2017

PM$_{2.5}$ SIP EVALUATION REPORT
McWane Ductile – Utah

1.0 Introduction

The following is part of the Technical Support Documentation for Section IX, Part H.13 of the Utah SIP; to address the Provo/Orem PM$_{2.5}$ Nonattainment Area. This document specifically serves as an evaluation of the McWane Ductile – Utah facility.

1.1 Facility Identification

Name: McWane Ductile – Utah
Address: 2550 South Industrial Parkway, Provo, Utah, Utah County
Owner/Operator: McWane Ductile – Utah
UTM coordinates: 4,464,500 m Northing, 436,000 m Easting, Zone 12

1.2 Facility Process Summary

McWane Ductile – Utah (MDU) uses a cupola to melt scrap metal, fluxes, and other materials to produce the molten metal used to cast iron products. The cupola is a hollow vertical refractory lined steel cylinder with hinged doors at the bottom to allow the furnace to be emptied when not in use.

When charging the furnace, the doors are closed and a bed of sand is placed at the bottom of the furnace, covering the doors. The charge consists of coke for fuel, scrap metal, alloying materials, and flux.

In addition to being a source of fuel, the presence of coke in the melting process raises the carbon content of the metal to the casting specification. Flux, usually a fluoride salt, combines with impurities to form slag which rises to the surface of the molten metal where it exits via an elevated hold. Heat from the burning coke melts the scrap metal and flux, with the molten metal flowing to the bottom of the cupola where a hole, level with the top of the sand bed allows molten metal to be drawn off.

A new cupola gas handling system was installed in 2003 to reuse the cupola off-gases to preheat the cupola combustion air, reduce the emissions of PM via a baghouse, and reduce VOC and CO emissions by a combustion chamber.

MDU also operates an Annealing Oven to ensure the final properties of the manufactured pipe; a Special Lining Shotblast process to remove scale and prepare the pipe for painting; and a Special Line Painting process that applies specific coatings to the pipes.

1.3 Facility Criteria Air Pollutant Emissions Sources

The source consists of the following emission units:

Cupola (85 tons per hour and 205,000 tons per year)
Desulfurization Unit and Inoculation Treatment
Annealing Oven (63.29 MMBut/hr total)

Finishing Heaters:

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

Welding

Material Handling and Fugitive Particulates

- Finishing Cement Handling
- Finishing Sand Handling
- Silos
- Slag Conveyor
- Scrap Cutting
- Tuyere Injection to Cupola
- Scrap Handling
- Limestone Handling
- Ferro Silica Handling
- Coke/Anode Handling
- Lime Handling
- Paved Roads and Parking Areas
- Unpaved Roadways
- Industrial Waste Landfill

Pipe Cleaning (Sand Core Removal)

Specialty Lining Shotblast

Casting

Coating Operations

Zinc Coating

Fuel Storage Tanks

VOC Fugitives

Diesel-fired Emergency Generators:

- Delavaud Emergency Genset – 380 hp
- Recuperator Emergency Genset – 550 hp

Natural Gas-fired Emergency Generators:

- Works Office
- Main Office
- Oven Control
- Specialty Lining

Cooling Towers (8)

Miscellaneous Sources

- Pipe Cutting
- Pipe Grinding
- Mold Grinding
- Mold Blast
- Mold Flux Fines Repair
- Machine Shop Grinding
- Blackening

1.4 Facility 2014 Baseline Actual Emissions and Current PTE

In 2014, MDU’s baseline actual emissions were determined to be the following (in tons per year):

Table 1: Actual Emissions

Pollutant	Actual Emissions (Tons/Year)
$PM_{2.5}$	12.55
SO_2	3.90
NO_x	38.60
VOC	29.55
NH_3	0.50

The current PTE values for MDU, as established by the most recent NSR permit issued to the source (DAQE-AN107940032-16) are as follows:

Table 2: Current Potential to Emit

Pollutant	Potential to Emit (Tons/Year)
$PM_{2.5}$	20.71
SO_2	25.1
NO_x	87.6
VOC	140.85
NH_3	*

* No allowable emissions or PTE were ever determined for this facility

2.0 Modeled Emission Values

A full explanation of how the modeling inputs are determined can be found elsewhere. However, a shortened explanation is provided here for context.

The base year for all modeling was set as 2014, as this is the most recent year in which a complete annual emissions inventory was submitted from each source. Each source’s submission was then verified (QA-QC) – checking for condensable particulates, ammonia (NH3) emissions, and calculation methodologies. Once the quality-checked 2014 inventory had been prepared, a set of projection year inventories was generated by “growing” the 2014 inventory by REMI growth factors. Individual inventories were generated for each projection year: 2017, 2019, 2020, 2023, 2024, and 2026. If necessary, the first projection year, 2017, was adjusted to account for any changes in equipment between 2014 and 2017. For new equipment not previously listed or included in the source’s inventory, actual emissions were assumed to be 90% of its individual PTE.

For MDU, for example, a summary of the modified emission totals for 2017 are shown below in Table 3. Updated values with growth applied would then propagate through for each of the subsequent projection years.

Table 3: Modeled Emission Values (Plant-Wide)

Pollutant	2017 Projected Actual Emissions (Tons/Year)
$PM_{2.5}$	14.24
SO_2	4.47
NO_x	44.66
VOC	33.41
NH_3	0.56

Finally, the effects of BACT were then applied during the appropriate projection year. BACT applied between 2014 and 2017, was previously taken into account during the 2017 adjustment shown above. For future BACT, meaning those items expected to be coming online between today and the regulatory attainment date (December 31, 2019), the effects of those changes would be applied during the 2019 projection year. This is included in the notes attached to the appropriate emission inventory model input spreadsheet.

3.0 BACT Selection Methodology

The general procedure for identifying and selecting BACT is through use of a process commonly referred to as the "top-down" BACT analysis. The top-down process consists of five steps which consecutively identify control measures, and gradually eliminate less effective or infeasible options until only the best option remains. This process is performed for each emission unit and each pollutant of concern. The five steps are as follows:

1. Identify All Existing and Potential Emission Control Technologies: UDAQ evaluated various resources to identify the various controls and emission rates. These include, but are not limited to: federal regulations, Utah regulations, regulations of other states, the RBLC, recently issued permits, and emission unit vendors.

2. Eliminate Technically Infeasible Options: Any control options determined to be technically infeasible are eliminated in this step. This includes eliminating those options with physical or technological problems that cannot be overcome, as well as eliminating those options that cannot be installed in the projected attainment timeframe.

3. Evaluate Control Effectiveness of Remaining Control Technologies: The remaining control options are ranked in the third step of the BACT analysis. Combinations of various controls are also included.

4. Evaluate Most Effective Controls and Document Results: The fourth step of the BACT analysis evaluates the economic feasibility of the highest ranked options. This evaluation includes energy, environmental, and economic impacts of the control option.

5. Selection of BACT: The fifth step in the BACT analysis selects the "best" option. This step also includes the necessary justification to support the UDAQ's decision.

Should a particular step reduce the available options to zero (0), no additional analysis is required. Similarly, if the most effective control option is already installed, no further analysis is needed.

4.0 BACT for the Cupola

The cupola at the MDU is a large, refractory-lined, vessel designed to produce liquid cast iron. Raw materials: scrap metal, limestone, alloying materials, carbon additives, and coke (fuel), are charged (added) from the top of the cupola and allowed to melt. The limestone serves as a flux, which carries impurities to the surface of the molten iron where it can be separated off. The majority of emissions occur during melting, when forced pre-heated (see below) combustion air is circulated into the cupola to combust with the coke and maintains the necessary heat to melt the iron. The exhaust gases and particulates escape the cupola and are routed through a recuperator to recover heat (and preheat fresh incoming combustion air) before being exhausted to the atmosphere. The exhaust gases are controlled with a baghouse for particulate emissions, while a

CO burner system was installed in the recuperator to control CO and VOC emissions. A final air-to-oil heat exchanger further cools the exhaust gases prior to final release.

4.1 PM2.5

Particulate emissions from the cupola are generated from the combustion of coke and from metal fumes which condense in the exhaust gas stream. A second source of particulate emissions is the CO burner system installed in the recuperator. A small amount of natural gas is burned in a set of burners to combust CO and VOCs in the exhaust gas. Emissions from these burners are mostly condensable PM2.5 and represent only about 1% of the total particulate emissions from the cupola system.

4.1.1 Available Control Options

Available controls of particulate emissions from cupolas all fall into the post combustion control area. The nature of how a cupola operates prevents the use of both pre-combustion controls and combustion substitution. The cupola is not "fired" with a traditional burner like a boiler, but instead relies on the inherent heat of the materials within the cupola to ignite new charges of coke fuel and the circulating combustion air to provide oxygen and help with mixing (turbulence).

Fuel switching or changing to an electrically heated cupola are not possible, as this would require a completely redesigned process from the ground up. Although both processes exist, the cupola size, amount of meltable iron, production capacity, production speed, chemistry, product quality, and a number of other factors would all need to be evaluated. This level of redesign is outside the scope of the SIP BACT evaluation process.

The list of available controls is thus reduced to those add-on controls typically applied for control of particulate-laden gas streams:
- Baghouse/Fabric Filter
- Wet Scrubber
- Electrostatic Precipitator (ESP)
- High-efficiency Cyclone

Available controls for the natural gas-fired CO burner system are good combustion practices, proper burner design, and clean burning fuel. Other pre- and post-combustion controls are either not available given the configuration of the CO burner system, or are already included as part of the listed controls for the cupola system.

4.1.2 Evaluation of Technical Feasibility of Available Controls

All of the available controls are technically feasible.

4.1.3 Evaluation and Ranking of Technically Feasible Controls

Two add-on control options, baghouse/fabric filters and ESPs, are approximately equal in overall control efficiency with an estimated 99.9% reduction in total filterable particulates. While only wet scrubbers are capable of removing condensable particulate emissions, achieving the same efficiency of removal of filterable particulates imposes some additional restrictions and costs on the source in terms of system back pressure, wastewater, and energy costs. Most wet scrubbers achieve between 70 and 99% removal efficiency. High-efficiency cyclones are primarily used for product recovery and removal of larger particles, and have lower removal efficiencies, typically below 70% for PM2.5.

4.1.4 Further Evaluation of Most Effective Controls

Although wet scrubbers can achieve additional reductions in condensable particulate emissions, they are not the best option. There are two sources of condensable emissions: metal fumes from the molten material in the cupola, and condensable emissions from the combustion of natural gas. The metal fumes tend to condense quickly, adhering to other particulates present in the exhaust gas stream before exiting the stack. These particulates can easily be captured in a baghouse or other filtration system. The condensables resulting from natural gas combustion take much longer to condense, and may remain in the vapor phase for an extended time after leaving the stack. However, as this second type of condensables accounts for only 1% of the total particulate from the cupola (approximately 110 pounds of emissions in 2014), the added benefit is negligible.

Wet scrubbers can also remove SO2 and other acid gases (such as H2SO4). Total emissions of SO2 and other acid gases in 2014 were less than 5 tons per year. Installation of a wet scrubber of appropriate particulate control efficiency is expected to have an annualized cost approaching $100,000. Since only a negligible amount of additional PM2.5 reduction is gained, only the incremental emission reduction in SO2 and acid gases is used for calculating the cost effectiveness. $100,000/5 tons = $20,000/ton. This is not cost effective as an incremental cost/benefit.

Wet scrubbers can impose substantial back pressure which leads to leakage of particulates and other pollutants from the cupola capture system. There are also increased energy costs and wastewater treatment and disposal issues associated with wet scrubbers. These concerns all eliminate wet scrubbers from consideration as BACT.

4.1.5 Selection of BACT

As both baghouse/fabric filters and ESPs are effectively equal in terms of control efficiency, and the source already has a baghouse/fabric filter installed, BACT in this instance is the continued use of the existing baghouse for control of filterable particulates and condensed metal fumes. BACT for the CO burners continues to be good combustion practices, proper burner design, and use of natural gas as fuel.

4.2 NOx

As with all combustion processes, NOx, or oxides of nitrogen, are formed from the combustion of fuel in the cupola. There are three components to NOx: fuel NOx, which is the oxidation of the nitrogen bound in the fuel; thermal NOx, or the oxidation of the nitrogen (N2) present in the combustion air itself; and prompt NOx, which is formed from the combination of combustion air nitrogen (N2) with various partially-combusted intermediary products derived from the fuel. As the melting of iron is a long duration process, fuel NOx and thermal NOx are the major contributors, with the effects of prompt NOx vanishing over the full melting period. The formation of NOx is temperature dependent – combustion temperatures below 2700°F greatly inhibit the creation of NOx.

4.2.1 Available Control Options

Pre-combustion controls:
Fuel switching (natural gas fired cupolas)

Alternative heating (electrically heated cupolas)

Combustion controls:
Urea injection / Selective non-catalytic reduction (SNCR)
Low-NOx burners (on CO burner)
Good combustion practices
Use of natural gas (on CO burner)

Post-combustion controls:
Selective catalytic reduction (SCR)

Transfer technology (alternative NOx controls):
Some transfer technologies, such as Enviroscrub's Pahlmann™ process, Linde's LoTOx™ technology, or EMx™ (previously known as SCONOx™), are possibly available, but have never been implemented or tested for NOx control at an iron cupola. All are commercially available, in theory but have been designed primarily for control of other systems – primarily in the power industry (EMx™ to turbines, LoTOx™ for use in combination with wet scrubbers for SO2 control, Pahlmann™ for use with coal-fired boilers)

4.2.2 Evaluation of Technical Feasibility of Available Controls

Pre-combustion controls: There is some nitrogen present in both the coke (a derivative of coal) and in the other raw materials charged into the cupola, but this is fairly minimal. Although both fuel switching (natural gas-fired cupolas) and alternative heating (electrically heated cupolas) have been used at similar facilities, these two technologies are not considered technically feasible. At present, MDU's process relies on specific grades of ductile iron, which in turn relies on specific chemistry – the blending of the proper components into the iron during the melting process. The coke serves not only as a fuel source, but also supplies carbon, necessary to improve the strength and ductility of the final cast iron. As carbon can make up as much as 3% of the final finished product, some form of carbon would be added regardless of the fuel type chosen. With MDU's current cupola design and configuration, switching to an alternatively heated cupola would require redesigning the entire melting and casting process – an endeavor beyond the scope of BACT.

Combustion controls: MDU previously attempted to implement an SNCR system in 2005. A urea injection system was installed on the cupola and operated during the second half of that year. A stack test report was provided to UDAQ on January 20, 2006 (attached). The test demonstrated that NOx reduction rates were extremely variable, even with high urea injection percentages. The expected level of control was 80%, but the efficiency achieved in practice was approximately 23%, well below an acceptable value given the design estimates and chemical use rates. An estimate of control cost ranked the unit at $93,000/ton of NOx removed. SNCR is considered technically infeasible.

For the CO burner system, the use of natural gas as fuel, good combustion practices, and low-NOx burners are all considered technically feasible. Other types of burners (such as ultra-low-NOx burners, or the use of flue gas recirculation) were not considered available given the specific design and purpose of the CO burner, and the low heat input (24 MMBtu total) to the system.

SCR is technically feasible.

The EMx™ system uses a coated oxidation catalyst installed in the flue gas to remove both NOx and CO without a reagent such as ammonia. The NO emissions are oxidized to NO2 and then absorbed onto the catalyst. A dilute hydrogen gas is passed through the catalyst periodically to de-absorb the NO2 from the catalyst and reduce it to N2 prior to exiting from the stack. EMx™ prefers an operating temperature range between 500°F and 700°F. The catalyst uses a potassium carbonate coating, and the catalyst must be regenerated periodically. The regeneration gas consists of steam, carbon dioxide, and a dilute concentration of hydrogen. The regeneration gas is passed through the isolated portion of the catalyst while the remaining catalyst stays in contact with the flue gas. This process is potentially technically feasible, although questions on catalyst poisoning, fouling, and temperature concerns have not been specifically addressed.

Linde’s LoTOx™ technology uses ozone injection to oxidize NO and NO2 to N2O which is highly soluble and easier to remove through the use of another control device such as a wet scrubber. UDAQ has seen and permitted the application of this technology in combination with a wet gas scrubber for emission control at a petroleum refinery. The process is technically feasible; although installation and use of a wet scrubber was eliminated from consideration under particulate controls (see Section 4.1.4 above and Section 4.2.3 below for additional information).

Enviroscrub’s Pahlmann™ Process is a sorbent-based control system which functions similarly to a dry scrubber (see Section 4.3.1 for additional information). In this system, Pahlmanite (a manganese dioxide sorbent) is injected into the exhaust stream for NOx removal and then collected in a particulate control device like a baghouse. The sorbent is then regenerated in an aqueous process, filtered and dried, and is ready for reinjection. The wastewater is sent offsite for disposal. This process is potentially technically feasible; however, questions about: lower exhaust gas temperatures, maintaining reductions in CO and VOC emissions at the CO burner, or the need for additional fuel use, have not been addressed. In addition, separation of the sorbent from the other particulate collected in the baghouse might decrease the potential usefulness of this process.

4.2.3 Evaluation and Ranking of Technically Feasible Controls

Good combustion practices, the use of natural gas as fuel, and low-NOx burners, all at the CO burner, are currently installed technology/practices.

The remaining post combustion controls are ranked as follows.

SCR is capable of achieving control efficiencies of 70-90% NOx additional reduction beyond the baseline.

EMx™ can achieve 60-70% additional NOx reduction, but has not been demonstrated or tested on any emission system outside of natural gas combustion turbines.

LoTOx™ can potentially achieve an additional 50% reduction but requires additional pollutant control systems to remove the N2O which impose additional infrastructure for little to no additional PM2.5 removal.

The Pahlmann™ process has an unknown control efficiency rating, as it has only been tested on coal-fired electric utility boilers. It shows promise for the control of multiple pollutants, but requires the addition of a baghouse for particulate removal (for capture of the sorbent), an aqueous sorbent regeneration process, and a wastewater treatment/disposal process.

4.2.4 Further Evaluation of Most Effective Controls

Good combustion practices, the use of natural gas as fuel, and low-NOx burners, all at the CO burner, are all currently installed technology/practices. These controls represent the baseline and do not require further evaluation.

The source submitted a control cost analysis for SCR following the process outlined in Chapter 2 (Selective Catalytic Reduction) of US EPA's Control Cost Manual. The average exhaust flow rate 101,919 acfm and temperature of 239ºF were converted to an "order-of-magnitude" equivalent heat rate of coal, by assuming the cupola is a boiler fired primarily on coal. With a total annualized cost of approximately $2.0 million installation of SCR could remove 46.8 tons of NOx/year, resulting in a control cost of about $41,600/ton.

The source did not provide control cost estimates for EMx™, LoTOx™ or Pahlmann™; however, these control technologies have other issues that exclude them from being considered as BACT. The lack of being demonstrated in practice is the primary hurdle to acceptance for these controls. The low stack gas temperature after exiting the baghouse is a second concern for EMx™ which operates best with stack temperatures between 500 and 700ºF.

Both LoTOx™ and Pahlmann™ require significant investment in secondary control systems and wastewater treatment/disposal. There are also associated energy costs as well as the environmental costs that go along with these systems. None of these post-combustion controls are suitable as BACT.

4.2.5 Selection of BACT

Recommended BACT for control of NOx is retention of the existing NOx control systems: good combustion practices, the use of natural gas as fuel, and low-NOx burners. Retention of the existing 33 lb NOx/hr emission limit is also recommended.

4.3 SO2

SO2 emissions are directly related to the amount of sulfur in the raw materials. This is primarily the amount of sulfur contained in the coke as the other raw materials contain minimal amounts of sulfur.

4.3.1 Available Control Options

Only two control options are available to reduce SO2 emissions from the cupola:

- Placing a limit on the fuel coke sulfur content
- Line scrubber or dry alkaline injection scrubber

A wet gas scrubber can also be used to remove SO2 (and other acid gas) emissions, but have not been tested or operated in conjunction with a cast iron cupola. This would represent a potential transfer technology, but would require additional evaluation to determine if it would even be effective.

4.3.2 Evaluation of Technical Feasibility of Available Controls

Setting a limit on coke fuel sulfur content is technically feasible as this represents the base case at MDU. The cupola has a SO2 emission limit of 0.23 lb/ton of feed.

Control efficiencies for lime injection / dry injection scrubbing range from 50 to 98%. The two technologies are essentially the same. A low-water content slurry of lime, limestone, or another sorbent is injected into the exhaust gas stream just after it exits the production unit, in this case the cupola. The water in the slurry evaporates, and the sorbent is dispersed as a fine powder that absorbs the SO2 or acid gases. In the dry sorbent system, the sorbent is injected directly as a powder but otherwise functions similarly. The powder is then collected in the fabric filter where it forms part of the filter cake and continues the absorption process. This technology is technically feasible, as it is currently being employed on eight (8) cast iron cupolas in the US with production rates between 25 tons/hr and 90 tons/hr.

Wet scrubbers have proven to be highly effective control devices for control of SO2 emissions depending on the inlet concentration and allowable pressure drop. Typical sorbent material is limestone or lime. Limestone is very inexpensive but control efficiencies for limestone systems are limited to approximately 90%. Lime is easier to manage on-site and has control efficiencies up to 95%, but is significantly more costly. Proprietary sorbents with reactivity-enhancing additives provide control efficiencies greater than 95% but can be very costly. Wet scrubber systems have been primarily used in electrical utility applications, but have been transferred to petroleum refineries for control of SO2 emissions from burning refinery fuel gas. However, without a sufficient concentration of pollutant, high pressure drops are the greatest issue. Too high a degree of back-pressure can lead to emissions escaping from the capture system on the cupola. There are no instances of cupolas (cast iron or otherwise) operating with wet gas scrubber systems for pollutant control. Wet gas scrubbers are potentially technically feasible.

4.3.3 Evaluation and Ranking of Technically Feasible Controls

Based on similar cupolas operating with sorbent injection controls, the average emission limit for SO2 appears to be 0.22 lbs/ton of material charged. The one similarly-controlled, but smaller cupola, which operates at only 25 tons/hr, has an emission limit of 0.36 lb/ton.

Simply controlling the amount of sulfur charged in the raw materials (the base MDU case) gives an emission limit of 0.23 lb/ton. While operation of a wet gas scrubber without back-pressure concerns would not improve emissions significantly over the base case as the concentration of SO2 in the exhaust stream is too low to support a low pressure drop operation.

4.3.4 Further Evaluation of Most Effective Controls

The base control case provides nearly identical control efficiency to add-on sorbent injection controls; a difference of only 0.01 lb/ton of material charged or approximately 1 ton of NOx per year. Any additional add-on controls, sorbent injection or a wet gas scrubber, would have a significant incremental cost – $100,000/ton or greater. No add-on controls are economically feasible.

4.3.5 Selection of BACT

Continuing to limit the amount of sulfur charged with the raw materials is recommended as BACT. The existing SO2 emission limit of 0.23 lb/ton of feed is also recommended as BACT.

4.4 VOC

VOC emissions are the result of unburned hydrocarbons formed during, or remaining after, incomplete combustion. VOC emissions are dependent on choice of fuel, combustion temperature, residence time, air-to-ratio, and other combustion design and operating practices.

4.4.1 Available Control Options

There are two approaches to controlling VOC emissions:

The first is to limit the VOCs present in the exhaust gas through good combustion practices and proper equipment design. Ensuring combustion is as close to complete as possible limits the amount of VOCs being emitted as all the fuel should be converted to CO2 and water. The cupola melting process limits the combustion process as the fuel and combustion air cannot mix freely, but only within the alternating layers of charged raw materials. The liquid iron also picks up some of the fuel in the form of carbon; while the limestone flux picks up impurities (slag) which may contain some “fuel-like” materials that continue to combust even while being removed.

Thus, the second approach is to control VOC emissions, post-combustion. These approaches are divided into active and passive systems. The active systems all require additional heat input to oxidize the VOCs present in the exhaust stream. The simplest version is to simply reheat the exhaust stream with another combustor, such as an afterburner or flare. The additional heat and combustion air will further oxidize the residual VOCs (and CO) present in the exhaust into CO2 and water. This is the system currently in use at MDU and serves as the base case for additional comparison and analysis.

Other active systems combine the afterburner control with some form of heat recovery. Recuperative thermal oxidizers (RCTO) use a heat exchanger to recover the energy from the treated exhaust gas and use it to preheat the incoming untreated exhaust. Regenerative thermal oxidizers (RTO) use several heat recovery chambers each fitted with a ceramic heat recovery media surrounding the central combustion chamber. The incoming untreated gas is preheated by passing through one of these heat recovery chambers prior to being treated in the combustion chamber. Each heat recovery chamber switches back and forth between pre-heating and re-heating modes depending on the temperature of the ceramic media inside. RTO units are more efficient than RCTO units, but the operating concepts are identical.

In active systems, the method for supplying the additional heat can also make a difference. Most systems rely on burning natural gas as a fuel for the afterburners, as natural gas combustion (unlike the burning of solid fuels for example) adds little additional VOCs to the exhaust stream. Some smaller RTO systems are occasionally electrically heated, but in larger systems the electrical heating process is too inefficient.

Passive systems, such as catalytic oxidation or specialized catalytic systems like EMx™, rely on the use of a catalyst to lower the VOC oxidation temperature into a range which matches the exhaust gas conditions. VOCs continue to oxidize within the catalyst chamber without additional heat input; although some systems combine the use of a catalyst with small amounts of additional heat input to speed the oxidation process.

4.4.2 Evaluation of Technical Feasibility of Available Controls

Good combustion practices are technically feasible and consist of following industry recommended practices.

The use of afterburner (CO burner) controls are technically feasible and are currently in place and operating on the cupola at MDU.

Neither RCTO nor RTO are technically feasible due to fouling concerns. Currently the afterburner control unit is situated between the cupola and the baghouse. Replacing the afterburner with either a RCTO or RTO would cause the new unit to become plugged with the dust that is normally removed by the fabric filter. The small tubes in a shell-and-tube heat exchanger (RCTO) or the small pores of the ceramic heat recovery media (RTO) are highly subject to fouling by dust. Placing either unit downstream of the baghouse would greatly increase fuel costs as the exhaust gas would experience considerable cooling before reaching the unit. The baghouse is located just prior to the exhaust stack, requiring extensive additional piping and increased fan pressure to allow locating a new unit downstream of the baghouse.

The use of oxidation catalysts experience similar fouling problems as RCTO and RTO units. In addition they are subject to poisoning by sulfur compound emissions. Placing the unit downstream of the baghouse does not completely negate the poisoning issue, and raises the need for supplemental heating as the stack gas temperature has cooled below the active range of most catalysts.

4.4.3 Evaluation and Ranking of Technically Feasible Controls

The use of an afterburner for VOC control is the most effective option, followed by reliance only on good combustion practices.

4.4.4 Further Evaluation of Most Effective Controls

No additional evaluation is required for ranked controls as these controls are already in place and operating on the MDU cupola.

4.4.5 Selection of BACT

Retention of the existing afterburner (CO burner) system fired on natural gas with good combustion controls on the cupola is recommended as BACT. MDU currently does not have a short-term limitation on VOC emissions in either the most recently issued NSR permit or the moderate PM2.5 SIP. An annual limit which includes emissions from painting operations does exist but is of little value. A short-term limit on CO emissions of 0.80 lbs/ton of iron melted serves as a surrogate in the most recently issued NSR permit – as the intention of the CO burner system was to control emissions of CO, with control of VOCs as a beneficial side effect.

The recommendation is for no limitation on VOC emissions from the cupola, as the system is operated with feedback controls for CO emissions and is not directly optimized for VOC emissions. Emissions of VOC are estimated at 0.07 lb/ton of iron melted.

5.0 BACT for the Desulfurization Unit and Inoculation Treatment

The desulfurization unit controls the sulfur content of the iron produced by the cupola. If the iron contains too high a level of sulfur it can be brittle or have other undesirable properties. The chemical makeup of the iron is monitored and lime is added as needed to reduce the sulfur content of the molten iron as it flows from the cupola to the ladle.

5.1 PM2.5

The desulfurization process generates particulate emissions as the lime solids are volatilized as they are added to the molten metal. Some small amounts of metal vapors are also released as the solid lime is added. Particulate emissions are the only pollutants of concern from the desulfurization process.

5.1.1 Available Control Options

As with particulate emissions from the cupola itself, particulate emissions from the desulfurization process is limited to those add-on controls typically applied for control of particulate-laden gas streams:

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

5.1.2 Evaluation of Technical Feasibility of Available Controls

All controls are technically feasible.

5.1.3 Evaluation and Ranking of Technically Feasible Controls

Two of the add-on control options, baghouse/fabric filters and ESPs, are approximately equal in overall control efficiency with an estimated 99.9% reduction in total filterable particulates. Wet scrubbers achieve between 95 and 99% removal efficiency. Finally, the high-efficiency cyclones are primarily used for product recovery and removal of larger particles, and have lower removal efficiencies, typically below 70% for PM2.5.

5.1.4 Further Evaluation of Most Effective Controls

MDU currently uses a baghouse with an emission rate of 0.01 gr/dscf for control of the particulates from the desulfurization system. Newer baghouses or ESP units are capable of achieving a higher level of control and thus meet a limitation of 0.001 gr/dscf. MDU submitted a cost analysis for upgrading the baghouse/fabric filter to meet a higher control efficiency but this was considered economically infeasible at $44,000/ton of PM2.5 removed. Replacement of the existing baghouse with the other alternative control systems (ESP, wet scrubber, high efficiency cyclone) would be even more expensive for potentially less control of PM2.5.

5.1.5 Selection of BACT

Retention of the existing baghouse is recommended as BACT. There is no limit on the baghouse listed in either the most recent NSR permit or the moderate PM2.5 SIP. No emission limitation is required for this unit, as total emissions are relatively small (0.04 tons of PM2.5 in 2014).

6.0 BACT for the Annealing Oven

The annealing oven is a large, natural gas-fired oven used for heat controlling the cast iron pipe as it emerges from the casting machines. The pipe is heated to the annealing temperature of 1800ºF and then cooled to 1400ºF and held at a constant temperature for as long as several hours (but typically cycled for 4 to 8 hours). This softens the metal and improves ductility and machinability.

6.1 PM2.5

As the annealing oven is fired on natural gas, all of the normal combustion-related emission by-products are emitted.

6.1.1 Available Control Options

Unlike with the cupola, there are no particulate emissions generated except through combustion of the natural gas. Good combustion practices and use of natural gas as fuel are the base case. Add-on controls for particulate emissions from the annealing oven would be limited to those add-on controls typically applied for control of particulate-laden gas streams:

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

6.1.2 Evaluation of Technical Feasibility of Available Controls

The annealing oven is a large device, approximately 70 feet long, 25 feet wide and 8 feet high. Either end of the oven is open to the atmosphere, creating a 25’x8’ window on each side of the oven that makes capture and control of the emissions from the oven difficult. The oven is designed so that pipe can be added to and removed from the oven in a continuous fashion (fed in one side and removed from the other) without opening or closing doors. This draws in considerable additional air which is vented through the exhaust stack. Particulate emissions, already generated in low concentration during combustion, are further diluted with this additional air influx.

This makes use of wet scrubbers, ESPs, and cyclones all technically infeasible. The additional pressure drops, size requirements, and energy costs are all fatal flaws for these add-on controls. The unusually high exhaust temperature of 1700ºF is also a potential problem for both the wet scrubber and most fabric filter configurations. Wet scrubbers operate best with inlet gas temperatures below 700ºF. The additional piping required to cool the gas would occupy a large amount of space. Fabric filters also break down in excessive temperatures, requiring the use of high-temperature bags, or some form of gas cooling prior to application. Add-on controls are not considered technically feasible.

6.1.3 Evaluation and Ranking of Technically Feasible Controls

As all add-on controls are considered infeasible, only good combustion practices and use of natural gas as fuel remain. Both are already employed at MDU, so no ranking is required.

6.1.4 Further Evaluation of Most Effective Controls

No additional evaluation of these two control techniques is required.

6.1.5 Selection of BACT

Retention of the existing control techniques of good combustion practices and use of natural gas as fuel are recommended as BACT. There is no limitation on PM2.5 emissions in either the most recent NSR permit or moderate PM2.5 SIP. As the existing techniques represent work practice standards, no emission limitation is required.

6.2 SO2

As the annealing oven is fired on natural gas, emissions of SO2 are extremely minor. Natural gas is naturally low in sulfur content, and the cast iron pipe has been specifically controlled for sulfur content (see desulfurization system, Section 5 above).

6.2.1 Available Control Options

No available control options have been documented for control of SO2 emissions from combustion of natural gas. Desulfurization systems such as dry lime or sorbent injection could be applied, but have never been seen in commercial development for natural gas, direct-fired heating units.

6.2.2 Evaluation of Technical Feasibility of Available Controls

Good combustion controls and use of natural gas as fuel

6.2.3 Evaluation and Ranking of Technically Feasible Controls

As all add-on controls are considered infeasible, only good combustion practices and use of natural gas as fuel remain. Both are already employed at MDU, so no ranking is required.

6.2.4 Further Evaluation of Most Effective Controls

No additional evaluation of these two control techniques is required.

6.2.5 Selection of BACT

Retention of the existing control techniques of good combustion practices and use of natural gas as fuel are recommended as BACT. There is no limitation on SO2 emissions in either the most recent NSR permit or moderate PM2.5 SIP. As the existing techniques represent work practice standards, no emission limitation is required.

6.3 NOx

As with the cupola, emissions of NOx are formed from the combustion of fuel in the oven. Since natural gas, being primarily methane (CH4), is relatively free of fuel-bound nitrogen, the primary component of NOx emissions from the annealing oven is thermal NOx.

6.3.1 Available Control Options

There are several possible control options that have been identified:

- Low Temperature Oxidation (LoTOx)
- Selective Catalytic Reduction (SCR)
- Non-selective Catalytic Reduction (NSCR)
- Selective Non-catalytic Reduction (SNCR)
- Ultra-low-NOx Burner (ULNB)
- Flue Gas Recirculation (FGR), Low Excess Air (LEA)
- Exhaust Gas Recirculation (EGR)
- Low-NOx Injection Burner

- Use of Natural Gas, Low-NOx Burners (existing)
- Good Combustion Practices

6.3.2 Evaluation of Technical Feasibility of Available Controls

LoTOx: The LoTOx system is a process which uses ozone injection to convert NOx into higher oxides of nitrogen, such as N_2O_5. It also converts NO into N_2O which is highly soluble and can then be removed in a secondary control system such as a wet scrubber. However the process functions optimally at exhaust gas temperatures below 300ºF. The annealing oven's exhaust temperature of 1700ºF raises technical concerns for the functionality of this process.

MDU has also raised questions concerning this technology. The process has never been applied to natural gas-fired, direct heating units such as an oven. The need for additional add-on controls and the additional footprint space required imposes a logistical hardship. The wastewater generated requires caustic soda treatment for nitric acid control prior to disposal/release. Finally, the heat input rate of the oven is too small for commercially available LoTOx systems.

SCR: SCR systems employ the use of a reagent, either ammonia or urea, to reduce NOx to elemental nitrogen (N_2). A catalyst is used to lower the temperature required for the reaction and to speed up the process. A SCR unit could be adapted to operate above the heating zone of the oven just before the exhaust stack. Although there are technical issues with space constraints, and this location only allows for control of the emissions exiting the exhaust stack, this control technology is considered technically feasible.

NSCR: As with SCR units, an add-on control device could be located above the heating zone of the oven just prior to the exhaust stack. However, NSCR technology does not use ammonia/urea as a reagent, but uses the NOx present in the exhaust stream to oxidize the CO, H_2 and hydrocarbons also present. The technology operates most effectively on, and is intended for, streams with low oxygen content (below 0.5 vol%). The configuration of the annealing oven's open sides and continuously fed process allows for a high percentage of dilution air to enter the exhaust stream. Consequently, the oxygen content is quite high – close to atmospheric conditions. As this system cannot operate under these conditions it is considered technically infeasible.

SNCR: SNCR is similar to SCR in that ammonia or urea is used as a reagent to reduce NOx to N_2. However, no catalyst is used in this process, and often the ammonia/urea is injected directly into the combustion zone of the process to control NOx as early in the process as possible. SNCR is most effective on processes with high concentrations of uncontrolled NOx (200-400 ppm); thus SNCR will be less effective if utilized on the annealing oven due to the large amount of dilution air in the exhaust. However, this technology is considered technically feasible.

ULNB: These replacement burners operate by staging combustion within the length of the burner "nozzle". Fuel and air are mixed and distributed in different ratios along the length of the burner, creating different mixing and firing zones that operate in fuel-lean and fuel-rich modes. Some degree of internal flue gas recirculation also takes place along the burner which further lowers overall flame temperature. The burners are longer than both traditional and low-NOx burners and the flame extends a greater distance as well. MDU has noted that replacing the existing burners with ULNBs would require a complete redesign of the annealing oven heating system to eliminate the possibility of uneven heating/cooling of the cast iron pipes (the exact scenario the annealing oven is designed to avoid).

FGR/LEA: Both of these processes operate similarly in that the amount of combustion air is controlled to limit the amount of oxygen present and reduce flame temperature. FGR returns a portion of the exhaust gases to the inlet of the system as combustion air, while LEA simply limits the total amount of combustion air being supplied. The current configuration of the annealing oven's two open sides renders both technologies infeasible as the large amount of dilution air entering the system overwhelms any attempt to limit the combustion oxygen input.

Exhaust gas recirculation: A similar technology to FGR, exhaust gas recirculation also returns a portion of the exhaust gas to the incoming air stream. However, rather than attempting to lower the oxygen content, this system uses the recirculated gas to absorb the heat of combustion and lower the overall flame temperature. The technology is typically employed in diesel engines which operate on excess air already and can best benefit from the increased mass of exhaust. This technology is technically infeasible as the large amount of dilution air still overwhelms the amount of recirculated exhaust available; the high exhaust temperature proof that increasing the amount of combustion air has little effect on flame temperature.

Lox-NOx injection burner: Currently there are no examples of this technology being employed on similar (natural gas-fired, direct heating) equipment; however, it is considered technically feasible. MDU states that while it would require some redesign of the combustion system to employ, it has considered the economic feasibility of such a system. This evaluation is included in Section 6.3.3 and 6.3.4.

Both good combustion practices and use of natural gas as fuel in the existing low-NOx burners represent the base case currently employed at MDU and are therefore technically feasible.

6.3.3 Evaluation and Ranking of Technically Feasible Controls

SCR can achieve the highest level of NOx control, with a possible controlled emission rate of 8.2 lb of NOx/MMscf of natural gas; Low-NOx injection at 38.1 lb/MMscf, and SNCR at 46.2 lb/MMscf round out the list. By way of comparison, the existing controls achieve NOx emissions of 50.0 lb/MMscf of natural gas.

6.3.4 Further Evaluation of Most Effective Controls

SCR: Given the open design of the annealing oven, only a fraction of the emissions can be captured by the exhaust stack. Some portion will escape the open doors and not be controlled by any add-on device. MDU has estimated approximately 2/3 of the emissions are not captured by the exhaust stack, and calculated an estimated control cost of $66,000/ton of NOx removed. However, given the induced draft nature of the oven, UDAQ estimates that only 1/3 of the total emissions escape through the doors – the majority of the emissions being pulled in and upward by the lower pressure of the combustion zone and the forced draft up the stack. Using the same numbers provided by MDU, but doubling the emission reduction possible, yields an estimated control cost of $33,000/ton of NOx removed. This is still economically infeasible; especially when the system is removing only 8.12 tons of NOx (based on 2014 actual emissions), and the possibility of ammonia slip is taken into consideration.

Low-NOx injection burners: MDU previously presented a cost analysis to UDAQ for installation of this type of system in 2013. The annualized cost was estimated at $367,700. In 2016, its revised analysis estimates the annualized cost at $340,700. With the total expected emission reduction of 3.32 tons/year, this yields an updated control cost of $102,600/ton of NOx reduced. Low-NOx injection burners are not economically feasible. Given that their installation would also require redesign of the combustion system, these burners do not represent BACT.

SNCR: The cost of an SNCR system was not supplied by MDU. Most SNCR systems rely on ammonia/urea injection to occur within the combustion zone to begin NOx reduction as quickly as possible. MDU has stated that ammonia/urea injection within the heating zone is technically infeasible due to the proximity of the untreated pipe and possible surface corrosion issues. SNCR is estimated to only reduce NOx emissions by 0.06 tons/year over the base case, and would still require much of the same physical equipment as a SCR unit (ammonia/urea storage and the injection system) imposing physical constraint issues. SNCR does not represent BACT.

6.3.5 Selection of BACT

Retention of the existing low-NOx burners, use of natural gas as fuel and good combustion controls are recommended as BACT. The annealing oven has a limitation on total heat input imposed in the moderate PM2.5 SIP of 63.29 MMBtu/hr. Retention of this limitation on heat input is also recommended as BACT. No direct limitation on NOx emissions is recommended given the open door configuration. The heat input restriction represents a best work practice standard.

6.4 VOC

VOC emissions from the annealing oven are the result of unburned hydrocarbons formed during incomplete combustion. The formation of VOCs is dependent on combustion system design, choice of fuel, combustion temperature, and operating practices.

6.4.1 Available Control Options

The available control options are limited to good combustion practices, use of natural gas as fuel, and proper burner design. There are several post-combustion control options, both active (such as various forms of thermal oxidation) and passive (different variants of catalytic oxidation), but all rely on exhaust concentrations higher than what is generated in the annealing oven exhaust. MDU was unable to obtain any vendor quotes for commercially available post-combustion systems that could be applied to the annealing oven.

6.4.2 Evaluation of Technical Feasibility of Available Controls

Good combustion practices, use of natural gas as fuel, and proper burner design are technically feasible as these control systems are in place and operational on the annealing oven at present.

The current open door design of the annealing oven allows a large quantity of dilution air into the exhaust stream, lowering the concentration of VOCs in the exhaust. Based on MDU’s evaluation of the exhaust, the VOC concentration is approximately 4.6 ppmv as propane at 3% O_2. Thermal incineration/oxidation, whether through use of an afterburner or some form of heat recovery system (regenerative/recuperative), is feasible only when inlet VOC concentrations are around 100 ppm. The trace concentrations from natural gas combustion further diluted with excess air influx render add-on post combustion controls technically infeasible.

6.4.3 Evaluation and Ranking of Technically Feasible Controls

Good combustion practices, use of natural gas as fuel and proper burner design are the base case condition on the annealing oven and do not need to be ranked.

6.4.4 Further Evaluation of Most Effective Controls

Good combustion practices, use of natural gas as fuel and proper burner design are the base case condition on the annealing oven and do not need to be evaluated further.

6.4.5 Selection of BACT

Retention of the existing controls of good combustion practices, use of natural gas as fuel and proper burner design are recommended as BACT. As these represent work practice standards, no VOC emission limit is recommended.

7.0 BACT for the Finishing Heaters

The finishing heaters are three small natural gas fired heaters of 2.25 MMBtu/hr, 1.94 MMBtu/hr, and 2.0 MMBtu/hr. These heaters dry and cure the coated pipe.

7.1 PM2.5

As the finishing heaters are fired on natural gas, all of the normal combustion-related emission by-products are emitted.

7.1.1 Available Control Options

There are no particulate emissions generated except through combustion of the natural gas. Good combustion practices and use of natural gas as fuel are the base case. Add-on controls for particulate emissions from the finishing heaters would be limited to those add-on controls typically applied for control of particulate-laden gas streams:

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

7.1.2 Evaluation of Technical Feasibility of Available Controls

The finishing heaters are extremely small units with relatively small amounts of emissions given the total amount of natural gas consumed. The heaters are not required to be fired in conjunction, but may be fired separately, meaning any controls must be able to be applied separately as well.

This makes use of baghouses, wet scrubbers, ESPs, and cyclones all technically infeasible. The size requirements and energy costs are all fatal flaws for these add-on controls. Add-on controls are not considered technically feasible.

7.1.3 Evaluation and Ranking of Technically Feasible Controls

As all add-on controls are considered infeasible, only good combustion practices and use of natural gas as fuel remain. Both are already employed at MDU, so no ranking is required.

7.1.4 Further Evaluation of Most Effective Controls

No additional evaluation of these two control techniques is required.

7.1.5 Selection of BACT

Retention of the existing control techniques of good combustion practices and use of natural gas as fuel are recommended as BACT. There is no limitation on PM2.5 emissions in either the most recent NSR permit or moderate PM2.5 SIP. As the existing techniques represent work practice standards, no emission limitation is required.

7.2 SO2

As the finishing heaters are fired on natural gas, emissions of SO2 are extremely minor. Natural gas is naturally low in sulfur content.

7.2.1 Available Control Options

No available control options have been documented for control of SO2 emissions from combustion of natural gas. Desulfurization systems such as dry lime or sorbent injection could be applied, but have never been seen in commercial development for natural gas, direct-fired heating units – especially for units of this size.

7.2.2 Evaluation of Technical Feasibility of Available Controls

Good combustion controls and use of natural gas as fuel

7.2.3 Evaluation and Ranking of Technically Feasible Controls

As all add-on controls are considered infeasible, only good combustion practices and use of natural gas as fuel remain. Both are already employed at MDU, so no ranking is required.

7.2.4 Further Evaluation of Most Effective Controls

No additional evaluation of these two control techniques is required.

7.2.5 Selection of BACT

Retention of the existing control techniques of good combustion practices and use of natural gas as fuel are recommended as BACT. There is no limitation on SO2 emissions in either the most recent NSR permit or moderate PM2.5 SIP. As the existing techniques represent work practice standards, no emission limitation is required.

7.3 NOx

Emissions of NOx are formed from the combustion of fuel in the heaters. Since natural gas, being primarily methane (CH_4), is relatively free of fuel-bound nitrogen, the primary component of NOx emissions from the heaters is thermal NOx.

7.3.1 Available Control Options

There are several possible control options that have been identified:

- Low Temperature Oxidation (LoTOx)

- Selective Catalytic Reduction (SCR)
- Non-selective Catalytic Reduction (NSCR)
- Selective Non-catalytic Reduction (SNCR)
- Ultra-low-NOx Burner (ULNB)
- Flue Gas Recirculation (FGR), Low Excess Air (LEA), Exhaust Gas Recirculation (EGR)
- Low-NOx Injection Burner
- Use of Natural Gas, Low-NOx Burners (existing)
- Good Combustion Practices

7.3.2 Evaluation of Technical Feasibility of Available Controls

LoTOx: The LoTOx system is a process which uses ozone injection to convert NOx into higher oxides of nitrogen, such as N2O5. It also converts NO into N2O which is highly soluble and can then be removed in a secondary control system such as a wet scrubber. The process is technically infeasible given the large infrastructure requirements for such small emitting units.

SCR: SCR systems employ the use of a reagent, either ammonia or urea, to reduce NOx to elemental nitrogen (N2). A catalyst is used to lower the temperature required for the reaction and to speed up the process. This control technology would be potentially feasible, but space considerations, the low exhaust temperature of the heaters, and the small amount of emissions make this technically infeasible.

NSCR: Similar to a SCR unit, NSCR technology does not use ammonia/urea as a reagent, but uses the NOx present in the exhaust stream to oxidize the CO, H2 and hydrocarbons also present. NSCR suffers the same issues as SCR in terms of applicability and is considered technically infeasible.

SNCR: SNCR is similar to SCR in that ammonia or urea is used as a reagent to reduce NOx to N2. However, no catalyst is used in this process. This process is technically infeasible as without a catalyst to lower the reaction temperature, the exhaust temperature of the heaters is too low to make use of SNCR technology.

ULNB: These replacement burners operate by staging combustion within the length of the burner “nozzle”. The burners are longer than both traditional and low-NOx burners and the flame extends a greater distance as well. ULNB have not been developed for heaters of this size. ULNBs can occasionally experience “flame-out” and plugging issues, and are primarily designed for larger units with much higher gas flow rates. The low gas flow rates of these heaters make these burners technically infeasible.

FGR: Flue gas recirculation recycles a portion of the exhaust gas back to be used as inlet combustion air. Since the exhaust gas has a lower oxygen content than ambient air, this lowers the available oxygen for combustion, slowing combustion and lowering the combustion temperature. This technology is technically infeasible – as the heaters are used within the curing/drying building without specific dedicated stacks. As the emissions from the heaters are fugitive in nature, collecting the exhaust gases would require redesigning the curing/drying building.

Low Excess Air (LEA)/Exhaust gas recirculation: Both are similar technologies to FGR. LEA simply reduces the amount of incoming air available for combustion. Exhaust gas recirculation, like FGR, also returns a portion of the exhaust gas to the incoming air stream. However, rather than attempting to lower the oxygen content, this system uses the recirculated gas to absorb the heat of combustion and lower the overall flame temperature. LEA is technically feasible but commercially unavailable, as no heaters in this size range have been developed using this technology. Exhaust gas recirculation is technically infeasible, for the same reasons as FGR.

Lox-NOx injection burner: Currently there are no examples of this technology being employed on any units of this size. The technology is considered commercially unavailable and will not be evaluated further.

Good combustion practices, low-NOx burners, and use of natural gas as fuel in the heaters represent the base case currently employed at MDU and are therefore technically feasible.

7.3.3 Evaluation and Ranking of Technically Feasible Controls

Good combustion practices, low-NOx burners and use of natural gas as fuel in the heaters represent the base case currently employed at MDU and do not need to be ranked.

7.3.4 Further Evaluation of Most Effective Controls

Good combustion practices, low-NOx burners and use of natural gas as fuel in the heaters do not need to be evaluated further.

7.3.5 Selection of BACT

Retention of the existing low-NOx burners, use of natural gas as fuel and good combustion controls are recommended as BACT. These controls represent a work practice standard and do not require a specific NOx emission limitation.

7.4 VOC

VOC emissions from the finishing heaters are the result of unburned hydrocarbons formed during incomplete combustion. The formation of VOCs is dependent on combustion system design, choice of fuel, combustion temperature, and operating practices.

7.4.1 Available Control Options

The available control options are limited to good combustion practices, use of natural gas as fuel, and proper burner design. There are several post-combustion control options, both active (such as various forms of thermal oxidation) and passive (different variants of catalytic oxidation). MDU was unable to obtain any vendor quotes for commercially available post-combustion systems that could be applied to the finishing heaters.

7.4.2 Evaluation of Technical Feasibility of Available Controls

Good combustion practices, use of natural gas as fuel, and proper burner design are technically feasible as these control systems are in place and operational on the finishing heaters at present.

7.4.3 Evaluation and Ranking of Technically Feasible Controls

Good combustion practices, use of natural gas as fuel and proper burner design are the base case condition on the annealing oven and do not need to be ranked.

7.4.4 Further Evaluation of Most Effective Controls

Good combustion practices, use of natural gas as fuel and proper burner design are the base case condition on the finishing heaters and do not need to be evaluated further.

7.4.5 Selection of BACT

Retention of the existing controls of good combustion practices, use of natural gas as fuel and proper burner design are recommended as BACT. As these represent work practice standards, no VOC emission limit is recommended.

8.0 BACT for Welding Operations

8.1 PM2.5

Particulate matter is generated by the welding process itself. As the welding rod is melted the metal fumes condense into fine metal particulates.

8.1.1 Available Control Options

Only two control options have been identified for control of welding particulates:

- Management Practices; and
- Capture and Collection Systems

8.1.2 Evaluation of Technical Feasibility of Available Controls

Both options are considered technically feasible

8.1.3 Evaluation and Ranking of Technically Feasible Controls

Management practices reduce particulate generation by maintaining weld quality while reducing fume generation. It includes operating equipment according to manufacturer's instructions, using optimized fillers and carrier gases, and the use of capture and collection systems.

Capture and collection systems include welding booths or hoods, torch fume extractors, and high efficiency filters.

Both options can be used in conjunction.

8.1.4 Further Evaluation of Most Effective Controls

A baghouse or similar high efficiency filter system in combination with a welding booth/hood (when applicable) is considered the capture/control system with the lowest emission rate. Although control cost evaluations are difficult to estimate as welding emissions are highly variable and exhaust flowrates are also subject to the items being welded, MDU was able to provide some information on control costs. Capture and control systems are estimated at $24,000/ton of PM2.5 removed. This represents BACT; however, it is subject to applicability provisions. Often MDU is welding long and unwieldy pieces of pipe or other cast iron product (light poles, etc). These objects can be difficult or impossible to simply move into a welding booth, and erecting a new booth or hood around each item to be welded each this occurs can also be a logistical impossibility.

8.1.5 Selection of BACT

Thus, for welding processes, BACT is recommended as best management practices. These practices should include: welding inside a welding booth/hood equipped with a filter whenever possible, indoors with a building dust control system as practical, and to limit uncontrolled outdoor welding. BACT shall also include following manufacturer's recommended practices.

9.0 BACT for Material Handling and Fugitive Particulates

9.1 PM2.5

Although MDU divided all material handling and fugitive emissions into three separate sections: Emissions Collected at Pickup Points (finishing cement, finishing sand, silos), Emissions Not Collected (slag conveyor, scrap cutting, tuyere injection drop point, scrap handling, limestone/ferro silica/coke/lime handling) and Roads/Landfill, essentially these can all be treated as potential fugitive dust/emission sources and reviewed similarly. There are a few special cases that need additional consideration, but these can be viewed as exceptions and will be called out individually.

9.1.1 Available Control Options

For all material handling operations, the same control options are available. If the emission source has not yet been contained in some fashion, then some sort of collection/containment system is the first level of control. This can range from a partial enclosure (such as putting up wind break walls around a storage pile), to total enclosures (putting the emission point inside a building). Conveyor drop points can be shielded, and conveyors can be covered. Some emission points cannot be collected or contained, such as roads or disturbed ground within a landfill.

The second level of control is sweeping, watering, the use of chemical dust suppressants (magnesium chloride for example), and material moisture content for control of fugitive emissions. Some of these controls are useful for certain applications, watering for roads and dust control at the landfill; but cannot be applied in other applications, for example watering cannot be applied near cement or other operational areas of the plant for employee safety purposes.

The third level of control is those add-on controls typically applied for control of any other particulate source:
- Baghouse/Fabric Filter
- Wet Scrubber
- Electrostatic Precipitator (ESP)
- High-efficiency Cyclone

These will be evaluated further below.

9.1.2 Evaluation of Technical Feasibility of Available Controls

<u>For all collected materials (finishing cement, finishing sand, silos):</u> these emission sources have already been contained. No process involving water is considered technically feasible – either the material involves cement which should not contact water in a control device/process for obvious reasons, or the material/emitting unit should not contact water for employee safety (overloading the weight capacity of a holding silo for example). This includes any form of chemical dust

suppression, as these chemicals simply trap moisture from the surrounding air.

ESPs are not considered technically feasible as they are not effective when controlling sporadic or intermittent emission sources. These units also have large footprint requirements which would be prohibitive for material handling processes.

All other controls are technically feasible.

For non-collected materials (slag conveyor, scrap cutting, tuyere injection drop point, scrap handling, limestone/ferrosilica/coke/lime handling): These materials have been contained to some extent. Most of these processes occur under cover to avoid inclement weather (specifically precipitation) impacts. Some slag conveyor sections are not covered; however slag is solid and only generates particulates during conveyor "drops". Slag cutting and tuyere injection to the cupola are special cases. Slag cutting cannot be contained as it is a mobile operation involving an MDU employee with a torch. The tuyere injection process is where pressurized air is used to inject carbon and silicon into the cupola during the melting process. This generates some fugitive emissions as material is unloaded from shipping sacks (supersacks) but is otherwise contained in an enclosed area.

Again, no process involving water is considered technically feasible. Many of these materials are still extremely hot and use of water would create ultra-hot steam clouds that would endanger employee safety. For the remaining processes, the use of water risks the exposure of other materials at the facility to moisture. This includes any form of chemical dust suppression, as these chemicals simply trap moisture from the surrounding air.

ESPs are not considered technically feasible as they are not effective when controlling sporadic or intermittent emission sources. These units also have large footprint requirements which would be prohibitive for material handling processes.

Baghouses and cyclones are technically feasible for most material handling operations (conveyors, conveyor drop points). However, for material handling operations which cannot be captured such as scrap cutting, or for some initial materials (limestone, scrap, ferrosilica) these control devices are not technically feasible as the emissions cannot be routed through a traditional ductwork system.

For roads and the industrial landfill: Watering, material moisture content, paving (unpaved areas only), sweeping (paved roads only), silt content reduction (unpaved roads only), and reducing speed (unpaved roads only) are all applicable and technically feasible controls (parentheticals apply).

9.1.3 Evaluation and Ranking of Technically Feasible Controls

For all collected materials: Baghouses are the most effective means of control, able to achieve between 95 and 99.9% control of particulate emissions.

For non-collected materials: Where baghouses can be applied, such as conveyor drop points, they represent the most effective method of control. For those emission sources where baghouses cannot be applied – all uncaptured fugitive sources – the use of a partial enclosure represents the best level of control. This would include such areas as tuyere injection, scrap cutting and coke handling.

For roads and industrial landfill: All controls are assumed effective and applicable, with the exception of paving previously unpaved roads. Previous studies have shown it is not economically feasible to pave an unpaved road for PM control.

9.1.4 Further Evaluation of Most Effective Controls

For all collected materials: Baghouses are currently employed as the control technology for all these emission sources. No additional evaluation is required.

For non-collected materials: Baghouses are currently being employed where such devices are applicable. For those areas where a baghouse cannot be applied the use of partial enclosures were evaluated. At the tuyere injection system, the fugitive emissions are already contained in an enclosed area. Additional enclosures would not further improve emission controls. Scrap cutting is performed with a torch on an "as needed" basis with no additional containment or collection process. Although construction of an enclosure would reduce emissions, total annual emissions are estimated at less than 100 lbs/year. This is not economically feasible. Coke handling operations cover the unloading of large (10-12 inches in diameter) coke pieces from railcars via belly dump onto a concrete pad/temporary storage pile. A loader then trams the coke into a hopper and covered conveyor for charging in the cupola. MDU analyzed the control cost for construction of a partial enclosure for the belly dump area. Total annual emissions are less than 1 ton, with the annualized cost of the enclosure estimated at $50,000. This is not economically feasible.

For roads and industrial landfill: With the exception of paving, all controls are presently in use and do not need additional evaluation. Paving was previously eliminated and will not be further evaluated.

9.1.5 Selection of BACT

For all collected materials: Retention of the existing baghouses is recommended as BACT. As these are all small emission points viewed as a collective, no specific emission limitations are required. An opacity (visibility) requirement is recommended as a work practice standard.

For non-collected materials: Retention of the existing baghouses where already in use is recommended as BACT. No specific numerical emission limitation is required. An opacity requirement is recommended as a work practice standard.

For roads and industrial landfill: Continued use of best management practices is recommended as BACT. Adherence to UDAQ fugitive dust rules opacity requirements is also recommended as BACT.

10.0 BACT for Pipe Cleaning Operations.

After the pipes are cast, they must be cleaned to remove the sand core so they can be properly annealed. While most of the sand is removed in the casting area where the pipe ends are manually cleaned as part of the quality assurance check, the remaining residual sand is blown out of the pipe using compressed air.

10.1 PM2.5

The only emissions are the fine particulates (sand) blown out of the pipe by compressed air.

10.1.1 Available Control Options

As there are no combustion related emissions all available controls are considered add-on controls. Identified controls are those add-on controls typically applied for control of particulate-laden gas streams:

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

10.1.2 Evaluation of Technical Feasibility of Available Controls

All control options are considered technically feasible with the exception of ESPs. Sand consists primarily of silicon dioxide, which is extremely electrically resistive, which cannot be aided by helper chemicals. It is essentially electrically inert. The use of an ESP is considered technically infeasible.

10.1.3 Evaluation and Ranking of Technically Feasible Controls

The use of a baghouse is the most effective means of control for particulate emissions. Wet scrubbers are also highly effective, but the recovered sand must then be dried out before it can be reused in core making. Cyclones are the least effective of the available technologies, but represent the base case at MDU as this technology is currently in use at the facility.

10.1.4 Further Evaluation of Most Effective Controls

With the exception of wet scrubbers, no additional environmental or energy costs are associated with these technologies. Wet scrubbers have additional water requirements, and the recovered sand must be dried before it can be reused, imposing an energy cost. However, this cost is rather low and does not change the overall ranking of the controls. Baghouses are still the most effective choice.

10.1.5 Selection of BACT

Use of a baghouse for control of the pipe cleaning operations is recommended as BACT. MDU is proposing to install a new baghouse to replace the existing cyclone with a completion date of December 31, 2018. Total uncontrolled emissions are less than 2 tons per year, so no emission limitation is required. Adherence to the general opacity (visibility) requirements is recommended as BACT.

11.0 BACT for the Specialty Lining Shotblast Process

Before a specialty lining is applied, the inside of the pipe is shotblasted to ensure a clean surface is available for the coating. Currently the operation is completed in an enclosed hood and the dust is vented to a baghouse. Emissions are estimated at less than 2 tons per year.

11.1 PM2.5

The only emissions are the fine particulates generated by the shotblasting process.

11.1.1 Available Control Options

As there are no combustion related emissions all available controls are considered add-on controls. Identified controls are those add-on controls typically applied for control of particulate-laden gas streams:
- Baghouse/Fabric Filter
- Wet Scrubber
- Electrostatic Precipitator (ESP)
- High-efficiency Cyclone

11.1.2 Evaluation of Technical Feasibility of Available Controls

All control options are considered technically feasible.

11.1.3 Evaluation and Ranking of Technically Feasible Controls

The use of a baghouse is the most effective means of control for particulate emissions.

Wet scrubbers, ESPs, and cyclones are all less effective than the control option currently installed at the facility and will not be further evaluated.

11.1.4 Further Evaluation of Most Effective Controls

As the most effective mechanism for control is installed an operational, no additional evaluation is required.

11.1.5 Selection of BACT

Use of a baghouse for control of the specialty lining shotblast operations is recommended as BACT. Total controlled emissions are less than 2 tons per year, so no emission limitation is required. Adherence to the general opacity (visibility) requirements is recommended as BACT.

12.0 BACT for the Casting Operations

The casting process generates particulate emissions as the molten iron is transferred between the cupola’s holding ladle into a transfer ladle, and from the transfer ladle into the casting ladle of the casting machine.

12.1 PM2.5

Molten metal fumes condense to form particulates which are controlled partially by the desulfurization process baghouse and partially by the ladle baghouse. The casting process emits 2.77 tons/year of PM2.5 emissions.

12.1.1 Available Control Options

There are no combustion related emissions so all available controls are considered add-on controls. Identified controls are those add-on controls typically applied for control of particulate-laden gas streams:
- Baghouse/Fabric Filter
- Wet Scrubber

- Electrostatic Precipitator (ESP)
- High-efficiency Cyclone

12.1.2 Evaluation of Technical Feasibility of Available Controls

All control options are considered technically feasible.

12.1.3 Evaluation and Ranking of Technically Feasible Controls

The use of a baghouse is the most effective means of control for particulate emissions. Wet scrubbers, ESPs and cyclones are less effective controls.

12.1.4 Further Evaluation of Most Effective Controls

Construction of a new dedicated baghouse for control of particulate emissions would be the highest rated choice, but highly cost prohibitive at an estimated control cost of $600,000/ton of PM2.5 removed. The other listed controls would be similarly cost prohibitive. Currently partial control of the particulate emissions is achieved by the existing ladle and desulfurization system baghouses which control emissions to less than 3 tons/year.

12.1.5 Selection of BACT

Retention of the existing partial baghouse controls is recommended as BACT for the Casting Operations. No specific emission limitation is recommended as existing controls are commandeered from other processes synergistically.

13.0 BACT for Coating Operations

There are two pollutants of concern with coating operations: particulates generated during coating application, and VOCs generated both as the coating is applied and begins to dry.

13.1 PM2.5

The particulates generated during coating operations are primarily the result of spraying applications. Small droplets remain entrained in the air and are exhausted as particulates.

13.1.1 Available Control Options

There are three types of coating operations performed at MDU. None require the use of combustion as part of the coating process. As there are no combustion-related emissions, all available controls are considered add-on controls. Identified controls are those add-on controls typically applied for control of particulate-laden gas streams, with two exceptions. Cyclones cannot be employed because the coating would simply stick to the inside of the cyclone and eventually render the cyclone useless. However, this technology is replaced with an alternative – high transfer efficiency application techniques.

- Dry Filter Systems
- Good Operating Practices
- Wet Scrubber
- Electrostatic Precipitator (ESP)
- High Transfer Efficiency Application Techniques

13.1.2 Evaluation of Technical Feasibility of Available Controls

Wet ESPs are not considered technically feasible. This technology has difficulty in controlling the extremely sticky emissions from spray booths and is less useful in variable operations like coating operations.

Wet Scrubbers are not considered technically feasible. The coatings used are not soluble in most scrubber liquids (which is typically water or water-based solutions). In fact, most are water-phobic, being applied specifically to protect the iron pipe from water corrosion damage.

Good Operating Practices are considered technically feasible.

High Transfer Efficiency Application Techniques include the use of HVLP spray guns, roller and brush applications, dip applications, and flow applications. These applications are technically feasible.

Dry Filtration Systems use some form of particulate filtration to prevent coating particulates from being emitted. They can consist of paint arrestor filters, carbon filtration canisters, or other disposable filtration media. Depending on the coating being used, these devices are technically feasible or potentially infeasible (see below).

13.1.3 Evaluation and Ranking of Technically Feasible Controls

The use of high transfer efficiency application techniques and good operating practices yield the highest control efficiencies. Spray booths with dry particulate filtration systems can be of some additional control, however MDU has investigated their use and determined that they are subject to frequent plugging with the sticky coatings used on ductile iron pipes leading to frequent work interruptions to replace filter media.

13.1.4 Further Evaluation of Most Effective Controls

With the elimination of dry filter media, the use of high transfer efficiency application techniques and good operating practices remain and can be used in conjunction. No additional evaluation of these two control techniques is required.

13.1.5 Selection of BACT

Retention of the existing control techniques of high transfer efficiency application and good operating practices are recommended as BACT. As these represent work practice standards, no emission limitations are required.

13.2 VOC

VOC emissions are a function of the VOC content of the coatings being applied, the application technique, and to some degree the methods used to clean up.

13.2.1 Available Control Options

There are potentially a great number of transferrable processes from which control options could be applied, generating the following list of possible controls:

- Volume concentrators

- Carbon adsorption
- Thermal oxidation (RTO, RCO, TO)
- High transfer efficiency application techniques
- Low VOC coatings
- Best management practices

13.2.2 Evaluation of Technical Feasibility of Available Controls

Many of the control techniques have been demonstrated and achieved in practice; however, the asphaltic coatings used by MDU pose specific technical problems and concerns.

Volume concentrators: These devices raise the concentration of VOC vapors in the exhaust stream making it easier to treat with another system. The easiest concentrator is a rotating series of chambers – each containing a sorbent. A chamber is placed in the exhaust stream, absorbs the VOC vapors until saturated, and then switched for the next chamber. The now full chamber is regenerated, typically with hot gas, and the more concentrated VOC vapors are treated – often with thermal oxidation. However, the asphaltic coatings in use tend to plug the sorbents and even the ductwork/switching equipment in some cases, leading to frequent process interruption.

Carbon adsorption: Similar to a volume concentrator but without the switching process, this system uses a filter bank or cartridge of activated carbon to adsorb the VOC vapors. Once the cartridge is full it is simply replaced with a new one and the full cartridge is sent off site for regeneration or disposal. MDU has investigated the use of these cartridges and found them unreliable. They were subject to frequent plugging and failure rates were much higher than anticipated. This control is technically infeasible.

Thermal oxidation: All forms of thermal oxidation, whether using heat recovery or not, were evaluated together. In order to effectively operate any form of thermal oxidation system, a single localized exhaust is preferable, but adherence to USEPA Method 204 for Total Enclosures is a minimum for demonstrating proper capture and control of VOC emissions. MDU demonstrated that merely adding in the necessary infrastructure to accommodate Method 204 design principals would cost $2.5 million before calculating the control cost of any thermal oxidation system. It would also require significant relocation of utilities, storage areas, other operating areas of the plant, and perhaps require expansion of the facility beyond its existing boundary. This is considered technically infeasible.

High transfer efficiency application techniques are considered technically feasible.

The use of low VOC coatings is considered technically feasible.

Best management practices are considered technically feasible.

13.2.3 Evaluation and Ranking of Technically Feasible Controls

The use of high transfer efficiency application techniques, best management practices and low VOC coatings are all able to be used in tandem. There is no need to rank these controls. MDU is investigating the use of water-based and no-VOC coatings but has been unable to identify replacements for all coatings used at the facility.

13.2.4 Further Evaluation of Most Effective Controls

All technically feasible controls are currently employed at MDU. No additional evaluation is required.

13.2.5 Selection of BACT

Retention of the use of high transfer efficiency application techniques, low VOC coatings where applicable and best management practices are recommended as BACT. As these represent work practice standards, no specific emission limitation is required.

14.0 BACT for the Zinc Coating Operation

Arc spray equipment is used to apply a thin layer of zinc to a limited number of pipes to improve corrosion resistance. Arc spray (also called twin wire arc spray) is a process that uses an electrical arc to melt twin zinc wires. The molten metal is then sprayed with compressed air onto the desired surface.

14.1 PM2.5

The molten zinc droplets condense to form particulates which are currently controlled by a baghouse.

14.1.1 Available Control Options

There are no combustion related emissions, since the zinc wires are melted by electrical arc. All available controls are considered add-on controls. Identified controls are those add-on controls typically applied for control of particulate-laden gas streams:

- Baghouse/Fabric Filter
- Wet Scrubber
- Electrostatic Precipitator (ESP)
- High-efficiency Cyclone
- HEPA filters

14.1.2 Evaluation of Technical Feasibility of Available Controls

All control options are considered technically feasible.

14.1.3 Evaluation and Ranking of Technically Feasible Controls

The use of a baghouse is the most effective means of control for particulate emissions. Wet scrubbers, ESPs and cyclones are less effective controls. HEPA filters are essentially baghouses with especially high filtration levels. To achieve these filtration levels, the use of an enclosure and ventilation system is required, and frequent changing of the filter media is often a necessity.

14.1.4 Further Evaluation of Most Effective Controls

HEPA filtration has only recently been identified for specific applications where frequent changing of filter media is not a concern, or for applications involving toxic materials. In 2004, the California Air Resources Board approved the adoption of a regulation concerning chromium and nickel from thermal spraying. Although applicable to processes similar to that being employed by MDU, it was concerned only with chromium, chromium compounds, nickel, and nickel compounds and would not be applicable to a zinc-based application like MDU’s. HEPA filtration is capable of achieving removal efficiencies of 99.97%, while the MDU baghouse system can only achieve 99.90%.

14.1.5 Selection of BACT

Retention of the existing baghouse controls is recommended as BACT for the Zinc Coating Operations. No specific emission limitation is recommended as annual emissions are less than 0.01 tons per year.

15.0 BACT for the Fuel Storage Tanks

MDU has one 15,000 gallon diesel and one 1,000 gallon gasoline storage tank. Both storage tanks are fixed roof vertical tanks. Fugitive VOC emissions are minimal.

15.1 VOC

VOC emissions the result of the displacement of headspace vapors during filling operations and from breathing losses from daytime/nighttime heating and cooling variations. The tanks at MDU are not refilled frequently, so emissions are estimated to be minimal. Total annual emissions in 2014 were less than 0.01 tons.

15.1.1 Available Control Options

There are several identified control options:

- Internal floating roof tank
- Vapor recovery system
- Wet scrubber
- Pressure/vacuum valve settings
- Carbon filtration system
- Thermal oxidation

15.1.2 Evaluation of Technical Feasibility of Available Controls

Replacement of either storage tank with an internal floating roof tank is technically infeasible. The use of an internal floating roof tank is for tanks of much larger capacity than either tank in use at MDU.

The use of a vapor recovery system is not technically feasible. The gasoline tank is too small for a vapor recovery system to be of any practical use. Vapor recovery is not required on any gasoline tank below 12,740 gallons in size. Diesel has a much lower vapor pressure and would require a much larger tank volume than 12,740 gallons before vapor recovery would be considered viable.

Wet scrubbers have not been found in use on any fuel storage tanks of this size or type. They are not considered available or technically feasible.

Carbon filtration can be considered technically feasible, but would only be in use during refilling operations. Given the small amount of emissions from the tanks, and MDUs only statements regarding refilling operations, carbon filtration is not considered viable.

Thermal oxidation is not technically feasible; as the amount of emissions generated by the fuel required to keep the afterburner (or even just the pilot light) burning would greatly exceed the level of VOCs controlled. Use of an electrically heated thermal oxidizer would be technically feasible, but at significant cost.

Pressure/vacuum valve settings: This is a technically feasible option. Essentially the tank valve is adjusted to 10% of the maximum allowable working pressure. This allows notification if the tank is leaking – reducing emissions of VOC.

15.1.3 Evaluation and Ranking of Technically Feasible Controls

Only one control option is technically feasible which is adjusting the pressure/vacuum valve settings.

15.1.4 Further Evaluation of Most Effective Controls

Given the extremely small level of emissions from the storage tanks at MDU, adjusting the pressure/vacuum valve settings is a viable but unnecessary control option.

15.1.5 Selection of BACT

No controls are recommended as BACT. Adjusting the pressure/vacuum valve settings is a viable but unnecessary control option. This option does not need to be listed in any fashion as it will have no appreciable effect on emissions from the source.

16.0 BACT for Fugitive VOC Emissions

Fugitive VOC emissions include emissions from pipe striping and stenciling and parts degreasing.

16.1 VOC

16.1.1 Available Control Options

The fugitive emissions covered in this section are located throughout the source. Creating a capture system is technically infeasible. No destructive control options are considered available. Only good housekeeping practices and alternative chemical properties are considered available controls. Currently both options are employed at MDU.

16.1.2 Evaluation of Technical Feasibility of Available Controls

Since the only identified controls are both employed at MDU, both options are considered technically feasible.

16.1.3 Evaluation and Ranking of Technically Feasible Controls

No ranking of control options is required.

16.1.4 Further Evaluation of Most Effective Controls

No further evaluation is required

16.1.5 Selection of BACT

Retention of the existing work practice standards of good housekeeping practices and alternative chemical properties are recommended as BACT. No specific emission limitations are required.

17.0 BACT for Diesel-fired Emergency Generators

MDU operates two diesel-fired emergency generators.

17.1 Generator #1 – DeLavaud Emergency Generator

Generator #1, referred to as the DeLavaud generator in MDU's analysis is a 190 hp unit which supplies power to the overhead crane to empty ladles of molten iron in the event of a loss of electrical power or other emergency shutdown. UDAQ has completed a separate analysis of specific similar emission units which are common to many sources' such as emergency generators. Refer to the BACT analysis for Small Sources – Section 8A for details of that analysis.

17.1.1 MDU's Analysis for the DeLavaud Emergency Generator

Following a similar analysis to that performed by UDAQ, MDU has opted to install a replacement DeLavaud emergency generator. The new generator will meet Tier 3 emission standards, and be fired on ultra-low sulfur diesel. It will also meet all operational, emission and testing requirements of 40 CFR 60 Subpart IIII.

17.1.2 Selection of BACT

Installation of a new Tier 3 replacement DeLavaud emergency generator is recommended as BACT. The emission, testing and monitoring requirements of Subpart IIII of 40 CFR 60 are also recommended as sufficient demonstration of BACT.

17.2 Generator #2 – Recuperator Emergency Generator

MDU operates a recuperator in conjunction with the cupola which maximizes the heat recovery from the flue gas. The recuperator is temperature controlled with an oil-based heat exchanger. The recuperator emergency generator prevents the immediate shutdown of the heat exchanger during a power loss to protect employee safety and prevent equipment damage. The generator has a maximum rating of 550 hp. Please refer to UDAQ's analysis of larger diesel-fired emergency generators as found in Small Sources – Section 8B for additional details

17.2.1 MDU's Analysis for the Recuperator Emergency Generator

MDU determined that the existing generator did not require replacement or additional add-on control devices. The existing engine meets Tier 2 emission standards, as well as the emission and operational standards of 40 CFR 63 Subpart ZZZZ as an emergency generator. All add-on control devices were determined to be economically infeasible.

17.2.2 Selection of BACT

Continued operation of the existing recuperator emergency generator is recommended as BACT. The emission, testing and monitoring requirements of Subpart ZZZZ of 40 CFR 63 are also recommended as sufficient demonstration of BACT.

18.0 BACT for Natural Gas-fired Emergency Generators

MDU operates four natural gas-fired emergency generators; one each at the Works Office, Main Office, Oven Control, and Specialty Lining buildings. Each generator is less than 500 hp in power output.

18.1 UDAQ Analysis

UDAQ has completed a separate analysis of specific similar emission units which are common to many sources' such as natural gas-fired emergency generators. Refer to the BACT analysis for Small Sources – Section 8D for details of that analysis.

18.2 MDU's Analysis

MDU performed a similar analysis as UDAQ and determined that BACT for the natural gas-fired emergency generators was continued operation of the existing units, use of pipeline quality natural gas as fuel, and meeting the operational and emission limitations of Subpart JJJJ of 40 CFR 60.

18.3 Selection of BACT

Continued operation of the existing natural gas-fired emergency generators is recommended as BACT. The emission, testing and monitoring requirements of Subpart JJJJ of 40 CFR 60 are also recommended as sufficient demonstration of BACT.

19.0 BACT for the Cooling Towers

MDU operates eight (8) cooling towers to support various plant processes

19.1 Available Control Technology

There are four available control options for control of PM2.5 from cooling towers:

1) Use of dry cooling heat exchanger units;
2) High efficiency drift eliminators; and
3) Limitation on total dissolved solids (TDS) in the circulating water.

19.2 Evaluation of Technical Feasibility of Available Controls

MDU did not evaluate the possibility of using dry cooling heat exchanger units, and there is no mention of similar emission units (grey iron cupolas or ductile iron facilities) utilizing the technology. However, UDAQ has investigated the application of dry cooling at other facilities and the reasons presented by those sources for consideration/rejection of technical infeasibility, and have rejected dry cooling heat exchangers as technically feasible for this application.

All other control options are considered technically feasible.

19.3 Evaluation and Ranking of Technically Feasible Controls

A high-efficiency drift eliminator capable of 0.005% drift is considered the top level of control. Experimental analysis of the circulation water available at the MDU site has shown that no TDS limitation is required. The existing drift eliminators meet this level of drift efficiency with the exception of the cooling tower on cast machine #7. The remainder of this analysis addresses only that single cooling tower, as the rest meet the highest level of control.

19.4 Further Evaluation of Most Effective Controls

An analysis of the annual emissions from the cooling tower on cast machine #7 shows total PM2.5 emissions of approximately 1.5 lbs/yr. Replacement of the drift eliminator would cut emissions in half, to approximately 0.75 lbs/yr. Control cost effectiveness is well over $150,000/ton of PM2.5 reduced. This is not economically feasible.

19.5 Selection of BACT

Retention of the existing drift eliminators is recommended as BACT. Establishment of a TDS limitation in the circulation water is not required. No specific SIP limitation or monitoring is necessary as existing work practice standards should suffice to minimize emissions.

20.0 BACT for Miscellaneous Emission Sources

There are several miscellaneous particulate emission sources that did not fit into other categories:

- Pipe cutting
- Pipe grinding
- Mold grinding
- Mold blast
- Mold flux fines repair
- Machine shop grinding
- Blackening

These processes have total particulate emissions of less than 0.5 tons/year. Primarily these operations occur inside buildings which house other operations, and are thus at least partially controlled by those buildings ventilation systems. Rather than reviewing these items in detail, please refer to the analyses for Welding in Section 8.0 and Material Handling in Section 9.0 for additional details on particulate control of minor emission sources.

20.1 Selection of BACT

No additional controls are recommended as BACT for these miscellaneous emission sources. As no controls are required, no specific emission limits are recommended.

21.0 Startup and Shutdown Considerations

MDU did supply an analysis of startup and shutdown conditions.

Initial startup of the cupola proceeds with the cupola lid closed to ensure that the primary coke bed has ignited. After this startup period, the lid is raised to continue charging with raw materials. During this initial charging a rapid thermal expansion may occur as a result of the buildup of CO is through the control ductwork. This can result in a short period of uncontrolled emissions lasting 20-30 seconds. The thermal expansion wave will propagate backwards from the control devices back towards the cupola resulting in uncontrolled emissions at the cupola capture hood. The collection efficiency of the baghouse is obviously reduced due to the flow and backpressure issues. MDU follows the NESHAP standards in Subpart ZZZZZ for Iron and Steel Foundries Area Sources, by having an operation and maintenance (O&M) plan to ensure emissions are minimized during the startup period.

The cupola is also typically shut down each afternoon. Tuyeres inject hot blast air into the cupola to force the residual molten iron and slag through the tap hole in the bottom of the cupola. During the tap out process, some pollutant emissions may be blown out the bottom of the cupola rather than being captured through the cupola capture hood. The shutdown process takes approximately 10 minutes. MDU continues to follow its O&M plan to minimize emissions during this shutdown period. MDU is unaware of any control option beyond this process to further minimize emissions.

22.0 Ammonia Considerations

MDU has no regular emission sources of ammonia, and this BACT analysis has not resulted in the application of any ammonia injection process such as SNCR or SCR. Any ammonia emissions are the result of minor combustion related processes and amount to less than 1 ton per year.

23.0 Additional Feasible Measures and Most Stringent Measures

23.1 Extension of SIP Analysis Timeframe

As outlined in 40 CFR 51.1003(b)(2)(iii):

If the state(s) submits to the EPA a request for a Serious area attainment date extension simultaneous with the Serious area attainment plan due under paragraph (b)(1) of this section, such a plan shall meet the most stringent measure (MSM) requirements set forth at § 51.1010(b) in addition to the BACM and BACT and additional feasible measure requirements set forth at § 51.1010(a).

Thus, with the extension of the SIP regulatory attainment date from December 31, 2019 to December 31, 2024, the SIP must consider the application of both Additional Feasible Measures (AFM) and Most Stringent Measures (MSM).

23.2 Additional Feasible Measures at MDU

As defined in Subpart Z, AFM is any control measure that otherwise meets the definition of "best available control measure" (BACM) but can only be implemented in whole or in part beginning 4 years after the date of reclassification of an area as Serious and no later than the statutory attainment date for the area. The Provo/Orem Nonattainment Area was reclassified as Serious on June 9, 2017. Therefore, any viable control measures that could only be implemented in whole or in part beginning 6/9/2021 (4 years after the date of reclassification) are classified as AFM.

After a review of the available control measures described throughout this evaluation report, UDAQ was unable to identify any additional control measures that were eliminated from BACT consideration due to extended construction or implementation periods. Although there are some instances where technologies or control systems were removed from further consideration based on a lack of commercial or technological development, such as EMx™ or NOx absorber systems, there is no evidence to suggest that these systems will become viable for application merely by waiting 4 years. In addition, existing BACT controls on the emitting units where these alternative controls might have been applied will achieve the same or potentially greater levels of emission reduction; thus rendering the hypothetical discussion moot.

23.3 Most Stringent Measures at MDU

As defined in Subpart Z, MSM is defined as:

… any permanent and enforceable control measure that achieves the most stringent emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from among those control measures which are either included in the SIP for any other NAAQS, or have been achieved in practice in any state, and that can feasibly be implemented in the relevant PM2.5 NAAQS nonattainment area.

This is further refined and clarified in 40 CFR 51.1010(b), to include the following Steps:

Step 1) The state shall identify the most stringent measures for reducing direct PM2.5 and PM2.5 plan precursors adopted into any SIP or used in practice to control emissions in any state.
Step 2) The state shall reconsider and reassess any measures previously rejected by the state during the development of any previous Moderate area or Serious area attainment plan control strategy for the area.
Step 3) The state may make a demonstration that a measure identified is not technologically or economically feasible to implement in whole or in part by 5 years after the applicable attainment date for the area, and may eliminate such whole or partial measure from further consideration.
Step 4) Except as provided in Step 3), the state shall adopt and implement all control measures identified under Steps 1) and 2) that collectively shall achieve attainment as expeditiously as practicable, but no later than 5 years after the applicable attainment date for the area.

23.3.1 Step 1 – Identification of MSM

For purposes of this evaluation report UDAQ has identified for consideration the most stringent methods of control for each emission unit and pollutant of concern (PM2.5 or PM2.5 precursor) emitted at MDU. A summary is provided in the following table:

Table: Most Stringent Controls by Emission Unit

Emission Unit	Pollutant	Most Stringent Control Method
Cupola	PM2.5	Baghouse
	SO2	Limit sulfur in feed materials
	NOx	GCP, natural gas, low-NOx burners
	VOC	CO burner (afterburner control)
	SU/SD	work practice standards
Desulfurization/Inoculation Unit	PM2.5	Baghouse
Annealing Oven	PM2.5	GCP, natural gas
	SO2	GCP, natural gas
	NOx	GCP, natural gas, limit on heat input rate
	VOC	GCP, natural gas
Finishing Heaters	PM2.5	GCP, natural gas
	SO2	GCP, natural gas
	NOx	GCP, natural gas
	VOC	GCP, natural gas

Welding	PM2.5	Work practice standards
Material Handling	PM2.5	Baghouses, WPS
Pipe Cleaning	PM2.5	Baghouse
Specialty Lining Shotblast	PM2.5	Baghouse
Casting	PM2.5	Baghouse
Coating Operations	PM2.5	High efficiency transfer application (HETA), GOP
	VOC	HETA, GOP, low VOC coatings where possible
Zinc Coating	PM2.5	Baghouse
Fuel Storage Tanks	VOC	Adjusting the pressure/vacuum valve settings
VOC Fugitives	VOC	Work practice standards
Diesel Emergency Generators	Special	Upgrading Recuperator engine to Tier 3
Natural Gas Emergency Generators	Special	NG
Cooling Towers	PM2.5	None
Ammonia	NH4	None

The above listed controls represent the most stringent level of control identified from all other state SIPs or permitting actions, but do not necessarily represent the final choice of MSM. That is determined in Step 4.

23.3.2 Step 2 – Reconsideration of Previous SIP Measures

Utah has previously issued a SIP to address the moderate PM2.5 nonattainment areas of Logan, Salt Lake City, and Provo/Orem. The SIP was issued in parts: with the section devoted to the Logan nonattainment area being found at SIP Section IX.A.23, Salt Lake City at Section IX.A.21, and Provo/Orem at Section IX.A.22. Finally, the Emission Limits and Operating Practices for Large Stationary Sources, which includes the application of RACT at those sources, can be found in the SIP at Section IX Part H. Limits and practices specific to PM2.5 may be found in subsections 11, 12, and 13 of Part H.

Accompanying Section IX Part H was a Technical Support Document (TSD) that included multiple evaluation reports similar to this document for each large stationary source identified and listed in each nonattainment area. UDAQ conducted a review of those measures included in each previous evaluation report which contained emitting units which were at all similar to those installed and operating at MDU.

There were several technologies that had been eliminated from further consideration at some point during many of the previous reviews. Some emitting units were considered too small, or emissions too insignificant to merit further consideration at that time. The cost effectiveness considerations may have been set at too low a threshold (a philosophical question of cost in RACT versus BACT). And many cases of technology being technically infeasible for application – such as applying catalyst controls to infrequently used emitting units which may never reach an operating temperature where use of the catalyst becomes viable and effective.

In all but one case, these rejected control technologies were already brought forward and re-evaluated using updated information (more recent permits, emission rates and cost information) by MDU in its Supplemental MSM/BACT analysis report. The one case which was not reconsidered was the deferment of VOC controls for the wastewater treatment systems at four Salt Lake City area refineries. This issue does not apply to MSM, as there is no wastewater treatment system located at the facility, and no VOC-laden water of any sort needs to be treated. Thus, there are no additional technologies identified in Step 2.

23.3.3 Step 3 – Demonstration of Feasibility

A control technology or control strategy can be eliminated as MSM if the state demonstrates that it is either technically or economically infeasible.

This demonstration of infeasibility must adhere to the criteria outlined under §51.1010(b)(3), in summary:

1) When evaluating technological feasibility, the state may consider factors including but not limited to a source's processes and operating procedures, raw materials, plant layout, and potential environmental or energy impacts
2) When evaluating the economic feasibility of a potential control measure, the state may consider capital costs, operating and maintenance costs, and cost effectiveness of the measure.
3) The SIP shall include a detailed written justification for the elimination of any potential control measure on the basis of technological or economic infeasibility.

This evaluation report serves as written justification of technological or economic feasibility/infeasibility for each control measure outlined herein. Where applicable, the most effective control option was selected, unless specifically eliminated for technological or economical infeasibility. Expanding on the previous table, the following additional information is provided:

Table: Feasibility Determination

Emission Unit	Pollutant	Most Stringent Control Method	Is Method Feasible?
Cupola	PM2.5	Baghouse	Yes
	SO2	Limit sulfur in feed materials	Yes
	NOx	GCP, NG, low-NOx burners	Yes
	VOC	CO burner (afterburner control)	Yes
	SU/SD	work practice standards	Yes
Desulfurization	PM2.5	Baghouse	Yes
Annealing Oven	PM2.5	GCP, NG	Yes
	SO2	GCP, NG	Yes
	NOx	GCP, NG, heat input rate	Yes
	VOC	GCP, NG	Yes
Finishing Heaters	PM2.5	GCP, NG	Yes
	SO2	GCP, NG	Yes
	NOx	GCP, NG	Yes
	VOC	GCP, NG	Yes
Welding	PM2.5	Work practice standards	Yes
Material Handling	PM2.5	Baghouses, WPS	Yes
Pipe Cleaning	PM2.5	Baghouse	Yes
Specialty Lining Shotblast	PM2.5	Baghouse	Yes
Casting	PM2.5	Baghouse	Yes
Coating Operations	PM2.5	HETA, GOP	Yes
	VOC	HETA, GOP, low VOC	Yes
Zinc Coating	PM2.5	Baghouse	Yes
Fuel Storage Tanks	VOC	Pressure/vacuum valve settings	Yes
VOC Fugitives	VOC	Work practice standards	Yes

Diesel Generators	Special	Tier 3 Recuperator engine	Maybe, cost?
Natural Gas Generators	Special	NG	Yes
Cooling Towers	PM2.5	None	Yes
Ammonia	NH4	None	Yes

Most of the entries on the above table are already being implemented as BACT level controls, with two exceptions. Adjusting the pressure/vacuum valve settings on the two storage tanks was determined to be a feasible control option under the BACT analysis, but for essentially zero overall return on emission reductions. However, under MSM this option should be pursued. Replacement of the recuperator emergency engine with a Tier 3 or better performing engine was not the conclusion reached by MDU, but was a potentially viable option under UDAQ's Small Source analysis. While ultimately not selected as BACT, this option should be implemented under MSM requirements.

24.0 New PM2.5 SIP – General Requirements

The general requirements for all listed sources are found in SIP Subsection IX.H.21. These serve as a means of consolidating all commonly used and often repeated requirements into a central location for consistency and ease of reference. As specifically stated in subsection IX.H.21.a below, these general requirements apply to all sources subsequently listed in either IX.H.22 (Salt Lake City) or IX.H.23 (Provo/Orem), and are in addition to (and in most cases supplemental to) any source-specific requirements found within those two subsections.

These conditions of Section IX.H.21 have not yet been drafted; however, they are most likely to be similar to conditions IX.H.11.a-f of the existing moderate SIP. Those conditions primarily covered the general definitions, recordkeeping/reporting, stack testing, and CEM requirements

24.1 Monitoring, Recordkeeping and Reporting

As stated above, the general requirements IX.H.11.a through IX.H.11.f primarily serve as declaratory or clarifying conditions, and do not impose compliance provisions themselves. Rather, they outline the scope of the conditions which follow in the source specific requirements of IX.H.12 and IX.H.13.

For example, most of the conditions in those subsections include some form of short-term emission limit. This limitation also includes a compliance demonstration methodology – stack test, CEM, visible opacity reading, etc. In order to ensure consistency in compliance demonstrations and avoid unnecessary repetition, all common monitoring language has been consolidated under IX.H.11.e and IX.H.11.f. Similarly, all common recordkeeping and reporting provisions have been consolidated under IX.H.11.c.

24.2 Discussion of Attainment Demonstration

As is discussed above in Items 24.0 and 24.1, these are general conditions and have few if any specific limitations and requirements. Their inclusion here serves three purposes. 1. They act as a framework upon which the other requirements can build. 2. They demonstrate a prevention of backsliding. By establishing the same or functionally equivalent general requirements as were included in the original SIP, this demonstrates both that the original requirements have been considered, and either retained or updated/replaced as required. 3. When a general requirement has been removed, careful consideration was given as to its specific need, and whether its retention would in any way aid in the demonstration of attainment with the 24-hr standard. If no argument can be made in that regard, the requirement was simply removed.

25.0 New PM2.5 SIP – MDU Specific Requirements

The LSPP specific conditions in Section IX.H.3 address those limitations and requirements that apply only to the LSPP Power Plant in particular.

IX.H.13.c.i Emissions of VOC from the finishing paint line shall not exceed 1 ton/day.

Subparagraph A: Compliance with the above conditions shall be demonstrated as follows:
VOC emissions at the 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.
Subparagraph 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.

IX.H.13.c.ii. The Annealing Oven furnaces are limited to 63.29 MMBtu/hr.

IX.H.13.c.iii Emissions from the desulfurization and ductile treatment system shall be routed through the operating baghouse prior to be emitted into the atmosphere.

IX.H.13.c.iv Emissions from the Special Lining Shotblast operations shall be routed through the operating baghouse prior to being emitted into the atmosphere.

25.1 Monitoring, Recordkeeping and Reporting

Monitoring for IX.H.13.c.i is specifically outlined in IX.H.13.c.i.a; while IX.H.13.c.ii, iii and iv are addressed by the general requirements of IX.H.11.c. Recordkeeping is also subject to the requirements of IX.H.11.c.

25.2 Discussion of Attainment Demonstration

MDU is primarily a source of VOC emissions. While some SO2 and direct particulate emissions are included as a part of the overall contribution from MDU, it is a listed source because of VOC.

VOC emissions are addressed by limiting the VOCs from painting operations. Although there are other sources of VOC at the facility, the largest contributor to total VOCs comes from painting, and with no economically viable control option for eliminating VOCs directly, only placing a limit on total emissions remains as an alternative. There are no specific limitations on PM2.5 or SO2 emissions. Instead, emissions are limited by ensuring that the previously identified RACT control options for the primary emitting units remain in place. These options were: limiting the heat input at the annealing oven furnace, continuing to operate the desulfurization and ductile treatment system baghouse, and continuing to operate the specialty lining shotblast baghouse.

26.0 References

- Incorporation of Several Permitting Changes. Approval Order DAQE-AN107940026-13. State of Utah, Department of Environmental Quality, Division of Air Quality. John Jenks, Engineer. March 11, 2013.
- Haley & Aldrich. Reasonably Available Control Technology (RACT) PSCIPC; Provo, Utah. Haley & Aldrich, Inc., Columbus, OH., February 28, 2013.
- PSCIPCO – PSCIPCO PM2.5 SIP RACT Analysis - Supplement #2. August 7, 2013.
- PSCIPCO – PM2.5 SIP RACT Analysis Supplemental, PSCIPCO - Provo, Utah. May 10, 2013.
- Techlaw – UDSHW Contract 126015, Work Assignment No. 07, Utah PM2.5 SIP RACT Support, Revised RACT Evaluation Report PSCIPCo; Provo. June 28, 2013.
- PSCIPCO – PM2.5 SIP for Provo Nonattainment Area (comment on proposed PM2.5 SIP RACT). October 31, 2013.
- PSCIPCO Startup, Shutdown and SIP Implementation Schedule. April 30, 2014.

***Note: Reference list is not complete at this time as this is a Draft Document.