PM$_{2.5}$ SIP Evaluation Report – Kennecott Utah Copper LLC-Power Plant

UTAH PM$_{2.5}$ SERIOUS SIP

Salt Lake City Nonattainment Area

Utah Division of Air Quality

Major New Source Review Section

July 1, 2018

DAQ-2018-007701

$PM_{2.5}$ SERIOUS SIP EVALUATION REPORT
KENNECOTT UTAH COPPER LLC- POWER PLANT, TAILINGS AND LABORATORY

1.0 Introduction-Purpose

The following is an updated version of the original RACT evaluation that was completed on October 1, 2013 as a part of the Technical Support Documentation for Section IX, Parts H.11, 12 and 13 of the Utah SIP; to address the Salt Lake City $PM_{2.5}$ and Provo, Utah $PM_{2.5}$ Nonattainment Areas.

1.1 Facility Identification

Name: Kennecott Utah Copper LLC (KUC)
Address: 8362 West 10200 South
Bingham Canyon, UT 84006
Owner/Operator: Rio Tinto/KUC
UTM coordinates:
405,200 m Easting, 4,507,400, m Northing, UTM Zone 12 (Power Plant)
405,250 m Easting, 4,510,400, m Northing, UTM Zone 12 (Tailings)
403,800 m Easting, 4,507,700, m Northing, UTM Zone 12 (Laboratory)

1.2 Facility Process Summary

Kennecott Utah Copper LLC (KUC) owns and operates the Utah Power Plant (UPP) which had four boilers to generate power. The initial plant was constructed in 1943, and has been operated with the current output capacity and configuration since 1959. The plant did operate on both coal and natural gas. In 2011 KUC received an Approval Order (AO) to install a combined-cycle, natural gas-fired combustion turbine (CT) to replace three coal-fired boilers (Units 1, 2 and 3). Units 1, 2 and 3 were removed from service in October 2016. The Power Plant and Tailings Impoundment constitute a major source of PM_{10}, NO_x, and SO_2. 40 CFR 64 applies to the boiler.

In September 2016, KUC entered into power purchase agreement with Rocky Mountain Power, whereby Units 1, 2 and 3 at UPP ceased operation in October of 2016. KUC will continue to operate Unit 4 in compliance with the applicable requirements. Upon completion of the construction of Unit 5, KUC will operate the unit in compliance with the applicable requirements.

The Tailings Impoundment stores tailings generated from the concentrating process. The tailings received from the Copperton Concentrator are routed through cyclones to separate out the coarse and fine tailings. The fine tailings (or cyclone overflow) are deposited in the interior of the tailings facility which is kept saturated by spigotting once every four days and does not result in any emissions. The coarse tailings (or cyclone underflow) are used to build the embankment which generates less dust due to its larger particle size. This current practice of building the embankments out of the coarse underflow fraction is less dust generating than the use of whole tailings that was used to build the south embankment. The emissions are predominately fugitive.

The power plant operates under Approval Order (AO) DAQE-AN105720031-15 issued November 10, 2015. Under the 1990 Clean Air Act the power plant, Tailings Impoundment and laboratory constitute a major Title V source and operate under Title V Operating Permit #3500346002 issued August 26, 2009. The Tailings Impoundment operates under the AO DAQE-AN0572018-06 issued on April 6, 2006. The AO DAQE-AN105720028-13, dated November 26, 2013, for the Bonneville Borrow Plant (BBP) was revoked under DAQE-GN105720030-15, dated May 7, 2015. Therefore, a description of the BBP has been removed from this report.

The UPP is subject to 40 CFR 60 Subpart A- General Provisions, 40 CFR 60 Subpart IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, 40 CFR 60 Subpart JJJJ - Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, 40 CFR 60 Subpart KKKK - Standards of Performance for Stationary Combustion Turbines, 40 CFR 63 Subpart YYYY - National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines, 40 CFR 63 Subpart ZZZZ - National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines, 40 CFR 63 Subpart CCCCCC - National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities and 40 CFR 63 Subpart JJJJJJ - National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources.

1.3 Facility 2016 Baseline Emissions

Site-wide 2016 Actual Emissions (tons/yr) for power plant, tailings impoundment, and laboratory.

$PM_{2.5}$	NO_x	SO_2	VOC	NH_3
71.78	1,322.52	1,500.34	8.21	0.24

1.4 Facility Criteria Air Pollutant Emissions Sources

Emission Unit	Potential to Emit				
	$PM_{2.5}$	NO_x	SO_2	VOC	NH_3
Power Plant	248.00	1,641.27	2,577.06	41.03	0.24
Tailings Impoundment	5.44	0.26	*	0.04	0.00
Laboratory	0.12	0.68	0.13	0.12	0.01

*SO_2 emissions are less than 0.01 TPY.

The following emission units are not source specific. A separate BACT analysis has been conducted on these common emission units. The technical support for these sources is in the PM¬2.5 Serious SIP – BACT for Small Source document (“PM2.5 Serious SIP – BACT for Small Sources.,” 2017).

Power Plant

Unit 4 Boiler
Unit 5 Combustion Turbine and Duct Burner
Cold Solvent Parts Washers
Petroleum Storage Tanks
Diesel Engine
Natural Gas Generator
Wet Cooling Towers
Gasoline Tanks
Paved and Unpaved Service Roads

Tailings Impoundment

Unpaved Service Roads
LP Fired Emergency Generator

Laboratory

Process Laboratory Dust Collector
Environmental Laboratory Dust Collector
Muffle Furnace Filter
Flux Mixers Filter
Ore Compactor Filter
Hot Water 7.133 MMBTU/hr natural gas fired boiler

2.0 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.

The final BACT evaluations for the Kennecott Laboratory, Power Plant and Tailings Impoundment sites were performed using data that Kennecott submitted (CH2MHill, 2013), (CH2M, 2017b),(CH2M, 2018), EPA documents (Environmental Protection Agency, 2000), comments received from Techlaw on the Kennecott RACT submittal, comments received from EPA, comments received from the public, AOs, and the Title V permit.

2.1 Emission Unit (EU) and Existing Controls

Power Plant

Historically, KUC has operated three coal fired boilers rated at 100 megawatts (MW) combined, referred to as Units 1-3, at the UPP. The units operated on coal during the spring, summer and fall months, but were limited to burning natural gas during the winter months between November 1 and March 1. KUC was required by the PM2.5 moderate SIP (dated December 7, 2016) to not operate Units #1, #2 and #3 after January 1, 2018. In October 2016, KUC permanently ceased operation of Units 1-3 (CH2M, 2017a). Therefore, a BACT analysis for Units 1-3 is not included in this document.

2.1.1 Unit 4 Boiler

Description:

Unit 4 is a tangentially fired boiler capable of burning both coal and natural gas, rated at 838 million British Thermal Units per hour (MMBTU/hr) (coal), or 872 MMBTU/hr (natural gas), equipped with an electrostatic precipitator. The uncontrolled NO_x emission limit as listed in the 2015 Approval Order is 306 lbs per hour when operated on natural gas. This results in a NO_x emission rate of 319.5 tons per year when operated for 2,088 hours during the period of November 1st to February 28th the following year or 1,340.3 tons per year when operated 8,760 hours per year.

Emissions Summary:

The PTE* (tons/yr) for Unit 4 is as follows:

	$PM_{2.5}$	NO_x	SO_2	VOC
Coal-Fired	186	5,134	5.78	259
Natural Gas-Fired	35	695	0.78	43

*This is based on the fuel limits listed in Condition II.B.3.b of the 2015 Approval Order.

The 2016 actual emissions (tons/yr) for Unit 4 is as follows:

	$PM_{2.5}$	NO_x	SO_2	VOC
Coal-Fired	38.16	648.82	914.64	4.61
Natural Gas-Fired	0.06	1.25	0.01	0.05

Control Options:

[Pollutant (NO_x)]

Good combustion practices
Low NO_x burners (LNB)
LNB with over-fire air (OFA)
Ultra-Low NO_x Burners (ULNB)
Selective Catalytic Reduction (SCR)
Selective Non-Catalytic Reduction (SNCR)

Technological Feasibility:

All control technologies are technically feasible.

An SCR has an efficiency rating of 90% NO_x removal while and SNCR is only 50% efficient. The SCR is the more efficient control unit.

A RACT analysis was performed in 2013 (CH2MHill, 2013) using 2,880 hours of operation which Unit 4 is allowed to operate during the winter months. The RACT analysis stated that the Unit 4 baseline emission rate is 0.150 lb/MMBtu. The November 10, 2015 Approval Order, DAQE-AN105720031-15, has a NO_x emission limit of 306 lbs per hr when burning natural gas. This results in a NO_x PTE of 319.46 tons per yr. The

2013 RACT analysis evaluated the installation of an LNB and OFA system and an SCR system on Unit 4. The LNB and OFA system result in an emission rate of 0.08 lb/MMBtu. This reduced the emissions from 319.46 tons per year to 170.38 tons per year. This would be a reduction in the hourly emission rate from 306 lbs per hr to 163.2 lbs per hr. If an SCR was added with a 90% reduction to the LNB and OFA system, the emission rate would be reduced from 163.2 lbs per hr to 16.32 lbs/hr.

Currently the 2015 Approval Order allows a NO_x emission rate of 306 lbs per hour and 336 ppm. If the emissions are reduced from 306 lbs per hour to 16.32 lbs per hour then the ppm limit should also be reduced from 336 ppm to 179 ppm with LNB and OFA. Then with a 90% efficient SCR the emission rate should be 17.9 ppm.

Previous SIP determination for UPP Unit 4 required the installation of LNB with OFA and SCR with 90% NO_x control when operating on natural gas during the winter months between November 1 and March 1. Because the top technology is already identified in previous SIPs, additional analysis is not necessary.

Economic Feasibility:

In the November 10, 2015 Approval Order Unit #4 has an allowed NO_x emission rate of 377 lb per hr when burning coal and 306 lb/hr when burning natural gas. When 306 lb per hr and 2,088 hrs per yr is used the allowed emission rate is 319.46 tons per year. If LNB and OFA are installed then the emission rate is170.38 tons per year with a 149.08 tons/yr reduction in NO_x. This is assuming the reduction from 0.15 lb/MMBTU to 0.08 lb/MMBTU as stated in the 2013 RACT submittal. When this is combined with the annual cost of $578,000 per year this results in a cost of $3,877/ton of NO_x removed. If and annual emission rate of 8,760 hours is used then the cost is reduced to $924 per ton of NO_x removed.

If an SCR is installed the emission rate is reduced from 319.46 tons per year to 31.95 tons per year. This is a 287.52 tons per year reduction in NO_x assuming the reduction from 0.15 lb/MMBTU to 0.015 lb/MMBTU as stated in the 2013 RACT submittal. This at an annual cost of $1,323,000 per year which results in a cost of $4,601 per ton of NO_x removed. If and annual emission rate of 8,760 hours is used then the cost is reduced to $1,097 per ton of NO_x removed.

If an SCR is installed with ULNB and OFA the emission rate is reduced from 319.46 tons per year to 17.04 tons per year. This is a 302.43 tons per year reduction in NO_x assuming the reduction from 0.15 lb/MMBTU to 0.08 lb/MMBTU then a 90% reduction with the SCR as stated in the 2013 RACT submittal. This at an annual cost of $1,901,000 per year which results in a cost of $6,286 per ton of NO_x removed. If and annual emission rate of 8,760 hours is used then the cost is reduced to $1,498 per ton of NOx removed.

BACT Selection:

LNB with OFA that have a 50% control efficiency and when coupled with the SCR with

90% control efficiency, this results in a reduction of NO_x emissions 1,269 tons per year when operated 8,760 hrs per year. The ULNB and OFA with SCR constitute BACT for controlling NO_x emissions.

KUC submitted a BACT analysis (Steve Schnoor, 2018), (Black and Veatch, 2018) to operate Unit #4 on Coal during the period March 1 to October 31. The BACT requires that KUC install Over-fired Air (OFA) and Selective Catalytic Reduction (SCR). This will reduce the NO_x emissions from 384 ppm to 80 ppm.

Implementation Schedule:

January 1, 2019.

[Pollutant $PM_{2.5}$, NO_2 and VOC]

Control Options:

Good combustion practices
Use of pipeline quality natural gas

Technological Feasibility:

All control technologies are technically feasible. Unit 4 has an Electrostatic Precipitator to control $PM_{2.5}$ and SO_2 emissions.

Economic Feasibility:

Not applicable because all control technologies identified have been selected.

BACT Selection:

Use of pipeline quality natural gas, good combustion practices, good design and proper operation constitute BACT for Unit 4.

Implementation Schedule:

January 1, 2019.

Startup/Shutdown Considerations

Occasionally a unit will need to be taken offline to make repairs. These are generally planned outages that are scheduled during Low Load hours if possible. The unit will be ramped down slowly in a controlled fashion to minimize impacts to equipment and the environment.

Unscheduled outages can be triggered by events outside of the operators control. These generally cause the Burner Management System to initiate an instantaneous safety shut down. These trips will cause the automatic power down of the Electrostatic Precipitators to prevent a possible secondary raw fuel ignition. Once the root cause of the trip has been determined and mitigated the unit is put back online based on manufacturer's recommended procedures based on the conditions existing at the time the unit is re-started.

Unit 4 has not been historically operated during the winter months. This unit was designed to be a baseload unit. It was not designed for frequent start-up and shut down and is usually left online during Low Load Hours of short duration (overnight), thus reducing frequency of startups and shutdowns. Emissions of NO_x will be limited with add-on controls and operational controls with good combustion practices after January 1, 2019. These controls are currently not in place and procedures will be developed using information from emission control manufacturers. KUC will operate Unit 4 per manufacturer's recommendations to limit emissions of NO_x during periods of startup and shutdown.

Low NO_x burners generally achieve NO_x emissions reduction through staged combustion and controlling amount of oxygen in the primary combustion zone. KUC will achieve startup and shutdown NO_x emissions reduction through the utilization of the existing LNB and OFA system, and with SCR system, adherence to good combustion practices, and burning of pipeline-quality natural gas.

2.1.2 Unit 5 Combustion Turbine and Duct Burner

Description:

Unit 5 is a combined‑cycle combustion turbine and HRSG with a nominal generating capacity of approximately 275 megawatts (MW). Dry low nitrogen oxide (DLN) combustors and the selective catalytic reduction (SCR) system will control nitrogen oxide (NOx) emissions. The catalytic oxidation (CatOx) system will control emissions of carbon monoxide (CO) and volatile organic compounds (VOCs).

Emissions Summary:

The PTE (tons/yr) for Unit 5 as permitted in AO DAQE-AN105720031-15, dated November 10, 2015, is listed below:

PM2.5	SO2	NOx	VOC
64.98	12.42	65.34	22.50

Control Options:

[Pollutant (NO_x)]

Water injection

Steam injection
Selective Catalytic Reduction (SCR)
Selective Non-Catalytic Reduction (SNCR)
Low NOx burners (LNB) with good combustion practices

Technological Feasibility:

An SCR has an efficiency rating of 90% NO_x removal while and SNCR is only 50% efficient. The SCR is the more efficient control unit.

Unit 5 uses a new natural gas-fired stationary combustion turbine equipped with the current dry low-NO_x combustor designs. It is technically infeasible to use water or steam injection on the dry low-NO_x combustors on this Unit 5. There were no additional control option identified for Unit 5.

Economic Feasibility:

SCR and catalytic oxidation has already been selected as BACT, therefore an economic feasibility analysis has not been conducted.

BACT Selection:

SCR and catalytic oxidation constitutes BACT for controlling NO_x emissions from the combustion turbine and duct burner.

Implementation Schedule:

January 1, 2019.

Control Options:

[Pollutant ($PM_{2.5}$, NO_2 and VOC]

Good combustion practices
Use of pipeline quality natural gas
Catalytic Oxidation for VOC control

Technological Feasibility:

All control technologies are technically feasible.

Economic Feasibility:

Not applicable because all control technologies identified have been selected.

BACT Selection:

Use of pipeline quality natural gas, good combustion practices, good design and proper operation constitute, and catalytic oxidation is BACT for Unit 5.

Implementation Schedule:

January 1, 2019.

Startup/Shutdown Considerations

Occasionally a unit will need to be taken offline to make repairs. These are generally planned outages that are scheduled during Low Load hours if possible. The unit will be ramped down slowly in a controlled fashion to minimize impacts to equipment and the environment.

Unscheduled outages can be triggered by events outside of the operator's control. These generally cause the Burner Management System to initiate an instantaneous safety shut down. Once the root cause of the trip has been determined and mitigated the unit is put back online based on manufacturer's recommended procedures based on the conditions existing at the time the unit is re-started.

KUC will achieve startup and shutdown NO_x emissions reduction through the utilization of the proper operation of the SCR and catalytic oxidation, adherence to good combustion practices, and burning of pipeline-quality natural gas.

2.2 Emission Unit (EU) and Existing Controls

Tailings Impoundment

Description:

Tailings are sent to the tailings site via a slurry pipeline. At the facility, tailings are separated by size in a cyclone with the larger particles used to build the embankments and the smaller particles discharged in slurry form in the impoundment. Emissions from the tailings site are mainly from wind erosion of dry tailings on the embankment. The facility has a current dust control plan approved by the UDAQ Director for control of fugitive particulate matter. The dust control plan requires frequent monitoring of the impoundment for wind erosion potential, applying chemical dust suppressants in the late spring, applying water via water trucks and the dust suppression sprinkler system as needed to maintain adequate moisture content.

In 2013, KUC conducted a study to identify and evaluate the range of dust control practices that have been attempted and successfully applied for mine tailings impoundments. This study also reviewed published literature and available air quality compliance documentation to extend the breadth of the evaluation.

The tailings site can be categorized into four operational areas: impoundment, active embankment, inactive embankment, and reclaimed areas.

2.2.1 Tailings Impoundment

[Pollutant $PM_{2.5}$]

Control Options:

Watering
Polymer application
Revegetation
Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists in minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reducing wind erosion and emissions.

Technological Feasibility:

Because of the size of the tailing site, enclosures are technically infeasible. It is not technically feasible to apply polymers to areas that are actively being sprayed with water. The water decreases the polymers and washes it away. All remaining controls are technically feasible.

Economic Feasibility:

All remaining control technologies are economically feasible. Therefore, an economic feasibility was not performed.

BACT Selection:

The impoundment area is saturated with water and does not result in windblown dust emissions unless the wind exceeds 25 mph. Visual inspections are routinely performed to ensure the impoundment is saturated with water and in the unlikely event an area appears to be drying out, the area would be re-saturated. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions. Additionally, the impoundment area is saturated with water and does not result in windblown dust emissions. The current practices of dust management at the tailings site also represent the most stringent measure.

Implementation Schedule:

Proper operations are already in place.

Startup/Shutdown Considerations

There are no startup/shutdown operations to be considered for these sources.

2.2.2 Tailings Active (Flat) Embankments

[Pollutant $PM_{2.5}$]

Control Options:

Watering
Polymer application
Revegetation
Enclosures

Technological Feasibility:

Because of the size of the tailing site, enclosures are technically infeasible. It is not technically feasible to apply polymers to areas that are actively being sprayed with water. The water decreases the polymers and washes it away. All remaining controls are technically feasible.

Economic Feasibility:

All remaining control technologies are economically feasible. Therefore, an economic feasibility was not performed.

BACT Selection:

The tailings are actively deposited in the embankment areas. In an active embankment cell, the tailings are deposited every fourth day. The tailings are extremely wet when deposited. Areas can remain moist for several days. Application of water for dust control in active areas is not feasible as it tends to channelize directly to the drain point instead of spreading across the surface. The flat embankment areas will therefore have a potential for wind erosion on days 2, 3, and 4. Emissions are estimated based on days with potential for wind erosion. The current practices of reducing particulate emissions by dust management is most effective in reducing emissions and identified as BACT. The current practices of dust management at the tailings site also represent the most stringent measure.

Implementation Schedule:

Proper operations are already in place.

Startup/Shutdown Considerations

There are no startup/shutdown operations to be considered for these sources.

2.2.3 Tailings Inactive and Sloped Embankments

[Pollutant $PM_{2.5}$]

Control Options:

Watering
Polymer application
Revegetation
Enclosures

Technological Feasibility:

Because of the size of the tailing site, enclosures are technically infeasible. It is not technically feasible to apply polymers to areas that are actively being sprayed with water. The water decreases the polymers and washes it away. All remaining controls are technically feasible.

Economic Feasibility:

All remaining control technologies are economically feasible. Therefore, an economic feasibility was not performed.

BACT Selection:

In the inactive embankment areas, where tailings deposition has been completed for the year, KUC installs sprinklers for watering. Over the past few years, KUC converted this to an automated sprinkler system that wets the surface at regular intervals. This upgrade allows the surface to maintain its moisture.

The embankment slopes are sprayed with polymers to minimize windblown dust. Polymer is reapplied as necessary to maintain its effectiveness to minimize emissions.

The current practices of reducing particulate emissions by dust management is most effective in reducing emissions and identified as BACT. The current practices of dust management at the tailings site also represent the most stringent measure.

Implementation Schedule:

Proper operations are already in place.

Startup/Shutdown Considerations

There are no startup/shutdown operations to be considered for these sources.

2.2.4 Tailings Reclaimed Areas

[Pollutant $PM_{2.5}$]

Control Options:

Watering
Polymer application
Revegetation
Enclosures

Technological Feasibility:

Because of the size of the tailing site, enclosures are technically infeasible. It is not technically feasible to apply polymers to areas that are actively being sprayed with water. The water decreases the polymers and washes it away. All remaining controls are technically feasible.

Economic Feasibility:

All remaining control technologies are economically feasible. Therefore, an economic feasibility was not performed.

BACT Selection:

Once released for reclamation, KUC implements a revegetation plan to reclaim the areas. Polymers are applied to areas still waiting to be reclaimed. The current practices of reducing particulate emissions by dust management is most effective in reducing emissions and identified as BACT. The current practices of dust management at the tailings site also represent the most stringent measure.

Implementation Schedule:

Proper operations are already in place.

Startup/Shutdown Considerations

There are no startup/shutdown operations to be considered for these sources.

2.2.5 Biosolids Application

Biosolids are primarily organic materials produced during wastewater treatment which may be put to beneficial use (Environmental Protection Agency, 2000). An example of such use is the addition of biosolids to soil to supply nutrients and replenish soil organic matter. This is known as land application. Biosolids can be used on agricultural land, forests, rangelands, or on disturbed land in need of reclamation.

Odors from biosolids applications are the primary negative impact to the air. Most odors associated with land application are a greater nuisance than threat to human health or the environment. Odor controls focus on reducing the odor potential of the biosolids or incorporating them into the soil. Stabilization processes such as digestion can decrease the potential for odor generation. Biosolids that have been disinfected through the addition of lime may emit ammonia odors but they are generally localized and dissipate rapidly. Biosolids stabilization reduces odors and usually results in an operation that is less offensive than manure application.

The Environmental Protection Agency's 40 CFR Part 503, Standards for the Use and Disposal of Sewage Sludge (the Part 503 Rule), requires that wastewater solids be processed before they are land applied. This processing is referred to as "stabilization" and helps minimize odor generation, destroys pathogens (disease causing organisms), and reduces vector attraction potential.

[Pollutant $PM_{2.5}$ and NH_3]

Salt Lake County and Salt Lake City operate small landfill type operations that produce organic material which are used by the Tailings Facility to enhance the reclamation of closed tailings areas. The application of biosolids does not result in any emissions of $PM_{2.5}$, SO_2, NO_x or VOC. Very small quantities of ammonia emissions are estimated from these operations resulting from the natural process of decomposition. The 2016 actual emissions from the source were 0.021 tpy of ammonia.

Control Options:

Biosolids stabilization

Technological Feasibility:

All controls are technically feasible.

Economic Feasibility:

All control technologies are economically feasible.

BACT Selection:

That the wastewater solids be processed before they are land applied. This control is already being applied.

Implementation Schedule:

Proper operations are already in place.

Startup/Shutdown Considerations

There are no startup/shutdown operations to be considered for these sources.

2.3 Consideration of Ammonia

The only sources of ammonia emissions at the Power plant is from the SCRs that will be installed on Units 4 and 5, combustion of natural gas, diesel and coal, and rubber cement emissions from Salt Lake City Biosolids. The ammonia emissions from rubber cement in 2014 was 0.02 tpy. There are several sources of ammonia emissions from combustion with the largest being 0.04 tpy from the combustion of coal at Unit #4. All other sources of ammonia from natural gas combustion were smaller. The SCRs have not been installed, so there are no actual emissions to discuss. The potential emissions

The only source of ammonia at the laboratory in 2016 was from the natural gas-fired boiler and they were 0.01 tpy.

The unreacted ammonia can be treated as a $PM_{2.5}$ precursor. Although ammonia was previously not considered as a precursor pollutant in Utah's $PM_{2.5}$ Serious SIP, and the source's BACT analysis did not include an analysis of BACT for ammonia emissions, an analysis is being included here for completeness.

There are only two sources of ammonia emissions at the UPP. The SCR units used to control emissions of NO_x from the Unit 4 boiler and the Unit 5 combustion turbine. The catalyst serves to lower the reaction temperature required and helps speed the process. Ideally, a stoichiometric amount of ammonia would be added – just enough to fully reduce the amount of NO_x present in the exhaust stream. However, some amount of ammonia will always pass through the process unreacted; and since the process possesses some degree of variability, a small amount of additional ammonia is added to account for minor fluctuations. The ammonia which passes through the process unreacted and exits in the exhaust stream is termed “slip” (sometimes “ammonia slip”). The amount varies from facility to facility, but ranges from almost zero to as high as 30 ppm in poorly controlled systems. Also, as catalyst systems degrade over time, the degree of ammonia slip will gradually increase as increasing amounts of ammonia are added to maintain NO_x

reduction performance. The unreacted ammonia can be treated as a $PM_{2.5}$ precursor.

Control Options:

There is only one control technique considered available for ammonia emissions. Monitoring of ammonia slip emissions and setting a “not to exceed” emission rate limitation. This allows for setting up a feedback process where the source can adjust ammonia injection rates based on both parameters: NO_x emission reduction levels and ammonia slip levels. Should catalyst activity, over time, degrade to the point where both parameters cannot be met, then the SCR catalyst should be replaced.

Technological Feasibility:

This represents a work practice standard, and is inherently technically feasible.

A review of recently issued permits for SCR units at large combustion turbine installations reveals NH_3 emission limits ranging between 2.0 ppm and 5.0 ppm.

The source has not provided a cost effectiveness breakdown for the SCR ammonia systems at the UPP so that a limitation could be established.

Economic Feasibility:

All control technologies are economically feasible. Therefore, an economic feasibility was not performed.

BACT Selection:

Given the difficulty in designing a new SCR system for control of a pollutant not currently listed as a precursor pollutant, and the expected high cost for this process, no change in ammonia slip requirements is recommended at this time.

Implementation Schedule:

A proper design of the SCRs when they are installed to limit the ammonia slip.

Startup/Shutdown Considerations

There are no startup/shutdown operations to be considered for these sources.

3.0 Conclusion- Emissions Reduction through BACT implementation

3.1 Reduction in emissions from the upgrade of Unit 4

The boiler operated as Unit 4 will be upgraded with LNB with OFA and SCR. The upgraded Unit 4 will begin operation by January 1, 2019.

Unit 4 reduction in NO_x emissions will result from the installation of LNB with OFA and SCR. With the installation of these controls the NOx limit will be reduced from 336 ppmdv to 20 ppmdv which will result in the emissions being reduced by 302 tons when operated from November 1st to February 28th each year or 1,269 tons when operated 8,760 hours per year.

$PM_{2.5}$, SO_2 and VOCs are estimated to remain the same.

3.2 Tailings Impoundment

Controls have not been included in Part H of the $PM_{2.5}$ SIP. The Tailings Impoundment is in constant change. A SIP requirement does not allow for change.

The 1994 PM_{10} SIP was descriptive and did not allow for change. The 1994 system has been removed and a new better discharge system has been implemented at the Tailings Impoundment site. Some of the 1994 requirements were as follows:

Peripheral discharge system containing four segments with 7,500 gallons per minute of tailings flow.
A complete sequence through a given segment shall be considered to contain ten successive areas. The cycle time shall be four days.

Now KUC is required revegetate the exterior of the dike so that no more than 5% of the area can be subject to wind erosion.

Now they are also required to do the following: When it is determined by Kennecott or the Director, that additional tailings dust control beyond the above should be considered or tailings Impoundment operational problems are occurring, Kennecott shall meet with the Director, or Director's staff, to discuss proposed fugitive dust controls and implementation schedule within five working days after verbal notification by either party.

The above condition allows for Director discretion which could not be implemented into the $PM_{2.5}$ SIP.

Based on the above examples and that a SIP does not allow for change or improvement, conditions requiring fugitive dust control have not been included in the $PM_{2.5}$ SIP. The Tailings Impoundment is subject to the requirements of the most recent federally approved Fugitive Emissions and Fugitive Dust rules.

4.0 Implementation Schedule and Testing Requirements

4.1 Power Plant

Units 1, 2 and 3 was taken off line before January 1, 2018.

Unit 4 will be required to meet the emission limits of Section 5.0 by January 1, 2019.

4.2 Tailings

There are no additional controls scheduled for the Tailings site.

4.3 Bonneville Borrow Plant

The Approval Order the BBP has been rescinded. Therefore, the implementation schedule has been removed from this report.

5.0 New PM2.5 SIP – KUC Power Plant Specific Requirements

The KUC Power Plant specific conditions in Section IX.H.13 address those limitations and requirements that apply only to the LSPP Power Plant in particular.

IX.H.22.k.i This condition lists the specific requirements applicable to the KUC UPP.

Subparagraph A: When burning natural gas, Unit #4 shall not exceed the following emission rates to the atmosphere:

POLLUTANT	grains/dscf 68^{o}F. 29.92 in Hg	ppmdv 3% O_2	lbs/hr	lbs/event
I. $PM_{2.5}$:				
Filterable	0.004			
Filterable + condensable	0.03			
~~II. NO_x:~~		~~60~~		
II. NO_x:		20	17.0	
Startup / Shutdown				395

IV. Startup / Shutdown Limitations:

1. The total number of startups and shutdowns together shall not exceed 690 per calendar year.

2. The NO_x emissions shall not exceed 395 lbs from each startup/shutdown event, which shall be determined using manufacturer data.

3. Definitions:

(i) Startup cycle duration ends when the unit achieves half of the design electrical generation capacity.

(ii) Shutdown duration cycle begins with the initiation of boiler shutdown and ends when fuel flow to the boiler is discontinued.

Subparagraph B: Upon commencement of operation of Unit #4, stack testing to demonstrate compliance with each emission limitation in IX.H.12.k.i.A and IX.H.12.k.i.B shall be performed as follows:

* Initial compliance testing for the Unit 4 boiler is required. Initial testing shall be performed when burning natural gas and also when burning coal as fuel. The initial test shall be performed within 60 days after achieving the maximum heat input capacity production rate at which the affected facility will be operated and in no case later than 180 days after the initial startup of a new emission source.

The limited use of natural gas during maintenance firings and break-in firings does not constitute operation and does not require stack testing.

Pollutant	Test Frequency	
I.	$PM_{2.5}$	every year
II.	NO_x	every year

Subparagraph C: Unit #5 (combined cycle, natural gas-fired combustion turbine) shall not exceed the following emission rates to the atmosphere:

POLLUTANT	lb/hr	lb/event	ppmdv (15% O_2 dry)
I. $PM_{2.5}$ with duct firing: Filterable + condensable	18.8		
II. VOC:			2.0*
III. NO_x:			2.0*
Startup / Shutdown		395	

* Except during startup and shutdown.

IV. Startup / Shutdown Limitations:

1. The total number of startups and shutdowns together shall not exceed 690 per calendar year.
2. The NO_x emissions shall not exceed 395 lbs from each startup/shutdown event, which shall be determined using manufacturer data.

3. Definitions:

   (i) Startup cycle duration ends when the unit achieves half of the design electrical generation capacity.

   (ii) Shutdown duration cycle begins with the initiation of turbine shutdown sequence and ends when fuel flow to the gas turbine is discontinued.

Subparagraph D: Upon commencement of operation of Unit #5*, stack testing to demonstrate compliance with the emission limitations in IX.H.12.m.i.C shall be performed as follows for the following air contaminants

* Initial compliance testing for the natural gas turbine and duct burner is required. The initial test shall be performed within 60 days after achieving the maximum heat input capacity production rate at which the affected facility will be operated and in no case later than 180 days after the initial startup of a new emission source.

The limited use of natural gas during maintenance firings and break-in firings does not constitute operation and does not require stack testing.

Pollutant	Test Frequency
I. $PM_{2.5}$	every year
II. NO_x	every year
III. VOC	every year

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Steve Schnoor. (2018, May 23). Best Available Control Technology (BACT) for the Utah Power Plant.

NSR

Rio Tinto

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801-204-2814

Steve Schnoor
Manager – Environment, Land and Water

April 27, 2017

Mr. Bryce Bird
Utah Division of Air Quality
150 North 1950 West
Salt Lake City, Utah 84114

Attn: Mr. Nando Meli

Subject: **Kennecott Utah Copper LLC**
$PM_{2.5}$ SIP Best Available Control Technology Analysis

Dear Mr. Bird:

Kennecott Utah Copper LLC (KUC) is submitting the $PM_{2.5}$ State Implementation Plan (SIP) Best Available Control Technology (BACT) analysis, as requested by the Utah Division of Air Quality. Attached are BACT determinations for emission sources at the following KUC facilities –

- Bingham Canyon Mine and Copperton Concentrator
- Utah Power Plant, Tailings and Laboratory
- Smelter, Refinery and Molybdenum Autoclave Process Plant

Should you have any questions, please feel free to contact Cassady Kristensen at 801-204-2129.

Sincerely,

Steve Schnoor
Manager – Environment, Land and Water

Enclosure

FINAL REPORT

Kennecott Utah Copper

$PM_{2.5}$ State Implementation Plan Best Available Control Technology Determinations

Submitted to

Utah Division of Air Quality

Prepared for:

Kennecott Utah Copper

Prepared by:

ch2m

April 2017

FINAL

BACT Determinations for the Bingham Canyon Mine and Copperton Concentrator

Prepared for

Kennecott Utah Copper

April 2017

Prepared by

ch2m

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Contents

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Acronyms and Abbreviations

AO	approval order
BACT	best available control technology
BCM	Bingham Canyon Mine
CAA	Clean Air Act
CO	carbon monoxide
EPA	Environmental Protection Agency
gr/dscf	grains per standard cubic feet
GPS	Global Positioning System
KUC	Kennecott Utah Copper
MMBTU/hr	million British Thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NH_3	ammonia
NOx	nitrogen oxides
PM_{10}	particulate matter less than or equal to 10 micrometers in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 micrometers in aerodynamic diameter
ppm	parts per million
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SIP	State Implementation Plan
SO_2	sulfur dioxide
TPY	tons per year
UDAQ	Utah Department of Air Quality
VOC	volatile organic compound

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SECTION 1

Introduction

Kennecott Utah Copper LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities: Bingham Canyon Mine (BCM) and the Copperton Concentrator. In addition to a BACT analysis, KUC has also documented Most Stringent Measures for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and meet any reasonable further progress requirements. As requested by the Utah Division of Air Quality (UDAQ), the BACT analysis should identify and evaluate reasonable and available control technologies for each relevant pollutant. The technical and economic feasibility of each potential technology are components of the BACT analysis that help to show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). For each emission source, the BACT analysis followed a four step process:

Step 1—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC)

Step 2—Eliminate technically infeasible options

Step 3—Eliminate economically/chronologically infeasible options

Step 4—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent Most Stringent Measures.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS were combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends that BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development standard.

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SECTION 2

Recent Permitting Actions

Current operations at the BCM are permitted under Approval Order (AO) DAQE-AN105710037-15, issued on November 10, 2015.

Emissions from the BCM are mainly limited by the following conditions:

- "Total material moved (ore and waste) shall not exceed 260 million tons per rolling 12-month period." This condition limits the total material moved at the Bingham Canyon Mine, thus limiting both fugitive and tailpipe emissions.
- "Maximum total mileage per calendar day for ore and waste haul trucks shall not exceed 30,000 miles." This condition limits daily vehicle miles travelled at the Bingham Canyon Mine, thus limiting both fugitive and tailpipe emissions.
- "Emissions of particulate matter less than or equal to 10 micrometers in aerodynamic diameter (PM_{10}), NO_x, and SO_2 combined shall not exceed 7,350 tons and emissions of $PM_{2.5}$, NO_x, and SO_2 shall not exceed 6,205 tons per rolling 12-month period."
- "KUC shall apply a chemical dust suppressant to active haul roads located outside of the pit influence boundary no less than twice per year."

KUC is required to submit an annual fugitive dust control report that provides a description of the fugitive dust control practices implemented at the BCM.

Current operations at the Copperton Concentrator are permitted under AO DAQE-AN105710035-13 issued on June 25, 2013. Potential to Emit (PTE) emissions for the Copperton Concentrator are a very small percentage of combined emissions from the mine and concentrator facilities. Emissions for the Copperton Concentrator are limited by implementation of BACT controls.

PTE emissions in tpy for the BCM and the Copperton Concentrator are shown in Table 2-1.

Table 2-1
Facility Potential to Emit Emissions (Including Fugitive and Nonroad Engine Emissions)

	PM_{10} PTEs (tpy)	**$PM_{2.5}$ PTEs (tpy)**	**NO_x PTEs (tpy)**	**SO_2 PTEs (tpy)**	**VOC PTEs (tpy)**
Bingham Canyon Mine	1,519	369	5,838	7	314
Copperton Concentrator	25.3	13.86	10.66	0.1	4.04

Notes:
PM_{10} = Particulate matter 10 microns or smaller in aerodynamic diameter
NO_x = oxides of nitrogen
SO_2 = sulfur dioxide
VOC = volatile organic compounds
$PM_{2.5}$ = Particulate matter 2.5 microns or smaller in aerodynamic diameter
PTE = potential to emit
tpy = tons per year

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SECTION 3

BACT Determinations

This section provides BACT determinations for emission sources deemed significant at the BCM and the Copperton Concentrator.

3.1 Bingham Canyon Mine

3.1.1 In-pit Crusher

Source Description: The crusher is used to crush copper ore mined at the BCM. Particulate emissions from the in-pit crusher are controlled with a baghouse.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies baghouse (fabric filter) and enclosures with water sprays as possible control technologies for limiting emissions from crusher.

Step 2—Eliminate Technically Infeasible Options. Not Applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies are feasible.

Step 4—Identify BACT. Fabric filters are the most effective in controlling emissions. Therefore, baghouse (fabric filter) constitutes BACT for the in-pit crusher.

The baghouse for the crusher is permitted at a grain loading of 0.002 grains per standard cubic feet (gr/dscf). Review of the RBLC did not identify emission rates lower than 0.002 gr/dscf for the similarly used baghouses. This emission rate therefore represents Most Stringent Measure for the in-pit crusher. Additionally, this emission rate was established by UDAQ as BACT for the BCM permitting in 2011.

3.1.2 Disturbed Areas

Source Description: Disturbed areas from mining activities. KUC current practices include application of palliatives and revegetation of the areas as soon as practical, as well as water application from passing water trucks in the operational areas to minimize dust.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies revegetation, adding moisture, and enclosures (wind screens) as possible control technologies for fugitive emissions.

Step 2—Eliminate Technically Infeasible Options.

Applying additional moisture (water) on the disturbed areas as mining occurs is not technically feasible for KUC's mine operations. The ore is transferred through a series of conveyors. Excessive moisture in the ore material causes the conveyors to foul and breakdown resulting in costly equipment repairs. Therefore, adding moisture to the ore material is not technically feasible.

Because the disturbed areas are so expansive and cover varying terrain, adding enclosures or wind screens are not technically feasible for this mine source.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 were technically infeasible or selected as BACT.

Step 4—Identify BACT. The practice of applying palliatives and revegetation is the most effective in reducing emissions. Therefore, the application of palliatives and revegetation constitute BACT.

The application of palliatives and revegetation also represent BACM for the disturbed areas. Because best available measures are in use, they also represent Most Stringent Measures.

3.1.3 Waste Rock Offloading from Trucks

Source Description: Haul trucks dump waste rock or overburden at the waste rock disposal areas while minimizing the height of the drop.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies water application and enclosures as possible control technologies for fugitive emissions from such sources of emissions.

Another possible control technology not identified, but effective in reducing emissions from batch drop transfer points, is minimizing the drop distance while the waste rock is being dumped.

Step 2—Eliminate Technically Infeasible Options.

Because the drop location is not static an enclosure is not technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable as the remaining technology of minimizing the drop distance, while the waste rock is being dumped, is selected as BACT.

Step 4—Identify BACT. Minimizing drop distances while the waste rock is being dumped is effective in controlling emissions and constitute BACT.

Minimizing drop distances while the waste rock is being dumped also represents BACM. Because best available measures are in use, they also represent Most Stringent Measures.

3.1.4 Graders

Source Description: The graders primarily operate on the haul roads, maintaining surfaces of the roads. Particulate is controlled by the application of water and chemical dust suppressants to the roads.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies the application of water and chemical dust suppressants as a possible control technology for fugitive emissions.

Step 2—Eliminate Technically Infeasible Options. Not Applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary constitute BACT.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the graders. Because best available measures are in use, they also represent Most Stringent Measures.

3.1.5 Bulldozers

Source Description: The dozers operate in the pit, on the haul roads performing cleanup operations, and in dumping operations at the waste rock disposal areas.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies the application of water and chemical dust suppressants as required as a possible control technology for fugitive emissions.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary constitute BACT.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the bull dozers. Because best available measures are in use, they also represent Most Stringent Measures.

3.1.6 Unpaved Haul Roads

Source Description: Haul roads are used to transfer ore and waste rock.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies potential technologies for control of fugitive emissions on unpaved haul roads as; paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance (through the use of road base material) of haul roads.

Step 2—Eliminate Technically Infeasible Options. Paving the haul roads is not technically feasible at the BCM because of the weight of the haul trucks and the rapid deterioration that would occur and the frequently changing road locations.

Application of chemical dust suppressants is not technically feasible for some haul road locations because of the adverse effect the chemical can have on the coefficient of friction of the road surface. Given that the grade of the haul roads exceeds 10 percent in some locations, creating a slippery skin on the road inhibits the ability of mobile equipment to brake and steer safely while traveling on the grade.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The remaining technologies of water application, chemical dust suppressants out of the pit influence boundary, limiting unnecessary traffic on roads, and routine maintenance of haul roads are economically and chronologically feasible.

Step 4—Identify BACT. The application of water and road-base material within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary is effective in minimizing emissions. Watering the unpaved haul road reduces fugitive $PM_{2.5}$ and PM_{10} emissions by binding the soil particles together, reducing free particles available to be picked up by wind or vehicles. Additional watering and application of chemical dust suppressants on certain locations of unpaved haul roads also occurs when heavy traffic is expected along the road. Water is applied on a scheduled basis and supplemented as needed based on dust conditions. Dust is also reduced through performing regular and routine maintenance of the haul roads (through use of road-base material) and limiting unnecessary traffic on roads.

In recent years, KUC has purchased newer haul trucks with higher capacity where possible, which has led to a decrease in the round-trips and vehicle miles traveled, thereby reducing fugitive dust emissions.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the unpaved haul roads. Because best available measures are in use, they also represent Most Stringent Measures.

3.1.7 Tailpipe Emissions from Mobile Sources

Source Description: Tailpipe emissions from haul trucks and support equipment such as graders and dozers. Tailpipe emissions from the haul trucks and support equipment meet the required EPA standards for NONROAD equipment.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies no add on control technologies for tailpipe emissions from haul trucks and support equipment of the size used at the Bingham Canyon Mine.

Step 2—Eliminate Technically Infeasible Options. Not applicable.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable.

Step 4—Identify BACT. Haul trucks and support equipment used at the facility meet the required EPA standards for nonroad equipment. The facility uses on-road specification diesel fuel in its off-road equipment. In 2007, an EPA ruling required sulfur content in all on-road specification diesel fuels be reduced (from 50 parts per million [ppm] formerly to 15 ppm currently). Because only on-road specification diesel fuel is used in its equipment, the facility has also made a transition to ultra-low sulfur diesel fuel. All of the facility's diesel-powered equipment now runs on ultra-low sulfur diesel fuel.

Additionally, the facility periodically upgrades its haul truck fleet to also take advantage of available higher-tier-level, lower-emitting engines. In recent years, KUC has purchased newer haul trucks with higher capacity where possible, which has led to a decrease in round-trips and truck operating hours, thereby reducing emissions.

KUC purchases newer haul trucks with higher capacity and Tier level which meet its mining needs. This also represents Most Stringent Measures.

3.1.8 Fueling Stations

Source Description: Adding gasoline and diesel to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies two control techniques for controlling VOC emissions from gasoline and diesel fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. Stage 1 and 2 vapor recovery constitutes BACT for these sources.

The use of Stage 1 and Stage 2 vapor recovery systems also represent Most Stringent Measures for the fueling stations.

3.1.9 Cold Solvent Degreasers

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.

Step 2—Eliminate Technically Infeasible Options. Not applicable as the identified control technology is technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. When not in use, the lids on the degreasers are kept closed at all times to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for degreasers.

The above identified practices also represent Most Stringent Measures for the degreasers.

3.2 Copperton Concentrator

3.2.1 Tioga Heaters

Source Description: Natural gas-fired heaters are used throughout the Copperton Concentrator. The individual heaters are rated at less than 5 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance.

3.2.1.1 NO_x BACT

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The technology identified in the RBLC for controlling NO_x emissions from heaters of good combustion practices is already in use and constitute BACT.

3.2.1.2 $PM_{2.5}$, SO_2, CO, and VOC BACT

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters and these control technologies constitute BACT.

Low NO_X burners and use of pipeline quality natural gas and good combustion practices also represent most stringent measures for the Tioga heaters.

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BACT Summary

This section provides a summary of BACT for the remaining emission sources at the BCM and the Copperton Concentrator.

Table 4-1. BACT Summary

Emission Source ID/Name	Emission Source Description	BACT Summary
C6/C7 Conveyor Transfer Point	Conveyor Transfer Point	Emissions from the transfer point are controlled with a baghouse rated at 0.007 gr/dscf. With the top control technology implemented, it also represents most stringent measures.
C7/C8 Conveyor Transfer Point	Conveyor Transfer Point	Emissions from the transfer point are controlled with a baghouse rated at 0.007 gr/dscf. With the top control technology implemented, it also represents most stringent measures.
Product Molly Dryer	Natural Gas Product Dryer	Emissions are minimized with low NO_X burners and use of pipeline quality natural gas.
Lgr Product Molly Dryer	Natural Gas Product Dryer	Emissions are minimized with low NO_X burners and use of pipeline quality natural gas.
Lime Bin	Lime Storage Bin	Emissions are controlled with a bin vent filter.
Lime Bin	Lime Storage Bin	Emissions are controlled with a bin vent filter.
Sample Preparation	Sample preparation building at the mine	Emissions are controlled with a baghouse.
Molly Storage Bins	Moly storage bin	Emissions are controlled with a bin vent filter.
Molly Vacuum	Process Area	Process is enclosed to minimize emissions.
Molly Loading (Bags)	Process Area	Process is enclosed to minimize emissions.
Truck Dispatch EG at 6690	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards
Communications EG at 6190	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards
EmResp EG at Lark Gate	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards
Galena Gulch	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards
Dinkyville Hill	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards
Zelnora	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards
Prd Dryer Heater	Natural Gas Heater	Emissions are minimized with low NO_X burners and use of pipeline quality natural gas.
Prod Dryer Heater	Natural Gas Heater	Emissions are minimized with low NO_X burners and use of pipeline quality natural gas.

Table 4-1. BACT Summary

Emission Source ID/Name	Emission Source Description	BACT Summary
Truck Offloading Ore Main In-pit Crusher	Material Offloading/Loading	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
Truck Offloading Ore Stockpile	Material Offloading/Loading	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
Main In-Pit Enclosed Transfer Points 1, 2 and 3	Conveyor Transfer Point	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
In-pit Enclosed Transfer Point 4	Conveyor Transfer Point	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
Conveyor-stacker Transfer Point	Conveyor Transfer Point	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
Coarse Ore Stacker	Conveyor Transfer Point	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
Reclaim Tunnels	Conveyor Transfer Point	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
Front End Loaders		Application of water and/or chemical dust suppressants to minimize emissions.
Truck Loading	Material Offloading/Loading	Minimal emissions due to material characteristics such as large ore size and presence of very small quantities of fine material.
SXEW Copper Extraction		Mist eliminator and enclosures minimize emissions from the process.
Tertiary Crushing	Road base crushing system	Water sprays and enclosures minimize emissions from road base crushing system.
Screening	Road base crushing system	
Transfer Points	Road base crushing system	
Copper Ore Storage Pile	Ore Stockpile	Water sprays and compaction is used to minimize emissions.
Blasting with Minimized Area	Blasting operations at the mine	Water injection and controlled blasting minimize emissions from these operations.
Drilling with Water Injection	Drilling operations at the mine	
Gasoline Fueling	Fueling stations at the Concentrator	Stage 1 and Stage 2 vapor recovery systems minimize emissions.
Cold Solv. Degrease. Washers	Cold solvent degreasers at the Concentrator	Keeping the lids closed on the degreasers minimize solvent loss and emissions.
Pebble Crushing in Crusher CR-01	Pebble crushing system at the Concentrator	Water sprays and enclosures minimize emissions from pebble-crushing system.
Pebble Crushing in Crusher CR-02	Pebble crushing system at the Concentrator	
Transfer from CNV CV-04 onto CNV CV-05	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-05 into Crushed Pebble Surge Bin BN-02	Material transfer in the pebble crushing circuit	

Table 4-1. BACT Summary

Emission Source ID/Name	Emission Source Description	BACT Summary
Transfer from SAG No. 1 Belt Feeder FE-03 onto CNV CV-06 and CNV CV-11	Material transfer in the pebble crushing circuit	Water sprays and enclosures minimize emissions from pebble-crushing system.
Transfer from CNV CV-11 to SAG 1 Feed Chute	Material transfer in the pebble crushing circuit	
Transfer from SAG No. 2 Belt Feeder FE-04 onto CNV CV-10	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-10 to SAG 2 Feed Chute	Material transfer in the pebble crushing circuit	
Transfer from SAG No. 3 Belt Feeder FE-05 onto CNV CV-09	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-09 to SAG 3 Feed Chute	Material transfer in the pebble crushing circuit	
Transfer from SAG No. 4 Belt Feeder FE-06 onto CNV CV-07 and CNV CV-08	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-08 to SAG 4 Feed Chute	Material transfer in the pebble crushing circuit	
Transfer onto CNV CV-02	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-02 onto CNV CV-03	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-03 into the Surge Bin BN-01	Material transfer in the pebble crushing circuit	
Transfer from Belt Feeders FE-02 and FE-01 into crushers CR-01 and CR-02	Material transfer in the pebble crushing circuit	
Transfer from bottom of crushers CR-01 and CR-02 onto CNV CV-04	Material transfer in the pebble crushing circuit	
Transfer from CNV CV-03 into the Surge Bin BN-03	Material transfer in the pebble crushing circuit	
Transfer from Belt Feeders FE-07 onto CNV CV-04	Material transfer in the pebble crushing circuit	

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SECTION 5

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

5.1 Bingham Canyon Mine

KUC is proposing the following limitations and monitoring requirements for the Bingham Canyon Mine.

- Maximum total mileage per calendar day for ore and waste haul trucks shall not exceed 30,000 miles. KUC shall keep records of daily total mileage for all periods when the mine is in operation. KUC shall track haul truck miles with a Global Positioning System (GPS) or equivalent.

This condition establishes a limitation on daily activity. The daily mileage limitation effectively limits fugitive road dust emissions, tailpipe emissions from the haul trucks, and overall activity of sources at the mine. Ore processing at the Copperton Concentrator, which results in minimal emissions, is also limited through the BCM activity limitations.

Emissions resulting from the movement of ore and waste around the mine represent a significant portion of overall emissions at the BCM. The emissions related to material movement include fugitive dust generated from truck travel on the haul roads and the tailpipe emissions from the haul trucks. Specifically, on an annual basis, greater than 99.9 percent of total mine emissions for NO_X and SO_2 come from the haul truck tailpipes. Also, on an annual basis, material movement represents 85 percent of the overall particulate emissions at the BCM. Based on these emissions, the material movement of ore and waste by haul trucks represents a vast majority of overall emissions at the BCM and can effectively be used to represent mine operations.

Daily emissions from the BCM can be regulated with the limitation on vehicle miles traveled by ore and waste haul trucks of 30,000 miles per day. Compliance to this limitation is demonstrated on a daily basis and is an appropriate metric for a 24-hour particulate standard.

It should be noted; the 30,000 miles per day limitation also limits overall BCM operations. Ancillary mining activities such as operation of the in-pit crusher, mining support equipment, blasting, and drilling only occur to produce adequate amount of ore and waste rock that can be hauled via the trucks and sent to the concentrator via the conveyor system.

On a 24-hour basis, these emissions can be represented with a 30,000 miles per day limitation. Since they effectively represent mine operations, a single daily limitation is appropriate in the SIP for the BCM. These emissions have been included in the appropriate SIP model.

KUC uses a real time tracking system for both tracking haul trucks as well as for recording miles travelled. These records are used to comply with the 30,000 miles per day limitation. The system may be a GPS or a system with similar tracking capabilities necessary to comply with this condition.

- KUC Shall Use Ultra-low Sulfur Diesel Fuel in Its Haul Trucks.

This condition establishes a requirement for the use of ultra-low sulfur diesel fuel in haul trucks.

- To minimize emissions at the mine:

- The owner/operator shall control emissions from the in-pit crusher with a baghouse.
- Apply water to all active haul roads as weather and operational conditions warrant, except during precipitation or freezing conditions, and shall apply a chemical dust suppressant to active haul roads located outside of the pit influence boundary no less than twice per year.
- A chemical dust suppressant shall be applied as weather and operational conditions warrant except during precipitation or freezing conditions on unpaved access roads that receive haul truck traffic and light vehicle traffic.

These conditions require the control of emissions from the in-pit crushers with a baghouse.

The condition also establishes requirements for reducing and controlling fugitive particulate emissions from active unpaved haul roads at the mine. Water and chemical dust suppressants shall be used to minimize fugitive dust.

Specifically, active ore and waste haulage roads within the pit influence boundary are water sprayed and/or treated with a commercial dust suppressant. Crushed road-base material is applied to active ore and waste haulage roads within the pit influence boundary to enhance the effectiveness of fugitive dust control measures. Commercial dust suppressants are applied to active ore and waste haulage roads outside of the pit influence boundary no less than twice per year.

Each year KUC reports dust control measures implemented at the BCM during the previous year with details such as volume of water applied, commercial dust suppressant activity, etc.

- KUC is Subject to the Requirements in the Most Recent Federally approved Fugitive Emissions and Fugitive Dust Rule.

KUC is subject to the fugitive dust rules approved by UDAQ and EPA. These rules outline requirements that mines are to follow in minimizing the fugitive dust from the mining operations.

5.2 Copperton Concentrator

No limitations or monitoring requirements are proposed for the Copperton Concentrator emission sources as the emissions from the facility are minimal and are effectively controlled with the implementation of BACT.

FINAL

BACT Determinations for the Utah Power Plant, Tailings Site, and Laboratory

Prepared for

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April 2017

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Acronyms and Abbreviations

AO	approval order
BACT	best available control technology
CAA	Clean Air Act
CatOx	catalytic oxidation
CO	carbon monoxide
DLN	dry low nitrogen
EPA	Environmental Protection Agency
KUC	Kennecott Utah Copper
LNB	low NO_x burner
MMBTU/hr	*million British Thermal Units per hour*
MW	megawatts
NAAQS	National Ambient Air Quality Standard
NOx	nitrogen oxides
OFA	over-fire air
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppmvd	parts per million by volume dry
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SCR	selective catalytic reduction
SIP	State Implementation Plan
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
tpy	tons per year
UDAQ	Utah Department of Air Quality
UPP	Utah Power Plant
VOC	volatile organic compound

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SECTION 1

Introduction

Kennecott Utah Copper, LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities located at the northwest corner of Salt Lake County, Utah: Utah Power Plant (UPP), tailings site, and the laboratory. The tailings site receives tailings in slurry form. The slurry is deposited in the tailings pond. The UPP is a coal and natural gas fired power plant that supplies power for KUC operations. Coal is used to fuel the plant in spring, summer, and fall; while natural gas is approved for use in the winter months. The laboratory is used to perform various tests and also functions to optimize operations through analysis of materials. In addition to a BACT analysis, KUC has also documented the most stringent measures for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and to meet any reasonable further progress requirements. As requested by the Utah Division of Air Quality (UDAQ), the BACT analysis should identify and evaluate BACT for each relevant pollutant. The technical and economic feasibility of each potential technology are components of the BACT analysis that help to show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC). For each emission source, the BACT analysis followed a four step process:

Step 1—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC)

Step 2—Eliminate technically infeasible options

Step 3—Eliminate economically/chronologically infeasible options

Step 4—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent most stringent measures.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS was combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends that BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development.

SECTION 2

Recent Permitting Actions

An approval order (AO) was issued for the UPP on November 10, 2015, which authorized the construction and operation of a natural gas fired emergency generator. Issued in 2011, AO DAQE-AN105720026-11 authorized KUC to replace Boiler Units 1, 2, and 3 with a new natural gas fired combustion turbine operating in combined cycle mode with a heat recovery steam generator. The new combustion turbine will be equipped with state of the art add-on controls to minimize emissions from the unit and represents BACT. Dry low nitrogen oxide (DLN) combustors and the selective catalytic reduction (SCR) system will control NO_x emissions. The catalytic oxidation (CatOx) system will control carbon monoxide (CO) and VOC emissions. Good combustion practices and burning natural gas will minimize emissions of the remaining pollutants.

The tailings site was permitted under AO DAQE-AN10572018-06. The emissions sources at the laboratory are permitted under AO DAQE-261-95. All three facilities operate under a single Title V operating permit, #3500346002.

The current potential to emit (PTE) emissions in tons per year (tpy) for the tailing site, UPP, and the laboratory are shown in Table 1-1.

Table 2-1. Facility Potential to Emit

	PM_{10} PTE (tpy)	$PM_{2.5}$ PTE (tpy)	NO_x PTE (tpy)	SO_2 PTE (tpy)	VOC PTE (tpy)
UPP	248	248	1,641	2,577	41
Tailings Site	36.3	5.4**	0.26	—*	0.04
Laboratory	0.12	0.12	0.68	0.13	0.12

Notes:
$PM_{2.5}$ = particulate matter 2.5 microns or smaller in aerodynamic diameter
PM_{10} = particulate matter 10 microns or smaller in aerodynamic diameter
PTE = potential to emit
NO_x = oxides of Nitrogen
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compounds
CO = carbon monoxide
*Permitted combustion sources result in negligible SO_2 emissions at the tailings site.
**$PM_{2.5}$ emissions are estimated to be 15 percent of PM_{10} emissions.

Distinguishing by season of operation is allowed under EPA's *Implementation Guidance for the 2006 24-hour Fine Particle NAAQS* (March 2, 2012), which specifically acknowledges that several nonattainment areas located in the western United States only have experienced exceedances during the winter season. In such cases, the EPA authorizes states to (1) develop a seasonal emission inventory and (2) evaluate emission reduction strategies for a single season only [p. 11]. "When following a seasonal approach, the EPA believes that *the control strategy evaluation* (based on seasonal emission reduction measures) and the assessment of future year air quality concentrations (through air quality modeling or other analyses) *should be conducted for that season*." [p. 12]. In view of the nature of Utah's $PM_{2.5}$ nonattainment circumstance, the BACT analysis for UPP focuses primarily on a wintertime control strategy.

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SECTION 3

BACT Determinations

This section provides BACT determinations for emission sources deemed significant at the UPP and tailings site. Emissions at the laboratory are minimal, currently effectively controlled with implementation of BACT, and therefore not included in this analysis.

3.1 Utah Power Plant

Historically, KUC has operated three coal fired boilers rated at 100 megawatts (MW) combined, referred to as Units 1-3, at the UPP. The units operated on coal during the summer months, but were limited to burning natural gas during the winter months between November 1 and March 1. In October 2016, KUC has permanently ceased operation of Units 1-3. Therefore, a BACT analysis for Units 1-3 is not included in this document.

3.1.1 UPP Unit 4 Boiler

Source Description: Tangentially fired boiler capable of burning both coal and natural gas, rated at 838 million British Thermal Units per hour (MMBTU/hr) (coal), or 872 MMBTU/hr (natural gas), equipped with an electrostatic precipitator. Since the ambient 24-hour concentrations of $PM_{2.5}$ exceed the NAAQS only during the winter months, the BACT analysis is limited to controls for the combustion of natural gas, which are the only controls that may affect the attainment of the $PM_{2.5}$ NAAQS in the Salt Lake City nonattainment area.

3.1.1.1 NO_x BACT

Step 1—Identify All NO_x Control Technologies listed in RBLC. The RBLC identifies (1) low NO_x burners with over-fire air (low NO_x burner [LNB] with over-fire air [OFA]) and (2) LNB with OFA and SCR as potential technologies for NO_x control from a natural gas fired boiler.

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Previous SIP determination for UPP Unit 4 required the installation of LNB with OFA and SCR with 90% NO_x control when operating on natural gas during the winter months between November 1 and March 1. Because the top technology is already identified in previous SIPs, additional analysis is not necessary.

Step 4—Identify BACT. LNB with OFA and SCR with 90% control efficiency constitute BACT for controlling NO_x emissions from natural gas combustion in the boiler during the wintertime period (November 1 through March 1).

3.1.1.2 SO_2 BACT

Step 1—Identify all SO_2 Control Technologies listed in RBLC. The RBLC identifies the use of pipeline quality natural gas as a control when burning natural gas.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4— Identify BACT. The use of pipeline quality natural gas constitute BACT when burning natural gas.

3.1.1.3 $PM_{2.5}$ BACT

Step 1—Identify all $PM_{2.5}$ Control Technologies listed in RBLC. The RBLC identifies good combustion practices as a control for reducing $PM_{2.5}$ when burning natural gas.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. Good combustion practices constitute BACT while burning natural gas.

3.1.1.4 VOC BACT

Step 1—Identify all VOC Control Technologies listed in RBLC. The RBLC identifies good combustion practices as a control when burning natural gas.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4— Identify BACT. Good combustion practices constitute BACT for VOC while burning natural gas.

Controlling NO_x emissions by 90 percent with LNB, OFA, and SCR and the use of pipeline quality natural gas and good combustion practices represent most stringent measures for Unit 4 at the UPP when operating on natural gas between November 1 and March 1.

3.1.2 UPP Unit 5 Combustion Turbine and Duct Burner

Source Description: A combustion turbine and duct burner in combined-cycle operation with a nominal generating capacity of approximately 275 MW, equipped with SCR and CatOx.

3.1.2.1 NO_x BACT

Step 1—Identify All NO_x Control Technologies listed in RBLC. The RBLC identifies selective noncatalytic reduction (SNCR) and SCR as potential technologies for NO_x control. The SCR technology is the most stringent control alternative listed in the RBLC.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. SCR constitutes BACT for controlling NO_x emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.2 VOC BACT

Step 1—Identify All CO and VOC Control Technologies listed in RBLC. The RBLC identifies CatOx to control emissions of CO and VOC.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. CatOx constitutes BACT for controlling CO and VOC emissions from the combustion turbine and duct burner.

3.1.2.3 SO_2 BACT

Step 1—Identify All SO_2 Control Technologies listed in RBLC. The RBLC identifies the use of pipeline quality natural gas and good combustion practices as a control when burning natural gas.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The use of pipeline quality natural gas and good combustion practices constitute BACT for controlling SO_2 emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.4 $PM_{2.5}$ BACT

Step 1—Identify All $PM_{2.5}$ Control Technologies listed in RBLC. The RBLC identifies the use of pipeline quality natural gas and good combustion practices as a control when burning natural gas.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The use of pipeline quality natural gas and good combustion practices constitute BACT for controlling $PM_{2.5}$ emissions from the Unit 5 combustion turbine and duct burner.

Limiting NO_X emissions to 2 parts per million by volume dry (ppmvd) at 15% O_2 and the use of pipeline quality natural gas and good combustion practices represent the most stringent measures for Unit 5 at the UPP.

3.1.3 Cooling Towers

Source Description: Noncontact water cooling towers are used to control waste heat from the boilers. All towers are equipped with drift eliminators with drift loss rated at 0.002 percent.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.002 percent and good operating practices represent most stringent measures for the cooling towers.

3.1.4 Tioga Space Heaters

Source Description: Natural gas-fired space heaters are used for comfort heating and cooling, and water heating throughout the power plant. The space heaters use low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. All space heaters are rated at less than 5 MMBTU/hr.

3.1.4.1 NO_x BACT

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The technologies identified in the RBLC for controlling NO_x emissions from heaters (LNB and good combustion practices) are already in use and constitute BACT.

3.1.4.2 $PM_{2.5}$, SO_2, and VOC BACT

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.

Step 2—Eliminate Technically Infeasible Options. Not applicable as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measures for Tioga Space Heaters at the UPP.

3.2 Tailings Site

3.2.1 Wind Erosion from Tailings Embankment

Source Description: Tailings are sent to the tailings site via a slurry pipeline. At the facility, tailings are separated by size in a cyclone with the larger particles used to build the embankments and the smaller particles discharged in slurry form in the impoundment. Emissions from the tailings site are mainly from wind erosion of dry tailings on the embankment. The facility has a current dust control plan approved by the UDAQ Executive Director for control of fugitive particulate matter.

Step 1—Identify All Control Technologies Listed in RBLC. The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

- Watering
- Polymer application
- Revegetation
- Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

Step 2—Eliminate Technically Infeasible Options. Because of the size of the impoundment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The tailings site can be categorized into four operational areas: impoundment, flat embankment, sloped embankment, and reclaimed areas. The impoundment area is saturated with water and does not result in windblown dust emissions. Visual inspections are routinely performed to ensure the impoundment is saturated with water and in the unlikely event an area appears to be drying out, the area would be resaturated.

The tailings are actively deposited in the embankment areas. In an active embankment cell, the tailings are deposited every fourth day. The tailings are extremely wet when deposited. Areas can remain moist for several days. Application of water for dust control in active areas is not feasible as it tends to channelize directly to the drain point instead of spreading across the surface. The flat embankment areas will therefore have a potential for wind erosion on days 2, 3, and 4. Emissions are estimated based on days with potential for wind erosion.

In the inactive embankment areas, where tailings deposition has been completed for the year, KUC installs sprinklers for watering. In 2010 and 2011, KUC converted this to an automated sprinkler system that wets the surface at regular intervals. This upgrade allows the surface to maintain its moisture.

The embankment slopes are sprayed with polymers to minimize windblown dust. Polymer is reapplied as necessary to maintain its effectiveness to minimize emissions.

Once released for reclamation, KUC implements a revegetation plan to reclaim the areas. Polymers are applied to areas still waiting to be reclaimed.

The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.

Step 4—Identify BACT. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions. The dust control plan requires frequent monitoring of the impoundment for wind erosion potential, applying chemical dust suppressants in the late spring, applying water via water trucks and the dust suppression sprinkler system as needed to maintain adequate moisture content. Therefore, KUC recognizes water spray/wet suppression, polymer application, and revegetation are selected as BACT for the tailings site.

The current practices of dust management at the tailings site also represent most stringent measures.

3.3 Service Roads

Source Description: Service roads exist throughout the tailings site and are used by KUC personnel daily.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies potential technologies for control of fugitive emissions on unpaved roads as; paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance of roads.

Step 2—Eliminate Technically Infeasible Options. Paving the haul roads is not technically feasible at the tailings site because of the frequently changing road locations over time resulting from tailing placement.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The remaining technologies of water application, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are economically and chronologically feasible.

Step 4—Identify BACT. The application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are identified as BACT for the service roads.

The application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads also represent most stringent measures for the service roads at the tailings site.

SECTION 4

BACT Summary

This section provides a summary of BACT for emission sources deemed insignificant at the UPP, tailings site, and the laboratory.

Table 4-1. BACT Summary

Emission Source ID/Name	Emission Source Description	BACT Summary
Natural Gas Steam Boiler	Natural Gas Steam Boiler	Emissions are minimized with low NO_X burners and use of pipeline quality natural gas.
Nat Gas Purge Vents	Natural Gas Safety Purge Vents	Operating procedures minimize emissions from purging events.
Gasoline Fueling	Fueling Station at the UPP	Stage 1 and Stage 2 vapor recovery systems minimize emissions.
Coal Storage Pile	Coal Storage Pile	Water sprays are used to minimize emissions from the storage pile.
Drop to Coal Storage Pile	Coal Transfer	Enclosures and water sprays are used to minimize emissions.
Coal Transfer Point	Coal Transfer	Enclosures and water sprays are used to minimize emissions.
Ash Handling	Ash Transfer	Water sprays are used to minimize emissions from ash handling operations.
Salt Lake City Biosolids	Organic matter used to enhance reclamation	Emissions are minimized by inherent moisture content of approximately 40%.
South Valley Biosolids	Organic matter used to enhance reclamation	Emissions are minimized by inherent moisture content of approximately 40%.
Cold Solv. Degrease. Washers	Cold Solvent Degreasers	Keeping the lids closed on the degreasers minimize solvent loss and emissions.
Unpaved	Service Roads at the UPP	The unpaved roads are treated with magnesium chloride and watered at regular frequency to minimize emissions.
Paved	Service Roads at the UPP	Paving the surface is the highest form of dust control for roads.
Tailings Diesel Engine	Diesel Emergency Generator	Emissions comply with applicable New Source Performance Standards.
UPP Diesel Engine	Diesel Emergency Generator	Emissions comply with applicable New Source Performance Standards.
Natural Gas Generators	Natural Gas Generators	Emissions comply with applicable New Source Performance Standards.
LPG Engine 1	LPG Communications Generator	Emissions comply with applicable New Source Performance Standards.

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SECTION 5

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

5.1 Utah Power Plant

KUC is proposing the following limitations and monitoring requirements for the UPP.

Unit 5 shall not exceed the following emission rates to the atmosphere

Pollutant	lb/hr	Ppmvd (15% O_2 dry)
NO_x		2.0*
$PM_{2.5}$ with duct firing: Filterable and condensable	18.8	

*Under steady state operation

Stack testing to show compliance with the above Unit 5 emissions limitations shall be performed as follows:

Pollutant	Test Frequency
$PM_{2.5}$	every year
NO_x	every year

The heat input during all compliance testing shall be no less than 90% of the design rate.

The following requirements are applicable to Unit 4 during the period November 1 to February 28/29 inclusive:

During the period from November 1, to the last day in February inclusive, only natural gas shall be used as a fuel, unless the supplier or transporter of natural gas imposes a curtailment. The power plant may then burn coal, only for the duration of the curtailment plus sufficient time to empty the coal bins following the curtailment.

Except during a curtailment of natural gas supply, emissions to the atmosphere from the indicated emission points shall not exceed the following rates and concentrations:

Pollutant	Grains/dscf	ppmdv (3% O2) 68°F, 29.92 in. Hg
$PM_{2.5}$ Filterable	0.004	
Filterable and condensable	0.03	
NO_x		336
NO_x (after 1/1/2018)		60

If operated during the winter months, stack testing to show compliance with the above Unit #4 emissions limitations shall be performed as follows:

Pollutant	Test Frequency
$PM_{2.5}$	every year
NO_x	every year

The heat input during all compliance testing shall be no less than 90% of the maximum average hourly production rate achieved in any 24-hour period during the previous three (3) years. The limited use of natural gas during startup, for maintenance firings and break-in firings does not constitute operation and does not require stack testing.

5.2 Tailings Site

The primary source of emissions at the tailings site is wind-blown dust. The intent of the $PM_{2.5}$ serious nonattainment SIP is to review emissions during winter time inversions. Since these inversions represent stagnant wind conditions, emissions from the tailings site will be minimal and therefore tailings site SIP conditions are not necessary for the $PM_{2.5}$ SIP. Emissions at the tailings site are effectively controlled with the implementation of BACT and most stringent measures.

5.3 Laboratory

No limitations or monitoring requirements are proposed for the laboratory emission sources as the emissions from the facility are minimal and are effectively controlled with the implementation of BACT and most stringent measures.

FINAL

Best Available Control Technology Determinations for the Smelter, Refinery, and Molybdenum Autoclave Process

Prepared for

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April 2017

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Acronyms and Abbreviations

ACT	Alternative control techniques
AO	approval order
BACT	best available control technology
BCM	Bingham Canyon Mine
CAA	Clean Air Act
CEM	Continuous emissions monitor
CFR	*Code of Federal Regulations*
CHP	Combined heat and power
CO	carbon monoxide
CPI	Consumer Price Index
EPA	Environmental Protection Agency
ESP	Electrostatic precipitator
FGR	Flue gas recirculation
FS	Flash Smelting
GPS	Global Positioning System
gr/dscf	grains per standard cubic feet
KUC	Kennecott Utah Copper
LNB	Low NOx burner
MACT	maximum achievable control technology
MAP	molybdenum autoclave process
MMBtu/hr	million British Thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NH_3	ammonia
NO_x	nitrogen oxides
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppm	parts per million
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SCR	Selective catalytic reduction
SIP	State Implementation Plan
SO_2	sulfur dioxide
SOP	Standard operating procedure
TEG	Turbine Electric Generator
tpy	tons per year

ACRONYMS AND ABBREVIATIONS (CONTINED)

UDAQ	Utah Department of Air Quality
ULNB	Ultra-low NOx burner
VOC	volatile organic compound
WRAP	Western Regional Air Partnership

SECTION 1

Introduction

Kennecott Utah Copper LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities: smelter, refinery, and the molybdenum autoclave process (MAP). In addition to a BACT analysis, KUC has also documented the most stringent measures for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and meet any reasonable further progress requirements. As requested by the Utah Department of Air Quality (UDAQ), the BACT analysis should identify and evaluate reasonable and available control technologies for each relevant pollutant. The technical and economic feasibility of each potential control technology are components of the BACT analysis that help show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). For each emission source, the BACT analysis followed a four step process:

Step 1—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC)

Step 2—Eliminate technically infeasible options

Step 3—Eliminate economically/chronologically infeasible options

Step 4—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent most stringent measures.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS were combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends the BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development.

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SECTION 2

Recent Permitting Actions

The smelter, refinery, and MAP together have over 70 individual significant and insignificant sources. The smelter recently had UDAQ permitting actions. A modified approval order (AO) was issued for the smelter on June 10, 2014. AO DAQE-AN0103460054-14 allows the smelter to operate a crushing and screening plant and modifies stack testing requirements for the smelter emissions sources. No other significant modifications were made to the smelter AO in the last 5 years.

The EPA performed extensive technology reviews of smelter emissions in support of the 2002 primary copper smelting major source maximum achievable control technology (MACT) standard (40 *Code of Federal Regulations* [*CFR*] 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC smelter are included in the Federal Register notices associated with the draft and final promulgation of both of these rules. Both of these standards establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. The primary copper smelting area source MACT standard specifically identifies the KUC smelter main stack emission performance as MACT for copper smelters (existing sources, not using batch copper converters). Smelter process and emission controlling technologies that contributed to EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred subsequent to promulgation of the MACT standards.

AO DAQE-AN01013460045-10 for the refinery was issued in 2010 to add the combined heat and power (CHP) unit. The CHP unit utilizes SoLoNO$_X$™ burners minimizing NO_X emissions from the unit. The smelter and refinery facilities operate under a single Title V Operating Permit # 3500030003.

The MAP facility, will process molybdenum disulfide into molybdenum trioxide and ammonia. The MAP facility was originally permitted in 2008 and was modified in March 2013 (AO DAQE-AN0103460052-13) to reflect the updated design of the plant. The permitting actions require thorough control technology analysis and the plant will implement BACT to minimize emissions from the facility.

Potential to emit (PTE) emissions in tons per year (tpy) for the Smelter, Refinery and MAP are shown in Table 2-1.

Table 2-1. Facility Potential to Emit Emissions

	PM_{10} PTEs (tpy)	**$PM_{2.5}$ PTEs (tpy)**	**NO_x PTEs (tpy)**	**SO_2 PTEs (tpy)**	**VOC PTEs (tpy)**
Smelter	510.82	426.35	185.29	1,085.72	13.50
Refinery	25.64	25.64	38.57	4.44	8.42
MAP	13.11	9.99	35.57	2.43	6.71

Notes:
PM_{10} = Particulate matter 10 microns or smaller in aerodynamic diameter
NO_x = oxides of nitrogen
SO_2 = sulfur dioxide
VOC = volatile organic compounds
$PM_{2.5}$ = Particulate matter 2.5 microns or smaller in aerodynamic diameter
PTE = potential to emit
tpy = tons per year

SECTION 3

Best Available Control Technology Determinations

This section provides BACT determinations for emission sources deemed significant at the smelter, refinery, and the MAP facility.

3.1 Smelter

The EPA performed extensive technology reviews of smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules (e.g., the design of the smelter is based on the furnace technology). Typical smelting operations require batch processing which intermittently produces high concentrations of SO_2 and particulate in a manner that can reduce the efficiency of the acid plant as a control device. By employing the flash smelting (FS) and flash converting (FC) technologies, KUC is able to eliminate many of the problems inherent with batch type smelter operations. These improvements include continuous flow of off-gases to the acid plant during the FC process as well as reduced total volume of off-gases. Additionally, the furnaces are stationary which improves the ability to capture the off-gases as well as the ability to capture any fugitive emissions with the secondary capture system, which cleans the gases with baghouses and scrubbers before venting to the main stack. As a result, both MACT standards go so far as to establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology.

The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources not using batch copper converters). The KUC Smelter employs several technologies to minimize the smelting emissions that report to the main stack.

- The concentrate dryer burns natural gas to heat/dry concentrate for use in the FS furnace. Operation with low-NO_x burners (LNB) along with lower dryer temperatures minimizes the formation of NO_x while also preventing the formation of SO_2. KUC operates both a baghouse and a scrubber as controls for the concentrate dryer.
- The secondary gas system collects fugitive emissions in the hot metals building (typically associated with the furnaces) and vents them through a baghouse and a sodium-based scrubber before they are vented to the main stack.
- The matte grinding circuit crushes and dries granulated matte for use in the FC furnace. The ground matte is collected in a baghouse and pneumatically conveyed to the FC furnace feed bin. NO_x emissions from natural gas combustion are controlled with LNB and low temperature firing and PM_{10} emissions are controlled with the production baghouse.
- In the anodes area, blister copper from the FC furnace is refined in two available refining furnaces to remove the final traces of sulfur. Copper production can be supplemented with copper scrap, which can be added to the refining furnaces for re-melt. The anodes refining furnaces are natural gas fired with oxy-fuel burners. Off-gas is vented (in series) to a quench tower, lime injection, baghouse, and scrubber and vented to the main stack. NO_x reduction activities also include maintaining furnaces to prevent ingress of air.
- The shaft furnace and holding furnace are used to re-melt anode scrap and other copper scrap to incorporate into copper production. LNBs are used to reduce NO_x from the natural gas combustion and a

baghouse is operated to control PM_{10} emissions. The shaft furnace is in the anodes area, but vents separately to the main stack.

3.1.1 Main Stack

Source Description. Multiple process equipment emissions are routed through the main stack. Such equipment includes the matte granulators, acid plant, anode building, powerhouse, furnaces, dryers, and grinding circuits. Many of these sources of emissions have their own primary control devices (baghouse, scrubbers, etc.). Some are then routed to the secondary gas system and then through the main stack.

Equipment emissions routed through the main stack at the smelter include:

Equipment	Pollutant Emissions	Primary Emissions Control
Concentrate dryer	$PM_{2.5}$, SO_2, NO_X	LNB, baghouse, and scrubber
Powerhouse superheater	$PM_{2.5}$, SO_2, NO_X, VOC	Ultra-low NOx burner (ULNB), Flue gas recirculation (FGR), fuel throughput limits, and good operational practices
Powerhouse Foster Wheeler aux boiler	$PM_{2.5}$, SO_2, NO_X, VOC	LNB, FGR, fuel throughput limits, and good operational practices
Matte grinding	$PM_{2.5}$, SO_2	LNB, baghouse and good operational practices
Anode refining furnaces	$PM_{2.5}$, SO_2, NO_X, VOC	Oxy-fuel burners, baghouse, and scrubbers
Anode shaft furnace	$PM_{2.5}$, SO_2, NO_X, VOC	Baghouse
Anode holding furnace	$PM_{2.5}$, SO_2, NO_X, VOC	Baghouse
Vacuum cleaning system	$PM_{2.5}$	Baghouse
North and south matte granulators	$PM_{2.5}$, SO_2	Scrubber, SGS baghouse, and SGS scrubbers

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies different control technologies for process equipment eventually routed through the main stack. These control technologies are currently in place as previously discussed.

The EPA performed extensive technology reviews of smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC smelter are included in the Federal Register notices associated with the draft and final promulgation of both of these rules. Both of these standards go so far as to establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. The primary copper smelting area source MACT standard specifically identifies the KUC smelter main stack emission performance as MACT for copper smelters (existing sources not using batch copper converters). Smelter process and emission controlling technologies that contributed to EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred subsequent to promulgation of the MACT standards.

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 selected as BACT.

Step 4—Identify BACT. Because no new major developments in technologies have occurred subsequent to the promulgation of the MACT standards, the control technologies currently in place constitute BACT.

Complying with applicable requirements of the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE) represent the most stringent measures for the main stack.

3.1.2 Powerhouse Holman Boiler

Source Description: The boiler is used to provide process steam at the smelter. Emissions of NO_x are limited with flue gas recirculation, LNB, opacity limits, an alternate monitoring plan; which requires continuous monitoring of operational parameters (fuel use, stack oxygen, steam output) and operational controls with good combustion practices. Emissions of $PM_{2.5}$, CO, SO_2, and VOC are limited with use of pipeline quality natural gas, good combustion practices, gas consumption limit, good design, opacity limits, and proper operation of the boiler.

3.1.2.1 NO_x BACT

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired boilers:

- Selective catalytic reduction (SCR)
- FGR
- LNBs with good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The Holman boiler is equipped with FGR and LNB to reduce NO_x emissions. The addition of the SCR would reduce the emissions from the boiler from 9.9 tpy (based on 2016 actual emissions) to 2.0 tpy.

From the Alternative Control Techniques (ACT) Document — NO_x Emissions from Industrial / Commercial / Institutional Boilers, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 100 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.03 lb/MMBtu. From Table 6-5 of the ACT document, the total annualized cost for the 100 MMBtu/hr gas boiler is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from Consumer Price Index (CPI) Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74; therefore, for the Holman boiler, the estimated cost is $487,287.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $62,000 and is therefore not cost effective for BACT.

Step 4—Identify BACT. FGR, LNBs with good combustion practices, limited gas consumption, good design, and proper operation constitute BACT for this source.

KUC continuously monitors operation parameters to predict NO_x emissions and ensure proper boiler operation. The parameters monitored are fuel use (to predict NO_x emissions lb/hr), stack oxygen (to monitor proper boiler operation and compliance with NO_x lb/MMBtu emission limit), and steam output (used to estimate heat input if fuel use is unavailable). The ranges for these parameters were developed during a 30-day monitoring campaign where data from a certified NO_x analyzer were used to develop predictive equations with the operation parameters.

3.1.2.2 SO_2, VOC, and $PM_{2.5}$ BACT

Step 1—Identify All Control Technologies listed in the RBLC. The RBLC identifies the following as possible control technologies for boilers:

- Use of pipeline quality natural gas and good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable because all potential technologies identified in Step 1 were selected as BACT.

Step 4—Identify BACT. Use of pipeline quality natural gas, good combustion practices, opacity limits, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNBs with good combustion practices, limited gas consumption, good design, and proper boiler operation represent the most stringent measures for the Holman Boiler.

3.1.3 Feed Process (Wet and Dry)

Source Description: Silica flux, concentrate, and converter slag are transferred directly to feed bins then conveyed to the dryer. Particulate emissions from the loading of the flux and concentrate, and from transfer points of the conveyor, are vented to a baghouse.

Step 1—Identify All Control Technologies listed in RBLC. Although RBLC did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, electrostatic precipitators (ESPs), and wet scrubbers.

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP, because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP and then by wet scrubbers.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable as most effective technology identified in Step 1 selected as BACT.

Step 4—Identify BACT. Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

The use of a baghouse to control particulate emissions also represents the most stringent measures for both the wet and dry feed process.

3.1.4 Matte and Slag Granulators

Source Description: Slag and matte granulators are each equipped with a three-stage impingement plate scrubber. The smelter operates two matte granulators and one slag granulator. The molten matte is granulated with water in two separate granulation tanks (two matte granulators), each equipped with a scrubber. The convertor slag is granulated in a separate granulator (one slag granulator), also equipped with a scrubber. The matte granulators are vented through the main stack. The slag granulator is vented to the atmosphere through a separate stack. $PM_{2.5}$ and SO_2 emissions are controlled by a neutral pH three-stage impingement plate scrubber.

3.1.4.1 $PM_{2.5}$ BACT

Step 1—Identify All Control Technologies Listed in RBLC. Although RBLC did not provide controls for the specific operation, other possible particulate control technologies include baghouses, cyclones, ESP, and scrubbers.

Step 2—Eliminate Technically Infeasible Options. While baghouses are most effective in controlling particulate emissions, this technology is not feasible for the granulators. The exhaust from the granulators has very high moisture content, which is not suitable for baghouses. Moisture condensation can cause accumulation of mud on the bags and baghouse walls. This results in blinded bags and clogged dust removal equipment. As discussed in the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook, cyclones are mainly used to control large particles.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, as most technically feasible technology for this process, identified in Step 2, was selected as BACT.

Step 4—Identify BACT. Scrubbers constitute BACT for the granulators.

3.1.4.2 SO_2 BACT

Step 1—Identify All Control Technologies listed in RBLC. The RBLC does not identify any specific control technologies for the granulators.

Step 2—Eliminate Technically Infeasible Options. Not applicable

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable

Step 4—Identify BACT. Scrubbers constitute BACT for the granulators.

The use of scrubbers also represent the most stringent measures for both the matte and slag granulators.

3.1.5 Feed Storage Building

Source Description: Wet copper concentrate feed is stored in the enclosed wet feed storage building. Particulate matter from loading materials into the feed storage building, from reclaiming materials, and from conveyor/transfer point SME 002-A, are vented to a baghouse.

Step 1—Identify All Control Technologies listed in RBLC. Although RBLC did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, as most effective technology, identified in Step 1, selected as BACT.

Step 4—Identify BACT. Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

The use of a baghouse to control particulate emissions also represents Most Stringent Measures for the feed storage building.

3.1.6 Anode Area Fugitives

Source Description: Emissions from the anode building process are controlled with a baghouse, quench tower, and scrubber. However, some emissions escape as fugitives.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC does not identify any specific control technologies for process fugitives. The MACT, however, does address such emissions.

40 *CFR* 63.11147(a)(3) states, "You must operate one or more capture systems that collect the gases and fumes released from each vessel used to refine blister copper, re-melt anode copper, or re-melt anode scrap and convey each collected gas stream to a control device. One control device may be used for multiple collected gas streams."

KUC certified compliance with 63.11147(a)(3), as required by 63.11150(b)(4), in a letter dated and received by UDAQ on January 30, 2007.

Step 2—Eliminate Technically Infeasible Options. Not applicable

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable

Step 4—Identify BACT. In addition to opacity limits and required maintenance, current design of anode process units and the collection hoods on anode building processes have been engineered/designed to reduce fugitives and these practices constitute BACT.

The current design of anode process units and the collection hoods on anode building processes were engineered/designed to reduce fugitives and these represent most stringent measures.

3.1.7 Smelter Fugitives

Source Description: Emissions from smelter processes are controlled with appropriate control technologies including closed processes, launder hoods and others outlined below. However, some emissions escape as fugitives.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC does not identify any specific control technologies for such fugitives.

The EPA performed extensive technology reviews of smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Regarding the design and fugitive emission controls of the KUC smelter, the EPA provided the following discussion when promulgating the final copper smelting MACT standard (FR Vol. 67, No. 113, Page 40488):

> Due to its unique design and operations, most of the process fugitive emission sources associated with smelters using batch converting are eliminated at the Kennecott smelter. There are no transfers of molten material in open ladles between the smelting, converting, and anode refining departments at the Kennecott smelter. In addition, there are no fugitive emissions associated with the repeated rolling-out of converters for charging, skimming, and pouring. Also, only one continuous flash converter is needed at the Kennecott smelter compared with the need for three of more batch copper converters at the other smelters.

Both standards go so far as to establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. Smelter process and emission controlling technologies that contributed to the EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred subsequent to the promulgation of the MACT standards.

Specific notes regarding control techniques listed in Table 5 of Attachment 5 of the EPA comments are listed below:

- KUC smelter hot metals operations are serviced by an extensive local ventilation (secondary gas) system. This system collects gasses and routes them through baghouses and scrubbers before venting them to the main stack where they are continuously monitored for multiple pollutants.
- KUC smelter hot metals operations are completely enclosed in a building.
- KUC processes only clean scrap in its melting furnaces.
- A leak detection/prevention/repair program is not applicable to KUC smelter furnaces and hot metals process units because they are enclosed and operate at negative pressure due to their inherent design.
- Because KUC furnaces are enclosed and do not require open air transfer of molten metal, they are not dependent on hooding systems for process gas collection.
- It is not necessary to add curtains to improve hood performance at the KUC smelter as the process does not rely on hoods to capture process gasses.
- The KUC process does not require the open air transfer of molten metal from smelting to converting vessels so it is not necessary to collect these emissions.
- The EPA noted in the primary copper smelting MACT standard, KUC was the first smelter in the United States to capture and control emissions from anode refining furnaces.

Step 2—Eliminate Technically Infeasible Options. Not applicable

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable

Step 4—Identify BACT. In addition to opacity limits and required maintenance, current designs of processes were engineered/designed to reduce fugitives and therefore these practices constitute BACT.

The current designs of processes were engineered/designed to reduce fugitives and therefore these practices also represent the most stringent measures.

3.1.8 Acid Plant Fugitives

Source Description: The double contact acid plant removes SO_2 from the off-gases of the flash furnaces. The sulfuric acid produced by the plant is sold. Among other technologies, the system is equipped with tubular candle fiber mist eliminators and the tail gas is discharged to the main stack. However, some emissions escape as fugitives, which are controlled using best operational practices to minimize emissions. Best operational practices to minimize the emissions include opacity limits, weekly visual opacity surveys and the requirement of prompt repair or correction and control to minimize emissions.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC does not identify any specific control technologies for such fugitives.

Step 2—Eliminate Technically Infeasible Options. Not applicable

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable

Step 4—Identify BACT. Best operational practices may include, but are not limited to (1) placement or adjustment of negative pressure ductwork and collection hoses, (2) welding of process gas leaks, or (3) containment of process gas leaks. These practices and current design of processes were engineered/designed to reduce fugitives and therefore constitute BACT.

The best operational practices currently implemented and the current design of the processes also represent the most stringent measures for the acid plant fugitives.

3.1.9 Powerhouse Foster Wheeler Boiler

Source Description: This boiler is used to produce superheated steam to start the smelter, drive acid plant compressors, and standby power. Emissions of NO_x are limited with FGR, LNB with good combustion practice, continuous monitoring of NO_x at the smelter main stack, and limitations on fuel throughput. Emissions of $PM_{2.5}$, CO, SO_2, and VOCs are limited with use of pipeline quality natural gas; good combustion practices; good design and proper operation of the boiler; and continuous monitoring of opacity, particulate, and SO_2 at the smelter main stack.

3.1.9.1 NO_x BACT

Step 1—Identify All Control Technologies listed in RBLC. The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired boilers.

- SCR
- FGR
- LNB with good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The powerhouse boiler is equipped with FGR and LNB to reduce NO_x emissions. Emissions from this boiler are vented through the main stack and it is difficult to differentiate the boiler NO_x emissions from the main stack emissions. Based on the understanding of operations at the Smelter, the addition of the SCR might reduce the annual emissions from the boiler from 5.3 tpy (based on 2016 actual emissions and engineering estimates) to 1.1 tpy.

From the Alternative Control Techniques Document – NO_x Emissions from Industrial/Commercial/Institutional Boiler, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 100 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.03 lb/MMBtu. From Table 6-5, the total annualized cost for the 100 MMBtu/hr gas boiler is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from CPI Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74; therefore, for the powerhouse boiler the estimated cost is $261,000.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $62,000 and is therefore not cost effective for BACT.

Step 4—Identify BACT. FGR, LNB with good combustion practices, good design and proper operation constitute BACT.

3.1.9.2 SO_2, VOC, and $PM_{2.5}$ BACT

Step 1—Identify All Control Technologies listed in RBLC. The RBLC identifies the following as possible control technologies for boilers.

- Use of pipeline quality natural gas and good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, because all potential technologies identified in Step 1 are selected as BACT.

Step 4—Identify BACT. Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measures for the Powerhouse Foster Wheeler Boiler.

3.1.10 Miscellaneous Storage Piles/Loadout

Source Description: Concentrate, granulated matte, slag, and other materials are stored in storage piles on pads. Water sprays or chemicals are applied as necessary to minimize fugitive emissions.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies dry foggers, adding moisture, and enclosures as possible control technologies for fugitive emissions. Other possible technologies available to control fugitive dust emissions that are not identified in the RBLC include chemical dust suppression, baghouse, cyclone, and scrubber.

Step 2—Eliminate Technically Infeasible Options. The emission sources are fugitive in nature and therefore it is not technically feasible to duct emissions to a baghouse, scrubber, or cyclone. Additionally, the locations of the storage piles are also changing, making the construction of permanent enclosures difficult. Therefore, these control technologies are not technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The remaining technology of water or chemical applications is economically and chronologically feasible.

Step 4—Identify BACT. KUC uses water sprays, chemical dust suppressants, and temporary enclosures to minimize particulate emissions from the miscellaneous storage piles, which were demonstrated to be very effective. These business practices constitute BACT for this emission source.

The use of water sprays, chemical dust suppressants, and temporary enclosures to minimize particulate emissions from the miscellaneous storage piles also represent the most stringent measures.

3.1.11 Slag Concentrator

Source Description: Emissions associated with the crushing, grinding, and slag processing at the smelter are minimized with the water sprays and enclosures.

Step 1—Identify All Control Technologies Listed in RBLC. Although RBLC did not provide controls for the specific operation, other possible particulate control technologies include baghouses, cyclones, scrubbers, water sprays, and enclosures.

Step 2—Eliminate Technically Infeasible Options. Baghouses are not feasible for the slag processing equipment. The slag stock piles are sprayed with water frequently to minimize emissions. The material as a result has very high moisture content, which is not suitable for baghouses. Moisture droplets and condensation can cause accumulation of mud on the bags, baghouse walls, and ductwork. This results in blinded bags and clogged dust removal equipment. Further, when ambient temperatures are below freezing, the mud will freeze on the baghouse bags and plug them.

Wet scrubbers are not expected to be effective in minimizing emissions from crushing and grinding operations. Operation of the scrubbers is compromised due to below freezing ambient temperatures and very cold water streams in the scrubber. The duct work of the scrubbers will freeze during subfreezing ambient temperature conditions.

As discussed in the WRAP Fugitive Dust Handbook, cyclones are mainly used to control large particles.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The remaining technology of water sprays and enclosures is economically and chronologically feasible.

Step 4—Identify BACT. KUC uses water sprays and enclosures to minimize particulate emissions from the slag concentrator, which were demonstrated to be very effective. These business practices constitute the BACT for this emission source.

The use of water sprays and enclosures to minimize particulate emissions represent the most stringent measures from the slag concentrator.

3.1.12 Smelter Cooling Towers

Source Description: Three noncontact water cooling towers are used for various smelter processes. The towers are equipped with drift eliminators with drift loss rated at 0.001 percent.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.

Step 2—Eliminate Technically Infeasible Options. Not applicable, as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, because all potential technologies identified, in Step 1, are selected as BACT.

Step 4—Identify BACT. Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.001 percent and good operating practices represent most stringent measures for the cooling tower.

3.2 Refinery

3.2.1 Boilers

Source Description: The two boilers are rated at 82 MMBtu/hr (gas) and 79 MMBtu/hr (oil) each and are permitted to operate on natural gas to meet the steam demand at the refinery. During natural gas curtailment, the boilers are permitted to operate on oil. Emissions of NO_x are limited with FGR and LNB with good combustion practices. Emissions of $PM_{2.5}$, SO_2, and VOCs are limited with good combustion practices, good design, opacity limits, sulfur content limit, and proper operation of the boilers.

3.2.1.1 NO_x BACT

Step 1—Identify All Control Technologies listed in RBLC. The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired boilers

- SCR
- FGR
- LNB with good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The refinery boilers are equipped with FGR and LNB to reduce NO_x emissions. The addition of the SCR will reduce the emissions from the boilers from 12.9 tpy (based on based on 2016 actual emissions) to 2.6 tpy.

From the Alternative Control Techniques Document – NO_x Emissions from Industrial/Commercial/Institutional Boilers, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 50 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing

SCR technology is 0.02 lb/MMBtu (the 100 MMBtu/hr boiler controlled NO_x emission rate with SCR is listed at 0.03 lb/MMBtu). From Table 6-5 of the ACT document, the total annualized cost for the 50 MMBtu/hr gas boiler (closest entry to 82 MMBtu/hr Refinery boiler) is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from CPI Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74. The estimated costs for the refinery boilers is $428,040 for both boilers.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $42,000 for the refinery boilers and is, therefore, not cost effective for BACT.

Step 4—Identify BACT. FGR, LNB with good combustion practices, good design, and proper operation constitute BACT for this source.

3.2.1.2 SO_2, VOC, and $PM_{2.5}$ BACT

Step 1—Identify All Control Technologies listed in RBLC. The RBLC identifies the following as possible control technologies for natural gas fired boilers:

- Use of pipeline quality natural gas and good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, because all potential technologies identified, in Step 1, selected as BACT.

Step 4—Identify BACT. Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measures for the boilers.

3.2.2 CHP Unit

Source Description: The CHP unit will generate power and steam to support refinery operations. The CHP unit uses a low NO_x duct burner and the turbine has $SoLoNO_x$ burners. Emissions of $PM_{2.5}$, SO_2, and VOC are limited with good design and proper operation.

3.2.2.1 NO_x BACT

Step 1—Identify All Control Technologies listed in RBLC. The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired turbines and duct burners.

- SCR
- LNB with good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. The CHP unit is equipped with LNB ($SoLoNO_x$ technology burners on turbine) to reduce NO_x emissions. The addition of the SCR will reduce actual annual emissions from the CHP unit from 12.2 tpy (based on 2014 actual emissions) to 1.2 tpy. The CHP unit had major work performed in 2015 and 2016, therefore 2014 emissions are used for the analysis.

Solar developed an estimation spreadsheet for the Taurus 70 combustion turbine and duct burner arrangement, which utilized vendor quotations for the installation of an SCR system. From the Solar calculations, the annualized capital and operating costs were estimated to be $932,100/yr.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $85,000 for the CHP unit and is therefore not cost effective for BACT.

Step 4—Identify BACT. LNB with good combustion practices, good design, and proper operation of the CHP Unit constitute BACT for this source.

3.2.2.2 SO_2, VOC, and $PM_{2.5}$ Best Available Control Technologies

Step 1—Identify All Control Technologies listed in RBLC. The RBLC identifies the following as possible control technologies for small turbines and duct burners:

- Use of pipeline quality natural gas and good combustion practices
- Good design and proper operation

Step 2—Eliminate Technically Infeasible Options. All control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, because all potential technologies identified, in Step 1, selected as BACT.

Step 4—Identify BACT. Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the CHP unit constitute BACT for this emission source.

LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measures for the CHP unit.

3.2.3 Refinery Cooling Towers

Source Description: Two noncontact water cooling towers are used for various refinery processes. The towers are equipped with drift eliminators with drift loss rated at 0.001 percent.

Step 1—Identify All Control Technologies Listed in RBLC. The RBLC identifies drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.

Step 2—Eliminate Technically Infeasible Options. Not applicable, as all identified control technologies are technically feasible.

Step 3—Eliminate Economically/Chronologically Infeasible Options. Not applicable, because all potential technologies identified, in Step 1, are selected as BACT.

Step 4—Identify BACT. Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.001 percent and good operating practices represent most stringent measures for the cooling tower.

SECTION 4

Best Available Control Technology Summary

This section provides a summary of BACT for emission sources deemed insignificant at the Smelter and Refinery.

Table 4-1. Best Available Control Technology Summary for Smelter and Refinery

Emission Source ID/Name	Emission Source Description	BACT Summary
Building heating	Natural gas heaters	Emissions are minimized with LNB and use of pipeline quality natural gas.
At water heaters	Natural gas water heaters	Emissions are minimized with LNB and use of pipeline quality natural gas.
Ground Matte Silo BH	Storage silo	Emissions controlled with a baghouse.
Mold Coating Silo BH	Storage silo	Emissions controlled with a baghouse.
Hydromet Plt Limestone Silo BH	Storage silo	Emissions controlled with a baghouse.
Hydromet Plt Lime Silo BH	Storage silo	Emissions controlled with a baghouse.
Lab BH	Smelter laboratory	Emissions controlled with a baghouse.
Recycle and Crushing Building	Recycle and crushing building	Process is enclosed to minimize emissions.
Anode Area Lime Silo	Storage silo	Emissions controlled with a baghouse.
Secondary Gas System Lime Silo	Storage silo	Emissions controlled with a baghouse.
Loading to Storage Pile on Patio	Material handling	Emissions are minimized with water sprays and enclosures.
Fueling	Fueling stations at the smelter	Stage 1 and Stage 2 vapor recovery systems minimize emissions.
Degreasing	Cold solvent degreasers at the Smelter	Keeping the lids closed on the degreasers minimize solvent loss and emissions.
Emergency backup power generators	Emergency generators	Emissions comply with applicable New Source Performance Standards.
Smelter Comm. Generator	LPG communications generator	Emissions comply with applicable New Source Performance Standards.
Cathode Wash	Process area	Emissions are minimized through enclosures and complying with standard operating procedures (SOPs).
Anode Scrap	Process area	Emissions are minimized through enclosures and complying with SOPs.
Hydrometallurgical Precious Metals Recovery Scrubber	Process area	Emissions controlled with scrubber
Hydrometallurgical Silver Production Scrubber	Process area	Emissions controlled with scrubber
Se Crushing/Packing Baghouse	Process area	Emissions controlled with baghouse

Table 4-1. Best Available Control Technology Summary for Smelter and Refinery

Emission Source ID/Name	Emission Source Description	BACT Summary
Au/Ag Baghouse	Process area	Emissions controlled with baghouse
Soda Ash Filter	Process area	Emissions controlled with bin vent filter
Space Heaters	Natural gas heaters	Emissions are minimized with LNB and use of pipeline quality natural gas.
Gasoline Fueling	Fueling stations at the refinery	Stage 1 and Stage 2 vapor recovery systems minimize emissions.
Degreasing	Cold solvent degreasers at the Smelter	Keeping the lids closed on the degreasers minimize solvent loss and emissions.
Paint	Process area	Emissions minimized with enclosures
Primer	Process area	Emissions minimized with enclosures
Diesel Generators	Emergency generator	Emissions comply with applicable New Source Performance Standards.
LPG Generator	LPG communications generator	Emissions comply with applicable New Source Performance Standards.

The MAP facility was first permitted in 2008 and was modified in March 2013 (AO DAQE-AN0103460052-13) to reflect the updated design of the plant. The permitting actions have required thorough control technology analysis that the plant will implement BACT to minimize emissions from the facility. Due to this very recent permitting action, KUC has not developed a detailed BACT analysis for the emission sources at MAP facility. However, KUC has developed the following summary of BACT for emission sources at the MAP facility.

Table 4-2. Best Available Control Technology Summary for the Molybdenum Autoclave Process Facility

Emission Source ID/Name	Emission Source Description	BACT Summary
CHP Unit	Combined Heat and Power Unit	LNB and use of pipeline quality natural gas will minimize emissions
Cooling Tower	20,000 gallon per minute (gpm) Cooling Tower	Drift eliminator with efficiency of 0.0005 percent will minimize emissions
IT Building Backup Generator	LPG Communications Generator	Emissions will comply with applicable New Source Performance Standards.
Emergency Fire Pump	Emergency Fire Pump	Emissions will comply with applicable New Source Performance Standards.
Dryers and Re-oxidizer	Three Process dryers and re-oxidizer each rated less than 5 MMBtu/hr	Use of pipeline quality natural gas will minimize emissions
Calciner	Process calciner rated at 16 MMBtu/hr	LNB and use of pipeline quality natural gas will minimize emissions
Startup Boiler	Process startup boiler rated at 30 MMBtu/hr	LNB and use of pipeline quality natural gas will minimize emissions
Scrubbers	Process ammonia, sulfuric acid and hydrogen sulfide emissions	Emissions will be controlled with scrubbers

Table 4-2. Best Available Control Technology Summary for the Molybdenum Autoclave Process Facility

Emission Source ID/Name	Emission Source Description	BACT Summary
Packaging Area	Material Packaging Area	Emissions will be controlled with baghouse and bin vent filters
Reagent Storage	Reagent Storage Tanks and Bins	Emissions will be controlled with bin vent filters and scrubbers
Material Handling	Concentrate transfer and handling	Emission sources will be located inside building and enclosures
Solvent Extraction Lines	Solvent tanks and mixers	Emissions will be minimized through SOPs
Test Laboratory	Laboratory for the MAP operations	Emissions will be controlled with baghouse
Process Boiler	Process boiler rated at 12 MMBtu/hr	LNB and use of pipeline quality natural gas will minimize emissions

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SECTION 5

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

5.1 Smelter

Emissions to the atmosphere from the indicated emission points shall not exceed the following rates and concentrations:

Emission Point	Pollutant	Test Frequency
Main Stack (Stack No. 11)	$PM_{2.5}$	• 89.5 lbs (filterable, daily average) • 434 lbs/hr (filterable + condensable daily average)
	SO_2	• 552 lbs/hr (3 hr. rolling average) • 422 lbs/hr (daily average)
	NO_x	• 154 lbs/hr (daily average)
Holman Boiler	NO_x	• 14.0 lbs/hr (calendar-day average)

Stack testing to show compliance with the emissions limitations of Condition (A) above shall be performed as specified below:

Emission Point	Pollutant	Test Frequency
Main Stack	PM_{10}	Every year
	SO_2	Continuous Emissions Monitor (CEM)
	NO_x	CEM
Holman Boiler	NO_x	Every 3 years and alternate method determined according to applicable new source performance standards

During startup/shutdown operations, NO_x and SO_2 emissions are monitored by CEMs or alternate methods in accordance with applicable NSPS standards. This condition establishes emissions limitations and compliance requirements for the smelter main stack and the Holman Boiler.

KUC continuously monitors operational parameters to predict NO_x emissions and to ensure proper boiler operation. The parameters monitored are fuel use (to predict NO_x emissions lb/hr), stack oxygen (to monitor proper boiler operation and compliance with NO_x lb/MMBtu emission limit), and steam output (used to estimate heat input if fuel use unavailable). The ranges for these parameters were developed during a 30-day monitoring campaign where data from a certified NO_x analyzer were used to develop predictive equations with the operational parameters. The alternative monitoring method identified in this condition is consistent with the applicable NSPS.

5.2 Refinery

Emissions to the atmosphere from the indicated emission point shall not exceed the following rate:

Emission Point	Pollutant	Maximum Emission
The sum of two (tankhouse) boilers	NO_x	9.5 lb/hr
Combined heat plant	NO_x	5.96 lbs/hr

Stack testing to show compliance with the above emission limitations shall be performed as follows:

Emission Point	Pollutant	Testing Frequency
Tankhouse boilers	NO_x	Every 3 years*
Combined heat plant	NO_x	Every year

Notes:

*Stack testing shall be performed on boilers that have operated more than 300 hours during a 3-year period.

KUC must operate and maintain the stationary combustion turbine, air pollution control equipment, and monitoring equipment in a manner consistent with good air pollution control practices for minimizing emissions at all times including during startup, shutdown, and malfunction. Records shall be kept on site which indicate the date, and time of startups and shutdowns. This condition establishes emissions limitations and compliance *requirements for the* Refinery Boilers and Combined Heat and Power unit.

5.3 Molybdenum Autoclave Process

Emissions to the atmosphere from the natural gas turbine, combined with the duct burner, and with the turbine electric generator (TEG); firing shall not exceed the following rate:

Emission Point	Pollutant	Maximum Emission Rate
Combined heat plant	NO_x	5.01 lbs/hr

Stack testing to show compliance with the above emission limitations shall be performed as follows:

Emission Point	Pollutant	Testing Frequency
Combined heat plant	NO_x	Every year

Records shall be kept on site which indicate the date and time of startups and shutdowns. This condition establishes emissions limitation and compliance requirements for the MAP facility combined heat and power unit.

FINAL REPORT

Kennecott Utah Copper

$PM_{2.5}$ State Implementation Plan: Best Available Control Technology Determinations

Submitted to

Utah Division of Air Quality

Prepared for:

Kennecott Utah Copper

Prepared by:

ch2m

February 2018

F I N A L

BACT Determinations for the Bingham Canyon Mine and Copperton Concentrator

Prepared for

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Acronyms and Abbreviations

AO	approval order
BACT	best available control technology
BCM	Bingham Canyon Mine
CAA	Clean Air Act
CO	carbon monoxide
EPA	Environmental Protection Agency
gr/dscf	grains per dry standard cubic feet
GPS	Global Positioning System
KUC	Kennecott Utah Copper
MMBTU/hr	million British Thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NH_3	ammonia
NOx	nitrogen oxides
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppm	parts per million
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SIP	State Implementation Plan
SO_2	sulfur dioxide
TPY	tons per year
UDAQ	Utah Department of Air Quality
VOC	volatile organic compound

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SECTION 1

Introduction

Kennecott Utah Copper LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities: Bingham Canyon Mine (BCM) and the Copperton Concentrator. In addition to a BACT analysis, KUC has also documented Most Stringent Measures for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and meet any reasonable further progress requirements. As requested by the Utah Division of Air Quality (UDAQ), the BACT analysis should identify and evaluate reasonable and available control technologies for each relevant pollutant. The technical and economic feasibility of each potential technology are components of the BACT analysis that help to show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). For each emission source, the BACT analysis followed a four-step process:

- **Step 1**—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC) and/or California Environmental Protection Agency – Air Resource Board BACT Clearinghouse (CARB)
- **Step 2**—Eliminate technically infeasible options
- **Step 3**—Eliminate economically/chronologically infeasible options
- **Step 4**—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent the most stringent measure.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS were combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends that BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development standard.

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SECTION 2

Recent Permitting Actions

Current operations at the BCM are permitted under Approval Order (AO) DAQE-AN105710042-18, issued on January 10, 2018.

Emissions from the BCM are mainly limited by the following conditions:

- "Total material moved (ore and waste) shall not exceed 260 million tons per rolling 12-month period." This condition limits the total material moved at the BCM, thus limiting all point, fugitive and tailpipe emissions.
- "Maximum total mileage per calendar day for ore and waste haul trucks shall not exceed 30,000 miles." This condition limits daily vehicle miles travelled at the BCM, thus limiting both fugitive and tailpipe emissions.
- "Emissions of particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}), NO_x, and SO_2 combined shall not exceed 7,350 tons and emissions of $PM_{2.5}$, NO_x, and SO_2 shall not exceed 6,205 tons per rolling 12-month period."
- "KUC shall apply a chemical dust suppressant to active haul roads located outside of the pit influence boundary no less than twice per year."

KUC is required to submit an annual fugitive dust control report that provides a description of the fugitive dust control practices implemented at the BCM.

Current operations at the Copperton Concentrator are permitted under AO DAQE-AN105710035-13 issued on June 25, 2013. Potential to Emit (PTE) emissions for the Copperton Concentrator are a very small percentage of combined emissions from the mine and concentrator facilities. Emissions for the Copperton Concentrator are limited by implementation of BACT controls.

PTE emissions in tpy for the BCM and the Copperton Concentrator are shown in Table 2-1.

Table 2-1. Facility Potential to Emit Emissions (Including Fugitive and Nonroad Engine Emissions)

	PM_{10} PTEs (tpy)	$PM_{2.5}$ PTEs (tpy)	NO_x PTEs (tpy)	SO_2 PTEs (tpy)	VOC PTEs (tpy)
Bingham Canyon Mine	1,519	369	5,838	7	314
Copperton Concentrator	25.3	13.86	10.66	0.1	4.04

Notes:
NO_x = oxides of nitrogen
PM_{10} = Particulate matter 10 microns or smaller in aerodynamic diameter
$PM_{2.5}$ = Particulate matter 2.5 microns or smaller in aerodynamic diameter
PTE = potential to emit
tpy = tons per year
SO_2 = sulfur dioxide
VOC = volatile organic compounds

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SECTION 3

BACT Determinations

This section provides BACT determinations for emission sources deemed significant at the BCM and the Copperton Concentrator.

KUC has reviewed publicly available permitting documents for open pit mines around the country. Permits for two facilities were reviewed in detail – the Morenci Mine and Rosemont Copper Project in Arizona. Although on a smaller scale, the Rosemont project was reviewed as the permit was based on recent BACT determinations for mining operations. Operations at the Morenci mine closely resemble those at KUC. Similar to the BCM and Copperton Concentrator, at these facilities emissions from large crushing operations are controlled with fabric filters, emissions from open areas, roads, storage piles and material handling are minimized with practices such as dust suppressant application and watering. Visible emissions limitations are included in the permit for mobile sources such as graders, dozers and haul trucks.

3.1 Bingham Canyon Mine

3.1.1 In-pit Crusher

Source Description: The crusher is used to crush copper ore mined at the BCM. Particulate emissions from the in-pit crusher are controlled with a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emissions controls information for copper ore crushers. However, the databases identify baghouse (fabric filter) and enclosures with water sprays as possible control technologies for limiting emissions from crushers. The databases did not provide needed information on copper ore crushing. Therefore, due to differences in the material type listed in the databases and copper ore crushed at the BCM, a direct comparison of baghouse grain loading cannot be established.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are economically feasible.
- **Step 4—Identify BACT.** Fabric filters are the most effective in controlling emissions. Therefore, use of a baghouse (fabric filter) constitutes BACT for the in-pit crusher.

The existing baghouse for the crusher is permitted at a grain loading of 0.016 grains per dry standard cubic feet (gr/dscf). KUC investigated the options of either upgrading the filter system in the baghouse or replacing the baghouse.

Based on the review the RBLC and CARB databases, KUC found small baghouses with the grain loading of 0.002 gr/dscf to 0.003 gr/dscf. Using the most stringent emissions rates, KUC requested vendor information on baghouse upgrades to meet the 0.002 gr/dscf grain loading. Based on the data provided by the vendors, the total installed costs for the upgraded baghouse would be about $608,000. Based on the grain loading of the upgraded baghouse, $PM_{2.5}$ emissions from the crusher will be reduced from 2.28 tpy after the primary control to 0.28 tpy. The vendor provided information is included in the Appendix.

Based on the costs for the baghouse replacement, the cost per ton of $PM_{2.5}$ removed is $304,000. Therefore, replacing the crusher baghouse is not cost effective for BACT. Additionally, the vendors are unable to guarantee continuous compliance with the low emission rate from the baghouse for the in-pit crusher.

The current emission rate therefore represents the most stringent measure for the in-pit crusher.

3.1.2 Disturbed Areas

Source Description: Disturbed areas from mining activities. KUC current practices include application of dust palliatives and revegetation of the areas as soon as practical, as well as water application from passing water trucks in the operational areas to minimize dust. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emissions controls information for disturbed areas from mining activities. However, the databases identify revegetation, adding moisture, and enclosures (wind screens) as possible control technologies for fugitive emissions.
- **Step 2—Eliminate Technically Infeasible Options.**

  Applying additional moisture (water) on the disturbed areas, as mining occurs, is not technically feasible for KUC's mine operations. The ore is transferred through a series of conveyors. Excessive moisture in the ore material causes the conveyors to foul and breakdown resulting in costly equipment repairs. Therefore, adding moisture to the ore material is not technically feasible.

  Because the disturbed areas are so expansive and cover varying terrain, adding enclosures or wind screens are not technically feasible for this mine source.

  However, at the request of UDAQ, KUC had discussions with mine management about the feasibility of application of water for dust control on the disturbed areas that have been released for reclamation. Because the areas are so expansive, set up of irrigation systems for watering is not technically feasible. Using water trucks would disturb the reclaimed areas and would not provide benefit over reclamation and would therefore not be technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 were technically infeasible or selected as BACT.
- **Step 4—Identify BACT.** The practice of applying dust palliatives and revegetation is the most effective in reducing emissions from disturbed areas that have been released for reclamation. Therefore, the application of palliatives and revegetation constitute BACT for areas released for reclamation.

The application of palliatives and revegetation also represent BACM for the disturbed areas. Because best available measures are in use, they also represent the most stringent measure.

3.1.3 Waste Rock Offloading from Trucks

Source Description: Haul trucks dump waste rock or overburden at the waste rock disposal areas while minimizing the height of the drop. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify water application and enclosures as possible control technologies for fugitive emissions from similar sources of emissions. Another possible control technology not identified, but effective in reducing emissions from batch drop transfer points, is minimizing the drop distance while the waste rock is being dumped.
- **Step 2—Eliminate Technically Infeasible Options.**

Because the drop location is not static, an enclosure is not technically feasible. Water application is not technically feasible because excessive water application may result in geotechnical issues on the waste rock dumps. Additionally, an installation or setup of a water irrigation system for water application is not technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as the remaining technology of minimizing the drop distance, while the waste rock is being dumped, is selected as BACT.
- **Step 4—Identify BACT.** Minimizing drop distances while the waste rock is being dumped is effective in controlling emissions and constitutes BACT.

Minimizing drop distances while the waste rock is being dumped also represents BACM. Because best available measures are in use, they also represent the most stringent measure.

3.1.4 Graders

Source Description: The graders primarily operate on the haul roads, maintaining surfaces of the roads. Particulate matter is controlled by the application of water and chemical dust suppressants to the roads. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify the application of water and chemical dust suppressants as a possible control technology for similar fugitive emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary constitute BACT.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the graders. Because best available measures are in use, they also represent the most stringent measure.

3.1.5 Bulldozers and Front-end Loaders

Source Description: The dozers and front-end loaders operate in the pit, on the haul roads performing cleanup operations, and in dumping operations at the waste rock disposal areas. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify the application of water and chemical dust suppressants as required as a possible control technology for similar fugitive emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary constitute BACT.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the bulldozers and front-end loaders. Because best available measures are in use, they also represent the most stringent measure.

3.1.6 Unpaved Haul Roads

Source Description: Haul roads are used to transfer ore and waste rock. The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary minimize emissions from the unpaved haul roads. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify potential technologies for control of fugitive emissions on unpaved haul roads as: paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance (including the use of road base material) of haul roads.
- **Step 2—Eliminate Technically Infeasible Options.** Paving the haul roads is not technically feasible at the mine because of the weight of the haul trucks, the rapid deterioration that would occur, and the frequently changing road locations. The location of these roads changes regularly making the paving of the surface infeasible. Paving the roads to minimize emissions is not technically feasible and will not be evaluated further. Additionally, with changing mine plans and haul routes, it is impossible to accurately estimate the costs for paving the road surface.

  Application of chemical dust suppressants is not technically feasible for some haul road locations because of the adverse effect the chemical can have on the coefficient of friction of the road surface. Given that the grade of the haul roads exceeds 10 percent in some locations, creating a slippery skin on the road inhibits the ability of mobile equipment to brake and steer safely while traveling on the grade.
- **Step 3**—**Eliminate Economically/Chronologically Infeasible Options.** The remaining technologies of water application, chemical dust suppressants outside of the pit influence boundary, limiting unnecessary traffic on roads, and routine maintenance of haul roads are economically and chronologically feasible.
- **Step 4**—**Identify BACT.** The application of water and road-base material within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary is effective in minimizing emissions. Watering the unpaved haul road reduces fugitive $PM_{2.5}$ and PM_{10} emissions by binding the soil particles together, reducing free particles available to be picked up by wind or vehicles. Additional watering and application of chemical dust suppressants on certain locations of unpaved haul roads also occurs when heavy traffic is expected along the road. Water is applied on a scheduled basis and supplemented as needed based on road conditions. Dust is also reduced through performing regular and routine maintenance of the haul roads (through use of road-base material) and limiting unnecessary traffic on roads.

In recent years, KUC has purchased newer haul trucks with higher capacity where possible, which has led to a decrease in the round-trips and vehicle miles traveled, thereby reducing fugitive dust emissions.

The annual fugitive dust control report for the mine is provided in the Appendix for reference.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the unpaved haul roads. Because best available measures are in use, they also represent the most stringent measure.

3.1.7 Tailpipe Emissions from Mobile Sources

Source Description: Tailpipe emissions from haul trucks and support equipment such as graders and dozers. Tailpipe emissions from the haul trucks and support equipment meet the required EPA standards for

NONROAD equipment. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify no add on control technologies for tailpipe emissions from haul trucks and support equipment of the size used at the BCM.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable.
- **Step 4—Identify BACT.** Haul trucks and support equipment used at the facility meet the required EPA standards for nonroad equipment. The facility uses on-road specification diesel fuel in its off-road equipment. In 2007, an EPA ruling required sulfur content in all on-road specification diesel fuels be reduced (from 50 parts per million [ppm] formerly to 15 ppm currently). Because only on-road specification diesel fuel is used in its equipment, the facility has also made a transition to ultra-low sulfur diesel fuel. All the facility's diesel-powered equipment now runs on ultra-low sulfur diesel fuel.

  Additionally, the facility periodically upgrades its haul truck fleet to also take advantage of available higher-tier-level, lower-emitting engines. In recent years, KUC has purchased newer haul trucks with higher capacity where possible, which has led to a decrease in round-trips and truck operating hours, thereby reducing emissions.

  Purchasing new haul trucks with higher capacity and Tier level which meet its mining needs also represents the most stringent measure.

  During the previous SIP work in 2014, KUC developed a detailed analysis for the haul truck engine repowering and upgrade to higher tier level trucks. The analysis is provided in the Appendix.

3.1.8 Fueling Stations

Source Description: Adding gasoline and diesel to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify two control techniques for controlling VOC emissions from gasoline and diesel fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

  The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the fueling stations.

3.1.9 Cold Solvent Degreasers

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed always to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for degreasers.

A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the mine were 1.7 tpy. The previously identified practices also represent the most stringent measure for the degreasers.

3.1.10 Mine Conveyor Transfer Points

Source Description: The mine has two ore conveyor transfer drop points — Point C6/C7 and Point C7/C8. All exhaust air and particulate emissions from each transfer drop point are routed through the respective baghouse before being vented to the atmosphere. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify baghouse (fabric filter) and enclosures with water sprays as possible control technologies for limiting emissions from transfer points.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Fabric filters are the most effective in controlling emissions. Therefore, the baghouse (fabric filter) constitutes BACT for the conveyor transfer points.

The baghouse for each of the transfer points is permitted at a grain loading of 0.007 gr/dscf. The 2014 actual $PM_{2.5}$ emissions for conveyor transfer points controlled with a baghouse were 0.69 and 0.42 tpy each. Due to the low level of emissions from these sources, the BACT analysis did not evaluate the upgrade of the baghouses for these units. Additionally, based on the economics data presented in Section 3.1.1 of this document for baghouse replacement/upgrades, any upgrades or replacement would not be economically feasible.

This emission rate also represents the most stringent measure for the conveyor transfer points.

3.1.11 Lime Bins

Source Description: The Copperton Concentrator has two lime silos used for lime storage. Particulate emissions generated during loading and unloading operations are vented through a filter. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify vent filters and enclosures as possible control technologies for limiting emissions from storage silos.

- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Vent filters are the most effective in controlling emissions. Therefore, bin vent filters constitute BACT for the lime silos/bins.

The vent filter for each of the lime silos is permitted at a grain loading of 0.016 gr/dscf. These units are operated intermittently. The 2014 actual $PM_{2.5}$ emissions for the two lime silos controlled with a baghouse were 0.02 tpy. Due to the low level of emissions from these sources, the upgrade of the vent filters for these units would not be economically feasible.

This emission rate also represents the most stringent measure for the lime silos.

3.1.12 Sample Preparation Building

Source Description: The sample preparation building at the mine is used for preparation of waste rock and ore samples for testing. Particulate emissions from the sample preparation building are vented through a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify baghouses and enclosures as possible control technologies for limiting emissions from buildings or enclosed areas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Baghouses are the most effective in controlling emissions. Therefore, the fabric filters (baghouse) constitute BACT for the sample preparation building.

The baghouse for the sample preparation building is permitted at a grain loading of 0.016 gr/dscf. The building and the control system are operated intermittently. The 2014 actual $PM_{2.5}$ emissions for the sample preparation building controlled with a baghouse were 0.05 tpy. Due to the low level of emissions from these sources, the upgrade of the baghouse for the unit would not be economically feasible.

This emission rate also represents the most stringent measure for the sample preparation building.

3.1.13 Propane Communications Generators

Source Description: The mine operates six (6) propane fired communications generators. These generators are used to support mine communication systems during emergencies or loss of power in the mine. Emissions are controlled with good combustion practices while operating the generators. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify good combustion practices as the primary control technology for emergency generators between 70 HP and 150 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generators. The emergency generators also comply with applicable New Source Performance Standards.

It should be noted that the 2014 actual $PM_{2.5}$ and precursor emissions for all the propane emergency generators combined were 0.18 tpy.

Good combustion practices also represent the most stringent measure for the propane communication generators.

3.1.14 Ore Handling

Source Description: The mined ore is moved around the mine through conveyors and trucked to the stock piles as needed. The sources include Truck Offloading Ore Main In-pit Crusher, Truck Offloading Ore Stockpile, Main In-Pit Enclosed Transfer Points, Conveyor-stacker Transfer Point, Coarse Ore Stacker and Reclaim Tunnels. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emission controls for such material handling sources from a copper mine. The location of many of these sources change regularly making the construction of emission controls such as enclosures and application of dust suppressants infeasible for such sources. Therefore, potential control technologies include material characteristics such as large size with minimal quantities of fine material, enclosures and inherent moisture content as applicable to the emission source.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Material characteristics such as large ore size and presence of very small quantities of fine material are identified as BACT for the ore handling sources.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for these ore handling sources were 0.94 tpy.

The material characteristics such as large ore size and presence of very small quantities of fine material, inherent moisture content and enclosures also represent the most stringent measure for the ore handling emission sources.

3.1.15 Ore Storage Pile

Source Description: Low grade ore is stockpiled at the mine and blended into the process as necessary. Potential wind-blown dust emissions are minimized through application of water sprays and chemical dust suppressants and compaction. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify water sprays, chemical dust suppressants and compaction as potential control technologies to minimize emissions from large storage piles.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Water sprays, chemical dust suppressants and compaction are identified as BACT for the ore storage pile.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for the ore storage pile were 0.33 tpy.

These controls also represent the most stringent measure for the ore storage pile.

3.1.16 Road Base Crushing and Screening Plant

Source Description: The mine has semiportable plants that crush and screen rock for use for base material on the unpaved haul roads. Particulate emissions from the crushing, screening, and transfer operations are effectively controlled with water sprays and belt enclosures. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emission controls for a road base crushing and screening plant for a copper mine. However, possible control technologies include baghouses, enclosures and water sprays for minimizing emissions from the road base crushing and screening plant.
- **Step 2—Eliminate Technically Infeasible Options.** The road base crushing system is moved through the mine to facilitate the production of road base material to meet demands. As a result, permanent installation of a baghouse to control emissions from the plant is not technically feasible. Water Sprays and temporary enclosures are feasible for the plant.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technically feasible technologies are economically feasible.
- **Step 4—Identify BACT.** Water sprays and enclosures are identified as BACT for the road base crushing and screening plant.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for the road base crushing and screening plant were 0.05 tpy.

These controls also represent the most stringent measure for the road base crushing and screening plants.

3.1.17 Drilling and Blasting

Source Description: Drilling and blasting are performed at the mine to access new ore bodies. Water injection is used to minimize emissions from drilling. The blast areas are controlled as practical to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific controls for drilling and blasting in open pit mines. Based on the mining experience, KUC identifies water injection and maintaining control of blast areas as potential control technologies to minimize emissions from drilling and blasting.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.

- **Step 4—Identify BACT.** Water injection and maintaining control of blast areas are identified as BACT from drilling and blasting operations.

It should be noted that the 2014 actual $PM_{2.5}$ and precursor emissions for drilling and blasting sources were 0.75 tpy. These controls also represent the most stringent measure for the drilling and blasting operations.

3.1.18 Solvent Extraction and Electrowinning Process

Source Description: Tanks, mixers and settlers are used in the solvent extraction and electrowinning process. Covers are used to minimize emissions from these sources. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific controls for solvent extraction and electrowinning process. Based on the mining experience, KUC identifies covers on process equipment to minimize emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Use of covers is identified as BACT for the solvent extraction and electrowinning process.

It should be noted that potential emissions of $PM_{2.5}$ and precursors for solvent extraction and electrowinning are minimal.

These controls also represent the most stringent measure for the solvent extraction and electrowinning process.

3.2 Copperton Concentrator

3.2.1 Tioga Heaters

Source Description: Natural gas-fired heaters are used throughout the Copperton Concentrator. The heaters are rated at less than 5 MMBTU/hr each. Specifically, the facility includes seven (7) 4.2 MMBtu/hr natural gas fired heaters and one (1) 2.4 MMBtu/hr natural gas fired heater. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.1.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC for controlling NO_x emissions from heaters of good combustion practices is already in use and constitutes BACT.

3.2.1.2 $PM_{2.5}$, SO_2, CO, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify the use of pipeline quality natural gas and good combustion practices as control technology for minimizing $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters and these control technologies constitute BACT.

At the request of UDAQ, KUC contacted vendors regarding the feasibility of replacement of the 8 Tioga heaters at the Copperton Concentrator.

Based on the data provided by the vendors, the total installed cost of the eight new heaters is estimated to be $940,000. The costs assume the installation costs to be 35 percent of the equipment costs. Theses heaters will be equipped with the latest burner technology. Assuming the new heaters will minimize NOx emissions by 90% from current levels, the new heaters might reduce the annual emissions from the Tioga heaters from 6.2 tpy (based on PTE emissions for the heaters) to 0.68 tpy. The vendor provided information is included in the Appendix.

Based on the costs for the new heaters, the cost of new heaters per ton of NO_x removed is $153,000. Therefore, replacing the Tioga heaters is not cost effective for BACT.

Low NO_X burners, use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the Tioga heaters.

3.2.2 Pebble Crushing System

Source Description: The pebble crushing system includes crusher and ore handling conveyors and transfer points. The system is placed inside a building to minimize particulate emissions to the atmosphere. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify baghouses, wet scrubbers, water sprays and enclosures as possible control technologies to minimize emissions from a crushing plant.
- **Step 2—Eliminate Technically Infeasible Options.** Because the emissions will be vented inside the building, wet scrubbers and fabric filters are not technically feasible. Water sprays are not feasible as the water makes the material too wet to crush.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technically feasible technologies are feasible.
- **Step 4—Identify BACT.** Enclosures, or placing the source inside the building, is effective in minimizing emissions from the crusher operations and identified as BACT for the pebble crushing system.

It should be noted, the 2014 actual $PM_{2.5}$ emissions for the pebble crushing system were 0.07 tpy. This control also represents the most stringent measure for the pebble crushing system.

3.2.3 Cold Solvent Degreasers

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed always to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for degreasers.

A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the concentrator were 0.08 tpy.

The previously identified practices also represent the most stringent measure for the degreasers.

3.2.4 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted that the 2014 actual VOC emissions for the gasoline fueling stations at the Copperton Concentrator were 0.29 tpy.

The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.2.5 Molybdenum Storage Bins and Loading Bags

Source Description: The Copperton Concentrator has molybdenum storage bins from which bags are loaded for offsite shipping. Particulate emissions generated during loading and unloading operations are vented through a filter. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify vent filters and enclosures as possible control technologies for limiting emissions from storage silos.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Vent filters are the most effective in controlling emissions. Therefore, bin vent filters constitute BACT for the molybdenum storage bins and loading bags.

The 2014 actual $PM_{2.5}$ emissions for these operations controlled with a bin vent filter were 0.5 tpy. Due to the low level of emissions from these sources, the upgrade of the vent filters for these units would not be economically feasible.

This control technology also represents the most stringent measure for the process.

3.2.6 Feed and Product Dryer Oil Heaters

Source Description: Natural gas-fired heaters provide heat to the feed and product dryers that are used in molybdenum process at the Copperton Concentrator. The heaters are rated at 5.7 MMBTU/hr and 2.2 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.6.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify Low NO_X burners and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC and CARB for controlling NO_x emissions from heaters of Low NO_X Burners and good combustion practices is already in use and constitutes BACT.

3.2.6.2 $PM_{2.5}$, SO_2, CO, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify use of pipeline quality natural gas and good combustion practices as control technologies for minimizing $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB databases identify use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters and these control technologies constitute BACT.

Low NO_X burners, use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the heaters. Due to low level of emissions from these units, upgrading these would not be economically feasible.

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

4.1 Bingham Canyon Mine

KUC is proposing the following limitations and monitoring requirements for the Bingham Canyon Mine.

- Maximum total mileage per calendar day for ore and waste haul trucks shall not exceed 30,000 miles. KUC shall keep records of daily total mileage for all periods when the mine is in operation. KUC shall track haul truck miles with a Global Positioning System (GPS) or equivalent.
- KUC Shall Use Ultra-low Sulfur Diesel Fuel in Its Haul Trucks.
- To minimize emissions at the mine:
- The owner/operator shall control emissions from the in-pit crusher with a baghouse.
- Apply water to all active haul roads as weather and operational conditions warrant, except during precipitation or freezing conditions, and apply a chemical dust suppressant to active haul roads located outside of the pit influence boundary no less than twice per year.
- A chemical dust suppressant shall be applied as weather and operational conditions warrant except during precipitation or freezing conditions on unpaved access roads that receive haul truck traffic and light vehicle traffic.
- KUC is Subject to the Requirements in the Most Recent Federally approved Fugitive Emissions and Fugitive Dust Rule.

Supporting Information

The condition above establishes a limitation on daily activity. The daily mileage limitation effectively limits fugitive road dust emissions, tailpipe emissions from the haul trucks, and overall activity of sources at the mine. Ore processing at the Copperton Concentrator, which results in minimal emissions, is also limited through the BCM activity limitations.

Emissions resulting from the movement of ore and waste around the mine represent a significant portion of overall emissions at the BCM. The emissions related to material movement include fugitive dust generated from truck travel on the haul roads and the tailpipe emissions from the haul trucks. Specifically, on an annual basis, greater than 99.9 percent of total mine emissions for NO_X and SO_2 come from the haul truck tailpipes. Also, on an annual basis, material movement represents 85 percent of the overall particulate emissions at the BCM. Based on these emissions, the material movement of ore and waste by haul trucks represents a vast majority of overall emissions at the BCM and can effectively be used to represent mine operations.

Daily emissions from the BCM can be regulated with the limitation on vehicle miles traveled by ore and waste haul trucks of 30,000 miles per day. Compliance with this limitation is demonstrated daily and is an appropriate metric for a 24-hour particulate standard.

It should be noted that the 30,000 miles per day limitation also limits overall BCM operations. Ancillary mining activities such as operation of the in-pit crusher, mining support equipment, blasting, and drilling only occur to produce an adequate amount of ore and waste rock that can be hauled via the trucks and sent to the concentrator via the conveyor system.

On a 24-hour basis, these emissions can be represented with the 30,000 miles per day limitation. Since they effectively represent mine operations, a single daily limitation is appropriate in the SIP for the BCM. These emissions have been included in the appropriate SIP model.

KUC uses a real-time tracking system for both tracking haul trucks as well as for recording miles travelled. These records are used to comply with the 30,000 miles per day limitation. The system may be a GPS or a system with similar tracking capabilities necessary to comply with this condition.

The condition also establishes a requirement for the use of ultra-low sulfur diesel fuel in haul trucks.

The conditions require the control of emissions from the in-pit crushers with a baghouse.

The condition also establishes requirements for reducing and controlling fugitive particulate emissions from active unpaved haul roads at the mine. Water and chemical dust suppressants shall be used to minimize fugitive dust.

Specifically, active ore and waste haulage roads within the pit influence boundary are water sprayed and/or treated with a commercial dust suppressant. Crushed road-base material is applied to active ore and waste haulage roads within the pit influence boundary to enhance the effectiveness of fugitive dust control measures. Commercial dust suppressants are applied to active ore and waste haulage roads outside of the pit influence boundary no less than twice per year.

Each year KUC reports dust control measures implemented at the BCM during the previous year with details such as volume of water applied, commercial dust suppressant activity, etc.

KUC is subject to the fugitive dust rules approved by UDAQ and EPA. These rules outline requirements that mines are to follow in minimizing the fugitive dust from the mining operations.

4.2 Copperton Concentrator

No limitations or monitoring requirements are proposed for the Copperton Concentrator emission sources as the emissions from the facility are minimal and are effectively controlled with the implementation of BACT.

Attachments

- In-pit Crusher Baghouse Vendor Data
- Mine FDCP Report
- Haul Trucks Analysis
- Degreaser Solvent SDS
- Tioga Heaters Vendor Information

FINAL

BACT Determinations for the Utah Power Plant, Tailings Site, and Laboratory

Prepared for

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February 2018

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Contents

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Acronyms and Abbreviations

AO	approval order
BACT	best available control technology
CAA	Clean Air Act
CatOx	catalytic oxidation
CO	carbon monoxide
DLN	dry low nitrogen
EPA	Environmental Protection Agency
KUC	Kennecott Utah Copper
LNB	low NO_x burner
MMBTU/hr	million British Thermal Units per hour
MW	megawatts
NAAQS	National Ambient Air Quality Standard
NOx	nitrogen oxides
OFA	over-fire air
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppmvd	parts per million by volume dry
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearinghouse
SCR	selective catalytic reduction
SIP	State Implementation Plan
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
tpy	tons per year
UDAQ	Utah Department of Air Quality
UPP	Utah Power Plant
VOC	volatile organic compound

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SECTION 1

Introduction

Kennecott Utah Copper, LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities located at the northwest corner of Salt Lake County, Utah: Utah Power Plant (UPP), tailings site, and the laboratory. The tailings site receives tailings in slurry form. The slurry is deposited in the tailings pond. The UPP is a coal and natural gas fired power plant that supplies power for KUC operations. Coal is used to fuel the plant in spring, summer, and fall; while natural gas is approved for use in the winter months. The laboratory is used to perform various tests and functions to optimize operations through analysis of materials. In addition to a BACT analysis, KUC has also documented the most stringent measure for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and to meet any reasonable further progress requirements. As requested by the Utah Division of Air Quality (UDAQ), the BACT analysis should identify and evaluate BACT for each relevant pollutant. The technical and economic feasibility of each potential technology are components of the BACT analysis that help to show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC). For each emission source, the BACT analysis followed a four-step process:

- **Step 1**—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC) and/or California Environmental Protection Agency – Air Resource Board BACT Clearinghouse (CARB)
- **Step 2**—Eliminate technically infeasible options
- **Step 3**—Eliminate economically/chronologically infeasible options
- **Step 4**—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent most stringent measure.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS was combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends that BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development.

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SECTION 2

Recent Permitting Actions

An approval order (AO) was issued for the UPP on November 10, 2015, which authorized the construction and operation of a natural gas fired emergency generator. Issued in 2011, AO DAQE-AN105720026-11 authorized KUC to replace Boiler Units 1, 2, and 3 with a new natural gas fired combustion turbine operating in combined cycle mode with a heat recovery steam generator. The new combustion turbine will be equipped with state of the art add-on controls to minimize emissions from the unit and represents BACT. Dry low nitrogen oxide (DLN) combustors and the selective catalytic reduction (SCR) system will control NO_x emissions. The catalytic oxidation (CatOx) system will control carbon monoxide (CO) and VOC emissions. Good combustion practices and burning natural gas will minimize emissions of the remaining pollutants.

The tailings site is permitted under AO DAQE-AN10572018-06. The emissions sources at the laboratory are permitted under AO DAQE-261-95. All three facilities operate under a single Title V Operating Permit #3500346002.

The current potential to emit (PTE) emissions in tons per year (tpy) for the tailings site, UPP, and the laboratory are shown in Table 1-1.

Table 2-1. Facility Potential to Emit

	PM_{10} PTE (tpy)	**$PM_{2.5}$ PTE (tpy)**	**NO_x PTE (tpy)**	**SO_2 PTE (tpy)**	**VOC PTE (tpy)**
UPP	248	248	1,641	2,577	41
Tailings Site	36.3	5.4**	0.26	—*	0.04
Laboratory	0.12	0.12	0.68	0.13	0.12

Notes:
$PM_{2.5}$ = particulate matter 2.5 microns or smaller in aerodynamic diameter
PM_{10} = particulate matter 10 microns or smaller in aerodynamic diameter
PTE = potential to emit
NO_x = oxides of Nitrogen
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compounds
*Permitted combustion sources result in negligible SO_2 emissions at the tailings site.
**$PM_{2.5}$ emissions are estimated to be 15 percent of PM_{10} emissions.

Distinguishing by season of operation is allowed under EPA's *Implementation Guidance for the 2006 24-hour Fine Particle NAAQS* (March 2, 2012), which specifically acknowledges that several nonattainment areas located in the western United States only have experienced exceedances during the winter season. In such cases, the EPA authorizes states to (1) develop a seasonal emission inventory and (2) evaluate emission reduction strategies for a single season only [p. 11]. "When following a seasonal approach, the EPA believes that *the control strategy evaluation* (based on seasonal emission reduction measures) and the assessment of future year air quality concentrations (through air quality modeling or other analyses) *should be conducted for that season*." [p. 12]. In view of the nature of Utah's $PM_{2.5}$ nonattainment circumstance, the BACT analysis for UPP focuses primarily on a wintertime control strategy.

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SECTION 3

BACT Determinations

This section provides BACT determinations for emission sources deemed significant at the UPP, Tailings site, and Laboratory.

3.1 Utah Power Plant

Historically, KUC has operated three coal fired boilers rated at 100 megawatts (MW) combined, referred to as Units 1-3, at the UPP. The units operated on coal during the spring, summer and fall months, but were limited to burning natural gas during the winter months between November 1 and March 1. In October 2016, KUC permanently ceased operation of Units 1-3. Therefore, a BACT analysis for Units 1-3 is not included in this document.

3.1.1 UPP Unit 4 Boiler

Source Description: Tangentially fired boiler capable of burning both coal and natural gas, rated at 838 million British Thermal Units per hour (MMBTU/hr) (coal), or 872 MMBTU/hr (natural gas), equipped with an electrostatic precipitator. Since the ambient 24-hour concentrations of $PM_{2.5}$ exceed the NAAQS during the winter months, the BACT analysis is limited to controls for the combustion of natural gas, which are the only controls that may affect the attainment of the $PM_{2.5}$ NAAQS in the Salt Lake City nonattainment area. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.1.1 NO_x BACT

- **Step 1—Identify All NO_x Control Technologies listed in RBLC and CARB.** The RBLC and CARB identifies (1) low NO_x burners with over-fire air (low NO_x burner [LNB] with over-fire air [OFA]) and (2) LNB with OFA and SCR as potential technologies for NO_x control from a natural gas fired boiler.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Previous SIP determination for UPP Unit 4 required the installation of LNB with OFA and SCR with 90% NO_X control when operating on natural gas during the winter months between November 1 and March 1. Because the top technology is already identified in previous SIPs, additional analysis is not necessary.
- **Step 4—Identify BACT.** LNB with OFA and SCR with 90% control efficiency constitute BACT for controlling NO_x emissions from natural gas combustion in the boiler during the wintertime period (November 1 through March 1).

Control efficiency of 90% for LNB with OFA and SCR is a default value used by the industry. A detailed design of the control systems would be necessary to develop anticipated control efficiency for Unit 4. Due to SIP time constraints, a detailed design is not feasible and therefore it is recommended that UDAQ use the default value.

3.1.1.2 SO_2 BACT

- **Step 1—Identify all SO_2 Control Technologies listed in RBLC and CARB.** The RBLC identifies the use of pipeline quality natural gas as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4— Identify BACT.** The use of pipeline quality natural gas constitutes BACT when burning natural gas.

3.1.1.3 $PM_{2.5}$ BACT

- **Step 1—Identify all $PM_{2.5}$ Control Technologies listed in RBLC.** The RBLC identifies good combustion practices as a control for reducing $PM_{2.5}$ when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Good combustion practices constitute BACT while burning natural gas.

3.1.1.4 VOC BACT

- **Step 1—Identify all VOC Control Technologies listed in RBLC.** The RBLC identifies good combustion practices as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4— Identify BACT.** Good combustion practices constitute BACT for VOC while burning natural gas.

Controlling NO_X emissions by 90 percent with LNB, OFA, and SCR and the use of pipeline quality natural gas and good combustion practices represent the most stringent measure for Unit 4 at the UPP when operating on natural gas between November 1 and March 1.

3.1.2 UPP Unit 5 Combustion Turbine and Duct Burner

Source Description: A combustion turbine and duct burner in combined-cycle operation with a nominal generating capacity of approximately 275 MW, equipped with SCR and CatOx. Construction of Unit 5 is not complete at this time.

3.1.2.1 NO_x BACT

- **Step 1—Identify All NO_x Control Technologies listed in RBLC and CARB.** The RBLC and CARB databases identifies selective noncatalytic reduction (SNCR) and SCR as potential technologies for NO_x control. The SCR technology is the most stringent control alternative listed in the RBLC.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** SCR constitutes BACT for controlling NO_x emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.2 VOC BACT

- **Step 1—Identify All CO and VOC Control Technologies listed in RBLC and CARB.** The RBLC identifies CatOx to control emissions of CO and VOC.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** CatOx constitutes BACT for controlling CO and VOC emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.3 SO_2 BACT

- **Step 1—Identify All SO_2 Control Technologies listed in RBLC and CARB.** The RBLC identifies the use of pipeline quality natural gas and good combustion practices as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The use of pipeline quality natural gas and good combustion practices constitute BACT for controlling SO_2 emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.4 $PM_{2.5}$ BACT

- **Step 1—Identify All $PM_{2.5}$ Control Technologies listed in RBLC and CARB**. The RBLC identifies the use of pipeline quality natural gas and good combustion practices as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The use of pipeline quality natural gas and good combustion practices constitute BACT for controlling $PM_{2.5}$ emissions from the Unit 5 combustion turbine and duct burner.

Limiting NO_X emissions to 2 parts per million by volume dry (ppmvd) at 15% O_2; CatOx for control of CO and VOC emissions; and the use of pipeline quality natural gas and good combustion practices represent the most stringent measure for Unit 5 at the UPP.

3.1.3 Cooling Towers

Source Description: Noncontact water cooling towers are used to control waste heat from the boilers. All towers are equipped with drift eliminators with drift loss rated at 0.002 percent. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Drift eliminators and good operating practices constitute BACT.

The existing Unit 4 Cooling Tower could be upgraded with 0.001 percent drift factor from the existing 0.002%. Based on KUC's discussions with the vendors, the total installed costs for the upgrade of the drift eliminator would be $177,000. The upgrade of the drift eliminators would reduce the annual emissions from the Unit 4 Cooling Tower from 3.49 tpy (PTE emissions for the cooling tower) to about 1.75 tpy. The vendor provided information is included in the Appendix.

Based on the costs for the drift eliminator upgrade, the cost per ton of $PM_{2.5}$ removed is $102,000. Therefore, replacing the replacing the existing drift eliminator with a high efficiency drift eliminator is not cost effective for BACT. Based on this cost effectiveness analysis, eliminators with 0.0005% drift loss are not further evaluated as they would not be cost effective as well.

The use of drift eliminators with drift loss rated at 0.002 percent and good operating practices represent the most stringent measure for the cooling towers.

The overall cost is $102,000 per ton of $PM_{2.5}$ removed but when amortized over a 20 year period the cost is reduced to $5,100/ton of $PM_{2.5}$ removed. This is cost effective as BACT.

If the cooling towers with a 0.0005% drift loss were implemented, then the cost may even be lower.

3.1.4 Tioga Space Heaters

Source Description: Natural gas-fired space heaters are used for comfort heating and cooling, and water heating throughout the power plant. The space heaters use low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. All space heaters are rated at less than 5 MMBTU/hr. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.4.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC and CARB for controlling NO_x emissions from heaters (LNB and good combustion practices) are already in use and constitute BACT.

3.1.4.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for Tioga Space Heaters at the UPP. As discussed in the BACT analysis for other KUC facilities, replacing the existing space heaters with new heaters is not cost effective for the BACT analysis.

3.1.5 Cold Solvent Degreaser

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identifies operating practices such as closing the degreaser lids as a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed at all times to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for the degreaser.

A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the UPP were 0.3 tpy.

The previously identified practices also represent the most stringent measure for the degreasers.

3.1.6 Natural Gas Emergency Generators

Source Description: The UPP operates two 1.2 MMBTU/hr natural gas generators. Emissions are controlled with good combustion practices while operating the generator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for natural gas generators less than 5 MMBTU/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the natural gas generators.

It should be noted, the 2014 actual emissions for $PM_{2.5}$ and precursors for the natural gas generators were 0.18 tpy.

Good combustion practices also represent the most stringent measure for the natural gas generators.

3.1.7 Roads at UPP

Source Description: Unpaved and paved access roads exist throughout the UPP and are used by KUC personnel daily. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies potential technologies for control of fugitive emissions on unpaved roads as: paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance of roads.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 4—Identify BACT.** Paving sections of the road, the application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are identified as BACT for the roads at the UPP.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from roads at the UPP were 0.27 tpy. Paving sections of the road, the application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads also represent the most stringent measure for the roads at the UPP.

3.1.8 Hot Water Heater

Source Description: Natural gas-fired water heater is used for water heating throughout the power plant. The water heater uses low NO_x burners (LNB) and regular inspections are done to the unit to ensure optimum combustion performance. The water heater is rated at 7.13 MMBTU/hr. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.8.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC for controlling NO_x emissions from the heater (LNB and good combustion practices) are already in use and constitute BACT.

3.1.8.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from the heater.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.

- **Step 4—Identify BACT.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from the heater and these control technologies constitute BACT.

The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for the hot water heater at the UPP.

3.1.9 Coal and Ash Handling at UPP

Source Description: Coal and ash handling system that includes small coal storage pile, conveyors, and coal and ash storage silos. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies potential technologies for control of fugitive emissions from coal and ash handling as enclosures and water sprays.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 4—Identify BACT.** Enclosures and water sprays are identified as BACT for coal and ash handling at the UPP.

It should be noted, the 2014 actual $PM_{2.5}$ emissions from coal and ash handling at the UPP were 0.92 tpy. Enclosures and water sprays also represent the most stringent measure for coal and ash handling at the UPP.

3.1.10 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted, the 2014 actual VOC emissions for the gasoline fueling stations at the UPP were 0.33 tpy.

The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.1.11 Diesel Fire Pump

Source Description: The UPP operates 175 HP diesel-fired fire pump during emergencies. The fire pump complies with applicable New Source Performance Standards to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. Potential emission control technologies identified in the RBLC and CARB for similar sized diesel fire pumps include good combustion practices and limiting the sulfur content of fuel to 0.0015 percent. Certification and compliance with applicable New Source Performance Standards is an acceptable means of demonstrating BACT for emergency fire pumps.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements are identified as BACT for all pollutants emitted from the emergency fire pump.

It should be noted that the 2014 actual emissions from the fire pump of $PM_{2.5}$ and precursors were 0.12 tpy.

Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements also represent the most stringent measure for the emergency fire pump.

3.1.12 Diesel Engine for Coal Unloading System

Source Description: The UPP had a170 HP diesel-fired engine to operate the coal unloading system. This emission source no longer exists at the UPP. Therefore, a BACT analysis has not been developed for this emission source.

3.2 Tailings Site

3.2.1 Wind Erosion from Tailings Site

Source Description: Tailings are sent to the tailings site via a slurry pipeline. At the facility, tailings are separated by size in a cyclone with the larger particles used to build the embankments and the smaller particles discharged in slurry form in the impoundment. Emissions from the tailings site are mainly from wind erosion of dry tailings on the embankment. The facility has a current dust control plan approved by the UDAQ Executive Director for control of fugitive particulate matter. A copy of the quarterly report that documents dust control measures implemented at the facility is included in the Appendix for reference. The dust control plan requires frequent monitoring of the impoundment for wind erosion potential, applying chemical dust suppressants in the late spring, applying water via water trucks and the dust suppression sprinkler system as needed to maintain adequate moisture content.

In 2013, KUC conducted a study to identify and evaluate the range of dust control practices that have been attempted and successfully applied for mine tailings impoundments. A study also reviewed published literature and available air quality compliance documentation to extend the breadth of the evaluation. The study is included in the Appendix.

The tailings site can be categorized into four operational areas: impoundment, active embankment, inactive embankment, and reclaimed areas. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.2 BACT Analysis for Tailings Impoundment

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

Watering

Polymer application

Revegetation

Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists in minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the impoundment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.**

The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.

- **Step 4—Identify BACT.** The impoundment area is saturated with water and does not result in windblown dust emissions. Visual inspections are routinely performed to ensure the impoundment is saturated with water and in the unlikely event an area appears to be drying out, the area would be re-saturated. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions. Additionally, the impoundment area is saturated with water and does not result in windblown dust emissions.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.3 BACT Analysis for Tailings Active (Flat) Embankments

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

Watering

Polymer application

Revegetation

Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the embankment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.
- **Step 4—Identify BACT.** The tailings are actively deposited in the embankment areas. In an active embankment cell, the tailings are deposited every fourth day. The tailings are extremely wet when deposited. Areas can remain moist for several days. Application of water for dust control in active areas is not feasible as it tends to channelize directly to the drain point instead of spreading across the surface. The flat embankment areas will therefore have a potential for wind erosion on days 2, 3, and 4. Emissions are estimated based on days with potential for wind erosion. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions and identified as BACT.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.4 BACT Analysis for Tailings Inactive and Sloped Embankments

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

  Watering

  Polymer application

  Revegetation

  Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the embankment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.

- **Step 4—Identify BACT.** In the inactive embankment areas, where tailings deposition has been completed for the year, KUC installs sprinklers for watering. Over the past few years, KUC converted this to an automated sprinkler system that wets the surface at regular intervals. This upgrade allows the surface to maintain its moisture.

  The embankment slopes are sprayed with polymers to minimize windblown dust. Polymer is reapplied as necessary to maintain its effectiveness to minimize emissions. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions and identified as BACT.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.5 BACT Analysis for Tailings Reclaimed Areas

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

  Watering

  Polymer application

  Revegetation

  Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the reclaimed areas, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.
- **Step 4—Identify BACT.** Once released for reclamation, KUC implements a revegetation plan to reclaim the areas. Polymers are applied to areas still waiting to be reclaimed. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions and are identified as BACT.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.6 Service Roads

- **Source Description:** Service roads exist throughout the tailings site and are used by KUC personnel daily.
- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies potential technologies for control of fugitive emissions on unpaved roads as; paving the unpaved roads, the

application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance of roads.

- **Step 2—Eliminate Technically Infeasible Options.** Paving the haul roads is not technically feasible at the tailings site because of the frequently changing road locations over time resulting from tailing placement.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The remaining technologies of water application, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are economically and chronologically feasible.
- **Step 4—Identify BACT.** The application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are identified as BACT for the service roads.

The application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads also represent the most stringent measure for the service roads at the tailings site.

3.2.7 Propane Communication Generator

Source Description: The tailings facility operates a propane fired communication generator. This generator is used to support communication systems during emergencies or loss of power at the tailings facility. Emissions are controlled with good combustion practices while operating the generator.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for emergency generators around 75 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- St**ep 3—Eliminate Economically/Chronologically Infeasible Options**. Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generator. The emergency generator also complies with applicable New Source Performance Standards.

Good combustion practices also represent the most stringent measure for the propane communication generator.

3.2.8 Biosolids Application

Source Description: Salt Lake County and Salt Lake City operate small landfill type operations that produce organic material which are used by the Tailings Facility to enhance the reclamation of closed tailings areas. The application of biosolids does not result in any emissions of $PM_{2.5}$, SO_2, NO_X or VOC. Very small quantities of ammonia emissions are estimated from these operations resulting from the natural process of decomposition. Therefore, a BACT analysis is not developed for this emission source. The 2014 actual emissions from the source were 0.021 tpy of ammonia.

3.3 Laboratory

3.3.1 Hot Water Boiler

Source Description: Natural gas-fired water boiler is used for water heating for the laboratory. The water boiler uses low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. The water heater is rated at 7.1 MMBTU/hr.

3.1.8.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from boilers less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC and CARB for controlling NO_x emissions from the boiler (LNB and good combustion practices) are already in use and constitute BACT.

3.1.8.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from the boiler.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from the boiler and these control technologies constitute BACT.

  The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for the hot water boiler at the laboratory.

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SECTION 4

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

4.1 Utah Power Plant

Unit 5

KUC is proposing the following limitations and monitoring requirements for the UPP. Unit 5 shall not exceed the following emission rates to the atmosphere.

Pollutant	lb/hr	ppmvd (@ 15% O_2)
NO_x		2.0*
$PM_{2.5}$ with duct firing: Filterable and condensable	18.8	

Note:
*Under steady state operation

Stack testing to show compliance with the above Unit 5 emissions limitations shall be performed as follows:

Pollutant	Test Frequency
$PM_{2.5}$	every year
NO_x	every year

The heat input during all compliance testing shall be no less than 90% of the design rate.

Unit 4

The following requirements are applicable to Unit 4 during the period November 1 to February 28/29 inclusive:

During the period from November 1, to the last day in February inclusive, only natural gas shall be used as a fuel, unless the supplier or transporter of natural gas imposes a curtailment. The power plant may then burn coal, only for the duration of the curtailment plus sufficient time to empty the coal bins following the curtailment.

Except during a curtailment of natural gas supply, emissions to the atmosphere from the indicated emission points shall not exceed the following rates and concentrations:

Pollutant	Grains/dscf	ppmdv (3% O_2) 68˚F, 29.92 in. Hg
$PM_{2.5}$ Filterable	0.004	
Filterable and condensable	0.03	
NO_x		336
NO_x (after 1/1/2018)		60

If operated during the winter months, stack testing to show compliance with the above Unit #4 emissions limitations shall be performed as follows:

Pollutant	Test Frequency
$PM_{2.5}$	every year
NO_x	every year

The heat input during all compliance testing shall be no less than 90% of the maximum average hourly production rate achieved in any 24-hour period during the previous three (3) years. The limited use of natural gas during startup, for maintenance firings and break-in firings does not constitute operation and does not require stack testing.

4.2 Tailings Site

The primary source of emissions at the tailings site is wind-blown dust. The intent of the $PM_{2.5}$ serious nonattainment SIP is to review emissions during winter time inversions. Since these inversions represent stagnant wind conditions, emissions from the tailings site will be minimal and therefore tailings site SIP conditions are not necessary for the $PM_{2.5}$ SIP. Emissions at the tailings site are effectively controlled with the implementation of BACT and the most stringent measure.

4.3 Laboratory

No limitations or monitoring requirements are proposed for the laboratory emission sources as the emissions from the facility are minimal and are effectively controlled with the implementation of BACT and the most stringent measure.

Attachments

- UPP Cooling Tower Vendor Data
- Tailings Quarterly Report
- Tailings Dust Control Practices Study
- Tailings FDCP
- Degreaser Solvent SDS

FINAL

Best Available Control Technology Determinations for the Smelter and Refinery

Prepared for

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February 2018

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Contents

Attachments

- Smelter Dryer/Granulator baghouse information
- Anodes Furnaces NO_X study
- Degreaser Solvent SDS
- EPA Compliance Letter

Tables

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Acronyms and Abbreviations

ACT	Alternative control techniques
AO	approval order
BACT	best available control technology
BCM	Bingham Canyon Mine
CAA	Clean Air Act
CEM	Continuous emissions monitor
CFR	*Code of Federal Regulations*
CHP	Combined heat and power
CO	carbon monoxide
CPI	Consumer Price Index
EPA	Environmental Protection Agency
ESP	Electrostatic precipitator
FGR	Flue gas recirculation
FS	Flash Smelting
GPS	Global Positioning System
gr/dscf	grains per standard cubic feet
KUC	Kennecott Utah Copper
LNB	Low NOx burner
MACT	maximum achievable control technology
MMBtu/hr	million British Thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NH_3	ammonia
NO_x	nitrogen oxides
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppm	parts per million
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SCR	Selective catalytic reduction
SIP	State Implementation Plan
SO_2	sulfur dioxide
SOP	Standard operating procedure
TEG	Turbine Electric Generator
tpy	tons per year
UDAQ	Utah Department of Air Quality

ULNB	Ultra-low NOx burner
VOC	volatile organic compound
WRAP	Western Regional Air Partnership

SECTION 1

Introduction

Kennecott Utah Copper LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities: Smelter andRefinery. In addition to a BACT analysis, KUC has also documented the most stringent measure for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and meet any reasonable further progress requirements. As requested by the Utah Department of Air Quality (UDAQ), the BACT analysis should identify and evaluate reasonable and available control technologies for each relevant pollutant. The technical and economic feasibility of each potential control technology are components of the BACT analysis that help show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environmental Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). For each emission source, the BACT analysis followed a four-step process:

- **Step 1**—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC) and/or California Environmental Protection Agency – Air Resource Board BACT Clearinghouse (CARB)
- **Step 2**—Eliminate technically infeasible options
- **Step 3**—Eliminate economically/chronologically infeasible options
- **Step 4**—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent the most stringent measure.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS were combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends the BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development.

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SECTION 2

Recent Permitting Actions

The Smelter and Refinery together have over 70 individual significant and insignificant sources. The Smelter recently had UDAQ permitting actions. A modified approval order (AO) was issued for the smelter on June 10, 2014. AO DAQE-AN0103460054-14 allows the Smelter to operate a crushing and screening plant and modifies stack testing requirements for the Smelter emissions sources. No other significant modifications were made to the Smelter AO in the last 5 years.

The EPA performed extensive technology reviews of Smelter emissions in support of the 2002 primary copper smelting major source maximum achievable control technology (MACT) standard (40 *Code of Federal Regulations* [*CFR*] 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC Smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Both standards establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources, not using batch copper converters). Smelter process and emission controlling technologies that contributed to EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred after promulgation of the MACT standards.

AO DAQE-AN01013460045-10 for the Refinery was issued in 2010 to add the combined heat and power (CHP) unit. The CHP unit utilizes SoLoNO$_X^{TM}$ burners minimizing NO_X emissions from the unit. The Smelter and Refinery facilities operate under a single Title V Operating Permit # 3500030003.

Potential to emit (PTE) emissions in tons per year (tpy) for the Smelter, Refinery and MAP are shown in Table 2-1.

Table 2-1. Facility Potential to Emit Emissions

	PM_{10} PTEs (tpy)	$PM_{2.5}$ PTEs (tpy)	NO_x PTEs (tpy)	SO_2 PTEs (tpy)	VOC PTEs (tpy)
Smelter	510.82	426.35	185.29	1,085.72	13.50
Refinery	25.64	25.64	38.57	4.44	8.42

Notes:
PM_{10} = Particulate matter 10 microns or smaller in aerodynamic diameter
NO_x = oxides of nitrogen
SO_2 = sulfur dioxide
VOC = volatile organic compounds
$PM_{2.5}$ = Particulate matter 2.5 microns or smaller in aerodynamic diameter
PTE = potential to emit
tpy = tons per year

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SECTION 3

Best Available Control Technology Determinations

This section provides BACT determinations for emission sources deemed significant at the Smelter and Refinery.

KUC has reviewed publicly available permitting documents for smelters around the country. Based on the review of the Hayden Smelter in Arizona, it was determined the technology implemented at the KUC Smelter is different from that at the Hayden Smelter. The permitting documents show that emissions from sources such as acid plant, anode plant and furnaces are limited with baghouses, optimum operation of processes and visible emissions limitations.

3.1 Smelter

The EPA performed extensive technology reviews of Smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC Smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules (e.g., the design of the Smelter is based on the furnace technology). Typical smelting operations require batch processing which intermittently produces high concentrations of SO_2 and particulate in a manner that can reduce the efficiency of the acid plant as a control device. By employing the flash smelting (FS) and flash converting (FC) technologies, KUC can eliminate many of the problems inherent with batch type smelter operations. These improvements include continuous flow of off-gases to the acid plant during the FC process as well as reduced total volume of off-gases. Additionally, the furnaces are stationary which improves the ability to capture the off-gases as well as the ability to capture any fugitive emissions with the secondary capture system, which cleans the gases with baghouses and scrubbers before venting to the main stack. As a result, both MACT standards go so far as to establish a separate category for only the KUC Smelter due to its unique design and emission performance not achievable by conventional technology.

The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources not using batch copper converters). The KUC Smelter employs several technologies to minimize the smelting emissions that report to the main stack.

- The concentrate dryer burns natural gas to heat/dry concentrate for use in the FS furnace. Operation with low-NO_x burners (LNB) along with lower dryer temperatures minimizes the formation of NO_x while also preventing the formation of SO_2. KUC operates both a baghouse and a scrubber as controls for the concentrate dryer.
- The secondary gas system collects fugitive emissions in the hot metals building (typically associated with the furnaces) and vents them through a baghouse and a sodium-based scrubber before they are vented to the main stack.
- The matte grinding circuit crushes and dries granulated matte for use in the FC furnace. The particulate from the ground matte is collected in a baghouse and pneumatically conveyed to the FC furnace feed bin. NO_x emissions from natural gas combustion are minimized with LNB and low temperature firing and PM_{10} emissions are controlled with the production baghouse.

- In the anodes area, blister copper from the FC furnace is refined in two available refining furnaces to remove the final traces of sulfur. Copper production can be supplemented with copper scrap, which can be added to the refining furnaces for re-melt. The anodes refining furnaces are natural gas fired with oxy-fuel burners. Off-gas is vented (in series) to a quench tower, lime injection, baghouse, and scrubber and vented to the main stack. NO_x reduction activities also include maintaining furnaces to prevent ingress of air.
- The shaft furnace and holding furnace are used to re-melt anode scrap and other copper scrap to incorporate into copper production. LNBs are used to reduce NO_x from the natural gas combustion and a baghouse is operated to control PM_{10} emissions. The shaft furnace is in the anodes area, but vents separately to the main stack.

3.1.1 Main Stack

Source Description. Multiple process equipment emissions are routed through the main stack. Such equipment includes the matte granulators, acid plant, anode building, powerhouse, furnaces, dryers, and grinding circuits. Many of these sources of emissions have their own primary control devices (baghouse, scrubbers, etc.). Some are then routed to the secondary gas system and then through the main stack. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

Equipment emissions routed through the main stack at the Ssmelter include:

Equipment	Pollutant Emissions	Primary Emissions Control
Concentrate dryer	$PM_{2.5}$, SO_2, NO_X	LNB, baghouse, and scrubber
Powerhouse superheater	$PM_{2.5}$, SO_2, NO_X, VOC	Ultra-low NOx burner (ULNB), Flue gas recirculation (FGR), fuel throughput limits, and good operational practices
Powerhouse Foster Wheeler aux boiler	$PM_{2.5}$, SO_2, NO_X, VOC	LNB, FGR, fuel throughput limits, and good operational practices
Matte grinding	$PM_{2.5}$, SO_2	LNB, baghouse and good operational practices
Anode refining furnaces	$PM_{2.5}$, SO_2, NO_X, VOC	Oxy-fuel burners, baghouse, and scrubbers
Anode shaft furnace	$PM_{2.5}$, SO_2, NO_X, VOC	Baghouse, LNB and good operational practices
Anode holding furnace	$PM_{2.5}$, SO_2, NO_X, VOC	Baghouse, LNB and good operational practices
Vacuum cleaning system	$PM_{2.5}$	Baghouse
North and south matte granulators	$PM_{2.5}$, SO_2	Scrubber, SGS baghouse, and SGS scrubbers

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies different control technologies for process equipment eventually routed through the main stack. These control technologies are currently in place as previously discussed.

The EPA performed extensive technology reviews of smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC Smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Both standards go so far as to establish a separate category for only the KUC Smelter due to its unique design and emission performance not achievable by conventional technology. The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources not using batch copper converters). Smelter process and emission controlling technologies that contributed to EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred after promulgation of the MACT standards.

Baghouses used to control particulate emissions from the concentrate dryer, matte grinding, anode furnaces and granulators are maintained regulatory and the bags are replaced as recommended by the vendors. The bags currently used by KUC in these baghouses are provided in the Appendix. The exhaust from these processes is at high temperature and low pH due to the acidic nature of the materials. Over the years, KUC has experimented with different types of bags, such as pleated bags, that are more effective in removing particulate. However, these bags could not provide optimum performance due to high temperature and low pH. Therefore, upgrading to different types of bags is not technically feasible for these processes.

Again, KUC maintains and replaces bags in these baghouses as recommended by vendors to maintain performance, pressure differential and particulate removal efficiency.

The KUC Smelter continues to be the cleanest Smelter operations in the world. KUC reviewed emission reductions alternatives for anode furnaces venting through the main stack. The operations at the Smelter are continuously optimized to ensure high efficiency operation of the facility, including periodic upgrades of the burners to maintain optimum operations. KUC performed a pre-feasibility level study to evaluate NO_X emissions reductions options for the anodes furnaces at the Smelter. The study evaluated emission reduction strategies such as SCR, SNCR, oxidation systems and wet scrubbers. Portions of the study are provided as an Attachment. The entire study is not included to ensure project confidentiality.

While all the identified technologies were determined to be feasible, each had significant energy and economic impacts. Based on the pre-feasibility study, the costs per ton of NO_X removed from these technologies ranges from $55,000 to $590,000. These costs are based on the prefeasibility study and actual implantation costs are expected to be higher as major process and structural modifications would need to be made to implement these alternatives.

Therefore, NOx emissions reduction technologies such as SCR, SNCR and wet scrubber are not cost effective for BACT for the anode furnaces venting to the main stack.

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 selected as BACT.

- **Step 4—Identify BACT.** Because no new major developments in technologies have occurred after the promulgation of the MACT standards, the control technologies currently in place constitute BACT.

Complying with applicable requirements of the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE) represent the most stringent measure for the main stack.

3.1.2 Powerhouse Holman Boiler

Source Description: The boiler is used to provide process steam at the smelter. Emissions of NO_x are limited with flue gas recirculation (FGR), LNB, opacity limits, an alternative monitoring plan which requires continuous monitoring of operational parameters (fuel use, stack oxygen, steam output), and operational controls with good combustion practices. Emissions of $PM_{2.5}$, CO, SO_2, and VOC are limited with use of pipeline quality natural gas, good combustion practices, gas consumption limit, good design, opacity limits, and proper operation of the boiler. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.2.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies the following as possible control technologies for NO_x for natural gas-fired boilers:

  Selective catalytic reduction (SCR)

  FGR

  LNBs with good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The Holman boiler is equipped with FGR and LNB to reduce NO_x emissions. The addition of the SCR would reduce the emissions from the boiler from 9.9 tpy (based on 2016 actual emissions) to 2.0 tpy.

From the Alternative Control Techniques (ACT) Document — NO_X Emissions from Industrial/Commercial/ Institutional Boilers, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 100 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.03 lb/MMBtu. From Table 6-5 of the ACT document, the total annualized cost for the 100 MMBtu/hr gas boiler is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from Consumer Price Index (CPI) Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74; therefore, for the Holman boiler, the estimated cost is $487,287.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $26,000 and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** FGR, LNBs with good combustion practices, limited gas consumption, good design, and proper operation constitute BACT for this source.

KUC continuously monitors operational parameters to predict NO_x emissions and ensure proper boiler operation. The parameters monitored are fuel use (to predict NO_x emissions lb/hr), stack oxygen (to monitor proper boiler operation and compliance with NO_x lb/MMBtu emission limit), and steam output (used to estimate heat input if fuel use is unavailable). The ranges for these parameters were developed during a 30-day monitoring campaign where data from a certified NO_x analyzer were used to develop predictive equations with the operation parameters.

3.1.2.2 SO_2, VOC, and $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies listed in the RBLC and CARB**. The RBLC and CARB identifies the following as possible control technologies for boilers:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 were selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, opacity limits, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNBs with good combustion practices, limited gas consumption, good design, and proper boiler operation represent the most stringent measure for the Holman Boiler.

3.1.3 Feed Process (Wet and Dry)

Source Description: Silica flux, concentrate, and converter slag are transferred directly to feed bins then conveyed to the dryer. Particulate emissions from the loading of the flux and concentrate, and from transfer points of the conveyor, are vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, electrostatic precipitators (ESPs), and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP, because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as most effective technology identified in Step 1 selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

The use of a baghouse to control particulate emissions also represents the most stringent measure for both the wet and dry feed process.

3.1.4 Matte and Slag Granulators

Source Description: Slag and matte granulators are each equipped with a three-stage impingement plate scrubber. The smelter operates two matte granulators and one slag granulator. The molten matte is granulated with water in two separate granulation tanks (two matte granulators), each equipped with a scrubber. The convertor slag is granulated in a separate granulator (one slag granulator), also equipped with a scrubber. The matte granulators are vented through the main stack. The slag granulator is vented to the atmosphere through a separate stack. $PM_{2.5}$ and SO_2 emissions are controlled by a neutral pH three-stage impingement plate scrubber. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.4.1 $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, other possible particulate control technologies include baghouses, cyclones, ESP, and scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** While baghouses are most effective in controlling particulate emissions, this technology is not feasible for the granulators. The exhaust from the granulators has very high moisture content, which is not suitable for baghouses. Moisture condensation can cause accumulation of mud on the bags and baghouse walls. This results in blinded bags and clogged dust removal equipment. As discussed in the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook, cyclones are mainly used to control large particles. Therefore, scrubbers are the technically feasible option.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most technically feasible technology for this process, identified in Step 2, was selected as BACT.
- **Step 4—Identify BACT.** Scrubbers constitute BACT for the granulators.

3.1.4.2 SO_2 BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB**. The RBLC and CARB do not identify any specific control technologies for the granulators.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** Scrubbers constitute BACT for the granulators.

The use of scrubbers also represents the most stringent measure for both the matte and slag granulators.

3.1.5 Feed Storage Building

Source Description: Wet copper concentrate feed is stored in the enclosed wet feed storage building. Particulate matter from loading materials into the feed storage building, from reclaiming materials, and from conveyor/transfer point SME 002-A, are vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

The use of enclosures and baghouse to control particulate emissions also represents the most stringent measure for the feed storage building.

3.1.6 Anode Area Fugitives

Source Description: Emissions from the anode building process are controlled with a baghouse, quench tower, and scrubber. However, some emissions can escape as fugitives. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB do not identify any specific control technologies for process fugitives. The MACT, however, does address such emissions.

40 *CFR* 63.11147(a)(3) states, “You must operate one or more capture systems that collect the gases and fumes released from each vessel used to refine blister copper, re-melt anode copper, or re-melt anode scrap and convey each collected gas stream to a control device. One control device may be used for multiple collected gas streams.”

KUC certified compliance with 63.11147(a)(3), as required by 63.11150(b)(4), in a letter dated and received by UDAQ on January 30, 2007. This document is included as an attachment to this report.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** In addition to opacity limits and required maintenance, current design of anode process units and the collection hoods on anode building processes have been engineered/designed to reduce fugitives and these practices constitute BACT.

The current design of anode process units and the collection hoods on anode building processes were engineered/designed to reduce fugitives and these represent the most stringent measure.

3.1.7 Smelter Fugitives

Source Description: Emissions from Smelter processes are controlled with appropriate control technologies including closed processes, launder hoods and others outlined below. However, some emissions can escape as fugitives. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB do not identify any specific control technologies for such fugitives.

  The EPA performed extensive technology reviews of Smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Regarding the design and fugitive emission controls of the KUC smelter, the EPA provided the following discussion when promulgating the final copper smelting MACT standard (FR Vol. 67, No. 113, Page 40488):

  > Due to its unique design and operations, most of the process fugitive emission sources associated with smelters using batch converting are eliminated at the Kennecott smelter. There are no transfers of molten material in open ladles between the smelting, converting, and anode refining departments at the Kennecott smelter. In addition, there are no fugitive emissions associated with the repeated rolling-out of converters for charging, skimming, and pouring. Also, only one continuous flash converter is needed at the Kennecott smelter compared with the need for three or more batch copper converters at the other smelters.

Both standards go so far as to establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. Smelter process and emission controlling technologies that contributed to the EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred after the promulgation of the MACT standards.

Specific notes regarding control techniques listed in Table 5 of Attachment 5 of the EPA comments are listed below:

- KUC Smelter hot metals operations are serviced by an extensive local ventilation (secondary gas) system. This system collects gasses and routes them through baghouses and scrubbers before venting them to the main stack where they are continuously monitored for multiple pollutants.

- KUC Smelter hot metals operations are completely enclosed in a building.
- KUC processes only grade 1 scrap in its melting furnaces.
- A leak detection/prevention/repair program is not applicable to KUC Smelter furnaces and hot metals process units because they are enclosed and operate at negative pressure due to their inherent design.
- Because KUC furnaces are enclosed and do not require open air transfer of molten metal, they are not dependent on hooding systems for process gas collection.
- It is not necessary to add curtains to improve hood performance at the KUC Smelter as the process does not rely on hoods to capture process gasses.
- The KUC process does not require the open-air transfer of molten metal from smelting to converting vessels so it is not necessary to collect these emissions.
- The EPA noted in the primary copper smelting MACT standard, KUC was the first Smelter in the United States to capture and control emissions from anode refining furnaces.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** In addition to opacity limits and required maintenance, current designs of processes were engineered/designed to reduce fugitives and therefore these practices constitute BACT. KUC has implemented best management practices to minimize fugitive emissions. These practices are reviewed frequently and improvements are implemented to minimize emissions.

The current designs of processes were engineered/designed to reduce fugitives and therefore these practices also represent the most stringent measure.

3.1.8 Acid Plant Fugitives

Source Description: The double contact acid plant removes SO_2 from the off-gases of the flash furnaces. The sulfuric acid produced by the plant is sold. Among other technologies, the system is equipped with tubular candle fiber mist eliminators and the tail gas is discharged to the main stack. However, some emissions can escape as fugitives, which are controlled using best operational practices to minimize emissions. Best operational practices to minimize the emissions include opacity limits, weekly visual opacity surveys and the requirement of prompt repair or correction and control to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB do not identify any specific control technologies for such fugitives.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** Best operational practices may include, (1) placement or adjustment of negative pressure ductwork and collection hoses, (2) welding of process gas leaks, or (3) containment of process gas leaks. These practices and current design of processes were engineered/designed to reduce fugitives and therefore constitute BACT.

The best operational practices currently implemented and the current designs of the processes also represent the most stringent measure for the acid plant fugitives.

3.1.9 Powerhouse Foster Wheeler Boiler

Source Description: This boiler is used to produce superheated steam to start the smelter, drive acid plant compressors, and standby power. Emissions of NO_x are limited with FGR, LNB with good combustion practice, continuous monitoring of NO_x at the smelter main stack, and limitations on fuel throughput. Emissions of $PM_{2.5}$, CO, SO_2, and VOCs are limited with use of pipeline quality natural gas; good combustion practices; good design and proper operation of the boiler; and continuous monitoring of opacity, particulate, and SO_2 at the Smelter main stack. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.9.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** The RBLC and CARB identify the following as possible control technologies for NO_x for natural gas-fired boilers.

  SCR

  FGR

  LNB with good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The powerhouse boiler is equipped with FGR and LNB to reduce NO_x emissions. Emissions from this boiler are vented through the main stack and it is difficult to differentiate the boiler NO_X emissions from the main stack emissions. Based on the understanding of operations at the smelter, the addition of the SCR might reduce the annual emissions from the boiler from 5.3 tpy (based on 2016 actual emissions and engineering estimates) to 1.1 tpy.

From the Alternative Control Techniques Document – NO_X Emissions from Industrial/Commercial/Institutional Boiler, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 100 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.03 lb/MMBtu. From Table 6-5, the total annualized cost for the 100 MMBtu/hr gas boiler is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from CPI Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74; therefore, for the powerhouse boiler the estimated cost is $261,000.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $15,000 and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** FGR, LNB with good combustion practices, good design and proper operation constitute BACT.

3.1.9.2 SO_2, VOC, and $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB**. The RBLC and CARB identify the following as possible control technologies for boilers.

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the Powerhouse Foster Wheeler Boiler.

3.1.10 Miscellaneous Storage Piles/Loadout

Source Description: Concentrate, granulated matte, slag, and other materials are stored in storage piles on pads. Water sprays or chemicals are applied as necessary to minimize fugitive emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify dry foggers, adding moisture, and enclosures as possible control technologies for fugitive emissions. Other possible technologies available to control fugitive dust emissions that are not identified in the RBLC include chemical dust suppression, baghouse, cyclone, and scrubber.
- **Step 2—Eliminate Technically Infeasible Options.** The emission sources are fugitive in nature and therefore it is not technically feasible to duct emissions to a baghouse, scrubber, or cyclone. Additionally, the locations of the storage piles are always changing, making the construction of permanent enclosures difficult. Therefore, these control technologies are not technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The remaining technology of water or chemical applications is economically and chronologically feasible.
- **Step 4—Identify BACT.** KUC uses water sprays, chemical dust suppressants, and temporary enclosures to minimize particulate emissions from the miscellaneous storage piles, which were demonstrated to be very effective. These business practices constitute BACT for this emission source.

The use of water sprays, chemical dust suppressants, and temporary enclosures to minimize particulate emissions from the miscellaneous storage piles also represent the most stringent measure.

3.1.11 Slag Concentrator

Source Description: Emissions associated with the crushing, grinding, and slag processing at the smelter are minimized with the water sprays and enclosures. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, other possible particulate control technologies include baghouses, cyclones, scrubbers, water sprays, and enclosures.

- **Step 2—Eliminate Technically Infeasible Options.** Baghouses are not feasible for the slag processing equipment. The slag stock piles are sprayed with water frequently to minimize emissions. The material as a result has very high moisture content, which is not suitable for baghouses. Moisture droplets and condensation can cause accumulation of mud on the bags, baghouse walls, and ductwork. This results in blinded bags and clogged dust removal equipment. Further, when ambient temperatures are below freezing, the mud will freeze on the baghouse bags and plug them.

Wet scrubbers are not expected to be effective in minimizing emissions from crushing and grinding operations. Operation of the scrubbers is compromised due to below freezing ambient temperatures and very cold water streams in the scrubber. The duct work of the scrubbers will freeze during subfreezing ambient temperature conditions.

As discussed in the WRAP Fugitive Dust Handbook, cyclones are mainly used to control large particles.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The remaining technology of water sprays and enclosures is economically and chronologically feasible.
- **Step 4—Identify BACT.** KUC uses water sprays and enclosures to minimize particulate emissions from the slag concentrator, which were demonstrated to be very effective. These business practices constitute the BACT for this emission source.

The use of water sprays and enclosures to minimize particulate emissions represent the most stringent measure from the slag concentrator.

3.1.12 Smelter Cooling Towers

Source Description: Three noncontact water cooling towers are used for various Smelter processes. The towers are equipped with drift eliminators with drift loss rated at 0.001 percent. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable, as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.001 percent and good operating practices represent the most stringent measure for the cooling tower. As determined in the BACT analysis for other KUC facilities, upgrading the drift eliminators with lower drift loss is not cost effective for the BACT analysis.

3.1.13 Ground Matte Silo

Source Description: Ground matte material is stored in silos. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.

- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.04 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the ground matte silo.

3.1.14 Molding Coatings Storage Silo

Source Description: Coatings material is stored in silos. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.003 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the coatings storage silo.

3.1.15 Lime Storage Silos

Source Description: The Smelter has three lime storage silos. These silos are used to store lime for the hydrometallurgical plant, anode area and the secondary gas system. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the three silo baghouses were 0.01 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the silos used to store lime for the hydrometallurgical plant, anode area and the secondary gas system.

3.1.16 Limestone Storage Silos

Source Description: The silo is used to store limestone for the hydrometallurgical plant. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.04 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for silo used to store limestone for the hydrometallurgical plant.

3.1.17 Recycle and Crushing Building

Source Description: The matte and slag material is recycled and crushed in a building. Particulate matter from these small-scale operations are minimized as they occur inside the building and are controlled with a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, enclosures, and water sprays.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is most effective at capturing fine particulate and minimizing emissions.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Conducting operations inside the building and use of a baghouse are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the recycle and crushing building were 0.03 tpy. Conducting crushing and recycling operations inside the building and use of a baghouse to control particulate emissions also represents the most stringent measure.

3.1.18 Smelter Laboratory

Source Description: The laboratory at the Smelter is used for preparation of samples for testing which sometimes results in dust. Particulate emissions from the laboratory building are vented through a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify baghouses and enclosures as possible control technologies for limiting emissions from buildings or enclosed areas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Baghouses are the most effective in controlling emissions. Therefore, fabric filters (baghouse) constitute BACT for the Smelter Laboratory.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for the laboratory controlled with a baghouse were 0.78 tpy. This emission rate also represents the most stringent measure for the Smelter Laboratory.

3.1.19 Propane Communication Generator

Source Description: The Smelter operates a propane fired communication generator. This generator is used to support communication systems during emergencies or loss of power at the Smelter. Emissions are controlled with good combustion practices while operating the generator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for emergency generators around 75 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generator. The emergency generator also complies with applicable New Source Performance Standards.

Good combustion practices also represent the most stringent measure for the propane communication generator.

3.1.20 Cold Solvent Degreaser

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identifies operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed at all times to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for the degreaser.

  A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found of ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the Smelter were 0.002 tpy.

The previously identified practices also represent the most stringent measure for the degreasers.

3.1.21 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted that the 2014 actual VOC emissions for the gasoline fueling stations at the Smelter were 0.07 tpy. The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.1.22 Diesel Emergency Generator for Pyrometallurgical Process

Source Description: The Smelter operates one 998 HP diesel-fired emergency generator to support the pyrometallurgical process during emergencies. The emergency generator is equipped with turbo charger and after cooling and complies with applicable New Source Performance Standards to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. Potential emission control technologies identified in the RBLC and CARB for similar sized diesel generators include turbo charger and after cooling, good combustion practices and limiting the sulfur content of fuel to 0.0015 percent. Certification and compliance with applicable New Source Performance Standards is an acceptable means of demonstrating BACT for emergency generators.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.

- **Step 4—Identify BACT.** Turbo charger and after cooling, good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements are identified as BACT for all pollutants emitted from the emergency generator.

It should be noted that the 2014 actual emissions from the generator of $PM_{2.5}$ and precursors were 0.78 tpy.

Turbo charger and after cooling, good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements also represent the most stringent measure for the emergency generator.

3.1.23 Space Heaters

Source Description: Natural gas-fired heaters are used throughout the Smelter. The individual heaters are rated at less than 5 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.23.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC for controlling NO_x emissions from heaters of good combustion practices is already in use and constitute BACT.

3.1.23.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The 2014 actual emissions from the heaters for $PM_{2.5}$ and precursors were 0.48 tpy. The use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the space heaters. As discussed in the BACT analysis for other KUC facilities, replacing the existing space heaters with new heaters is not cost effective for the BACT analysis.

3.1.24 Hot Water Boiler

Source Description: Natural gas-fired water boilers are used for water heating throughout the Smelter. The water boilers use low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. The water heaters are rated at less than 10 MMBTU/hr. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.24.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from boilers less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC and CARB for controlling NO_x emissions from the boilers (LNB and good combustion practices) are already in use and constitute BACT.

3.1.24.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from the boilers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from the boilers and these control technologies constitute BACT.

The 2014 actual emissions from the boilers for $PM_{2.5}$ and precursors were 0.61 tpy. The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for the hot water boilers at the Smelter.

3.2 Refinery

3.2.1 Boilers

Source Description: The two boilers are rated at 82 MMBtu/hr (gas) and 79 MMBtu/hr (oil) each and are permitted to operate on natural gas to meet the steam demand at the Refinery. During natural gas curtailment, the boilers are permitted to operate on oil. Emissions of NO_x are limited with FGR and LNB with good combustion practices. Emissions of $PM_{2.5}$, SO_2, and VOCs are limited with good combustion practices, good design, opacity limits, sulfur content limit, and proper operation of the boilers. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.1.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** The RBLC and CARB identifies the following as possible control technologies for NO_x for natural gas-fired boilers

SCR

FGR

LNB with good combustion practices

Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The Refinery boilers are equipped with FGR and LNB to reduce NO_x emissions. The addition of the SCR will reduce the emissions from the boilers from 12.9 tpy (based on based on 2016 actual emissions) to 2.6 tpy.

From the Alternative Control Techniques Document – NO_X Emissions from Industrial/Commercial/Institutional Boilers, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 50 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.02 lb/MMBtu (the 100 MMBtu/hr boiler controlled NO_x emission rate with SCR is listed at 0.03 lb/MMBtu). From Table 6-5 of the ACT document, the total annualized cost for the 50 MMBtu/hr gas boiler (closest entry to 82 MMBtu/hr Refinery boiler) is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from CPI Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74. The estimated cost for the refinery boilers is $428,040 for both boilers.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $65,000 for the Refinery boilers and is, therefore, not cost effective for BACT.

- **Step 4—Identify BACT.** FGR, LNB with good combustion practices, good design, and proper operation constitute BACT for this source.

3.2.1.2 SO_2, VOC, and $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB**. The RBLC and CARB identifies the following as possible control technologies for natural gas fired boilers:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the boilers.

3.2.2 CHP Unit

Source Description: The CHP unit will generate power and steam to support Refinery operations. The CHP unit uses a low NO_x duct burner and the turbine has SoLoNO$_x$ burners. Emissions of $PM_{2.5}$, SO_2, and VOC are limited with good design and proper operation. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.2.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC.** The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired turbines and duct burners.

  SCR

  LNB with good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The CHP unit is equipped with LNB (SoLoNO$_x$ technology burners on turbine) to reduce NO_x emissions. The addition of the SCR will reduce emissions by 90 percent.

Solar Turbines, Inc. developed an estimation spreadsheet for the Taurus 70 combustion turbine and duct burner arrangement, which utilized vendor quotations for the installation of an SCR system. From the Solar calculations, the annualized capital and operating costs were estimated to be $932,100/yr.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $35,000 for the CHP unit and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** LNB with good combustion practices, good design, and proper operation of the CHP Unit constitute BACT for this source.

3.2.2.2 SO_2, VOC, and $PM_{2.5}$ Best Available Control Technologies

- **Step 1—Identify All Control Technologies listed in RBLC**. The RBLC identifies the following as possible control technologies for small turbines and duct burners:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the CHP unit constitute BACT for this emission source.

LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the CHP unit.

3.2.3 Refinery Cooling Towers

Source Description: Two noncontact water cooling towers are used for various refinery processes. The towers are equipped with drift eliminators with drift loss rated at 0.001 percent. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable, as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, are selected as BACT.
- **Step 4—Identify BACT.** Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.001 percent and good operating practices represent the most stringent measure for the cooling tower. As determined in the BACT analysis for other KUC facilities, upgrading the drift eliminators with lower drift loss is not cost effective for the BACT analysis.

3.2.4 Propane Communication Generator

Source Description: The Refinery operates a propane fired communication generator. This generator is used to support communication systems during emergencies or loss of power at the Refinery. Emissions are controlled with good combustion practices while operating the generator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for emergency generators around 75 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generator. The emergency generator also complies with applicable New Source Performance Standards.

Good combustion practices also represent the most stringent measure for the propane communication generator.

3.2.5 Cold Solvent Degreaser

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identifies operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed always to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for the degreaser.

A Safety Data Sheet for the degreasing solvent is provided as an Attachment. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found of ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the Refinery were 0.02 tpy.

The above identified practices also represent the most stringent measure for the degreasers.

3.2.6 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted that the 2014 actual VOC emissions for the gasoline fueling stations at the Refinery were 0.04 tpy.

The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.2.7 Space Heaters

Source Description: Natural gas-fired heaters are used throughout the Refinery. The individual heaters are rated at less than 5 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.7.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC and CARB for controlling NO_x emissions from heaters of good combustion practices is already in use and constitute BACT.

3.3.7.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the space heaters. As discussed in the BACT analysis for other KUC facilities, replacing the existing space heaters with new heaters is not cost effective for the BACT analysis.

3.2.8 Diesel Emergency Generator

Source Description: The Refinery operates one 487 HP diesel-fired emergency generator to support the precious metals plant at the Refinery during emergencies. The emergency generator complies with applicable New Source Performance Standards to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. Potential emission control technologies identified in the RBLC and CARB for similar sized diesel generators include good combustion practices and limiting the sulfur content of fuel to 0.0015 percent. Certification and compliance with applicable New Source Performance Standards is an acceptable means of demonstrating BACT for emergency generators.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements are identified as BACT for all pollutants emitted from the emergency generator.

It should be noted, the 2014 actual emissions from the generator of $PM_{2.5}$ and precursors were 0.12 tpy.

Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements also represent the most stringent measure for the emergency generator.

3.2.9 Soda Ash Storage Silo

Source Description: The Refinery has on soda ash storage silo. The silo is used to store soda ash for the Refinery. Particulate matter from loading materials into the silo is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses in form of a bin vent filters are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.004 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the silo.

3.2.10 Precious Metals Packaging Area

Source Description: The Refinery has a small precious metals packaging area. Particulate matter from the process is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the packaging area baghouses were 0.008 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the precious metals packaging area.

3.2.11 Hydrometallurgical Precious Metals Processing

Source Description: The Refinery has a precious metals processing and recovery area. Particulate matter, ammonia and SO_2 from the process are vented to a scrubber. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** The fabric filter (baghouse) is more effective at capturing fine particulate. However, due to high temperature of the exhaust steam and its pH, baghouses are not technically feasible. Wet scrubbers are therefore the only technically feasible control of particulate emissions and SO_2.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Scrubbers are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ and precursor emissions from the processes were 0.58 tpy. The use of scrubbers to control particulate emissions, ammonia and SO_2 also represents the most stringent measure for the precious metals processing area.

3.2.13 Tankhouse Sources

Source Description: The Refinery Tankhouse and MPC buildings include liberator, cathode wash and anode scrub wash processes that result in sulfuric acid mist emissions. Potential sulfuric acid mist from the processes are vented to a mist eliminator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible sulfuric acid control technologies include scrubbers and mist eliminators.
- **Step 2—Eliminate Technically Infeasible Options.** The presence of electrolytes in the exhaust stream cannot be effectively captured with a wet scrubber. Therefore, wet scrubbers are not technically feasible for these sources. Mist eliminators are technically feasible and effective in minimizing sulfuric acid mist emissions.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Mist eliminators are the most effective control technology for controlling sulfuric acid mist emissions and constitute BACT.

It should be noted that the 2014 actual sulfuric acid mist as $PM_{2.5}$ emissions from the Tankhouse sources were 0.005 tpy. The use of mist eliminators to control sulfuric acid mist emissions also represents the most stringent measure for the Tankhouse sources.

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Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

4.1 Smelter

Emissions to the atmosphere from the indicated emission points shall not exceed the following rates and concentrations:

Emission Point	Pollutant	Test Frequency
Main Stack (Stack No. 11)	$PM_{2.5}$	• 85 lbs/hr (filterable) • 434 lbs/hr (filterable + condensable)
	SO_2	• 552 lbs/hr (3 hr. rolling average) • 422 lbs/hr (daily average)
	NO_x	• 154 lbs/hr (daily average)
Holman Boiler	NO_x	• 14.0 lbs/hr (calendar-day average)

Stack testing to show compliance with the emissions limitations of Condition (A) above shall be performed as specified below:

Emission Point	Pollutant	Test Frequency
Main Stack	$PM_{2.5}$	Every year
	SO_2	Continuous Emissions Monitor (CEM)
	NO_x	CEM
Holman Boiler	NO_x	Every 3 years and alternate method determined per applicable new source performance standards

Supporting Information

During startup/shutdown operations, NO_x and SO_2 emissions are monitored by CEMs or alternate methods in accordance with applicable NSPS rules. This condition establishes emissions limitations and compliance requirements for the Smelter main stack and the Holman Boiler.

KUC continuously monitors operational parameters to predict NO_x emissions and to ensure proper boiler operation. The parameters monitored are fuel use (to predict NO_x emissions lb/hr), stack oxygen (to monitor proper boiler operation and compliance with NO_x lb/MMBtu emission limit), and steam output (used to estimate heat input if fuel use unavailable). The ranges for these parameters were developed during a 30-day monitoring campaign where data from a certified NO_x analyzer were used to develop predictive equations with the operational parameters. The alternative monitoring method identified in this condition is consistent with the applicable NSPS.

4.2 Refinery

Emissions to the atmosphere from the indicated emission point shall not exceed the following rate:

Emission Point	Pollutant	Maximum Emission
The sum of two (tank house) boilers	NO_x	9.5 lb/hr
Combined heat plant	NO_x	5.96 lbs/hr

Stack testing to show compliance with the above emission limitations shall be performed as follows:

Emission Point	Pollutant	Testing Frequency
Tank house boilers	NO_x	Every 3 years*
Combined heat plant	NO_x	Every year

Note:
*Stack testing shall be performed on boilers that have operated more than 300 hours during a 3-year period.

Supporting Information

KUC must operate and maintain the stationary combustion turbine, air pollution control equipment, and monitoring equipment in a manner consistent with good air pollution control practices for minimizing emissions always including during startup, shutdown, and malfunction. Records shall be kept on site which indicate the date, and time of startups and shutdowns. This condition establishes emissions limitations and compliance requirements for the Refinery Boilers and Combined Heat and Power unit.

Attachments

- Smelter Dryer/Granulator Baghouse Information
- Anodes Furnaces NO_X Study
- Degreaser Solvent SDS
- EPA Compliance Letter

FINAL REPORT

Kennecott Utah Copper

$PM_{2.5}$ State Implementation Plan: Best Available Control Technology Determinations

Submitted to

Utah Division of Air Quality

Prepared for:

Kennecott Utah Copper

Prepared by:

ch2m

July 2017

F I N A L

BACT Determinations for the Bingham Canyon Mine and Copperton Concentrator

Prepared for

Kennecott Utah Copper

July 2017

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Contents

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Acronyms and Abbreviations

AO	approval order
BACT	best available control technology
BCM	Bingham Canyon Mine
CAA	Clean Air Act
CO	carbon monoxide
EPA	Environmental Protection Agency
gr/dscf	grains per dry standard cubic feet
GPS	Global Positioning System
KUC	Kennecott Utah Copper
MMBTU/hr	million British Thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NH_3	ammonia
NOx	nitrogen oxides
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppm	parts per million
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SIP	State Implementation Plan
SO_2	sulfur dioxide
TPY	tons per year
UDAQ	Utah Department of Air Quality
VOC	volatile organic compound

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SECTION 1

Introduction

Kennecott Utah Copper LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities: Bingham Canyon Mine (BCM) and the Copperton Concentrator. In addition to a BACT analysis, KUC has also documented Most Stringent Measures for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and meet any reasonable further progress requirements. As requested by the Utah Division of Air Quality (UDAQ), the BACT analysis should identify and evaluate reasonable and available control technologies for each relevant pollutant. The technical and economic feasibility of each potential technology are components of the BACT analysis that help to show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). For each emission source, the BACT analysis followed a four-step process:

- **Step 1**—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC) and/or California Environmental Protection Agency – Air Resource Board BACT Clearinghouse (CARB)
- **Step 2**—Eliminate technically infeasible options
- **Step 3**—Eliminate economically/chronologically infeasible options
- **Step 4**—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent the most stringent measure.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS were combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends that BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development standard.

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SECTION 2

Recent Permitting Actions

Current operations at the BCM are permitted under Approval Order (AO) DAQE-AN105710037-15, issued on November 10, 2015.

Emissions from the BCM are mainly limited by the following conditions:

- "Total material moved (ore and waste) shall not exceed 260 million tons per rolling 12-month period." This condition limits the total material moved at the BCM, thus limiting all point, fugitive and tailpipe emissions.
- "Maximum total mileage per calendar day for ore and waste haul trucks shall not exceed 30,000 miles." This condition limits daily vehicle miles travelled at the BCM, thus limiting both fugitive and tailpipe emissions.
- "Emissions of particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}), NO_x, and SO_2 combined shall not exceed 7,350 tons and emissions of $PM_{2.5}$, NO_x, and SO_2 shall not exceed 6,205 tons per rolling 12-month period."
- "KUC shall apply a chemical dust suppressant to active haul roads located outside of the pit influence boundary no less than twice per year."

KUC is required to submit an annual fugitive dust control report that provides a description of the fugitive dust control practices implemented at the BCM.

Current operations at the Copperton Concentrator are permitted under AO DAQE-AN105710035-13 issued on June 25, 2013. Potential to Emit (PTE) emissions for the Copperton Concentrator are a very small percentage of combined emissions from the mine and concentrator facilities. Emissions for the Copperton Concentrator are limited by implementation of BACT controls.

PTE emissions in tpy for the BCM and the Copperton Concentrator are shown in Table 2-1.

Table 2-1. Facility Potential to Emit Emissions (Including Fugitive and Nonroad Engine Emissions)

	PM_{10} PTEs (tpy)	$PM_{2.5}$ PTEs (tpy)	NO_x PTEs (tpy)	SO_2 PTEs (tpy)	VOC PTEs (tpy)
Bingham Canyon Mine	1,519	369	5,838	7	314
Copperton Concentrator	25.3	13.86	10.66	0.1	4.04

Notes:
NO_x = oxides of nitrogen
PM_{10} = Particulate matter 10 microns or smaller in aerodynamic diameter
$PM_{2.5}$ = Particulate matter 2.5 microns or smaller in aerodynamic diameter
PTE = potential to emit
tpy = tons per year
SO_2 = sulfur dioxide
VOC = volatile organic compounds

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SECTION 3

BACT Determinations

This section provides BACT determinations for emission sources deemed significant at the BCM and the Copperton Concentrator.

3.1 Bingham Canyon Mine

3.1.1 In-pit Crusher

Source Description: The crusher is used to crush copper ore mined at the BCM. Particulate emissions from the in-pit crusher are controlled with a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emissions controls information for copper ore crushers. However, the databases identify baghouse (fabric filter) and enclosures with water sprays as possible control technologies for limiting emissions from crushers. The databases did not provide needed information on copper ore crushing. Therefore, due to differences in the material type listed in the databases and copper ore crushed at the BCM, a direct comparison of baghouse grain loading cannot be established.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are economically feasible.
- **Step 4—Identify BACT.** Fabric filters are the most effective in controlling emissions. Therefore, use of a baghouse (fabric filter) constitutes BACT for the in-pit crusher.

The existing baghouse for the crusher is permitted at a grain loading of 0.016 grains per dry standard cubic feet (gr/dscf). KUC investigated the options of either upgrading the filter system in the baghouse or replacing the baghouse.

Based on the review the RBLC and CARB databases, KUC found small baghouses with the grain loading of 0.002 gr/dscf to 0.003 gr/dscf. Using the most stringent emissions rates, KUC requested vendor information on baghouse upgrades to meet the 0.002 gr/dscf grain loading. Based on the data provided by the vendors, the total installed costs for the upgraded baghouse would be about $608,000. Based on the grain loading of the upgraded baghouse, $PM_{2.5}$ emissions from the crusher will be reduced from 2.28 tpy after the primary control to 0.28 tpy. The vendor provided information is included in the Appendix.

Based on the costs for the baghouse replacement, the cost per ton of $PM_{2.5}$ removed is $304,000. Therefore, replacing the crusher baghouse is not cost effective for BACT. Additionally, the vendors are unable to guarantee continuous compliance with the low emission rate from the baghouse for the in-pit crusher.

The current emission rate therefore represents the most stringent measure for the in-pit crusher.

3.1.2 Disturbed Areas

Source Description: Disturbed areas from mining activities. KUC current practices include application of dust palliatives and revegetation of the areas as soon as practical, as well as water application from passing water trucks in the operational areas to minimize dust. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emissions controls information for disturbed areas from mining activities. However, the databases identify revegetation, adding moisture, and enclosures (wind screens) as possible control technologies for fugitive emissions.
- **Step 2—Eliminate Technically Infeasible Options.**

  Applying additional moisture (water) on the disturbed areas, as mining occurs, is not technically feasible for KUC's mine operations. The ore is transferred through a series of conveyors. Excessive moisture in the ore material causes the conveyors to foul and breakdown resulting in costly equipment repairs. Therefore, adding moisture to the ore material is not technically feasible.

  Because the disturbed areas are so expansive and cover varying terrain, adding enclosures or wind screens are not technically feasible for this mine source.

  However, at the request of UDAQ, KUC had discussions with mine management about the feasibility of application of water for dust control on the disturbed areas that have been released for reclamation. Because the areas are so expansive, set up of irrigation systems for watering is not technically feasible. Using water trucks would disturb the reclaimed areas and would not provide benefit over reclamation and would therefore not be technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 were technically infeasible or selected as BACT.
- **Step 4—Identify BACT.** The practice of applying dust palliatives and revegetation is the most effective in reducing emissions from disturbed areas that have been released for reclamation. Therefore, the application of palliatives and revegetation constitute BACT for areas released for reclamation.

The application of palliatives and revegetation also represent BACM for the disturbed areas. Because best available measures are in use, they also represent the most stringent measure.

3.1.3 Waste Rock Offloading from Trucks

Source Description: Haul trucks dump waste rock or overburden at the waste rock disposal areas while minimizing the height of the drop. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify water application and enclosures as possible control technologies for fugitive emissions from similar sources of emissions. Another possible control technology not identified, but effective in reducing emissions from batch drop transfer points, is minimizing the drop distance while the waste rock is being dumped.
- **Step 2—Eliminate Technically Infeasible Options.**

Because the drop location is not static, an enclosure is not technically feasible. Water application is not technically feasible because excessive water application may result in geotechnical issues on the waste rock dumps. Additionally, an installation or setup of a water irrigation system for water application is not technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as the remaining technology of minimizing the drop distance, while the waste rock is being dumped, is selected as BACT.
- **Step 4—Identify BACT.** Minimizing drop distances while the waste rock is being dumped is effective in controlling emissions and constitutes BACT.

Minimizing drop distances while the waste rock is being dumped also represents BACM. Because best available measures are in use, they also represent the most stringent measure.

3.1.4 Graders

Source Description: The graders primarily operate on the haul roads, maintaining surfaces of the roads. Particulate matter is controlled by the application of water and chemical dust suppressants to the roads. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify the application of water and chemical dust suppressants as a possible control technology for similar fugitive emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary constitute BACT.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the graders. Because best available measures are in use, they also represent the most stringent measure.

3.1.5 Bulldozers and Front-end Loaders

Source Description: The dozers and front-end loaders operate in the pit, on the haul roads performing cleanup operations, and in dumping operations at the waste rock disposal areas. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify the application of water and chemical dust suppressants as required as a possible control technology for similar fugitive emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary constitute BACT.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the bulldozers and front-end loaders. Because best available measures are in use, they also represent the most stringent measure.

3.1.6 Unpaved Haul Roads

Source Description: Haul roads are used to transfer ore and waste rock. The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary minimize emissions from the unpaved haul roads. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify potential technologies for control of fugitive emissions on unpaved haul roads as: paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance (including the use of road base material) of haul roads.
- **Step 2—Eliminate Technically Infeasible Options.** Paving the haul roads is not technically feasible at the mine because of the weight of the haul trucks, the rapid deterioration that would occur, and the frequently changing road locations. The location of these roads changes regularly making the paving of the surface infeasible. Paving the roads to minimize emissions is not technically feasible and will not be evaluated further. Additionally, with changing mine plans and haul routes, it is impossible to accurately estimate the costs for paving the road surface.

  Application of chemical dust suppressants is not technically feasible for some haul road locations because of the adverse effect the chemical can have on the coefficient of friction of the road surface. Given that the grade of the haul roads exceeds 10 percent in some locations, creating a slippery skin on the road inhibits the ability of mobile equipment to brake and steer safely while traveling on the grade.
- **Step 3**—**Eliminate Economically/Chronologically Infeasible Options.** The remaining technologies of water application, chemical dust suppressants outside of the pit influence boundary, limiting unnecessary traffic on roads, and routine maintenance of haul roads are economically and chronologically feasible.
- **Step 4**—**Identify BACT.** The application of water and road-base material within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary is effective in minimizing emissions. Watering the unpaved haul road reduces fugitive $PM_{2.5}$ and PM_{10} emissions by binding the soil particles together, reducing free particles available to be picked up by wind or vehicles. Additional watering and application of chemical dust suppressants on certain locations of unpaved haul roads also occurs when heavy traffic is expected along the road. Water is applied on a scheduled basis and supplemented as needed based on road conditions. Dust is also reduced through performing regular and routine maintenance of the haul roads (through use of road-base material) and limiting unnecessary traffic on roads.

In recent years, KUC has purchased newer haul trucks with higher capacity where possible, which has led to a decrease in the round-trips and vehicle miles traveled, thereby reducing fugitive dust emissions.

The annual fugitive dust control report for the mine is provided in the Appendix for reference.

The application of water within the pit influence boundary and water and chemical dust suppressants outside the pit influence boundary also represents BACM for the unpaved haul roads. Because best available measures are in use, they also represent the most stringent measure.

3.1.7 Tailpipe Emissions from Mobile Sources

Source Description: Tailpipe emissions from haul trucks and support equipment such as graders and dozers. Tailpipe emissions from the haul trucks and support equipment meet the required EPA standards for NONROAD equipment. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify no add on control technologies for tailpipe emissions from haul trucks and support equipment of the size used at the BCM.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable.

- **Step 4—Identify BACT.** Haul trucks and support equipment used at the facility meet the required EPA standards for nonroad equipment. The facility uses on-road specification diesel fuel in its off-road equipment. In 2007, an EPA ruling required sulfur content in all on-road specification diesel fuels be reduced (from 50 parts per million [ppm] formerly to 15 ppm currently). Because only on-road specification diesel fuel is used in its equipment, the facility has also made a transition to ultra-low sulfur diesel fuel. All the facility's diesel-powered equipment now runs on ultra-low sulfur diesel fuel.

  Additionally, the facility periodically upgrades its haul truck fleet to also take advantage of available higher-tier-level, lower-emitting engines. In recent years, KUC has purchased newer haul trucks with higher capacity where possible, which has led to a decrease in round-trips and truck operating hours, thereby reducing emissions.

  Purchasing new haul trucks with higher capacity and Tier level which meet its mining needs also represents the most stringent measure.

  During the previous SIP work in 2014, KUC developed a detailed analysis for the haul truck engine repowering and upgrade to higher tier level trucks. The analysis is provided in the Appendix.

3.1.8 Fueling Stations

Source Description: Adding gasoline and diesel to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify two control techniques for controlling VOC emissions from gasoline and diesel fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

  The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the fueling stations.

3.1.9 Cold Solvent Degreasers

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.

- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed always to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for degreasers.

A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the mine were 1.7 tpy. The previously identified practices also represent the most stringent measure for the degreasers.

3.1.10 Mine Conveyor Transfer Points

Source Description: The mine has two ore conveyor transfer drop points — Point C6/C7 and Point C7/C8. All exhaust air and particulate emissions from each transfer drop point are routed through the respective baghouse before being vented to the atmosphere. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify baghouse (fabric filter) and enclosures with water sprays as possible control technologies for limiting emissions from transfer points.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Fabric filters are the most effective in controlling emissions. Therefore, the baghouse (fabric filter) constitutes BACT for the conveyor transfer points.

The baghouse for each of the transfer points is permitted at a grain loading of 0.007 gr/dscf. The 2014 actual $PM_{2.5}$ emissions for conveyor transfer points controlled with a baghouse were 0.69 and 0.42 tpy each. Due to the low level of emissions from these sources, the BACT analysis did not evaluate the upgrade of the baghouses for these units. Additionally, based on the economics data presented in Section 3.1.1 of this document for baghouse replacement/upgrades, any upgrades or replacement would not be economically feasible.

This emission rate also represents the most stringent measure for the conveyor transfer points.

3.1.11 Lime Bins

Source Description: The Copperton Concentrator has two lime silos used for lime storage. Particulate emissions generated during loading and unloading operations are vented through a filter. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify vent filters and enclosures as possible control technologies for limiting emissions from storage silos.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Vent filters are the most effective in controlling emissions. Therefore, bin vent filters constitute BACT for the lime silos/bins.

The vent filter for each of the lime silos is permitted at a grain loading of 0.016 gr/dscf. These units are operated intermittently. The 2014 actual $PM_{2.5}$ emissions for the two lime silos controlled with a baghouse were 0.02 tpy. Due to the low level of emissions from these sources, the upgrade of the vent filters for these units would not be economically feasible.

This emission rate also represents the most stringent measure for the lime silos.

3.1.12 Sample Preparation Building

Source Description: The sample preparation building at the mine is used for preparation of waste rock and ore samples for testing. Particulate emissions from the sample preparation building are vented through a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify baghouses and enclosures as possible control technologies for limiting emissions from buildings or enclosed areas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Baghouses are the most effective in controlling emissions. Therefore, the fabric filters (baghouse) constitute BACT for the sample preparation building.

The baghouse for the sample preparation building is permitted at a grain loading of 0.016 gr/dscf. The building and the control system are operated intermittently. The 2014 actual $PM_{2.5}$ emissions for the sample preparation building controlled with a baghouse were 0.05 tpy. Due to the low level of emissions from these sources, the upgrade of the baghouse for the unit would not be economically feasible.

This emission rate also represents the most stringent measure for the sample preparation building.

3.1.13 Propane Communications Generators

Source Description: The mine operates six (6) propane fired communications generators. These generators are used to support mine communication systems during emergencies or loss of power in the mine. Emissions are controlled with good combustion practices while operating the generators. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify good combustion practices as the primary control technology for emergency generators between 70 HP and 150 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generators. The emergency generators also comply with applicable New Source Performance Standards.

It should be noted that the 2014 actual $PM_{2.5}$ and precursor emissions for all the propane emergency generators combined were 0.18 tpy.

Good combustion practices also represent the most stringent measure for the propane communication generators.

3.1.14 Ore Handling

Source Description: The mined ore is moved around the mine through conveyors and trucked to the stock piles as needed. The sources include Truck Offloading Ore Main In-pit Crusher, Truck Offloading Ore Stockpile, Main In-Pit Enclosed Transfer Points, Conveyor-stacker Transfer Point, Coarse Ore Stacker and Reclaim Tunnels. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emission controls for such material handling sources from a copper mine. The location of many of these sources change regularly making the construction of emission controls such as enclosures and application of dust suppressants infeasible for such sources. Therefore, potential control technologies include material characteristics such as large size with minimal quantities of fine material, enclosures and inherent moisture content as applicable to the emission source.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Material characteristics such as large ore size and presence of very small quantities of fine material are identified as BACT for the ore handling sources.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for these ore handling sources were 0.94 tpy.

The material characteristics such as large ore size and presence of very small quantities of fine material, inherent moisture content and enclosures also represent the most stringent measure for the ore handling emission sources.

3.1.15 Ore Storage Pile

Source Description: Low grade ore is stockpiled at the mine and blended into the process as necessary. Potential wind-blown dust emissions are minimized through application of water sprays and chemical dust suppressants and compaction. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify water sprays, chemical dust suppressants and compaction as potential control technologies to minimize emissions from large storage piles.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Water sprays, chemical dust suppressants and compaction are identified as BACT for the ore storage pile.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for the ore storage pile were 0.33 tpy.

These controls also represent the most stringent measure for the ore storage pile.

3.1.16 Road Base Crushing and Screening Plant

Source Description: The mine has semiportable plants that crush and screen rock for use for base material on the unpaved haul roads. Particulate emissions from the crushing, screening, and transfer operations are effectively controlled with water sprays and belt enclosures. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific emission controls for a road base crushing and screening plant for a copper mine. However, possible control technologies include baghouses, enclosures and water sprays for minimizing emissions from the road base crushing and screening plant.
- **Step 2—Eliminate Technically Infeasible Options.** The road base crushing system is moved through the mine to facilitate the production of road base material to meet demands. As a result, permanent installation of a baghouse to control emissions from the plant is not technically feasible. Water Sprays and temporary enclosures are feasible for the plant.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technically feasible technologies are economically feasible.
- **Step 4—Identify BACT.** Water sprays and enclosures are identified as BACT for the road base crushing and screening plant.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for the road base crushing and screening plant were 0.05 tpy.

These controls also represent the most stringent measure for the road base crushing and screening plants.

3.1.17 Drilling and Blasting

Source Description: Drilling and blasting are performed at the mine to access new ore bodies. Water injection is used to minimize emissions from drilling. The blast areas are controlled as practical to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific controls for drilling and blasting in open pit mines. Based on the mining experience, KUC identifies water injection and maintaining control of blast areas as potential control technologies to minimize emissions from drilling and blasting.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Water injection and maintaining control of blast areas are identified as BACT from drilling and blasting operations.

It should be noted that the 2014 actual $PM_{2.5}$ and precursor emissions for drilling and blasting sources were 0.75 tpy. These controls also represent the most stringent measure for the drilling and blasting operations.

3.1.18 Solvent Extraction and Electrowinning Process

Source Description: Tanks, mixers and settlers are used in the solvent extraction and electrowinning process. Covers are used to minimize emissions from these sources. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases do not identify specific controls for solvent extraction and electrowinning process. Based on the mining experience, KUC identifies covers on process equipment to minimize emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Use of covers is identified as BACT for the solvent extraction and electrowinning process.

It should be noted that potential emissions of $PM_{2.5}$ and precursors for solvent extraction and electrowinning are minimal.

These controls also represent the most stringent measure for the solvent extraction and electrowinning process.

3.2 Copperton Concentrator

3.2.1 Tioga Heaters

Source Description: Natural gas-fired heaters are used throughout the Copperton Concentrator. The heaters are rated at less than 5 MMBTU/hr each. Specifically, the facility includes seven (7) 4.2 MMBtu/hr natural gas fired heaters and one (1) 2.4 MMBtu/hr natural gas fired heater. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.1.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC for controlling NO_x emissions from heaters of good combustion practices is already in use and constitutes BACT.

3.2.1.2 $PM_{2.5}$, SO_2, CO, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify the use of pipeline quality natural gas and good combustion practices as control technology for minimizing $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters and these control technologies constitute BACT.

At the request of UDAQ, KUC contacted vendors regarding the feasibility of replacement of the 8 Tioga heaters at the Copperton Concentrator.

Based on the data provided by the vendors, the total installed cost of the eight new heaters is estimated to be $940,000. The costs assume the installation costs to be 35 percent of the equipment costs. Theses heaters will be equipped with the latest burner technology. Assuming the new heaters will minimize NOx emissions by 90% from current levels, the new heaters might reduce the annual emissions from the Tioga heaters from 3.3 tpy (based on 2014 actual emissions) to 0.33 tpy. The vendor provided information is included in the Appendix.

Based on the costs for the new heaters, the cost of new heaters per ton of NO_x removed is $317,000. Therefore, replacing the Tioga heaters is not cost effective for BACT.

Low NO_X burners, use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the Tioga heaters.

3.2.2 Pebble Crushing System

Source Description: The pebble crushing system includes crusher and ore handling conveyors and transfer points. The system is placed inside a building to minimize particulate emissions to the atmosphere. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify baghouses, wet scrubbers, water sprays and enclosures as possible control technologies to minimize emissions from a crushing plant.
- **Step 2—Eliminate Technically Infeasible Options.** Because the emissions will be vented inside the building, wet scrubbers and fabric filters are not technically feasible. Water sprays are not feasible as the water makes the material too wet to crush.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technically feasible technologies are feasible.
- **Step 4—Identify BACT.** Enclosures, or placing the source inside the building, is effective in minimizing emissions from the crusher operations and identified as BACT for the pebble crushing system.

It should be noted, the 2014 actual $PM_{2.5}$ emissions for the pebble crushing system were 0.07 tpy. This control also represents the most stringent measure for the pebble crushing system.

3.2.3 Cold Solvent Degreasers

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed always to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for degreasers.

A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the concentrator were 0.08 tpy.

The previously identified practices also represent the most stringent measure for the degreasers.

3.2.4 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB databases identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted that the 2014 actual VOC emissions for the gasoline fueling stations at the Copperton Concentrator were 0.29 tpy.

The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.2.5 Molybdenum Storage Bins and Loading Bags

Source Description: The Copperton Concentrator has molybdenum storage bins from which bags are loaded for offsite shipping. Particulate emissions generated during loading and unloading operations are vented through a filter. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify vent filters and enclosures as possible control technologies for limiting emissions from storage silos.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Vent filters are the most effective in controlling emissions. Therefore, bin vent filters constitute BACT for the molybdenum storage bins and loading bags.

The 2014 actual $PM_{2.5}$ emissions for these operations controlled with a bin vent filter were 0.5 tpy. Due to the low level of emissions from these sources, the upgrade of the vent filters for these units would not be economically feasible.

This control technology also represents the most stringent measure for the process.

3.2.6 Feed and Product Dryer Oil Heaters

Source Description: Natural gas-fired heaters provide heat to the feed and product dryers that are used in molybdenum process at the Copperton Concentrator. The heaters are rated at 5.7 MMBTU/hr and 2.2 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.6.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify Low NO_X burners and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC and CARB for controlling NO_x emissions from heaters of Low NO_X Burners and good combustion practices is already in use and constitutes BACT.

3.2.6.2 $PM_{2.5}$, SO_2, CO, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB databases identify use of pipeline quality natural gas and good combustion practices as control technologies for minimizing $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB databases identify use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, CO, and VOC emissions from heaters and these control technologies constitute BACT.

Low NO_X burners, use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the heaters. Due to low level of emissions from these units, upgrading these would not be economically feasible.

SECTION 4

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

4.1 Bingham Canyon Mine

KUC is proposing the following limitations and monitoring requirements for the Bingham Canyon Mine.

- Maximum total mileage per calendar day for ore and waste haul trucks shall not exceed 30,000 miles. KUC shall keep records of daily total mileage for all periods when the mine is in operation. KUC shall track haul truck miles with a Global Positioning System (GPS) or equivalent.
- KUC Shall Use Ultra-low Sulfur Diesel Fuel in Its Haul Trucks.
- To minimize emissions at the mine:
- The owner/operator shall control emissions from the in-pit crusher with a baghouse.
- Apply water to all active haul roads as weather and operational conditions warrant, except during precipitation or freezing conditions, and apply a chemical dust suppressant to active haul roads located outside of the pit influence boundary no less than twice per year.
- A chemical dust suppressant shall be applied as weather and operational conditions warrant except during precipitation or freezing conditions on unpaved access roads that receive haul truck traffic and light vehicle traffic.
- KUC is Subject to the Requirements in the Most Recent Federally approved Fugitive Emissions and Fugitive Dust Rule.

Supporting Information

The condition above establishes a limitation on daily activity. The daily mileage limitation effectively limits fugitive road dust emissions, tailpipe emissions from the haul trucks, and overall activity of sources at the mine. Ore processing at the Copperton Concentrator, which results in minimal emissions, is also limited through the BCM activity limitations.

Emissions resulting from the movement of ore and waste around the mine represent a significant portion of overall emissions at the BCM. The emissions related to material movement include fugitive dust generated from truck travel on the haul roads and the tailpipe emissions from the haul trucks. Specifically, on an annual basis, greater than 99.9 percent of total mine emissions for NO_X and SO_2 come from the haul truck tailpipes. Also, on an annual basis, material movement represents 85 percent of the overall particulate emissions at the BCM. Based on these emissions, the material movement of ore and waste by haul trucks represents a vast majority of overall emissions at the BCM and can effectively be used to represent mine operations.

Daily emissions from the BCM can be regulated with the limitation on vehicle miles traveled by ore and waste haul trucks of 30,000 miles per day. Compliance with this limitation is demonstrated daily and is an appropriate metric for a 24-hour particulate standard.

It should be noted that the 30,000 miles per day limitation also limits overall BCM operations. Ancillary mining activities such as operation of the in-pit crusher, mining support equipment, blasting, and drilling only occur to produce an adequate amount of ore and waste rock that can be hauled via the trucks and sent to the concentrator via the conveyor system.

On a 24-hour basis, these emissions can be represented with the 30,000 miles per day limitation. Since they effectively represent mine operations, a single daily limitation is appropriate in the SIP for the BCM. These emissions have been included in the appropriate SIP model.

KUC uses a real-time tracking system for both tracking haul trucks as well as for recording miles travelled. These records are used to comply with the 30,000 miles per day limitation. The system may be a GPS or a system with similar tracking capabilities necessary to comply with this condition.

The condition also establishes a requirement for the use of ultra-low sulfur diesel fuel in haul trucks.

The conditions require the control of emissions from the in-pit crushers with a baghouse.

The condition also establishes requirements for reducing and controlling fugitive particulate emissions from active unpaved haul roads at the mine. Water and chemical dust suppressants shall be used to minimize fugitive dust.

Specifically, active ore and waste haulage roads within the pit influence boundary are water sprayed and/or treated with a commercial dust suppressant. Crushed road-base material is applied to active ore and waste haulage roads within the pit influence boundary to enhance the effectiveness of fugitive dust control measures. Commercial dust suppressants are applied to active ore and waste haulage roads outside of the pit influence boundary no less than twice per year.

Each year KUC reports dust control measures implemented at the BCM during the previous year with details such as volume of water applied, commercial dust suppressant activity, etc.

KUC is subject to the fugitive dust rules approved by UDAQ and EPA. These rules outline requirements that mines are to follow in minimizing the fugitive dust from the mining operations.

4.2 Copperton Concentrator

No limitations or monitoring requirements are proposed for the Copperton Concentrator emission sources as the emissions from the facility are minimal and are effectively controlled with the implementation of BACT.

Attachments

- In-pit Crusher Baghouse Vendor Data
- Mine FDCP Report
- Haul Trucks Analysis
- Degreaser Solvent SDS
- Tioga Heaters Vendor Information

FINAL

BACT Determinations for the Utah Power Plant, Tailings Site, and Laboratory

Prepared for

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July 2017

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Contents

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Acronyms and Abbreviations

AO	approval order
BACT	best available control technology
CAA	Clean Air Act
CatOx	catalytic oxidation
CO	carbon monoxide
DLN	dry low nitrogen
EPA	Environmental Protection Agency
KUC	Kennecott Utah Copper
LNB	low NO_x burner
MMBTU/hr	million British Thermal Units per hour
MW	megawatts
NAAQS	National Ambient Air Quality Standard
NOx	nitrogen oxides
OFA	over-fire air
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppmvd	parts per million by volume dry
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearinghouse
SCR	selective catalytic reduction
SIP	State Implementation Plan
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
tpy	tons per year
UDAQ	Utah Department of Air Quality
UPP	Utah Power Plant
VOC	volatile organic compound

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SECTION 1

Introduction

Kennecott Utah Copper, LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities located at the northwest corner of Salt Lake County, Utah: Utah Power Plant (UPP), tailings site, and the laboratory. The tailings site receives tailings in slurry form. The slurry is deposited in the tailings pond. The UPP is a coal and natural gas fired power plant that supplies power for KUC operations. Coal is used to fuel the plant in spring, summer, and fall; while natural gas is approved for use in the winter months. The laboratory is used to perform various tests and functions to optimize operations through analysis of materials. In addition to a BACT analysis, KUC has also documented the most stringent measure for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and to meet any reasonable further progress requirements. As requested by the Utah Division of Air Quality (UDAQ), the BACT analysis should identify and evaluate BACT for each relevant pollutant. The technical and economic feasibility of each potential technology are components of the BACT analysis that help to show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environment Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC). For each emission source, the BACT analysis followed a four-step process:

- **Step 1**—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC) and/or California Environmental Protection Agency – Air Resource Board BACT Clearinghouse (CARB)
- **Step 2**—Eliminate technically infeasible options
- **Step 3**—Eliminate economically/chronologically infeasible options
- **Step 4**—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent most stringent measure.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS was combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends that BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development.

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SECTION 2

Recent Permitting Actions

An approval order (AO) was issued for the UPP on November 10, 2015, which authorized the construction and operation of a natural gas fired emergency generator. Issued in 2011, AO DAQE-AN105720026-11 authorized KUC to replace Boiler Units 1, 2, and 3 with a new natural gas fired combustion turbine operating in combined cycle mode with a heat recovery steam generator. The new combustion turbine will be equipped with state of the art add-on controls to minimize emissions from the unit and represents BACT. Dry low nitrogen oxide (DLN) combustors and the selective catalytic reduction (SCR) system will control NO_x emissions. The catalytic oxidation (CatOx) system will control carbon monoxide (CO) and VOC emissions. Good combustion practices and burning natural gas will minimize emissions of the remaining pollutants.

The tailings site is permitted under AO DAQE-AN10572018-06. The emissions sources at the laboratory are permitted under AO DAQE-261-95. All three facilities operate under a single Title V Operating Permit #3500346002.

The current potential to emit (PTE) emissions in tons per year (tpy) for the tailings site, UPP, and the laboratory are shown in Table 1-1.

Table 2-1. Facility Potential to Emit

	PM_{10} PTE (tpy)	**$PM_{2.5}$ PTE (tpy)**	**NO_x PTE (tpy)**	**SO_2 PTE (tpy)**	**VOC PTE (tpy)**
UPP	248	248	1,641	2,577	41
Tailings Site	36.3	5.4**	0.26	—*	0.04
Laboratory	0.12	0.12	0.68	0.13	0.12

Notes:
$PM_{2.5}$ = particulate matter 2.5 microns or smaller in aerodynamic diameter
PM_{10} = particulate matter 10 microns or smaller in aerodynamic diameter
PTE = potential to emit
NO_x = oxides of Nitrogen
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compounds
*Permitted combustion sources result in negligible SO_2 emissions at the tailings site.
**$PM_{2.5}$ emissions are estimated to be 15 percent of PM_{10} emissions.

Distinguishing by season of operation is allowed under EPA's *Implementation Guidance for the 2006 24-hour Fine Particle NAAQS* (March 2, 2012), which specifically acknowledges that several nonattainment areas located in the western United States only have experienced exceedances during the winter season. In such cases, the EPA authorizes states to (1) develop a seasonal emission inventory and (2) evaluate emission reduction strategies for a single season only [p. 11]. "When following a seasonal approach, the EPA believes that *the control strategy evaluation* (based on seasonal emission reduction measures) and the assessment of future year air quality concentrations (through air quality modeling or other analyses) *should be conducted for that season*." [p. 12]. In view of the nature of Utah's $PM_{2.5}$ nonattainment circumstance, the BACT analysis for UPP focuses primarily on a wintertime control strategy.

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BACT Determinations

This section provides BACT determinations for emission sources deemed significant at the UPP, Tailings site, and Laboratory.

3.1 Utah Power Plant

Historically, KUC has operated three coal fired boilers rated at 100 megawatts (MW) combined, referred to as Units 1-3, at the UPP. The units operated on coal during the spring, summer and fall months, but were limited to burning natural gas during the winter months between November 1 and March 1. In October 2016, KUC permanently ceased operation of Units 1-3. Therefore, a BACT analysis for Units 1-3 is not included in this document.

3.1.1 UPP Unit 4 Boiler

Source Description: Tangentially fired boiler capable of burning both coal and natural gas, rated at 838 million British Thermal Units per hour (MMBTU/hr) (coal), or 872 MMBTU/hr (natural gas), equipped with an electrostatic precipitator. Since the ambient 24-hour concentrations of $PM_{2.5}$ exceed the NAAQS during the winter months, the BACT analysis is limited to controls for the combustion of natural gas, which are the only controls that may affect the attainment of the $PM_{2.5}$ NAAQS in the Salt Lake City nonattainment area. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.1.1 NO_x BACT

- **Step 1—Identify All NO_x Control Technologies listed in RBLC and CARB.** The RBLC and CARB identifies (1) low NO_x burners with over-fire air (low NO_x burner [LNB] with over-fire air [OFA]) and (2) LNB with OFA and SCR as potential technologies for NO_x control from a natural gas fired boiler.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Previous SIP determination for UPP Unit 4 required the installation of LNB with OFA and SCR with 90% NO_X control when operating on natural gas during the winter months between November 1 and March 1. Because the top technology is already identified in previous SIPs, additional analysis is not necessary.
- **Step 4—Identify BACT.** LNB with OFA and SCR with 90% control efficiency constitute BACT for controlling NO_x emissions from natural gas combustion in the boiler during the wintertime period (November 1 through March 1).

Control efficiency of 90% for LNB with OFA and SCR is a default value used by the industry. A detailed design of the control systems would be necessary to develop anticipated control efficiency for Unit 4. Due to SIP time constraints, a detailed design is not feasible and therefore it is recommended that UDAQ use the default value.

3.1.1.2 SO_2 BACT

- **Step 1—Identify all SO_2 Control Technologies listed in RBLC and CARB.** The RBLC identifies the use of pipeline quality natural gas as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4— Identify BACT.** The use of pipeline quality natural gas constitutes BACT when burning natural gas.

3.1.1.3 $PM_{2.5}$ BACT

- **Step 1—Identify all $PM_{2.5}$ Control Technologies listed in RBLC.** The RBLC identifies good combustion practices as a control for reducing $PM_{2.5}$ when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Good combustion practices constitute BACT while burning natural gas.

3.1.1.4 VOC BACT

- **Step 1—Identify all VOC Control Technologies listed in RBLC.** The RBLC identifies good combustion practices as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4— Identify BACT.** Good combustion practices constitute BACT for VOC while burning natural gas.

Controlling NO_X emissions by 90 percent with LNB, OFA, and SCR and the use of pipeline quality natural gas and good combustion practices represent the most stringent measure for Unit 4 at the UPP when operating on natural gas between November 1 and March 1.

3.1.2 UPP Unit 5 Combustion Turbine and Duct Burner

Source Description: A combustion turbine and duct burner in combined-cycle operation with a nominal generating capacity of approximately 275 MW, equipped with SCR and CatOx. Construction of Unit 5 is not complete at this time.

3.1.2.1 NO_x BACT

- **Step 1—Identify All NO_x Control Technologies listed in RBLC and CARB.** The RBLC identifies selective noncatalytic reduction (SNCR) and SCR as potential technologies for NO_x control. The SCR technology is the most stringent control alternative listed in the RBLC.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** SCR constitutes BACT for controlling NO_x emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.2 VOC BACT

- **Step 1—Identify All CO and VOC Control Technologies listed in RBLC and CARB.** The RBLC identifies CatOx to control emissions of CO and VOC.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** CatOx constitutes BACT for controlling CO and VOC emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.3 SO_2 BACT

- **Step 1—Identify All SO_2 Control Technologies listed in RBLC and CARB.** The RBLC identifies the use of pipeline quality natural gas and good combustion practices as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The use of pipeline quality natural gas and good combustion practices constitute BACT for controlling SO_2 emissions from the Unit 5 combustion turbine and duct burner.

3.1.2.4 $PM_{2.5}$ BACT

- **Step 1—Identify All $PM_{2.5}$ Control Technologies listed in RBLC and CARB**. The RBLC identifies the use of pipeline quality natural gas and good combustion practices as a control when burning natural gas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The use of pipeline quality natural gas and good combustion practices constitute BACT for controlling $PM_{2.5}$ emissions from the Unit 5 combustion turbine and duct burner.

Limiting NO_X emissions to 2 parts per million by volume dry (ppmvd) at 15% O_2; CatOx for control of CO and VOC emissions; and the use of pipeline quality natural gas and good combustion practices represent the most stringent measure for Unit 5 at the UPP.

3.1.3 Cooling Towers

Source Description: Noncontact water cooling towers are used to control waste heat from the boilers. All towers are equipped with drift eliminators with drift loss rated at 0.002 percent. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Drift eliminators and good operating practices constitute BACT.

The existing Unit 4 Cooling Tower could be upgraded with 0.001 percent drift factor from the existing 0.002%. Based on KUC's discussions with the vendors, the total installed costs for the upgrade of the drift eliminator would be $177,000. The upgrade of the drift eliminators would reduce the annual emissions from the Unit 4 Cooling Tower from 2.426 tpy (based on 2014 actual emissions) to about 1.21 tpy. The vendor provided information is included in the Appendix.

Based on the costs for the drift eliminator upgrade, the cost per ton of $PM_{2.5}$ removed is $146,000. Therefore, replacing the replacing the existing drift eliminator with a high efficiency drift eliminator is not cost effective for BACT. Based on this cost effectiveness analysis, eliminators with 0.0005% drift loss are not further evaluated as they would not be cost effective as well.

The use of drift eliminators with drift loss rated at 0.002 percent and good operating practices represent the most stringent measure for the cooling towers.

3.1.4 Tioga Space Heaters

Source Description: Natural gas-fired space heaters are used for comfort heating and cooling, and water heating throughout the power plant. The space heaters use low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. All space heaters are rated at less than 5 MMBTU/hr. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.4.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC and CARB for controlling NO_x emissions from heaters (LNB and good combustion practices) are already in use and constitute BACT.

3.1.4.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for Tioga Space Heaters at the UPP. As discussed in the BACT analysis for other KUC facilities, replacing the existing space heaters with new heaters is not cost effective for the BACT analysis.

3.1.5 Cold Solvent Degreaser

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identifies operating practices such as closing the degreaser lids as a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed at all times to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for the degreaser.

A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the UPP were 0.3 tpy.

The previously identified practices also represent the most stringent measure for the degreasers.

3.1.6 Natural Gas Emergency Generators

Source Description: The UPP operates two 1.2 MMBTU/hr natural gas generators. Emissions are controlled with good combustion practices while operating the generator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for natural gas generators less than 5 MMBTU/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the natural gas generators.

It should be noted, the 2014 actual emissions for $PM_{2.5}$ and precursors for the natural gas generators were 0.18 tpy.

Good combustion practices also represent the most stringent measure for the natural gas generators.

3.1.7 Roads at UPP

Source Description: Unpaved and paved access roads exist throughout the UPP and are used by KUC personnel daily. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies potential technologies for control of fugitive emissions on unpaved roads as: paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance of roads.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 4—Identify BACT.** Paving sections of the road, the application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are identified as BACT for the roads at the UPP.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from roads at the UPP were 0.27 tpy. Paving sections of the road, the application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads also represent the most stringent measure for the roads at the UPP.

3.1.8 Hot Water Heater

Source Description: Natural gas-fired water heater is used for water heating throughout the power plant. The water heater uses low NO_x burners (LNB) and regular inspections are done to the unit to ensure optimum combustion performance. The water heater is rated at 7.13 MMBTU/hr. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.8.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC for controlling NO_x emissions from the heater (LNB and good combustion practices) are already in use and constitute BACT.

3.1.8.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from the heater.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from the heater and these control technologies constitute BACT.

The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for the hot water heater at the UPP.

3.1.9 Coal and Ash Handling at UPP

Source Description: Coal and ash handling system that includes small coal storage pile, conveyors, and coal and ash storage silos. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC.** The RBLC identifies potential technologies for control of fugitive emissions from coal and ash handling as enclosures and water sprays.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3**—**Eliminate Economically/Chronologically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 4**—**Identify BACT.** Enclosures and water sprays are identified as BACT for coal and ash handling at the UPP.

It should be noted, the 2014 actual $PM_{2.5}$ emissions from coal and ash handling at the UPP were 0.92 tpy. Enclosures and water sprays also represent the most stringent measure for coal and ash handling at the UPP.

3.1.10 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted, the 2014 actual VOC emissions for the gasoline fueling stations at the UPP were 0.33 tpy.

The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.1.11 Diesel Fire Pump

Source Description: The UPP operates 175 HP diesel-fired fire pump during emergencies. The fire pump complies with applicable New Source Performance Standards to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. Potential emission control technologies identified in the RBLC and CARB for similar sized diesel fire pumps include good combustion practices and limiting the sulfur content of fuel to 0.0015 percent. Certification and compliance with applicable New Source Performance Standards is an acceptable means of demonstrating BACT for emergency fire pumps.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements are identified as BACT for all pollutants emitted from the emergency fire pump.

It should be noted that the 2014 actual emissions from the fire pump of $PM_{2.5}$ and precursors were 0.12 tpy.

Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements also represent the most stringent measure for the emergency fire pump.

3.1.12 Diesel Engine for Coal Unloading System

Source Description: The UPP had a170 HP diesel-fired engine to operate the coal unloading system. This emission source no longer exists at the UPP. Therefore, a BACT analysis has not been developed for this emission source.

3.2 Tailings Site

3.2.1 Wind Erosion from Tailings Site

Source Description: Tailings are sent to the tailings site via a slurry pipeline. At the facility, tailings are separated by size in a cyclone with the larger particles used to build the embankments and the smaller particles discharged in slurry form in the impoundment. Emissions from the tailings site are mainly from wind erosion of dry tailings on the embankment. The facility has a current dust control plan approved by the UDAQ Executive Director for control of fugitive particulate matter. A copy of the quarterly report that documents dust control measures implemented at the facility is included in the Appendix for reference. The dust control plan requires frequent monitoring of the impoundment for wind erosion potential, applying chemical dust suppressants in the late spring, applying water via water trucks and the dust suppression sprinkler system as needed to maintain adequate moisture content.

In 2013, KUC conducted a study to identify and evaluate the range of dust control practices that have been attempted and successfully applied for mine tailings impoundments. A study also reviewed published literature and available air quality compliance documentation to extend the breadth of the evaluation. The study is included in the Appendix.

The tailings site can be categorized into four operational areas: impoundment, active embankment, inactive embankment, and reclaimed areas. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.2 BACT Analysis for Tailings Impoundment

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

  Watering

  Polymer application

Revegetation

Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists in minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the impoundment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.**

The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.

- **Step 4—Identify BACT.** The impoundment area is saturated with water and does not result in windblown dust emissions. Visual inspections are routinely performed to ensure the impoundment is saturated with water and in the unlikely event an area appears to be drying out, the area would be re-saturated. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions. Additionally, the impoundment area is saturated with water and does not result in windblown dust emissions.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.3 BACT Analysis for Tailings Active (Flat) Embankments

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

Watering

Polymer application

Revegetation

Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the embankment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.
- **Step 4—Identify BACT.** The tailings are actively deposited in the embankment areas. In an active embankment cell, the tailings are deposited every fourth day. The tailings are extremely wet when deposited. Areas can remain moist for several days. Application of water for dust control in active areas is not feasible as it tends to channelize directly to the drain point instead of spreading across the surface. The flat embankment areas will therefore have a potential for wind erosion on days 2, 3, and 4. Emissions are estimated based on days with potential for wind erosion. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions and identified as BACT.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.4 BACT Analysis for Tailings Inactive and Sloped Embankments

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

  Watering

  Polymer application

  Revegetation

  Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the embankment, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.
- **Step 4—Identify BACT.** In the inactive embankment areas, where tailings deposition has been completed for the year, KUC installs sprinklers for watering. Over the past few years, KUC converted this to an automated

sprinkler system that wets the surface at regular intervals. This upgrade allows the surface to maintain its moisture.

The embankment slopes are sprayed with polymers to minimize windblown dust. Polymer is reapplied as necessary to maintain its effectiveness to minimize emissions. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions and identified as BACT.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.5 BACT Analysis for Tailings Reclaimed Areas

- **Step 1—Identify All Control Technologies Listed in RBLC.** The following control technologies were identified in the RBLC for particulate control from impoundment type emissions sources:

  Watering

  Polymer application

  Revegetation

  Enclosures

Watering: Watering increases the moisture content of the surface, which conglomerates particles and reduces their likelihood to become airborne. The control efficiency for watering depends on how fast the area dries after water is added. Frequent watering is necessary to maintain its effectiveness.

Polymer Application: As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. Polymers suppress emissions by changing the physical characteristics of the surface material. The polymers form a hardened surface that binds the particles together, thereby reducing their likelihood to become airborne.

Revegetation: Revegetation assists with minimizing emissions. The vegetation holds the soil surface together and therefore makes it less prone to wind erosion.

Enclosures: Enclosures reduce the wind shear at the surface and thereby reduce wind erosion and emissions.

- **Step 2—Eliminate Technically Infeasible Options.** Because of the size of the reclaimed areas, enclosures are not feasible. All remaining technologies are feasible and are further evaluated below.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The control technologies cannot be ranked based on effectiveness as each control technology is effective for specific areas at the tailings site.
- **Step 4—Identify BACT.** Once released for reclamation, KUC implements a revegetation plan to reclaim the areas. Polymers are applied to areas still waiting to be reclaimed. The current practices of reducing particulate emissions by following the approved dust control plan is most effective in reducing emissions and are identified as BACT.

The current practices of dust management at the tailings site also represent the most stringent measure.

3.2.6 Service Roads

- **Source Description:** Service roads exist throughout the tailings site and are used by KUC personnel daily.
- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies potential technologies for control of fugitive emissions on unpaved roads as; paving the unpaved roads, the application of water and the use of dust suppression chemicals, limiting unnecessary traffic on roads and routine maintenance of roads.

- **Step 2—Eliminate Technically Infeasible Options.** Paving the haul roads is not technically feasible at the tailings site because of the frequently changing road locations over time resulting from tailing placement.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The remaining technologies of water application, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are economically and chronologically feasible.
- **Step 4—Identify BACT.** The application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads are identified as BACT for the service roads.

The application of water, chemical dust suppressants, limiting unnecessary traffic on roads, and routine maintenance of roads also represent the most stringent measure for the service roads at the tailings site.

3.2.7 Propane Communication Generator

Source Description: The tailings facility operates a propane fired communication generator. This generator is used to support communication systems during emergencies or loss of power at the tailings facility. Emissions are controlled with good combustion practices while operating the generator.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for emergency generators around 75 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- St**ep 3—Eliminate Economically/Chronologically Infeasible Options**. Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generator. The emergency generator also complies with applicable New Source Performance Standards.

Good combustion practices also represent the most stringent measure for the propane communication generator.

3.2.8 Biosolids Application

Source Description: Salt Lake County and Salt Lake City operate small landfill type operations that produce organic material which are used by the Tailings Facility to enhance the reclamation of closed tailings areas. The application of biosolids does not result in any emissions of $PM_{2.5}$, SO_2, NO_X or VOC. Very small quantities of ammonia emissions are estimated from these operations resulting from the natural process of decomposition. Therefore, a BACT analysis is not developed for this emission source. The 2014 actual emissions from the source were 0.021 tpy of ammonia.

3.3 Laboratory

3.3.1 Hot Water Boiler

Source Description: Natural gas-fired water boiler is used for water heating for the laboratory. The water boiler uses low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. The water heater is rated at 7.1 MMBTU/hr.

3.1.8.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from boilers less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC and CARB for controlling NO_x emissions from the boiler (LNB and good combustion practices) are already in use and constitute BACT.

3.1.8.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from the boiler.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from the boiler and these control technologies constitute BACT.

  The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for the hot water boiler at the laboratory.

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SECTION 4

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

4.1 Utah Power Plant

Unit 5

KUC is proposing the following limitations and monitoring requirements for the UPP. Unit 5 shall not exceed the following emission rates to the atmosphere.

Pollutant	lb/hr	ppmvd (@ 15% O_2)
NO_x		2.0*
$PM_{2.5}$ with duct firing: Filterable and condensable	18.8	

Note:
*Under steady state operation

Stack testing to show compliance with the above Unit 5 emissions limitations shall be performed as follows:

Pollutant	Test Frequency
$PM_{2.5}$	every year
NO_x	every year

The heat input during all compliance testing shall be no less than 90% of the design rate.

Unit 4

The following requirements are applicable to Unit 4 during the period November 1 to February 28/29 inclusive:

During the period from November 1, to the last day in February inclusive, only natural gas shall be used as a fuel, unless the supplier or transporter of natural gas imposes a curtailment. The power plant may then burn coal, only for the duration of the curtailment plus sufficient time to empty the coal bins following the curtailment.

Except during a curtailment of natural gas supply, emissions to the atmosphere from the indicated emission points shall not exceed the following rates and concentrations:

Pollutant	Grains/dscf	ppmdv (3% O_2) 68˚F, 29.92 in. Hg
$PM_{2.5}$ Filterable	0.004	
Filterable and condensable	0.03	
NO_x		336
NO_x (after 1/1/2018)		60

If operated during the winter months, stack testing to show compliance with the above Unit #4 emissions limitations shall be performed as follows:

Pollutant	Test Frequency
$PM_{2.5}$	every year
NO_x	every year

The heat input during all compliance testing shall be no less than 90% of the maximum average hourly production rate achieved in any 24-hour period during the previous three (3) years. The limited use of natural gas during startup, for maintenance firings and break-in firings does not constitute operation and does not require stack testing.

4.2 Tailings Site

The primary source of emissions at the tailings site is wind-blown dust. The intent of the $PM_{2.5}$ serious nonattainment SIP is to review emissions during winter time inversions. Since these inversions represent stagnant wind conditions, emissions from the tailings site will be minimal and therefore tailings site SIP conditions are not necessary for the $PM_{2.5}$ SIP. Emissions at the tailings site are effectively controlled with the implementation of BACT and the most stringent measure.

4.3 Laboratory

No limitations or monitoring requirements are proposed for the laboratory emission sources as the emissions from the facility are minimal and are effectively controlled with the implementation of BACT and the most stringent measure.

Attachments

- UPP Cooling Tower Vendor Data
- Tailings Quarterly Report
- Tailings Dust Control Practices Study
- Tailings FDCP
- Degreaser Solvent SDS

FINAL

Best Available Control Technology Determinations for the Smelter, Refinery, and Molybdenum Autoclave Process

Prepared for

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July 2017

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Contents

Attachments

- Smelter Dryer/Granulator baghouse information
- Anodes Furnaces NO_X study
- Degreaser Solvent SDS
- MAP NOI (Submitted September 2012)
- EPA Compliance Letter

Tables

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Acronyms and Abbreviations

ACT	Alternative control techniques
AO	approval order
BACT	best available control technology
BCM	Bingham Canyon Mine
CAA	Clean Air Act
CEM	Continuous emissions monitor
CFR	*Code of Federal Regulations*
CHP	Combined heat and power
CO	carbon monoxide
CPI	Consumer Price Index
EPA	Environmental Protection Agency
ESP	Electrostatic precipitator
FGR	Flue gas recirculation
FS	Flash Smelting
GPS	Global Positioning System
gr/dscf	grains per standard cubic feet
KUC	Kennecott Utah Copper
LNB	Low NOx burner
MACT	maximum achievable control technology
MAP	molybdenum autoclave process
MMBtu/hr	million British Thermal Units per hour
NAAQS	National Ambient Air Quality Standard
NH_3	ammonia
NO_x	nitrogen oxides
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in aerodynamic diameter
ppm	parts per million
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearing house
SCR	Selective catalytic reduction
SIP	State Implementation Plan
SO_2	sulfur dioxide
SOP	Standard operating procedure
TEG	Turbine Electric Generator
tpy	tons per year

UDAQ	Utah Department of Air Quality
ULNB	Ultra-low NOx burner
VOC	volatile organic compound
WRAP	Western Regional Air Partnership

SECTION 1

Introduction

Kennecott Utah Copper LLC (KUC) is submitting best available control technology (BACT) determinations for emission sources at the following KUC facilities: Smelter, Refinery, and the Molybdenum Autoclave Process (MAP). In addition to a BACT analysis, KUC has also documented the most stringent measure for emission sources at these facilities.

The Clean Air Act (CAA) requires that stationary sources implement BACT to demonstrate attainment as expeditiously as possible and meet any reasonable further progress requirements. As requested by the Utah Department of Air Quality (UDAQ), the BACT analysis should identify and evaluate reasonable and available control technologies for each relevant pollutant. The technical and economic feasibility of each potential control technology are components of the BACT analysis that help show whether a control technology is reasonable. The BACT analysis presented in this document was developed in accordance with the guidance established by the Environmental Protection Agency (EPA) and the CAA.

A BACT analysis was developed for emissions of particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). For each emission source, the BACT analysis followed a four-step process:

- **Step 1**—Identify all control technologies listed in the RACT/BACT/LAER Clearinghouse (RBLC) and/or California Environmental Protection Agency – Air Resource Board BACT Clearinghouse (CARB)
- **Step 2**—Eliminate technically infeasible options
- **Step 3**—Eliminate economically/chronologically infeasible options
- **Step 4**—Identify BACT

In addition, KUC reviewed available information, including recent BACT determinations (less than 10 years old by UDAQ) to determine if the permitted emissions represent the most stringent measure.

KUC understands additional controls beyond BACT may be required by UDAQ to demonstrate attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). However, a beyond BACT analysis is a separate and distinct review process from the BACT analysis and requires that a modeling analysis be performed demonstrating that implementation of additional controls beyond BACT would advance the attainment of the standard. It is important that these steps be implemented discretely and sequentially. The modeling of additional controls required to meet the $PM_{2.5}$ NAAQS were combined with the UDAQ State Implementation Plan (SIP) BACT request. KUC contends the BACT is determined and then modeled to determine attainment as part of the preparation of the SIP. KUC understands further controls may be necessary to meet the $PM_{2.5}$ NAAQS as part of the SIP development.

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SECTION 2

Recent Permitting Actions

The Smelter, Refinery, and MAP together have over 70 individual significant and insignificant sources. The Smelter recently had UDAQ permitting actions. A modified approval order (AO) was issued for the smelter on June 10, 2014. AO DAQE-AN0103460054-14 allows the Smelter to operate a crushing and screening plant and modifies stack testing requirements for the Smelter emissions sources. No other significant modifications were made to the Smelter AO in the last 5 years.

The EPA performed extensive technology reviews of Smelter emissions in support of the 2002 primary copper smelting major source maximum achievable control technology (MACT) standard (40 *Code of Federal Regulations* [*CFR*] 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC Smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Both standards establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources, not using batch copper converters). Smelter process and emission controlling technologies that contributed to EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred after promulgation of the MACT standards.

AO DAQE-AN01013460045-10 for the Refinery was issued in 2010 to add the combined heat and power (CHP) unit. The CHP unit utilizes SoLoNO$_X$™ burners minimizing NO_X emissions from the unit. The Smelter and Refinery facilities operate under a single Title V Operating Permit # 3500030003.

The MAP facility will process molybdenum disulfide into molybdenum trioxide and ammonia. The MAP facility was originally permitted in 2008 and was modified in March 2013 (AO DAQE-AN0103460052-13) to reflect the updated design of the plant. The permitting actions require thorough control technology analysis and the plant will implement BACT to minimize emissions from the facility.

Potential to emit (PTE) emissions in tons per year (tpy) for the Smelter, Refinery and MAP are shown in Table 2-1.

Table 2-1. Facility Potential to Emit Emissions

	PM_{10} PTEs (tpy)	$PM_{2.5}$ PTEs (tpy)	NO_x PTEs (tpy)	SO_2 PTEs (tpy)	VOC PTEs (tpy)
Smelter	510.82	426.35	185.29	1,085.72	13.50
Refinery	25.64	25.64	38.57	4.44	8.42
MAP	13.11	9.99	35.57	2.43	6.71

Notes:
PM_{10} = Particulate matter 10 microns or smaller in aerodynamic diameter
NO_x = oxides of nitrogen
SO_2 = sulfur dioxide
VOC = volatile organic compounds
$PM_{2.5}$ = Particulate matter 2.5 microns or smaller in aerodynamic diameter
PTE = potential to emit
tpy = tons per year

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SECTION 3

Best Available Control Technology Determinations

This section provides BACT determinations for emission sources deemed significant at the Smelter, Refinery, and the MAP facility.

3.1 Smelter

The EPA performed extensive technology reviews of Smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC Smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules (e.g., the design of the Smelter is based on the furnace technology). Typical smelting operations require batch processing which intermittently produces high concentrations of SO_2 and particulate in a manner that can reduce the efficiency of the acid plant as a control device. By employing the flash smelting (FS) and flash converting (FC) technologies, KUC can eliminate many of the problems inherent with batch type smelter operations. These improvements include continuous flow of off-gases to the acid plant during the FC process as well as reduced total volume of off-gases. Additionally, the furnaces are stationary which improves the ability to capture the off-gases as well as the ability to capture any fugitive emissions with the secondary capture system, which cleans the gases with baghouses and scrubbers before venting to the main stack. As a result, both MACT standards go so far as to establish a separate category for only the KUC Smelter due to its unique design and emission performance not achievable by conventional technology.

The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources not using batch copper converters). The KUC Smelter employs several technologies to minimize the smelting emissions that report to the main stack.

- The concentrate dryer burns natural gas to heat/dry concentrate for use in the FS furnace. Operation with low-NO_x burners (LNB) along with lower dryer temperatures minimizes the formation of NO_x while also preventing the formation of SO_2. KUC operates both a baghouse and a scrubber as controls for the concentrate dryer.
- The secondary gas system collects fugitive emissions in the hot metals building (typically associated with the furnaces) and vents them through a baghouse and a sodium-based scrubber before they are vented to the main stack.
- The matte grinding circuit crushes and dries granulated matte for use in the FC furnace. The particulate from the ground matte is collected in a baghouse and pneumatically conveyed to the FC furnace feed bin. NO_x emissions from natural gas combustion are minimized with LNB and low temperature firing and PM_{10} emissions are controlled with the production baghouse.
- In the anodes area, blister copper from the FC furnace is refined in two available refining furnaces to remove the final traces of sulfur. Copper production can be supplemented with copper scrap, which can be added to the refining furnaces for re-melt. The anodes refining furnaces are natural gas fired with oxy-fuel burners. Off-gas is vented (in series) to a quench tower, lime injection, baghouse, and scrubber and vented to the main stack. NO_x reduction activities also include maintaining furnaces to prevent ingress of air.

- The shaft furnace and holding furnace are used to re-melt anode scrap and other copper scrap to incorporate into copper production. LNBs are used to reduce NO_x from the natural gas combustion and a baghouse is operated to control PM_{10} emissions. The shaft furnace is in the anodes area, but vents separately to the main stack.

3.1.1 Main Stack

Source Description. Multiple process equipment emissions are routed through the main stack. Such equipment includes the matte granulators, acid plant, anode building, powerhouse, furnaces, dryers, and grinding circuits. Many of these sources of emissions have their own primary control devices (baghouse, scrubbers, etc.). Some are then routed to the secondary gas system and then through the main stack. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

Equipment emissions routed through the main stack at the Ssmelter include:

Equipment	Pollutant Emissions	Primary Emissions Control
Concentrate dryer	$PM_{2.5}$, SO_2, NO_X	LNB, baghouse, and scrubber
Powerhouse superheater	$PM_{2.5}$, SO_2, NO_X, VOC	Ultra-low NOx burner (ULNB), Flue gas recirculation (FGR), fuel throughput limits, and good operational practices
Powerhouse Foster Wheeler aux boiler	$PM_{2.5}$, SO_2, NO_X, VOC	LNB, FGR, fuel throughput limits, and good operational practices
Matte grinding	$PM_{2.5}$, SO_2	LNB, baghouse and good operational practices
Anode refining furnaces	$PM_{2.5}$, SO_2, NO_X, VOC	Oxy-fuel burners, baghouse, and scrubbers
Anode shaft furnace	$PM_{2.5}$, SO_2, NO_X, VOC	Baghouse, LNB and good operational practices
Anode holding furnace	$PM_{2.5}$, SO_2, NO_X, VOC	Baghouse, LNB and good operational practices
Vacuum cleaning system	$PM_{2.5}$	Baghouse
North and south matte granulators	$PM_{2.5}$, SO_2	Scrubber, SGS baghouse, and SGS scrubbers

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC identifies different control technologies for process equipment eventually routed through the main stack. These control technologies are currently in place as previously discussed.

The EPA performed extensive technology reviews of smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC Smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Both standards go so far as to establish a separate category for only the KUC Smelter due to its unique design and emission performance not achievable by conventional technology. The primary copper smelting area source MACT standard specifically identifies the KUC Smelter main stack emission performance as MACT for copper smelters (existing sources not using batch copper converters). Smelter process and emission controlling technologies that contributed to EPA’s designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred after promulgation of the MACT standards.

Baghouses used to control particulate emissions from the concentrate dryer, matte grinding, anode furnaces and granulators are maintained regulatory and the bags are replaced as recommended by the vendors. The bags currently used by KUC in these baghouses are provided in the Appendix. The exhaust from these processes is at high temperature and low pH due to the acidic nature of the materials. Over the years, KUC has experimented with different types of bags, such as pleated bags, that are more effective in removing particulate. However, these bags could not provide optimum performance due to high temperature and low pH. Therefore, upgrading to different types of bags is not technically feasible for these processes.

Again, KUC maintains and replaces bags in these baghouses as recommended by vendors to maintain performance, pressure differential and particulate removal efficiency.

The KUC Smelter continues to be the cleanest Smelter operations in the world. KUC reviewed emission reductions alternatives for anode furnaces venting through the main stack. The operations at the Smelter are continuously optimized to ensure high efficiency operation of the facility, including periodic upgrades of the burners to maintain optimum operations. KUC performed a pre-feasibility level study to evaluate NO_X emissions reductions options for the anodes furnaces at the Smelter. The study evaluated emission reduction strategies such as SCR, SNCR, oxidation systems and wet scrubbers. Portions of the study are provided as an Attachment. The entire study is not included to ensure project confidentiality.

While all the identified technologies were determined to be feasible, each had significant energy and economic impacts. Based on the pre-feasibility study, the costs per ton of NO_X removed from these technologies ranges from $55,000 to $590,000. These costs are based on the prefeasibility study and actual implantation costs are expected to be higher as major process and structural modifications would need to be made to implement these alternatives.

Therefore, NOx emissions reduction technologies such as SCR, SNCR and wet scrubber are not cost effective for BACT for the anode furnaces venting to the main stack.

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 selected as BACT.
- **Step 4—Identify BACT.** Because no new major developments in technologies have occurred after the promulgation of the MACT standards, the control technologies currently in place constitute BACT.

Complying with applicable requirements of the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE) represent the most stringent measure for the main stack.

3.1.2 Powerhouse Holman Boiler

Source Description: The boiler is used to provide process steam at the smelter. Emissions of NO_x are limited with flue gas recirculation (FGR), LNB, opacity limits, an alternative monitoring plan which requires continuous monitoring of operational parameters (fuel use, stack oxygen, steam output), and operational controls with good combustion practices. Emissions of $PM_{2.5}$, CO, SO_2, and VOC are limited with use of pipeline quality natural gas, good combustion practices, gas consumption limit, good design, opacity limits, and proper operation of the boiler. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.2.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies the following as possible control technologies for NO_x for natural gas-fired boilers:

Selective catalytic reduction (SCR)

FGR

LNBs with good combustion practices

Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The Holman boiler is equipped with FGR and LNB to reduce NO_x emissions. The addition of the SCR would reduce the emissions from the boiler from 9.9 tpy (based on 2016 actual emissions) to 2.0 tpy.

From the Alternative Control Techniques (ACT) Document — NO_X Emissions from Industrial/Commercial/Institutional Boilers, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 100 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.03 lb/MMBtu. From Table 6-5 of the ACT document, the total annualized cost for the 100 MMBtu/hr gas boiler is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from Consumer Price Index (CPI) Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74; therefore, for the Holman boiler, the estimated cost is $487,287.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $62,000 and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** FGR, LNBs with good combustion practices, limited gas consumption, good design, and proper operation constitute BACT for this source.

KUC continuously monitors operational parameters to predict NO_x emissions and ensure proper boiler operation. The parameters monitored are fuel use (to predict NO_x emissions lb/hr), stack oxygen (to monitor proper boiler operation and compliance with NO_x lb/MMBtu emission limit), and steam output (used to estimate heat input if fuel use is unavailable). The ranges for these parameters were developed during a 30-day monitoring campaign where data from a certified NO_x analyzer were used to develop predictive equations with the operation parameters.

3.1.2.2 SO_2, VOC, and $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies listed in the RBLC and CARB**. The RBLC and CARB identifies the following as possible control technologies for boilers:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 were selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, opacity limits, good design, and proper operation of the boiler constitute BACT for this emission source.

  FGR, LNBs with good combustion practices, limited gas consumption, good design, and proper boiler operation represent the most stringent measure for the Holman Boiler.

3.1.3 Feed Process (Wet and Dry)

Source Description: Silica flux, concentrate, and converter slag are transferred directly to feed bins then conveyed to the dryer. Particulate emissions from the loading of the flux and concentrate, and from transfer points of the conveyor, are vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, electrostatic precipitators (ESPs), and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP, because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable as most effective technology identified in Step 1 selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

The use of a baghouse to control particulate emissions also represents the most stringent measure for both the wet and dry feed process.

3.1.4 Matte and Slag Granulators

Source Description: Slag and matte granulators are each equipped with a three-stage impingement plate scrubber. The smelter operates two matte granulators and one slag granulator. The molten matte is granulated with water in two separate granulation tanks (two matte granulators), each equipped with a scrubber. The convertor slag is granulated in a separate granulator (one slag granulator), also equipped with a scrubber. The matte granulators are vented through the main stack. The slag granulator is vented to the atmosphere through a separate stack. $PM_{2.5}$ and SO_2 emissions are controlled by a neutral pH three-stage impingement plate scrubber. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.4.1 $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, other possible particulate control technologies include baghouses, cyclones, ESP, and scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** While baghouses are most effective in controlling particulate emissions, this technology is not feasible for the granulators. The exhaust from the granulators has very high moisture content, which is not suitable for baghouses. Moisture condensation can cause accumulation of mud on the bags and baghouse walls. This results in blinded bags and clogged dust removal equipment. As discussed in the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook, cyclones are mainly used to control large particles. Therefore, scrubbers are the technically feasible option.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most technically feasible technology for this process, identified in Step 2, was selected as BACT.
- **Step 4—Identify BACT.** Scrubbers constitute BACT for the granulators.

3.1.4.2 SO_2 BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB**. The RBLC and CARB do not identify any specific control technologies for the granulators.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** Scrubbers constitute BACT for the granulators.

The use of scrubbers also represents the most stringent measure for both the matte and slag granulators.

3.1.5 Feed Storage Building

Source Description: Wet copper concentrate feed is stored in the enclosed wet feed storage building. Particulate matter from loading materials into the feed storage building, from reclaiming materials, and from conveyor/transfer point SME 002-A, are vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

The use of enclosures and baghouse to control particulate emissions also represents the most stringent measure for the feed storage building.

3.1.6 Anode Area Fugitives

Source Description: Emissions from the anode building process are controlled with a baghouse, quench tower, and scrubber. However, some emissions can escape as fugitives. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB do not identify any specific control technologies for process fugitives. The MACT, however, does address such emissions.

40 *CFR* 63.11147(a)(3) states, "You must operate one or more capture systems that collect the gases and fumes released from each vessel used to refine blister copper, re-melt anode copper, or re-melt anode scrap and convey each collected gas stream to a control device. One control device may be used for multiple collected gas streams."

KUC certified compliance with 63.11147(a)(3), as required by 63.11150(b)(4), in a letter dated and received by UDAQ on January 30, 2007. This document is included as an attachment to this report.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** In addition to opacity limits and required maintenance, current design of anode process units and the collection hoods on anode building processes have been engineered/designed to reduce fugitives and these practices constitute BACT.

The current design of anode process units and the collection hoods on anode building processes were engineered/designed to reduce fugitives and these represent the most stringent measure.

3.1.7 Smelter Fugitives

Source Description: Emissions from Smelter processes are controlled with appropriate control technologies including closed processes, launder hoods and others outlined below. However, some emissions can escape as fugitives. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB do not identify any specific control technologies for such fugitives.

  The EPA performed extensive technology reviews of Smelter emissions in support of the 2002 primary copper smelting major source MACT standard (40 *CFR* 63 Subpart QQQ) and the 2007 primary copper smelting area source MACT standard (40 *CFR* 63 Subpart EEEEEE). Specific discussion of the unique aspects of pollution controls at the KUC smelter are included in the Federal Register notices associated with the draft and final promulgation of both rules. Regarding the design and fugitive emission controls of the KUC smelter, the EPA provided the following discussion when promulgating the final copper smelting MACT standard (FR Vol. 67, No. 113, Page 40488):

  > Due to its unique design and operations, most of the process fugitive emission sources associated with smelters using batch converting are eliminated at the Kennecott smelter. There are no transfers of molten material in open ladles between the smelting, converting, and anode refining departments at the Kennecott smelter. In addition, there are no fugitive emissions associated with the repeated rolling-out of converters for charging, skimming, and pouring. Also, only one continuous flash converter is needed at the Kennecott smelter compared with the need for three or more batch copper converters at the other smelters.

Both standards go so far as to establish a separate category for only the KUC smelter due to its unique design and emission performance not achievable by conventional technology. Smelter process and emission controlling technologies that contributed to the EPA's designation of the modernized smelter as a separate MACT category for HAP emissions, including off-gases from furnaces, also contribute to the control of fine particulate and precursor emissions. No new major developments in technologies or costs have occurred after the promulgation of the MACT standards.

Specific notes regarding control techniques listed in Table 5 of Attachment 5 of the EPA comments are listed below:

- KUC Smelter hot metals operations are serviced by an extensive local ventilation (secondary gas) system. This system collects gasses and routes them through baghouses and scrubbers before venting them to the main stack where they are continuously monitored for multiple pollutants.
- KUC Smelter hot metals operations are completely enclosed in a building.
- KUC processes only grade 1 scrap in its melting furnaces.

- A leak detection/prevention/repair program is not applicable to KUC Smelter furnaces and hot metals process units because they are enclosed and operate at negative pressure due to their inherent design.
- Because KUC furnaces are enclosed and do not require open air transfer of molten metal, they are not dependent on hooding systems for process gas collection.
- It is not necessary to add curtains to improve hood performance at the KUC Smelter as the process does not rely on hoods to capture process gasses.
- The KUC process does not require the open-air transfer of molten metal from smelting to converting vessels so it is not necessary to collect these emissions.
- The EPA noted in the primary copper smelting MACT standard, KUC was the first Smelter in the United States to capture and control emissions from anode refining furnaces.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** In addition to opacity limits and required maintenance, current designs of processes were engineered/designed to reduce fugitives and therefore these practices constitute BACT. KUC has implemented best management practices to minimize fugitive emissions. These practices are reviewed frequently and improvements are implemented to minimize emissions.

The current designs of processes were engineered/designed to reduce fugitives and therefore these practices also represent the most stringent measure.

3.1.8 Acid Plant Fugitives

Source Description: The double contact acid plant removes SO_2 from the off-gases of the flash furnaces. The sulfuric acid produced by the plant is sold. Among other technologies, the system is equipped with tubular candle fiber mist eliminators and the tail gas is discharged to the main stack. However, some emissions can escape as fugitives, which are controlled using best operational practices to minimize emissions. Best operational practices to minimize the emissions include opacity limits, weekly visual opacity surveys and the requirement of prompt repair or correction and control to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB do not identify any specific control technologies for such fugitives.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable
- **Step 4—Identify BACT.** Best operational practices may include, (1) placement or adjustment of negative pressure ductwork and collection hoses, (2) welding of process gas leaks, or (3) containment of process gas leaks. These practices and current design of processes were engineered/designed to reduce fugitives and therefore constitute BACT.

The best operational practices currently implemented and the current designs of the processes also represent the most stringent measure for the acid plant fugitives.

3.1.9 Powerhouse Foster Wheeler Boiler

Source Description: This boiler is used to produce superheated steam to start the smelter, drive acid plant compressors, and standby power. Emissions of NO_x are limited with FGR, LNB with good combustion practice, continuous monitoring of NO_x at the smelter main stack, and limitations on fuel throughput. Emissions of $PM_{2.5}$, CO, SO_2, and VOCs are limited with use of pipeline quality natural gas; good combustion practices; good design and proper operation of the boiler; and continuous monitoring of opacity, particulate, and SO_2 at the Smelter main stack. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.9.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** The RBLC and CARB identify the following as possible control technologies for NO_x for natural gas-fired boilers.

  SCR

  FGR

  LNB with good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The powerhouse boiler is equipped with FGR and LNB to reduce NO_x emissions. Emissions from this boiler are vented through the main stack and it is difficult to differentiate the boiler NO_X emissions from the main stack emissions. Based on the understanding of operations at the smelter, the addition of the SCR might reduce the annual emissions from the boiler from 5.3 tpy (based on 2016 actual emissions and engineering estimates) to 1.1 tpy.

From the Alternative Control Techniques Document – NO_X Emissions from Industrial/Commercial/Institutional Boiler, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 100 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.03 lb/MMBtu. From Table 6-5, the total annualized cost for the 100 MMBtu/hr gas boiler is \$1,500 to \$1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from CPI Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74; therefore, for the powerhouse boiler the estimated cost is \$261,000.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is \$62,000 and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** FGR, LNB with good combustion practices, good design and proper operation constitute BACT.

3.1.9.2 SO_2, VOC, and $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB**. The RBLC and CARB identify the following as possible control technologies for boilers.

Use of pipeline quality natural gas and good combustion practices

Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified in Step 1 are selected as BACT.

- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the Powerhouse Foster Wheeler Boiler.

3.1.10 Miscellaneous Storage Piles/Loadout

Source Description: Concentrate, granulated matte, slag, and other materials are stored in storage piles on pads. Water sprays or chemicals are applied as necessary to minimize fugitive emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify dry foggers, adding moisture, and enclosures as possible control technologies for fugitive emissions. Other possible technologies available to control fugitive dust emissions that are not identified in the RBLC include chemical dust suppression, baghouse, cyclone, and scrubber.
- **Step 2—Eliminate Technically Infeasible Options.** The emission sources are fugitive in nature and therefore it is not technically feasible to duct emissions to a baghouse, scrubber, or cyclone. Additionally, the locations of the storage piles are always changing, making the construction of permanent enclosures difficult. Therefore, these control technologies are not technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The remaining technology of water or chemical applications is economically and chronologically feasible.
- **Step 4—Identify BACT.** KUC uses water sprays, chemical dust suppressants, and temporary enclosures to minimize particulate emissions from the miscellaneous storage piles, which were demonstrated to be very effective. These business practices constitute BACT for this emission source.

The use of water sprays, chemical dust suppressants, and temporary enclosures to minimize particulate emissions from the miscellaneous storage piles also represent the most stringent measure.

3.1.11 Slag Concentrator

Source Description: Emissions associated with the crushing, grinding, and slag processing at the smelter are minimized with the water sprays and enclosures. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, other possible particulate control technologies include baghouses, cyclones, scrubbers, water sprays, and enclosures.

- **Step 2—Eliminate Technically Infeasible Options.** Baghouses are not feasible for the slag processing equipment. The slag stock piles are sprayed with water frequently to minimize emissions. The material as a result has very high moisture content, which is not suitable for baghouses. Moisture droplets and condensation can cause accumulation of mud on the bags, baghouse walls, and ductwork. This results in blinded bags and clogged dust removal equipment. Further, when ambient temperatures are below freezing, the mud will freeze on the baghouse bags and plug them.

  Wet scrubbers are not expected to be effective in minimizing emissions from crushing and grinding operations. Operation of the scrubbers is compromised due to below freezing ambient temperatures and very cold water streams in the scrubber. The duct work of the scrubbers will freeze during subfreezing ambient temperature conditions.

  As discussed in the WRAP Fugitive Dust Handbook, cyclones are mainly used to control large particles.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The remaining technology of water sprays and enclosures is economically and chronologically feasible.

- **Step 4—Identify BACT.** KUC uses water sprays and enclosures to minimize particulate emissions from the slag concentrator, which were demonstrated to be very effective. These business practices constitute the BACT for this emission source.

The use of water sprays and enclosures to minimize particulate emissions represent the most stringent measure from the slag concentrator.

3.1.12 Smelter Cooling Towers

Source Description: Three noncontact water cooling towers are used for various Smelter processes. The towers are equipped with drift eliminators with drift loss rated at 0.001 percent. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable, as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.001 percent and good operating practices represent the most stringent measure for the cooling tower. As determined in the BACT analysis for other KUC facilities, upgrading the drift eliminators with lower drift loss is not cost effective for the BACT analysis.

3.1.13 Ground Matte Silo

Source Description: Ground matte material is stored in silos. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.04 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the ground matte silo.

3.1.14 Molding Coatings Storage Silo

Source Description: Coatings material is stored in silos. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.003 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the coatings storage silo.

3.1.15 Lime Storage Silos

Source Description: The Smelter has three lime storage silos. These silos are used to store lime for the hydrometallurgical plant, anode area and the secondary gas system. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the three silo baghouses were 0.01 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the silos used to store lime for the hydrometallurgical plant, anode area and the secondary gas system.

3.1.16 Limestone Storage Silos

Source Description: The silo is used to store limestone for the hydrometallurgical plant. Particulate matter from loading materials into the silos is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.04 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for silo used to store limestone for the hydrometallurgical plant.

3.1.17 Recycle and Crushing Building

Source Description: The matte and slag material is recycled and crushed in a building. Particulate matter from these small-scale operations are minimized as they occur inside the building and are controlled with a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, enclosures, and water sprays.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is most effective at capturing fine particulate and minimizing emissions.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Conducting operations inside the building and use of a baghouse are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the recycle and crushing building were 0.03 tpy. Conducting crushing and recycling operations inside the building and use of a baghouse to control particulate emissions also represents the most stringent measure.

3.1.18 Smelter Laboratory

Source Description: The laboratory at the Smelter is used for preparation of samples for testing which sometimes results in dust. Particulate emissions from the laboratory building are vented through a baghouse.

Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify baghouses and enclosures as possible control technologies for limiting emissions from buildings or enclosed areas.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Baghouses are the most effective in controlling emissions. Therefore, fabric filters (baghouse) constitute BACT for the Smelter Laboratory.

It should be noted that the 2014 actual $PM_{2.5}$ emissions for the laboratory controlled with a baghouse were 0.78 tpy. This emission rate also represents the most stringent measure for the Smelter Laboratory.

3.1.19 Propane Communication Generator

Source Description: The Smelter operates a propane fired communication generator. This generator is used to support communication systems during emergencies or loss of power at the Smelter. Emissions are controlled with good combustion practices while operating the generator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for emergency generators around 75 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not Applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generator. The emergency generator also complies with applicable New Source Performance Standards.

Good combustion practices also represent the most stringent measure for the propane communication generator.

3.1.20 Cold Solvent Degreaser

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identifies operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.

- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed at all times to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for the degreaser.

  A Safety Data Sheet for the degreasing solvent is provided in the Appendix. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found of ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the Smelter were 0.002 tpy.

The previously identified practices also represent the most stringent measure for the degreasers.

3.1.21 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted that the 2014 actual VOC emissions for the gasoline fueling stations at the Smelter were 0.07 tpy. The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.1.22 Diesel Emergency Generator for Pyrometallurgical Process

Source Description: The Smelter operates one 998 HP diesel-fired emergency generator to support the pyrometallurgical process during emergencies. The emergency generator is equipped with turbo charger and after cooling and complies with applicable New Source Performance Standards to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. Potential emission control technologies identified in the RBLC and CARB for similar sized diesel generators include turbo charger and after cooling, good combustion practices and limiting the sulfur content of fuel to 0.0015 percent. Certification and compliance with applicable New Source Performance Standards is an acceptable means of demonstrating BACT for emergency generators.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.

- **Step 4—Identify BACT.** Turbo charger and after cooling, good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements are identified as BACT for all pollutants emitted from the emergency generator.

It should be noted that the 2014 actual emissions from the generator of $PM_{2.5}$ and precursors were 0.78 tpy.

Turbo charger and after cooling, good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements also represent the most stringent measure for the emergency generator.

3.1.23 Space Heaters

Source Description: Natural gas-fired heaters are used throughout the Smelter. The individual heaters are rated at less than 5 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.23.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC for controlling NO_x emissions from heaters of good combustion practices is already in use and constitute BACT.

3.1.23.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The 2014 actual emissions from the heaters for $PM_{2.5}$ and precursors were 0.48 tpy. The use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the space heaters. As discussed in the BACT analysis for other KUC facilities, replacing the existing space heaters with new heaters is not cost effective for the BACT analysis.

3.1.24 Hot Water Boiler

Source Description: Natural gas-fired water boilers are used for water heating throughout the Smelter. The water boilers use low NO_x burners (LNB) and regular inspections are done to the units to ensure optimum combustion performance. The water heaters are rated at less than 10 MMBTU/hr. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.1.24.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identifies LNB and good combustion practices as control technologies for minimizing NO_x emissions from boilers less than 10 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technologies identified in the RBLC and CARB for controlling NO_x emissions from the boilers (LNB and good combustion practices) are already in use and constitute BACT.

3.1.24.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from the boilers.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from the boilers and these control technologies constitute BACT.

The 2014 actual emissions from the boilers for $PM_{2.5}$ and precursors were 0.61 tpy. The use of pipeline quality natural gas, LNB and good combustion practices represent the most stringent measure for the hot water boilers at the Smelter.

3.2 Refinery

3.2.1 Boilers

Source Description: The two boilers are rated at 82 MMBtu/hr (gas) and 79 MMBtu/hr (oil) each and are permitted to operate on natural gas to meet the steam demand at the Refinery. During natural gas curtailment, the boilers are permitted to operate on oil. Emissions of NO_x are limited with FGR and LNB with good combustion practices. Emissions of $PM_{2.5}$, SO_2, and VOCs are limited with good combustion practices, good design, opacity limits, sulfur content limit, and proper operation of the boilers. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.1.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** The RBLC and CARB identifies the following as possible control technologies for NO_x for natural gas-fired boilers

SCR

FGR

LNB with good combustion practices

Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The Refinery boilers are equipped with FGR and LNB to reduce NO_x emissions. The addition of the SCR will reduce the emissions from the boilers from 12.9 tpy (based on based on 2016 actual emissions) to 2.6 tpy.

From the Alternative Control Techniques Document – NO_X Emissions from Industrial/Commercial/Institutional Boilers, 1994 ACT document, Table 6-7 presents controlled NO_x emission rates for various control technologies. For the 50 MMBtu/hr natural gas packaged water tube boiler, the controlled NO_x emission rate utilizing SCR technology is 0.02 lb/MMBtu (the 100 MMBtu/hr boiler controlled NO_x emission rate with SCR is listed at 0.03 lb/MMBtu). From Table 6-5 of the ACT document, the total annualized cost for the 50 MMBtu/hr gas boiler (closest entry to 82 MMBtu/hr Refinery boiler) is $1,500 to $1,900 per MMBtu/hr. To estimate the impact of escalating capital cost from 1992 to 2017 dollars, cost indices from CPI Inflation Calculator (http://www.bls.gov/data/inflation_calculator.htm) can be used. The escalation multiplier is determined to be 1.74. The estimated cost for the refinery boilers is $428,040 for both boilers.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $42,000 for the Refinery boilers and is, therefore, not cost effective for BACT.

- **Step 4—Identify BACT.** FGR, LNB with good combustion practices, good design, and proper operation constitute BACT for this source.

3.2.1.2 SO_2, VOC, and $PM_{2.5}$ BACT

- **Step 1—Identify All Control Technologies listed in RBLC and CARB**. The RBLC and CARB identifies the following as possible control technologies for natural gas fired boilers:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the boiler constitute BACT for this emission source.

FGR, LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the boilers.

3.2.2 CHP Unit

Source Description: The CHP unit will generate power and steam to support Refinery operations. The CHP unit uses a low NO_x duct burner and the turbine has $SoLoNO_x$ burners. Emissions of $PM_{2.5}$, SO_2, and VOC are limited with good design and proper operation. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.2.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC.** The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired turbines and duct burners.

  SCR

  LNB with good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The CHP unit is equipped with LNB (SoLoNO$_x$ technology burners on turbine) to reduce NO_x emissions. The addition of the SCR will reduce actual annual emissions from the CHP unit from 12.2 tpy (based on 2014 actual emissions) to 1.2 tpy. The CHP unit had major work performed in 2015 and 2016, therefore 2014 emissions are used for the analysis.

Solar Turbines, Inc. developed an estimation spreadsheet for the Taurus 70 combustion turbine and duct burner arrangement, which utilized vendor quotations for the installation of an SCR system. From the Solar calculations, the annualized capital and operating costs were estimated to be $932,100/yr.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $85,000 for the CHP unit and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** LNB with good combustion practices, good design, and proper operation of the CHP Unit constitute BACT for this source.

3.2.2.2 SO_2, VOC, and $PM_{2.5}$ Best Available Control Technologies

- **Step 1—Identify All Control Technologies listed in RBLC**. The RBLC identifies the following as possible control technologies for small turbines and duct burners:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, selected as BACT.

- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the CHP unit constitute BACT for this emission source.

LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the CHP unit.

3.2.3 Refinery Cooling Towers

Source Description: Two noncontact water cooling towers are used for various refinery processes. The towers are equipped with drift eliminators with drift loss rated at 0.001 percent. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify drift eliminators and good operating practices as control techniques for minimizing particulate emissions from cooling towers.

- **Step 2—Eliminate Technically Infeasible Options.** Not applicable, as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, are selected as BACT.
- **Step 4—Identify BACT.** Drift eliminators and good operating practices constitute BACT.

The use of drift eliminators with drift loss rated at 0.001 percent and good operating practices represent the most stringent measure for the cooling tower. As determined in the BACT analysis for other KUC facilities, upgrading the drift eliminators with lower drift loss is not cost effective for the BACT analysis.

3.2.4 Propane Communication Generator

Source Description: The Refinery operates a propane fired communication generator. This generator is used to support communication systems during emergencies or loss of power at the Refinery. Emissions are controlled with good combustion practices while operating the generator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as the primary control technology for emergency generators around 75 HP operated on propane. The emergency generators must also comply with the applicable New Source Performance Standards established by EPA.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies are feasible.
- **Step 4—Identify BACT.** Good combustion practices are identified as BACT for the propane fired emergency generator. The emergency generator also complies with applicable New Source Performance Standards.

Good combustion practices also represent the most stringent measure for the propane communication generator.

3.2.5 Cold Solvent Degreaser

Source Description: Cold solvents are used to degrease and clean equipment parts. The degreaser lids are kept closed when the unit is not in use to minimize solvent loss and emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identifies operating practices such as closing the degreaser lids a method to control/minimize VOC emissions.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as the identified control technology is technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** When not in use, the lids on the degreasers are kept closed always to minimize emissions. The solvent is recycled frequently, and no significant loss in volume is observed, implying minimal losses as emissions. These practices constitute BACT for the degreaser.

A Safety Data Sheet for the degreasing solvent is provided as an Attachment. KUC has experimented with low-VOC content degreasers in the past. However, these solvents were found of ineffective in cleaning parts and often resulted in residue on the parts. As a result, transition to low-VOC solvent as a degreasing agent is not further investigated for this analysis. Additionally, the 2014 actual VOC emissions from degreasers at the Refinery were 0.02 tpy.

The above identified practices also represent the most stringent measure for the degreasers.

3.2.6 Gasoline Fueling Stations

Source Description: Adding gasoline to storage tanks and dispensing from the storage tanks into vehicles. The fueling operation is equipped with Stage 1 and Stage 2 vapor recovery systems. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. The RBLC and CARB identify two control techniques for controlling VOC emissions from gasoline fueling operations. They are Stage 1 and Stage 2 vapor recovery systems.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Stage 1 and 2 vapor recovery constitutes BACT for these sources.

It should be noted that the 2014 actual VOC emissions for the gasoline fueling stations at the Refinery were 0.04 tpy.

The use of Stage 1 and Stage 2 vapor recovery systems also represent the most stringent measure for the gasoline fueling stations.

3.2.7 Space Heaters

Source Description: Natural gas-fired heaters are used throughout the Refinery. The individual heaters are rated at less than 5 MMBTU/hr each. The heaters are regularly inspected for optimum combustion performance. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.2.7.1 NO_x BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify good combustion practices as control technologies for minimizing NO_x emissions from heaters less than 5 MMBtu/hr.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The technology identified in the RBLC and CARB for controlling NO_x emissions from heaters of good combustion practices is already in use and constitute BACT.

3.3.7.2 $PM_{2.5}$, SO_2, and VOC BACT

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB.** The RBLC and CARB identify use of pipeline quality natural gas and good combustion practices as a control technology for minimizing $PM_{2.5}$, SO_2, and VOC emissions from heaters.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** The RBLC and CARB identifies use of pipeline quality natural gas and good combustion practices as a means of controlling $PM_{2.5}$, SO_2, and VOC emissions from heaters and these control technologies constitute BACT.

The use of pipeline quality natural gas and good combustion practices also represent the most stringent measure for the space heaters. As discussed in the BACT analysis for other KUC facilities, replacing the existing space heaters with new heaters is not cost effective for the BACT analysis.

3.2.8 Diesel Emergency Generator

Source Description: The Refinery operates one 487 HP diesel-fired emergency generator to support the precious metals plant at the Refinery during emergencies. The emergency generator complies with applicable New Source Performance Standards to minimize emissions. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies Listed in RBLC and CARB**. Potential emission control technologies identified in the RBLC and CARB for similar sized diesel generators include good combustion practices and limiting the sulfur content of fuel to 0.0015 percent. Certification and compliance with applicable New Source Performance Standards is an acceptable means of demonstrating BACT for emergency generators.
- **Step 2—Eliminate Technically Infeasible Options.** Not applicable as all identified control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable because all potential technologies identified in Step 1 are selected as BACT.
- **Step 4—Identify BACT.** Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements are identified as BACT for all pollutants emitted from the emergency generator.

It should be noted, the 2014 actual emissions from the generator of $PM_{2.5}$ and precursors were 0.12 tpy.

Good combustion practices, limiting the sulfur content of fuel to 0.0015 percent and complying with applicable New Source Performance Standards requirements also represent the most stringent measure for the emergency generator.

3.2.9 Soda Ash Storage Silo

Source Description: The Refinery has on soda ash storage silo. The silo is used to store soda ash for the Refinery. Particulate matter from loading materials into the silo is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.

- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses in form of a bin vent filters are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the silo baghouse were 0.004 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the silo.

3.2.10 Precious Metals Packaging Area

Source Description: The Refinery has a small precious metals packaging area. Particulate matter from the process is vented to a baghouse. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses, cyclones, ESP, and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible. The fabric filter (baghouse) is more effective at capturing fine particulate than an ESP because ESPs tend to collect larger particles selectively. Cyclones are only effective in capturing larger particulate. Wet scrubbers, although effective at capturing fine particulate, produce a wet sludge requiring disposal. Also, wet scrubbers have higher operating costs and lower removal efficiencies than fabric filters. Based on their control effectiveness, the fabric filter ranks at the top, followed by an ESP, and then by wet scrubbers.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Baghouses are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ emissions from the packaging area baghouses were 0.008 tpy. The use of a baghouse to control particulate emissions also represents the most stringent measure for the precious metals packaging area.

3.2.11 Hydrometallurgical Precious Metals Processing

Source Description: The Refinery has a precious metals processing and recovery area. Particulate matter, ammonia and SO_2 from the process are vented to a scrubber. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible particulate control technologies include baghouses and wet scrubbers.
- **Step 2—Eliminate Technically Infeasible Options.** The fabric filter (baghouse) is more effective at capturing fine particulate. However, due to high temperature of the exhaust steam and its pH, baghouses are not technically feasible. Wet scrubbers are therefore the only technically feasible control of particulate emissions and SO_2.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Scrubbers are the most effective control technology for controlling particulate emissions and constitute BACT.

It should be noted that the 2014 actual $PM_{2.5}$ and precursor emissions from the processes were 0.58 tpy. The use of scrubbers to control particulate emissions, ammonia and SO_2 also represents the most stringent measure for the precious metals processing area.

3.2.13 Tankhouse Sources

Source Description: The Refinery Tankhouse and MPC buildings include liberator, cathode wash and anode scrub wash processes that result in sulfuric acid mist emissions. Potential sulfuric acid mist from the processes are vented to a mist eliminator. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

- **Step 1—Identify All Control Technologies listed in RBLC and CARB.** Although RBLC and CARB did not provide controls for the specific operation, possible sulfuric acid control technologies include scrubbers and mist eliminators.
- **Step 2—Eliminate Technically Infeasible Options.** The presence of electrolytes in the exhaust stream cannot be effectively captured with a wet scrubber. Therefore, wet scrubbers are not technically feasible for these sources. Mist eliminators are technically feasible and effective in minimizing sulfuric acid mist emissions.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, as most effective technology, identified in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Mist eliminators are the most effective control technology for controlling sulfuric acid mist emissions and constitute BACT.

It should be noted that the 2014 actual sulfuric acid mist as $PM_{2.5}$ emissions from the Tankhouse sources were 0.005 tpy. The use of mist eliminators to control sulfuric acid mist emissions also represents the most stringent measure for the Tankhouse sources.

3.3 Molybdenum Autoclave Process

The MAP facility was first permitted in 2008 and was modified in March 2013 (AO DAQE-AN0103460052-13) to reflect the updated design of the plant. The MAP plant has not been operated and most of the equipment at the plant is currently up for sale.

The proposed CHP unit at the MAP plant represents most the emissions. The BACT analysis for CHP unit is presented below. The permitting actions have required thorough control technology analysis that the plant will implement BACT to minimize emissions from the facility. Due to this very recent permitting action, KUC has not developed a detailed BACT analysis for other non-significant emission sources at MAP facility. To assist with the SIP process, KUC has developed the following summary of BACT for other emission sources at the MAP facility.

KUC has attached the Notice of Intent application for the facility submitted to UDAQ in September 2012. The application includes BACT analysis for the emissions sources at the MAP facility.

3.3.1 CHP Unit

Source Description: The CHP unit will generate power and steam to support MAP operations. The CHP unit uses a low NO_x duct burner and the turbine has SoLoNO_x burners. Emissions of $PM_{2.5}$, SO_2, and VOC are limited with good design and proper operation. Potential control technologies in other nonattainment areas in states such as California and Alaska were reviewed for this analysis.

3.3.1.1 NO_x BACT

- **Step 1—Identify All Control Technologies listed in RBLC.** The RBLC identifies the following as possible control technologies for NO_x for natural gas-fired turbines and duct burners.

SCR

LNB with good combustion practices

Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** The CHP unit will be equipped with LNB (SoLoNO$_x$ technology burners on turbine) to reduce NO_x emissions. The addition of the SCR will reduce annual potential to emit emissions from the CHP unit from 26.1 tpy to 2.6 tpy.

Solar Turbines, Inc. developed an estimation spreadsheet for the Taurus 70 combustion turbine and duct burner arrangement, which utilized vendor quotations for the installation of an SCR system. From the Solar calculations, the annualized capital and operating costs were estimated to be $932,100/yr.

Based on the annualized costs for the SCR, the cost of additional control per ton of NO_x removed is $40,000 for the CHP unit and is therefore not cost effective for BACT.

- **Step 4—Identify BACT.** LNB with good combustion practices, good design, and proper operation of the CHP Unit constitute BACT for this source.

3.3.1.2 SO_2, VOC, and $PM_{2.5}$ Best Available Control Technologies

- **Step 1—Identify All Control Technologies listed in RBLC**. The RBLC identifies the following as possible control technologies for small turbines and duct burners:

  Use of pipeline quality natural gas and good combustion practices

  Good design and proper operation

- **Step 2—Eliminate Technically Infeasible Options.** All control technologies are technically feasible.
- **Step 3—Eliminate Economically/Chronologically Infeasible Options.** Not applicable, because all potential technologies identified, in Step 1, selected as BACT.
- **Step 4—Identify BACT.** Use of pipeline quality natural gas, good combustion practices, good design, and proper operation of the CHP unit constitute BACT for this emission source.

LNB with good combustion practices, good design, and proper operation on pipeline quality natural gas also represent the most stringent measure for the CHP unit.

Table 3-2. Best Available Control Technology Summary for the Molybdenum Autoclave Process Facility

Emission Source ID/Name	Emission Source Description	BACT Summary
CHP Unit	Combined Heat and Power Unit	LNB and use of pipeline quality natural gas will minimize emissions
Cooling Tower	20,000 gallons per minute (gpm) cooling tower	Drift eliminator with efficiency of 0.0005 percent will minimize emissions
IT Building Backup Generator	LPG Communications Generator	Emissions will comply with applicable New Source Performance Standards.
Emergency Fire Pump	Emergency Fire Pump	Emissions will comply with applicable New Source Performance Standards.
Dryers and Re-oxidizer	Three Process dryers and re-oxidizer each rated less than 5 MMBtu/hr	Use of pipeline quality natural gas will minimize emissions

Table 3-2. Best Available Control Technology Summary for the Molybdenum Autoclave Process Facility

Emission Source ID/Name	Emission Source Description	BACT Summary
Calciner	Process calciner rated at 16 MMBtu/hr	LNB and use of pipeline quality natural gas will minimize emissions
Startup Boiler	Process startup boiler rated at 30 MMBtu/hr	LNB and use of pipeline quality natural gas will minimize emissions
Scrubbers	Process ammonia, sulfuric acid and hydrogen sulfide emissions	Emissions will be controlled with scrubbers
Packaging Area	Material Packaging Area	Emissions will be controlled with baghouse and bin vent filters
Reagent Storage	Reagent Storage Tanks and Bins	Emissions will be controlled with bin vent filters and scrubbers
Material Handling	Concentrate transfer and handling	Emission sources will be located inside building and enclosures
Solvent Extraction Lines	Solvent tanks and mixers	Emissions will be minimized through SOPs
Test Laboratory	Laboratory for the MAP operations	Emissions will be controlled with baghouse
Process Boiler	Process boiler rated at 12 MMBtu/hr	LNB and use of pipeline quality natural gas will minimize emissions

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SECTION 4

Limitations and Monitoring Requirements

This section provides a summary of appropriate limitations and monitoring requirements for the emission sources included in the BACT analysis.

4.1 Smelter

Emissions to the atmosphere from the indicated emission points shall not exceed the following rates and concentrations:

Emission Point	Pollutant	Test Frequency
Main Stack (Stack No. 11)	$PM_{2.5}$	• 85 lbs/hr (filterable) • 434 lbs/hr (filterable + condensable)
	SO_2	• 552 lbs/hr (3 hr. rolling average) • 422 lbs/hr (daily average)
	NO_x	• 154 lbs/hr (daily average)
Holman Boiler	NO_x	• 14.0 lbs/hr (calendar-day average)

Stack testing to show compliance with the emissions limitations of Condition (A) above shall be performed as specified below:

Emission Point	Pollutant	Test Frequency
Main Stack	$PM_{2.5}$	Every year
	SO_2	Continuous Emissions Monitor (CEM)
	NO_x	CEM
Holman Boiler	NO_x	Every 3 years and alternate method determined per applicable new source performance standards

Supporting Information

During startup/shutdown operations, NO_x and SO_2 emissions are monitored by CEMs or alternate methods in accordance with applicable NSPS rules. This condition establishes emissions limitations and compliance requirements for the Smelter main stack and the Holman Boiler.

KUC continuously monitors operational parameters to predict NO_x emissions and to ensure proper boiler operation. The parameters monitored are fuel use (to predict NO_x emissions lb/hr), stack oxygen (to monitor proper boiler operation and compliance with NO_x lb/MMBtu emission limit), and steam output (used to estimate heat input if fuel use unavailable). The ranges for these parameters were developed during a 30-day monitoring campaign where data from a certified NO_x analyzer were used to develop predictive equations with the operational parameters. The alternative monitoring method identified in this condition is consistent with the applicable NSPS.

4.2 Refinery

Emissions to the atmosphere from the indicated emission point shall not exceed the following rate:

Emission Point	Pollutant	Maximum Emission
The sum of two (tank house) boilers	NO_x	9.5 lb/hr
Combined heat plant	NO_x	5.96 lbs/hr

Stack testing to show compliance with the above emission limitations shall be performed as follows:

Emission Point	Pollutant	Testing Frequency
Tank house boilers	NO_x	Every 3 years*
Combined heat plant	NO_x	Every year

Note:
*Stack testing shall be performed on boilers that have operated more than 300 hours during a 3-year period.

Supporting Information

KUC must operate and maintain the stationary combustion turbine, air pollution control equipment, and monitoring equipment in a manner consistent with good air pollution control practices for minimizing emissions always including during startup, shutdown, and malfunction. Records shall be kept on site which indicate the date, and time of startups and shutdowns. This condition establishes emissions limitations and compliance requirements for the Refinery Boilers and Combined Heat and Power unit.

4.3 Molybdenum Autoclave Process

Emissions to the atmosphere from the natural gas turbine, combined with the duct burner, and with the turbine electric generator (TEG); firing shall not exceed the following rate:

Emission Point	Pollutant	Maximum Emission Rate
Combined heat plant	NO_x	5.01 lbs/hr

Stack testing to show compliance with the above emission limitations shall be performed as follows:

Emission Point	Pollutant	Testing Frequency
Combined heat plant	NO_x	Every year

Supporting Information

Records shall be kept on site which indicate the date and time of startups and shutdowns. This condition establishes emissions limitation and compliance requirements for the MAP facility combined heat and power unit.

Attachments

- Smelter Dryer/Granulator Baghouse Information
- Anodes Furnaces NO_X Study
- Degreaser Solvent SDS
- MAP NOI (Submitted September 2012)
- EPA Compliance Letter

NO_X AND PARTICULATE MATTER AIR QUALITY CONTROL SYSTEM OPTIONS

Utah Power Plant Unit 4

BLACK & VEATCH PROJECT NO. 197302

PREPARED FOR

Rio Tinto Kennecott

24 MAY 2018

BLACK & VEATCH

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1.0 Executive Summary

1.1 INTRODUCTION

Black & Veatch Management Consulting, LLC (Black & Veatch) was retained by Rio Tinto Kennecott (Kennecott) to provide an environmental, technical and economic assessment of the NO_X and particulate matter (PM) air quality control system (AQCS) options for Utah Power Plant (UPP) Unit 4. The unit can be fueled using either coal or natural gas and is located 15 miles west of downtown Salt Lake City within Salt Lake County. Unit 4 has a capacity of 67 MW net. This report (Report) summarizes Black & Veatch's findings and conclusions from our review. A summary of UPP Unit 4 is included in Table 1-1 and the general facility location is illustrated in Figure 1-1.

Table 1-1 UPP Unit 4 Summary

FACILITY NAME	CAPACITY	ARRANGEMENT	COD	NERC REGION	TECHNOLOGIES
UPP Unit 4	67 MW net	Coal/natural gas fired boiler and steam turbine	1960	WECC	(1) Combustion Engineering Tangentially Fired Boiler (1) General Electric Single Reheat Steam Turbine Generator (STG)
Total Capacity	**67 MW net**				

Figure 1-1 General Facility Location (Source: Google Maps)

1.2 SCOPE OF WORK

To conduct this assessment, Black & Veatch provided the following services:

- UPP Unit 4 design description.
- NO_X and PM AQCS technology assessment.
- NO_X and PM AQCS capital and operations & maintenance (O&M) cost assessment.

In conducting this assessment, Black & Veatch (1) had discussions with various Kennecott participants; (2) posed questions to Kennecott that Black & Veatch, in its sole judgment, chose to ask about the facilities; (3) reviewed certain technical reports prepared by others, as identified in the Report; and (4) reviewed environmental documentation related to operation.

The Black & Veatch team, which included project management specialists, engineers, financial analysis experts, AQCS technology specialists, environmental consultants and supporting engineers and consultants, gathered available data from Kennecott to assess the status of the facility. Data requests for additional or updated documentation were submitted as necessary.

The conclusions and findings that resulted from this assessment are summarized in this Report. The Report was prepared in accordance with the Agreement for the Supply of Consultancy Services (and associated Products) between Rio Tinto Services Inc. (an affiliate of Kennecott) and Black & Veatch and the purchase order with effective date of November 16, 2017 and the information contained herein was developed based on the needs of Kennecott. The level of information included in the Report reflects the knowledge of issues gained by Black & Veatch during the course of the review. The Report is solely for the use of Kennecott. The conclusions and findings are summarized in this Report.

1.3 ASSUMPTIONS

During the assessment of UPP Unit 4, Black & Veatch used and relied upon certain information provided by Kennecott and others. Black & Veatch believes the information provided is true and correct and reasonable for the purposes of this Report. In preparing this Report and the opinions presented herein, Black & Veatch has made certain assumptions with respect to conditions that may exist, or events that may occur in the future. Black & Veatch believes that the use of this information and these assumptions is reasonable for purposes of this Report. However, some events may occur or circumstances may change that cannot be foreseen or controlled by Black & Veatch and that may render these assumptions incorrect. To the extent the actual future conditions differ from those assumed herein or provided to Black & Veatch by others, the actual results will differ from those that have been forecast.

Throughout this Report, Black & Veatch has stated assumptions and reported information provided by others, all of which were relied upon in the development of the opinions and conclusions of this Report. The following is a summary of key considerations and assumptions made in developing the opinions expressed in this Report. Black & Veatch assumes that:

- Coal, natural gas and associated transportation will continue to be available in the quantities and qualities required by the facility.
- An adequate supply of water and effluent discharge source will remain available throughout the remaining life of the facility.
- The facility will continue to be operated in accordance with good industry practice, the facility will continue to be appropriately staffed with qualified personnel, and that replacements and renewals will be made in a timely manner.
- All equipment for the facility will not be operated in a manner to cause it to exceed equipment manufacturer's ratings or recommendations.
- All contracts, agreements, rules, and regulations will be fully enforceable in accordance with their respective terms and that all parties will comply with the provisions of their respective agreements.
- All licenses, permits and approvals, and permit modifications (if necessary) will be obtained and/or renewed on a timely basis and any such renewals will not contain conditions that adversely impact the operating and maintenance costs.

In discussing UPP Unit 4, unless noted otherwise, Black & Veatch considers the equipment, systems and interconnections discussed to be those typically found in electric generation facilities of similar type.

Black & Veatch has provided recommendations for consideration where appropriate based upon previous experience and observations of similar facilities. When necessary, Black & Veatch identifies those areas it considers to have design or potential operational issues that may impact the reliable operation of UPP Unit 4. Black & Veatch considers any significant issues that may have previously occurred as having been addressed and resolved in a satisfactory manner unless noted otherwise.

1.4 CONCLUSIONS

On the basis of Black & Veatch's studies, analyses, and investigations of UPP Unit 4 and the assumptions previously set forth and elsewhere in this Report, Black & Veatch offers the conclusions in the following subsections.

1.4.1 NO_X and PM AQCS Technology Assessment

- Depending on the required emission reduction, Black & Veatch identified:
  - Closed coupled over fired air (CCOFA), separated over fired air (SOFA), selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR) as potential NO_X reduction technology options.
  - Addition of a pulsejet fabric filter (PJFF) as a PM reduction option.

1.4.2 NO_X and PM AQCS Capital and O&M Cost Assessment

- Using the potential emission target timing, AQCS technology options and AQCS technology costs outlined, Black & Veatch developed the capital and annual O&M cost scenarios for Unit 4 outlined below.

Table 1-2 NO_X Control Technology Capital Cost

COST COMPONENT	CCOFA + SOFA	SNCR	SCR (80% EMISSION REDUCTION)	SCR (71% EMISSION REDUCTION)
PEC	$800,000	$2,200,000	$9,700,000	$9,300,000
DIC	$800,000	$800,000	$7,000,000	$6,600,000
IC	$500,000	$3,000,000	$11,500,000	$11,300,000
TCI	**$2,100,000**	**$6,000,000**	**$28,200,000**	**$27,200,000**

Table 1-3 NO_X Control Technology Annual O&M Cost

COST COMPONENT	CCOFA + SOFA	SNCR	SCR (80%)	SCR (71%)
Annual O&M	N/A	$510,000	$2,620,000	$1,850,000

Table 1-4 PJFF Capital Cost

COST COMPONENT	PJFF
PEC	$6,500,000
DIC	$2,100,000
IC	$3,000,000
TCI	**$11,600,000**

Table 1-5 PJFF Annual O&M Cost

COST COMPONENT	PJFF
Annual O&M	$320,000

2.0 UPP Unit 4 Design Description

UPP Unit 4 consists of a single coal and natural gas fired steam unit and is located approximately 15 miles west of Salt Lake City, Utah near the town of Magna, Utah. The facility generating capacity is 67 MW net. Unit 4 supplies electricity to Kennecott's operations and is interconnected with the PacifiCorp owned transmission system. The facility possesses access to the necessary substation facilities, including a 44 kV switchyard, for the switching and distribution of all power produced to Kennecott's operations.

Table 2-1 UPP Unit 4 Overview

CATEGORY	DATA	CATEGORY	DATA
Location	Magna, UT	NERC Region	WECC
Capacity	67 MW net	COD	1960
Configuration	1x75 MW STG	Technology	Boiler: Combustion Engineering Tangentially Fired STG: General Electric Single Reheat
Fuel Type	Coal and Natural Gas	Coal Supplier	Bowie Resources, LLC (Bowie) Skyline Mine
Electric Interconnect	44 kV to 138 kV transformer owned by Kennecott	Gas Interconnect	Dominion Energy, Inc. (Dominion)

2.1 EQUIPMENT

Major plant equipment for Unit 4 relevant to this study is summarized in Table 2-2.

Table 2-2 Unit 4 Major Equipment

COMPONENT	QTY	DESCRIPTION
STG	1	General Electric single reheat rated at 75 MW
Boiler	1	Combustion Engineering (CE) Tangential Fired, subcritical, reheat, balanced draft with a continuous rating of 650,000 lb/hr of primary steam produced when burning coal or natural gas.
AQCS	1	Electrostatic Precipitator – Neundorfer, 8 fields

2.1.1 Boilers

Unit 4 boiler is a 75 MW gross balanced draft tangentially fired boiler manufactured by CE. NO_x and CO emissions from the Unit 4 boiler are managed by adjusting combustion air depending on the boiler output. The boiler fires coal as a primary fuel and has the capability to burn natural gas as a secondary fuel.

2.1.2 Steam Turbine Generator

Unit 4 STG is a 75 MW gross single reheat unit manufactured by General Electric. The STG is original and has had minimal modification since installation outside of regular preventative and major maintenance.

2.1.3 AQCS

Unit 4's current AQCS consists of an electrostatic precipitator (ESP) originally manufactured by Neundorfer. There currently are no NO_X or SO_2 controls on the unit. The ESP has six electrical fields and eight mechanical fields, with the electrical density increasing towards the back mechanical fields. Kennecott currently controls NO_X and CO emissions from Unit 4 using combustion management while the boiler is in operation.

2.2 FUEL SUPPLY

Unit 4 burns coal as its primary fuel supplied from Bowie's Skyline mine. Unit 4 is also interconnected to Dominion's natural gas pipeline and can utilize natural gas as a secondary fuel. This pipeline is able to supply maximum station demand. Unit 4 currently utilizes coal from March to October of each year. For the November to February period the facility either utilizes natural gas or does not operate.

3.0 NO_X and PM AQCS Technology Assessment

3.1 NO_X AQCS TECHNOLOGY ASSESSMENT

Black & Veatch developed three AQCS control scenarios for NO_X reduction (Table 3-1).

Table 3-1 NO_X Reduction Scenarios and Selected Technologies

SCENARIO	EMISSION TARGET	EMISSION REDUCTION (%)	AQCS TECHNOLOGY
1	Coal – 0.12 lb/mmBTU	61% (coal)	• CCOFA + SOFA +SNCR
2	Coal – 0.7 lb/MWh	80% (coal)	• SCR
3	Coal – 0.7 lb/MWh	80% (coal)	• CCOFA + SOFA + SCR

The capital and O&M cost of these NO_X AQCS scenarios are presented in Section 4.0. A technical summary of each AQCS technology identified is included in the sections below.

3.1.1 Over Fired Air (OFA)

Over-fire air (OFA) generally refers to introducing combustion air in two stages. Combustion air is directed to the burner zone in quantities (70 percent to 90 percent) that are less than that required to theoretically burn the fuel. The remainder of the combustion air (10 percent to 30 percent) is directed to OFA ports, which are located above the top row of burners. By reducing the excess air in the primary combustion (burner) zone, NO_X formation is reduced due to the limited amount of oxygen in the air. Furthermore, less oxygen means a decrease in combustion reactions and a decrease in the heat of reaction released, reducing the overall and peak temperatures in the burner zone (first stage). The additional air nozzles also spread the release of heat over a larger area in the furnace. Thermal NO_X formation increases with higher temperatures, so reducing the overall and peak temperatures reduces thermal NO_X. Any residual unburned material, such as CO that inevitably escapes the main burner zone, is subsequently oxidized as the OFA is added.

The expected NO_X reduction from a given OFA system depends on a number of factors. The stoichiometry in the burner zone decreases as the amount of OFA is increased, and a point is reached where CO emissions reach high levels and become uncontrollable. The point at which this occurs varies, depending on the balance of flows between individual burners. As the OFA amount approaches 10 to 15 percent, the probability for individual burners operating under fuel-rich conditions increases so that pockets of very high CO emissions would be formed.

A close coupled over-fire air (CCOFA) system injects air directly above the furnace burners. This orientation minimizes retrofit construction, as the ductwork can be installed right on top of the windbox and only needs to go a short distance to the injection ports. However, the short distance between the primary combustion zone and the over-fire air ports means that there is less time for the initial combustion processes to occur before the OFA is introduced. This will result in a lower emission reduction compared to a separated OFA system. Kennecott communicated that there are no OFA systems installed on Unit 4's boiler, so a new CCOFA system could potentially provide near 30% reduction in NO_X emissions.

Separated over-fire air (SOFA) is similar to CCOFA in methodology, but the placement of the OFA ports is further downstream, or separated, from the primary combustion zone. Staging the introduction of combustion air optimizes the combustion process, allowing operators to limit NO_X and CO formation. For Unit 4, SOFA would provide additional levels of staging than CCOFA, thereby reducing NO_X emissions further. SOFA can reduce NO_X formation by approximately 40 percent compared to units with no staged combustion. An additional 10 to 20 percent additional NO_X reduction can be expected from a SOFA system if CCOFA staging is installed.

It is sensible to install both CCOFA and SOFA at the same time as the systems require similar modifications. While it's possible that SOFA by itself could lower Unit 4's NO_X emissions by at least 30 percent, the reduction rate is highly dependent on the boiler configuration. To ensure adequate NO_X reduction, Black & Veatch suggests assuming installing of both systems to lower NO_X emissions by at least 30 percent. The incremental cost for installing CCOFA in addition to SOFA is estimated to be 10-20 percent of the total cost.

3.1.2 Selective Non-Catalytic Reduction (SNCR)

Selective non-catalytic reduction (SNCR) is a method that injects urea (H_2N - CO - NH_2) at multiple levels in the boiler. Urea is injected into areas of the boiler where the flue gas temperature ranges from 1,600° to 2,100° F. Urea is a non-hazardous reagent if shipped in dry pelletized form with no special shipping, storage, or usage limitations. Urea is stored as 40 to 50 percent urea solution, and will need to be kept heated or circulated in freezing climates such as the Salt Lake City area. The urea solution is pumped to the boiler and atomized with compressed air at the injection nozzles.

When injecting urea into the boiler, NO_X reduction should be balanced with ammonia slip for optimal performance. Ammonia slip is the ammonia that does not react with NO_X and instead "slips" out of the boiler as unreacted ammonia. High levels of ammonia slip can cause several negative operational impacts.

Ammonia can be used in lieu of urea for the SNCR, but at least one major SNCR vendor does not recommend ammonia. Ammonia reacts extremely fast making it very difficult to achieve good distribution across the boiler resulting in lower performance. Urea is often more favorable as it takes time to convert from urea to ammonia, delaying the vaporization of the ammonia and allowing better distribution and performance. For these reasons, Black & Veatch recommends against using ammonia for SNCR.

Reagent injection lances are usually located between the boiler soot blowers in the pendent superheat section. Optimum injector location is mainly a function of temperature, CO concentration, and residence time. To accommodate SNCR reaction temperature and boiler turndown requirements, several levels of injection lances are normally installed. A flue gas residence time of at least 0.3 seconds in the optimum temperature range is desired to ensure adequate SNCR performance. Residence times in excess of one second yield high NO_X reduction levels even under less than ideal mixing conditions. Computational fluid dynamics and chemical kinetic modelling can be performed to establish the optimum reagent injection locations and flow patterns. Additionally, detailed testing including temperature mapping and NO_X and CO level measurements across the boiler cross section should be performed prior to finalization of the SNCR design. Low CO levels are critical for SNCR performance, as the CO emissions need to be below 250 ppm at the injection location in order to assure the SNCR adequately removes NO_X. Boiler testing should be conducted to verify the CO emissions levels in the furnace.

Most SNCR systems can achieve anywhere from 20 to 35 percent NO_X reduction, depending on the initial NO_X concentrations. It is reasonable to expect approximately 30 percent reduction from the SNCR at Kennecott's Unit 4.

NO_x reduction with an SNCR is correlated to the starting NO_X concentrations, as higher percent removal can be achieved with higher initial concentrations. Higher concentrations allow more interaction between the pollutant and reagent, meaning increased reduction. Therefore, if SNCR is added to supplement SOFA or FGR, the removal efficiency by percentage will be less. Generally, if FGR and SOFA were added to reduce NO_X concentrations, the SNCR can be expected to reduce NO_X by an additional 15 percent of the NO_X after FGR and SOFA are implemented.

An SNCR system can be easily installed at most facilities, as the footprint is not large. Modeling of the boiler would need to be completed to determine the optimal injection location for the reagent lances to be installed. Multiple injection levels are usually installed between the superheater bundles. In addition to the injection lances, an area would need to be cleared for the urea storage and mixing tanks. From the storage tanks, a reagent recirculation skid would be installed to provide sufficient pressure to deliver the reagent to the mixing and measurement module, which would be used to meter and control the reagent feed rate to each injection level. These skids would use compressed air and/or water, so piping from the plant's utility system would need to be provided.

3.1.3 Selective Catalytic Reduction (SCR)

Selective catalytic reduction (SCR) reduces NO_X emissions by introducing ammonia (NH_3) into the flue gas upstream of a reaction chamber. Ammonia readily reduces the NO_X molecules into nitrogen and water at temperatures above 1600° F. The SCR reaction chamber, which is usually installed between the economizer and air preheater, is at temperatures much less than is optimal for NH_3-NO_x reactions, so catalysts are needed to promote the reactions. The reaction chamber contains one or multiple layers of catalyst that are made of metals and/or ceramics containing a highly porous structure.

The ammonia supply can be provided at a facility in multiple potential configurations. Anhydrous is nearly pure ammonia and is a gas at standard temperature and pressure. At most facilities, it is stored as a liquid under pressure and after being vaporized, can be injected directly into the ductwork as a gas. Anhydrous ammonia requires less storage footprint, but due to its volatility and caustic nature, special permits and area classifications must be planned for handling. Ammonia can also be delivered to a facility as a solution, with 19 percent (by weight) solutions being common. While ammonia solutions do not require special permits, the cost of transport is higher than anhydrous, as the consumer pays for the transport of water in addition to ammonia. Lastly, urea solutions can also be used, as they will decompose into ammonia. Urea is received and stored as a liquid on site, and likewise needs to be vaporized prior to being injected into the SCR. Urea systems require additional equipment to decompose the urea to ammonia prior to being injected into the SCR system.

Catalysts are imperative to the SCR, as the reactions will not occur without them. Precious metals (e.g. platinum) have previously been used as a base for SCR catalysts, but over the years, cheaper metals and their oxides have been successfully employed. Catalyst and other considerations limit the maximum operating temperature to 840° F, although there are catalysts that can operate up to 1000° F. Conventional SCR catalysts are coated by either a homogeneous ceramic or metal substrate, and the composition is vanadium-based. Titanium is included to disperse the vanadium catalyst, and tungsten is added to minimize adverse SO_2 and SO_3 oxidation reactions. An economizer bypass may be required to maintain the reactor temperature during low load operation, but this will reduce boiler efficiency at lower loads.

A number of alkali metals and trace elements (specifically arsenic) poison the catalyst, significantly reducing reactivity and life. Other elements such as sodium, potassium, and zinc can also poison the catalyst by neutralizing the active catalyst sites. Poisoning of the catalyst does not occur instantaneously, but is a steady process that occurs over the life of the catalyst. As the catalyst becomes deactivated, ammonia slip emissions increase, approaching design values. As a result, catalyst in a SCR system is consumable, requiring periodic replacement at a frequency dependent on the level of catalyst poisoning. However, effective catalyst management plans can be implemented that significantly reduce catalyst replacement requirements. For natural gas applications, significantly less catalyst poisoning is expected compared to coal burning facilities.

An SCR should be able to remove about 70 to 90 percent of the NO_X from a flue gas stream, regardless of whether the unit is firing natural gas or coal. However, it is more difficult to achieve higher removal rates (near 90 percent) at lower baseline NO_X levels, because at lower NO_X concentrations, there is less mixing and interactions of NO_X and NH_3 molecules.

Unit 4 does not have significant room in its flue gas ductwork, so further analysis will need to be completed to determine the feasibility of installing an SCR. Creative ductwork solutions may be able to accommodate an SCR, however pressure drop from the new equipment and associated ductwork may require installation of an additional ID fan. The addition of an ID fan has been included in the Section 4.0 cost estimates; this requirement can be confirmed if Kennecott proceeds with further study of this option.

3.2 PARTICULATE MATTER CONTROL TECHNOLOGIES

The predominant particulate control devices utilized in the power industry are PJFFs and ESPs. A description of a PJFF is included in the section below.

3.2.1 Pulse Jet Fabric Filter (PJFF)

PJFFs have proven themselves to economically meet the low particulate emission limits for a wide range of operations and fuel characteristics. The PJFF is relatively insensitive to ash loadings and various ash types, offering superb coal flexibility. Fabric filters (FF) are the current technology of choice when low outlet particulate emissions are required for coal fired applications. FFs collect particle sizes ranging from submicron to 100 microns in diameter at high removal efficiencies (proper application of the FF technology can result in clear stacks, generally less than 5 percent opacity).

FFs are generally categorized by the type of cleaning. The two predominant cleaning methods for utility applications are reverse gas (RG) and pulse jet (PJ). Initially, utility experience in the United

States was almost exclusively with reverse gas FF (RGFF). Although they are a very reliable and effective emissions control technology, RGFFs generally have a larger footprint, which is particularly difficult for retrofit implementations. PJFFs can be operated at higher flue gas velocities, and as a result, have a smaller footprint. The PJFF also generally has a lower capital cost than an RGFF and matches the performance and reliability of an RGFF. As a result, only PJFFs are considered for this study.

Cloth filter media is sewn into cylindrical tubes called bags, and each FF casing may contain thousands of these filter bags. A FF casing is typically divided into compartments that allow on-line maintenance or bag replacement after a compartment is isolated. The number of compartments is determined by maximum economic compartment size, total gas volume rate, air-to-cloth ratio (A/C ratio), and cleaning system design. Extra compartments for maintenance or off-line cleaning may increase cost, but it also increases reliability. Each compartment includes at least one hopper for temporary storage of the collected fly ash.

Fabric bags vary in composition, length, and cross section (diameter or shape). Bag selection characteristics vary with cleaning technology, emissions limits, flue gas and ash characteristics, desired bag life, capital cost, air-to-cloth ratio, and pressure differential. Fabric bags are typically guaranteed for 3 years but frequently last 5 years or more. PJFF bags are typically made of felted materials that do not rely as heavily on the dust cake's filtering capability as woven fiberglass bags do. This allows the PJFF bags to be cleaned more vigorously. The felted materials also allow the PJFF to operate at a much higher cloth velocity, which significantly reduces the size of the unit and the space required for installation.

In PJFFs, the flue gas typically enters the compartment hopper and passes from the outside of the bag to the inside, depositing particulate on the outside of the bag. To prevent the collapse of the bag, a metal cage is installed on the inside of the bag. The flue gas passes up through the center of the bag into the outlet plenum. The bags and cages are suspended from a tubesheet.

Cleaning is performed by initiating a downward pulse of air into the top of the bag that causes a ripple effect along the bag's length. This dislodges the dust cake from the bag surface, and the dust falls into the hopper. This cleaning may occur with the compartment on line or off-line. Care must be taken during design to ensure that the upward velocity between bags is minimized so that particulate is not re-entrained during the cleaning process.

The PJFF cleans bags in sequential, usually staggered, rows. During on-line cleaning, part of the dust cake from the row that is being cleaned may be captured by the adjacent rows.

4.0 NO_X and PM AQCS Capital and O&M Cost Assessment

After identifying potential AQCS technologies that could be utilized for Kennecott's Unit 4, costs for each technology were evaluated. Budgetary estimates from original equipment manufacturers (OEMs) and Black & Veatch's in-house databases were used to develop up front capital and annual operating & maintenance (O&M) cost estimates.

Capital costs were estimated using OEM costs for major equipment, direct costs for construction and installation, and indirect costs for engineering, management and other fees. Annual O&M costs were based on a full time employee's salary of $100,000 per year and estimated sorbent costs based on estimated consumption rates and supplier provided information. Additional annual O&M costs, such as auxiliary loads require further analysis to estimate and were not included in this study.

The cost estimates developed in this study are order of magnitude (OoM) with an accuracy of ± 50 percent. Table 4-1 summarizes the components which make up Black & Veatch's capital cost estimate for each AQCS option.

Table 4-1 Capital Cost Components

CAPITAL COST COMPONENT	ACRONYM
Purchased Equipment Cost	PEC
Direct Installation Costs	DIC
Indirect Costs	IC
Total Capital Investment	**TCI (PEC + DIC + IC)**

PEC includes the costs from OEMs and other purchased equipment such as ductwork, structural steel, electrical, instrumentation, and if needed, new ID fans. DIC includes the cost of installing the purchased equipment. IC refers to engineering, construction management, contractor fees, startup activities and contingencies. TCI is the sum of PEC, DIC and IC.

4.1 NO_X CONTROL TECHNOLOGIES

The capital and annual O&M costs for the NO_X control technologies are provided in Table 4-2 and Table 4-3, with details of the inclusions in the cost estimates outlined in the following subsections.

Table 4-2 NO_X Control Technology Capital Cost

COST COMPONENT	CCOFA + SOFA	SNCR	SCR (80% EMISSION REDUCTION)	SCR (71% EMISSION REDUCTION)
PEC	$800,000	$2,200,000	$9,700,000	$9,300,000
DIC	$800,000	$800,000	$7,000,000	$6,600,000
IC	$500,000	$3,000,000	$11,500,000	$11,300,000
TCI	**$2,100,000**	**$6,000,000**	**$28,200,000**	**$27,200,000**

Table 4-3 NO_X Control Technology Annual O&M Cost

COST COMPONENT	CCOFA + SOFA	SNCR	SCR (80%)	SCR (71%)
Annual O&M	N/A	$510,000	$2,620,000	$1,850,000

4.1.1 Over Fired Air (OFA)

Based on past projects and vendor quotations, Black & Veatch estimated a TCI of $2 million for installation of CCOFA + SOFA on Unit 4. This includes ductwork, nozzles, dampers, positioners, and an assumed amount of demolition and rework of existing equipment. There is no sorbent associated with the OFA systems, and there should not be a need to hire more staff for maintaining the new OFA ports. Therefore, Black & Veatch suggests there should be no additional annual O&M cost following installation of CCOFA + SOFA. There will be costs associated with periodic replacement of air nozzles and routine maintenance, however Black & Veatch suggests these requirements will be minimal on an annual basis.

4.1.2 Selective Non-Catalytic Reduction (SNCR)

A leading vendor provided a budgetary quote for an SNCR system, which includes the urea injection skid and the injection lances. The SNCR system design is based on a 50 percent urea solution, and typically 14 days of reagent is maintained on site. Installation factors and indirect costs were based on previous projects that Black & Veatch has executed. A TCI of approximately $6 million is estimated.

The sizing of the SNCR system was based on OFA ports being installed. Per Table 4-1, an SNCR is considered for NO_X AQCS scenarios 2 and 3. While scenario 2 shows a total of 61 percent NO_X removal, and Scenario 3 shows a 2021 reduction of 44 percent that would be provided by the SNCR, it should be noted that the actual NO_X mass that is removed by the SNCR is the same. The AQCS strategy is the same between the two scenarios, so the reduction provided by OFA and SNCR individually should be equivalent, regardless of the timing of their installations.

The annual O&M cost was estimated using a delivered price estimate from a urea solution provider to the greater Salt Lake City area. A 50 percent urea solution was assumed. The urea solution's injection rate should be approximately 36 gpm, with a price of $270/ton of solution assumed. The NO/NO_2 split was assumed to be 90 percent NO, based on the coal combustion due to coal having higher NO_X emissions. The cost of an additional operator was also included. A full time employee dedicated to the SNCR should not be necessary, but a certain amount of time over the course of a year for a person earning $100,000 a year was assumed. The same was assumed for maintenance personnel, along with costs for spare parts (assumed at 2.5 percent of the direct cost, with foundation and steel related equipment removed).

4.1.3 Selective Catalytic Reduction (SCR)

SCR catalyst costs for different NO_X removal rates were provided by two leading catalyst manufacturers, and escalation factors were applied for the SCR housing and associated systems, such as the ammonia injection skid. Factors were based on past projects by Black & Veatch, with higher installation costs applied for ductwork due to space limitations at Unit 4. Electrical modifications, including substation work, were included due to retrofits often needing extensive electrical reconfiguration.

Two different sizes were evaluated for the SCR catalyst, the size of the housing and associated equipment. In Scenario 4 of Table 4-1, the SCR is providing all of the NO_X removal, from current levels reducing to 0.7 lb/MWh, which requires approximately 80 percent removal. Scenario 5 is a staged AQCS strategy, with OFA being installed first to achieve the natural gas NO_X limit of 60 ppmvd at 3 percent O_2. In the future, if Kennecott needs to comply with a limit of 0.7 lb/MWh, then an additional 71 percent of NO_X emissions need to be removed through installation of an SCR.

The catalyst volume for an 80 percent reduction rate is 98 m3, and for 71 percent is 84 m3. This equates to a 17 percent increase in catalyst volume from one case to the other, but the volume difference has a nominal impact on the overall capital cost of the SCR. Similar amounts of structural steel, the same ID fans, similar civil and foundation work, etc. will need to be executed in either case. The quotations obtained from OEMs are budgetary in nature, but general performance guarantees that can be expected to include a 16,000 hour catalyst life guarantee, 1 percent SO_2/SO_3 conversion, an ammonia slip of 2 ppmvd, and pressure drops around 4 inches of water.

A SCR can use either urea or ammonia as its reagent, with ammonia being available in a solution or pure anhydrous form. Many past clients have elected not to use anhydrous ammonia due to handling requirements, so an ammonia solution and urea were used in the annual O&M cost estimate. It was also assumed one full time employee would be required to operate and maintain the SCR. Other fixed annual costs included testing for catalyst activity and maintenance labor and materials, which was assumed at 2.5 percent of the direct costs (foundation and steel equipment removed). This study assumed 29.4 percent ammonia solution would be used at a cost of $1,500/ton of solution.

Removing 80 percent of the NO_X emissions would require approximately 330 lb/hour of solution, and removing NO_X after OFA would require approximately 200 lb/hour of solution. These flow rates were assumed to be required 8,760 hours a year in order to estimate the annual sorbent cost. A variable annual cost also included for catalyst replacement and disposal. The catalyst replacement cost was based on a catalyst life assumption of 16,000 hours, operation for 8,760 hours/year and the cost of catalyst from the budgetary quotes received.

4.2 PARTICULATE MATTER CONTROL TECHNOLOGIES

The capital cost estimate for a new PJFF at Unit 4 assumed that new ID fans would be required. Escalation factors and engineering estimates were applied to the base equipment cost provided by a leading OEM (Table 4-4). Annual O&M costs assumed 1.5 full time employees, and 2.5 percent of the direct costs for maintenance parts and materials (Table 4-5).

Table 4-4 PJFF Capital Cost

COST COMPONENT	PJFF
PEC	$6,500,000
DIC	$2,100,000
IC	$3,000,000

COST COMPONENT	PJFF
TCI	**$11,600,000**

Table 4-5 PJFF Annual O&M Cost

COST COMPONENT	PJFF
Annual O&M	$320,000

United States Environmental Protection Agency
Office of Water Washington, D.C.
EPA 832-F-00-064 September 2000

Biosolids Technology Fact Sheet
Land Application of Biosolids

DESCRIPTION

Biosolids are primarily organic materials produced during wastewater treatment which may be put to beneficial use. An example of such use is the addition of biosolids to soil to supply nutrients and replenish soil organic matter. This is known as land application. Biosolids can be used on agricultural land, forests, rangelands, or on disturbed land in need of reclamation.

Recycling biosolids through land application serves several purposes. It improves soil properties, such as texture and water holding capacity, which make conditions more favorable for root growth and increases the drought tolerance of vegetation. Biosolids application also supplies nutrients essential for plant growth, including nitrogen and phosphorous, as well as some essential micro nutrients such as nickel, zinc, and copper. Biosolids can also serve as an alternative or substitute for expensive chemical fertilizers. The nutrients in the biosolids offer several advantages over those in inorganic fertilizers because they are organic and are released slowly to growing plants. These organic forms of nutrients are less water soluble and, therefore, less likely to leach into groundwater or run off into surface waters.

There are several methods to apply biosolids. The selection of the method depends on the type of land and the consistency of the biosolids. Liquid biosolids are essentially 94 to 97 percent water with relatively low amounts of solids (3 to 6 percent). These can be injected into the soil or applied to the land surface. Specialized vehicles are used to inject biosolids into the soil, as shown in Figure 1. These tankers have hoses leading from the storage tank to injection nozzles which release the biosolids.

Source: U.S. EPA, 1984.

FIGURE 1 BIOSOLIDS INJECTION EQUIPMENT

Modified tanker trucks are used for surface application (Figure 2). Biosolids applied to the land surface are usually incorporated into the soil with conventional farm equipment.

It is often economical to reduce the volume of biosolids prior to transportation or storage. The amount of water in biosolids can be reduced through mechanical processes such as draining, pressing, or centrifuging, resulting in a material composed of up to 30 percent dry solids. This material will be the consistency of damp soil. Dewatered biosolids do not require any specialized equipment and can be applied with conventional agricultural equipment, such as manure spreaders pulled by tractors.

Source: U.S. EPA, 1986.

FIGURE 2 LIQUID APPLICATION OF BIOSOLIDS

Figure 3 shows the spraying of biosolids, an application method primarily used in forested or reclamation sites. Liquid biosolids are sprayed from a tank towed by a truck or other vehicle.

The Environmental Protection Agency's 40 CFR Part 503, *Standards for the Use and Disposal of Sewage Sludge* (the Part 503 Rule), requires that wastewater solids be processed before they are land applied. This processing is referred to as "stabilization" and helps minimize odor generation, destroys pathogens (disease causing organisms), and reduces vector attraction potential. There are several methods to stabilize wastewater solids, including:

- Adjustment of pH, or alkaline stabilization.
- Digestion.
- Composting.
- Heat drying.

The Part 503 Rule defines two types of biosolids with respect to pathogen reduction, Class A and Class B, depending on the degree of treatment the solids have received. Both types are safe for land application, but additional requirements are imposed on Class B materials. These are detailed in the Part 503 Rule and include such things as restricting public access to the application site, limiting livestock grazing, and controlling crop harvesting schedules. Class A biosolids (biosolids treated so that there are no detectable pathogens) are not subject to these restrictions.

In addition to stabilization, the Part 503 Rule sets maximum concentrations of metals which cannot be exceeded in biosolids that will be land applied. These are termed Ceiling Concentrations. Part 503 also establishes Cumulative Pollutant Loading Rates for eight metals which may not be exceeded at land application sites. A third set of metals criteria is also included in Part 503, known as Pollutant Concentrations. If these concentrations are not exceeded in the biosolids to be land applied, the Cumulative Pollutant Loading Rates do not need to be tracked. Table 1 shows the three sets of federal limits applicable to biosolids to be land applied.

Source: U.S. EPA, 1986.

FIGURE 3 APPLICATION OF LIQUID BIOSOLIDS TO FOREST LAND

TABLE 1 MAXIMUM METAL CONCENTRATIONS

Metal	Ceiling Concentration (mg/kg)	Cumulative Pollutant Loading Rates (kg/hectare)	Pollutant Concentrations (mg/kg)
Arsenic	75	41	41
Cadmium	85	39	39
Copper	4,300	1,500	1,500
Lead	840	300	300
Mercury	57	17	17
Molybdenum	75	NL	NL
Nickel	420	420	420
Selenium	100	100	100
Zinc	7,500	2,800	2,800

NL = No limit

Source: U.S. EPA, 1993 and 1994.

The term *Exceptional Quality* is often used to describe a biosolids product which meets Class A pathogen reduction requirements, the most stringent metals limits (Pollutant Concentrations), and vector attraction reduction standards specified in the Part 503 Rule. Vectors (flies, mosquitoes, rodents, birds, etc.) Can transmit diseases directly to humans or play a specific role in the life cycle of a pathogen as a host. Vector attraction reduction refers to processing which makes the biosolids less attractive to vectors thereby reducing the potential for transmitting diseases. Exceptional Quality biosolids products are as safe as other agricultural and horticultural products and may be used without site restrictions.

APPLICABILITY

Land application is well-suited for managing solids from any size wastewater treatment facility. As the method of choice for small facilities, it offers cost advantages, benefits to the environment, and value to the agricultural community. However, biosolids produced by many major metropolitan areas across the country are also land applied. For example, biosolids from the Blue Plains Wastewater Treatment Facility serving the District of Columbia and surrounding communities in Virginia and Maryland have been land applied since the plant began operation in 1930. The cities of Philadelphia, Chicago, Denver, New York, Seattle, and Los Angeles all land apply at least part of their biosolids production.

Land application is most easily implemented where agricultural land is available near the site of biosolids production, but advances in transportation have made land application viable even where hauling distances are greater than 1,000 miles. For example, Philadelphia hauls dewatered biosolids 250 miles to reclaim strip-mines in western Pennsylvania and New York City ships some of its biosolids over 2,000 miles to Texas and Colorado.

ADVANTAGES AND DISADVANTAGES

Land application offers several advantages as well as some disadvantages that must be considered before selecting this option for managing biosolids.

Advantages

Land application is an excellent way to recycle wastewater solids as long as the material is quality-controlled. It returns valuable nutrients to the soil and enhances conditions for vegetative growth. Land application is a relatively inexpensive option and capital investments are generally lower than other biosolids management technologies. Contractors can provide the necessary hauling and land application equipment. In addition, on-site spatial needs can be relatively minor depending on the method of stabilization selected.

Disadvantages

Although land application requires relatively less capital, the process can be labor intensive. Even if contractors are used for application, management oversight is essential for program success. Land application is also limited to certain times of the year, especially in colder climates. Biosolids should not be applied to frozen or snow covered grounds, while farm fields are sometimes not accessible during the growing season. Therefore, it is often necessary to provide a storage capacity in conjunction with land application programs. Even when the timing is right (for example, prior to crop planting in agricultural applications), weather can interfere with the application. Spring rains can make it impossible to get application equipment into farm fields, making it necessary to store biosolids until weather conditions improve.

Another disadvantage of land application is potential public opposition, which is encountered most often when the beneficial use site is close to residential areas. One of the primary reasons for public concern is odor. In worst case situations, municipalities or counties may pass ordinances which ban or restrict the use of biosolids. However, many successful programs have gained public support through effective communications, an absolutely essential component in the beneficial use of biosolids.

Environmental Impacts

Despite many positive impacts to the environment, land application can have negative impacts on water, soil, and air if not practiced correctly.

Negative impacts to water result from the application of biosolids at rates that exceed the nutrient requirements of the vegetation. Excess nutrients in the biosolids (primarily nitrogen compounds) can leach from the soil and reach groundwater. Runoff from rainfall may also carry excess nutrients to surface water. However, because biosolids are a slow release fertilizer, the potential for nitrogen compounds to leach from biosolids amended soil is less than that posed by the use of chemical fertilizers. In areas fertilized by either biosolids or chemicals, these potential impacts are mitigated by proper management practices, including the application of biosolids at agronomic rates (the rate nutrients are used by the vegetation.) Maintenance of buffer zones between application areas and surface water bodies and soil conservation practices will minimize impacts to surface water.

Negative impacts to soil can result from mismanagement of a biosolids land application. Federal regulations contain standards related to all metals of concern and application of biosolids which meets these standards should not result in the accumulation of metals to harmful levels. Stringent record keeping and reporting requirements on both the federal and state level are imposed to prevent mismanagement.

Odors from biosolids applications are the primary negative impact to the air. Most odors associated with land application are a greater nuisance than threat to human health or the environment. Odor controls focus on reducing the odor potential of the biosolids or incorporating them into the soil. Stabilization processes such as digestion can decrease the potential for odor generation. Biosolids that have been disinfected through the addition of lime may emit ammonia odors but they are generally localized and dissipate rapidly. Biosolids stabilization reduces odors and usually results in an operation that is less offensive than manure application.

Overall, a properly managed biosolids land application program is preferable to the use of conventional fertilizers for the following reasons:

- Biosolids are a recycled product, use of which does not deplete non-renewable resources such as phosphorous.

- The nutrients in biosolids are not as soluble as those in chemical fertilizers and are therefore released more slowly.

- Biosolids appliers are required to maintain setbacks from water resources and are often subject to more stringent soil conservation and erosion control practices, nutrient management, and record keeping and reporting requirements than farmers who use only chemical fertilizers or manures.

- Biosolids are closely monitored.

- The organic matter in biosolids improves soil properties for optimum plant growth, including tilth, friability, fertility and water holding capacity. They also decrease the need for pesticide use.

A joint policy statement of the U.S. Department of Agriculture, the U.S. Food & Drug Administration, and the U.S. Environmental Protection Agency states, "...the use of high quality biosolids coupled with proper management procedures, should safeguard the consumer from contaminated crops and minimize any potential adverse effect on the environment" (U.S. EPA, 1981).

DESIGN CRITERIA

Design criteria for land application programs address issues related to application rates and suitable sites. Design criteria for physical facilities (such as stabilization) that are part of land application programs are discussed in separate fact sheets. Biosolids, site, and vegetative characteristics are the most important design factors to consider.

Biosolids must meet regulatory requirements for stabilization and metals content. In addition, nutrient content and physical characteristics, such as percent solids, are used to determine the appropriate application rate for the crop that will be grown and the soil in which the crops will be grown.

Site suitability is determined based on such factors as soil characteristics, slope, depth to groundwater, and proximity to surface water. In addition, many states have established site requirements to further protect water quality. Some examples include:

- Sufficient land to provide areas of non-application (buffers) around surface water bodies, wells, and wetlands.

- Depth from the soil surface to groundwater equal to at least one meter.

- Soil pH in the range of 5.5 to 7.5 to minimize metal leaching and maximize crop growing conditions.

Site suitability is also influenced by the character of the surrounding area. While odors and truck traffic many not be objectionable in an agricultural area, both will adversely impact residential developments and community centers close to fields where biosolids are applied.

The type of vegetation to be grown is also a design consideration. Vegetation, like soil characteristics, will generally not exclude biosolids application since most vegetation will benefit from the practice. However, the type of vegetation will impact the choice of application equipment, the amount of biosolids to be applied, and the timing of applications. The effect of vegetation on the choice of application equipment is discussed above in the description of this technology. The amount of biosolids that may be applied to a site is a function of the amount of nutrients required by the vegetation and the amount of metals found in the biosolids. Table 2 summarizes the application frequency, timing, and rates for various types of sites.

Another factor to be considered in designing a land application program is the timing of applications. Long periods of saturated or frozen ground limit opportunities for application. This is an important consideration in programs using agricultural lands; applications must be performed at times convenient

Typical Biosolids Application Rate Scenario

The recommended minimum amount of nitrogen needed by a typical corn crop to be grown in New Jersey is 120 pounds per acre per year. Biosolids containing 3 percent nitrogen could be applied at up to 5.4 dry tons per acre if used to supply all the nitrogen needed by the crop (i.e., no other nitrogen fertilizers used.) A city producing 10 dry tons of biosolids per day would require access to almost 700 acres of corn. If the biosolids contained only 1.5 percent nitrogen, twice as many tons could be applied per acre, requiring only half as many acres to land apply the same amount of biosolids generated.

TABLE 2 TYPICAL BIOSOLIDS APPLICATION SCENARIOS

Type of Site/Vegetation	Schedule	Application Frequency	Application Rate
Agricultural land			
Corn	April, May, after harvest	Annually	5 to 10 dry tons per acre
Small grains	March-June, August, fall	Up to 3 times per year	2 to 5 dry tons per acre
Soybeans	April-June, fall	Annually	5 to 20 dry tons per acre
Hay	After each cutting	Up to 3 times per year	2 to 5 dry tons per acre
Forest land	Year round	Once every 2 - 5 years	5 to 100 dry tons per acre
Range land	Year round	Once every 1 - 2 years	2 to 60 dry tons per acre
Reclamation sites	Year round	Once	60 to 100 dry tons per acre

Source: U.S. EPA, 1994.

to the farmer and must not interfere with the planting of crops. Most application of biosolids to agricultural land occurs in the early spring or late fall. As a result, storage or an alternate biosolids management option must be available to handle biosolids when application is not possible. Forest lands and reclamation sites allow more leeway in the timing of applications. In some areas of the United States, application can proceed year round.

Application is most beneficial on agricultural land in late fall or early spring before the crop is planted. Timing is less critical in forest applications when nutrients can be incorporated into the soil throughout the growing period. Winter application is less desirable in many locales. Rangelands and pasturelands also are more adaptable to applications during various seasons. Applications can be made as long as ground is not saturated or snow covered and whenever livestock can be grazed on alternate lands for at least 30 days after the application. The timing of single applications in land reclamation programs is less critical and may be dictated by factors such as regulatory compliance schedules.

PERFORMANCE

In 1995, approximately 54 percent of wastewater treatment plants managed biosolids through land application, an increase of almost 20 percent from information reported in 1993 (WEF, 1997 and U.S. EPA, 1993.) The vast majority of these land application programs use agricultural land, with minor amounts applied to forest lands, rangelands, or land in need of reclamation.

The use of land application increased steadily in the 1980s for several reasons, including decreasing availability and increasing costs associated with landfill disposal. Research also helped refine procedures for proper land application. Meanwhile, implementation of the Nationwide Pretreatment Program resulted in significant improvements in biosolids quality. The 1993 adoption of the Part 503 Rule created a structure for consistent application procedures across the nation. The regulations were developed with input from the U.S. Department of Agriculture, the U.S. Food and Drug Administration, biosolids generators, environmental groups, the public, state regulators, and academic researchers. Conservative assumptions were used to create regulations to "protect public health and the environment from all reasonably anticipated adverse effects" (U.S. EPA, 1993).

Land application is a reliable biosolids management option as long as the system is designed to address such issues as storage or alternate management for biosolids during periods when application cannot take place due to unfavorable weather or field conditions. Public opposition rather than technical constraints is the most common reason for discontinuing land application programs.

"*In fact, in all the years that properly treated biosolids have been applied to the land, we have been unable to find one documented case of illness or disease that resulted.*"

Martha Prothro, Former Deputy Assistant Administrator for Water, U.S. Environmental Protection Agency.

Source: Water Environment Web, 1998.

OPERATION AND MAINTENANCE

Land application systems generally use uncomplicated, reliable equipment. Operations include pathogen reduction processing, dewatering, loading of transport vehicles, transfer to application equipment, and the actual application. Operations and maintenance considerations associated with pathogen reduction processing are discussed in other fact sheets. The other operations require labor skills of heavy equipment operators, equipment maintenance personnel, and field technicians for sampling, all normally associated with wastewater treatment facilities.

In addition, the biosolids generator is responsible for complying with state and local requirements as well as federal regulations. The biosolids manager must be able to calculate agronomic rates and comply with record keeping and recording requirements. In fact, the generator and land applier must sign certification statements verifying accuracy and compliance. The generator should also allocate time to communicate with farmers, landowners, and neighbors about the benefits of biosolids recycling. Control of odors, along with a viable monitoring program, is most important for public acceptance.

COSTS

It is difficult to estimate the cost of land application of biosolids without specific program details. For example, there is some economy of scale due to large equipment purchases. The same size machine might be needed for a program that manages 10 dry tons of biosolids per day as one managing 50 dry tons per day; the cost of that machine can be spread over the 10 or 50 dry tons, greatly affecting average costs per dry ton. One source identified costs for land application varying from $60 to $290 per dry ton (O'Dette, 1996.) This range reflects the wide variety in land application methods as well as varying methods to prepare biosolids for land application. For example, costs for programs using dewatered biosolids include an additional step whereas costs for programs using liquid biosolids do not reflect the cost of dewatering. They do, however, include generally higher transportation costs.

Despite the wide range of costs for land application programs, several elements must be considered in estimating the cost of any biosolids land application program:

- Purchase of application equipment or contracting for application services.
- Transportation.
- Equipment maintenance and fuel.
- Loading facilities.
- Labor.
- Capital, operation and maintenance of stabilization facilities.
- Ability to manage and control odors.
- Dewatering (optional).
- Storage or alternate management option for periods when application is not possible due to weather or climate.
- Regulatory compliance, such as permit applications, site monitoring, and biosolids analyses.
- Public education and outreach efforts.

Land must also be secured. Some municipalities have purchased farms for land application; others apply biosolids to privately held land.

Some operating costs can be offset through the sale of the biosolids material. Since the biosolids reduce the need for fertilizers and pH adjustment, farmers sometimes pay to have biosolids applied to their lands.

REFERENCES

Other Related Fact Sheets

Odor Management in Biosolids Management
EPA 832-F-00-067
September 2000

Centrifugal Dewatering/Thickening
EPA 832-F-053
September 2000

Belt Filter Press
EPA 832-F-00-057
September 2000

Filter Press, Recessed Plate
EPA 832-F-00-058
September 2000

Alkaline Stabilization of Biosolids
EPA 832-F-00-052
September 2000

Other EPA Fact Sheets can be found at the following web address:
http://www.epa.gov/owmitnet/mtbfact.htm.

1. O'Dette, R.G., 1996. Determining the Most Cost Effective Option for Biosolids and Residuals Management. In *Proceedings of the 10th Annual Residuals and Biosolids Management Conference: 10 Years of Progress and a Look Toward the Future*. Alexandria. Water Environment Federation.

2. Sopper, W.E., Seaker, E.M., and Bastian, R.K., Editors, 1982. *Land Reclamation and Biomass Production and Municipal Wastewater and Sludge.* University Park. The Pennsylvania State University Press.

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12. Water Environment Web, http://www.wef.org/doc/bioquotes.html, September 3, 1998.

13. Water Quality Management Library, 1992. *Municipal Sewage Sludge Management: Processing, Utilization and Disposal*, ed. Cecil Lue-Hing, David R. Zenz, Richard Kuchenrither. Lancaster. Technomic Publishing Company, Inc.

ADDITIONAL INFORMATION

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Steve Schnoor
Manager – Environment, Land and Water

May 23, 2018

Mr. Bryce Bird, Director
Department of Environmental Quality
Division of Air Quality
P.O. Box 144820
Salt Lake City, Utah 84114-4820

Attn: Mr. Jon Black

Re: Kennecott Utah Copper
$PM_{2.5}$ State Implementation Plan

Dear Mr. Bird:

Per our ongoing communications, attached please see the Best Available Control Technology (BACT) analysis for the Utah Power Plant. The analysis was developed for Unit 4 operating on coal between the period of March and October. Based on this analysis, Kennecott Utah Copper (KUC) is proposing the following limits:

The following requirements are applicable during the period March 1 to October 31 inclusive:

I. *Emissions from Unit 4 to the atmosphere shall not exceed the following rates:*

Pollutant	*grains/dscf*	*lb/MMBTU*
1. *$PM_{2.5}$ filterable*	*0.029*	
2. *Filterable + Condensable*	*0.29*	
3. *NO_X*		*0.06*

At the Bingham Canyon Mine, emissions are currently limited to 6,205 tons per year of $PM_{2.5}$, SO_2 and NO_X combined. The Utah Division of Air Quality (UDAQ) has proposed an additional 24-hour limitation on NO_X emissions from diesel-fired ore and waste haul trucks. Consistent with recent conversations, KUC proposes the following limits:

I. *Emissions at the Bingham Canyon Mine shall not exceed 6,205 tons of NO_X, $PM_{2.5}$ and SO_2 combined per rolling 12-month period.*

II. *Maximum total NO_X emissions from ore and waste haul trucks shall not exceed 16.9 tons per day (calendar month average).*

Rio Tinto

Supporting Information for the Bingham Canyon Mine

Planning at the Bingham Canyon Mine is cyclical in nature. While a single mine plan can generally be represented for production purposes by a bell curve, multiple mine plans viewed together do not share that resemblance to a bell curve. Specifically, when one plan has reached a peak and progresses downward, a new plan is ramping up to eliminate gaps in peak efficiency. Mine planning is a dynamic effort with changes happening on a day-to-day basis for efficiency, maintenance and safety requirements.

The "Cornerstone" mine plan is the basis of the Approval Order issued in 2011 and is reflected in the limitations with which KUC complies. The year-by-year analysis of that mine plan had indicated that at this point in time we would be at peak production and on a decline over the next few years. However, that plan, as proposed, changed due to the Manefay slide.

Since the Manefay slide in 2013, the mine plan has been changed to ensure safe operations. As a result, KUC's emission levels over the last several years have been significantly less than those predicted by the Cornerstone mine plan. Additional efforts to ensure safe operations are still being implemented today and are impacting current and future mine plans.

As an example, our main haul route in and out of the lower mine (called the 10% haul road), has been periodically shutdown and restricted to single lane traffic over the past few years to minimize risks associated with rock slides and rock fall.

Since 2013, the mine continues to take extra precautions around safety. In order to ensure safe operations, there are times when it's necessary to move material around the pit to maintain a stable and safe work environment. There are also times when rerouting is necessary and even times when areas of the pit must be abandoned until safety measures are implemented. These activities over the past few years have impacted the progression of the mine plan and have resulted in decreased emission levels from those originally contemplated by the Cornerstone mine plan.

Should you have any questions, please contact me or Cassady Kristensen (Cassady.Kristensen@RioTinto.com; 801.204.2129).

Respectfully submitted,

Steve Schnoor
Manager – Environment, Land and Water

Enclosure

Attachment A
Cost Worksheets

Cost Effectiveness Calculations - Unit 4 with Burners and OFA

Table 1. Capital Cost Estimate

		Cost	Reference
Purchased Equipment			
Total Purchased Equipment Cost	B	$800,000	Vendor
Direct Installation Cost			
Foundation and supports	.08B	N/A	
Erection and handling	.14B	N/A	
Electrical	.04B	N/A	
Piping	.02B	N/A	
Painting	.01B	N/A	
Insulation	.01B	N/A	
Spare Parts	.07B	N/A	
Sales Taxes	.07B	N/A	
Building and site preparation not included			
Total Direct Installation Cost		$800,000	Vendor
Total Direct Cost		$1,600,000	
Indirect Cost			
Engineering	0.10B	N/A	
Construction and field expenses	0.05B	N/A	
Construction fee	0.10B	N/A	
Start-up	0.02B	N/A	
Performance test	0.01B	N/A	
Contingency	0.10B	N/A	
Total Indirect Cost		$500,000	Vendor
Total Capital Cost		**$2,100,000**	

Table 2. Annual Cost

		Annual Cost	Reference
Direct Costs			
Annual Operating Costs			N/A - as it's a burner replacement
Total Direct Cost		$0	
Indirect Costs			
Other		Included in Annual Operating Costs	
Total Annual Costs Excluding Capital Recovery		**$0**	
Capital recovery		$246,665	
Interest	10.0%		KUC
Lifetime	20 years		UDAQ
Total Annual Cost		**$246,665**	

Table 3. Cost Effectiveness

2017 Actual NOx Emissions	427.50	tons/year	Estimate
Control Efficiency	35%		Vendor Estimate
NOx Emission Reduction	149.63	tons/year	Calculated
Cost Effectiveness for NOx	$1,649	$/ton	

Cost Effectiveness Calculations - Unit 4 with OFA and SNCR

Table 1. Capital Cost Estimate

		Cost	Reference
Purchased Equipment			
Total Purchased Equipment Cost	B	$2,200,000	Vendor
Direct Installation Cost			
Foundation and supports	.08B	N/A	
Erection and handling	.14B	N/A	
Electrical	.04B	N/A	
Piping	.02B	N/A	
Painting	.01B	N/A	
Insulation	.01B	N/A	
Spare Parts	.07B	N/A	
Sales Taxes	.07B	N/A	
Building and site preparation not included			
Total Direct Installation Cost		$800,000	Vendor
Total Direct Cost		$3,000,000	
Indirect Cost			
Engineering	0.10B	N/A	
Construction and field expenses	0.05B	N/A	
Construction fee	0.10B	N/A	
Start-up	0.02B	N/A	
Performance test	0.01B	N/A	
Contingency	0.10B	N/A	
Total Indirect Cost		$3,000,000	Vendor
Total Capital Cost		**$6,000,000**	

Table 2. Annual Cost

		Annual Cost	Reference
Direct Costs			
Annual Operating Costs		$510,000	Vendor
Total Direct Cost		$510,000	
Indirect Costs			
Other		Included in Annual Operating Costs	
Total Annual Costs Excluding Capital Recovery		**$510,000**	
Capital recovery		$704,758	
Interest	10.0%		KUC
Lifetime	20 years		UDAQ
Total Annual Cost		**$1,214,758**	

Table 3. Cost Effectiveness

2017 Actual NOx Emissions	427.50	tons/year	Estimate
Control Efficiency	60%		Vendor Estimate
NOx Emission Reduction	256.50	tons/year	Calculated
Cost Effectiveness for NOx	$4,736	$/ton	

Cost Effectiveness Calculations - Unit 4 with OFA and SCR (with 80% reduction over baseline levels)

Table 1. Capital Cost Estimate

		Cost	Reference
Purchased Equipment			
Total Purchased Equipment Cost	B	$9,700,000	Vendor
Direct Installation Cost			
Foundation and supports	.08B	N/A	
Erection and handling	.14B	N/A	
Electrical	.04B	N/A	
Piping	.02B	N/A	
Painting	.01B	N/A	
Insulation	.01B	N/A	
Spare Parts	.07B	N/A	
Sales Taxes	.07B	N/A	
Building and site preparation not included			
Total Direct Installation Cost		$7,000,000	Vendor
Total Direct Cost		$16,700,000	
Indirect Cost			
Engineering	0.10B	N/A	
Construction and field expenses	0.05B	N/A	
Construction fee	0.10B	N/A	
Start-up	0.02B	N/A	
Performance test	0.01B	N/A	
Contingency	0.10B	N/A	
Total Indirect Cost		$11,500,000	Vendor
Total Capital Cost		**$28,200,000**	

Table 2. Annual Cost

		Annual Cost	Reference
Direct Costs			
Annual Operating Costs		$2,620,000	Vendor
Total Direct Cost		$2,620,000	
Indirect Costs			
Other		Included in Annual Operating Costs	
Total Annual Costs Excluding Capital Recovery		**$2,620,000**	
Capital recovery		$3,312,361	
Interest	10.0%		KUC
Lifetime	20 years		UDAQ
Total Annual Cost		**$5,932,361**	

Table 3. Cost Effectiveness

2017 Actual NOx Emissions	427.50	tons/year	Estimate
Control Efficiency	80%		Vendor Estimate
NOx Emission Reduction	342.00	tons/year	Calculated
Cost Effectiveness for NOx	$17,346	$/ton	

Cost Effectiveness Calculations - Unit 4 with Fabric Filter (FF)

Table 1. Capital Cost Estimate

		Cost	Reference
Purchased Equipment			
Total Purchased Equipment Cost	B	$6,500,000	Vendor
Direct Installation Cost			
Foundation and supports	.08B	N/A	
Erection and handling	.14B	N/A	
Electrical	.04B	N/A	
Piping	.02B	N/A	
Painting	.01B	N/A	
Insulation	.01B	N/A	
Spare Parts	.07B	N/A	
Sales Taxes	.07B	N/A	
Building and site preparation not included			
Total Direct Installation Cost		$2,100,000	Vendor
Total Direct Cost		$8,600,000	
Indirect Cost			
Engineering	0.10B	N/A	
Construction and field expenses	0.05B	N/A	
Construction fee	0.10B	N/A	
Start-up	0.02B	N/A	
Performance test	0.01B	N/A	
Contingency	0.10B	N/A	
Total Indirect Cost		$3,000,000	Vendor
Total Capital Cost		**$11,600,000**	

Table 2. Annual Cost

		Annual Cost	Reference
Direct Costs			
Annual Operating Costs		$320,000	Vendor
Total Direct Cost		$320,000	
Indirect Costs			
Other		Included in Annual Operating Costs	
Total Annual Costs Excluding Capital Recovery		**$320,000**	
Capital recovery		$1,362,532	
Interest	10.0%		KUC
Lifetime	20 years		UDAQ
Total Annual Cost		**$1,682,532**	

Table 3. Cost Effectiveness

2017 Actual PM2.5 Emissions	26.01	tons/year	AEI
Control Efficiency	40%	Estimate - additional control over ESP	
PM2.5 Emission Reduction	10.40	tons/year	Calculated
Cost Effectiveness for PM2.5	$161,720	$/ton	

Attachment B
Unit 4 AQCS Study

TECHNICAL MEMORANDUM

JACOBS

NO_X and PM BACT Analysis for Unit 4

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PREPARED BY: Jacobs

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Rio Tinto Kennecott Utah Copper LLC (KUC) operates the Utah Power Plant (UPP) in Magna, Utah. Currently, the power plant operates a single coal and natural gas fired steam unit, referred to as Unit 4. Unit 4 has a capacity of 67 MW net and has a maximum heat input to 838 mmBtu/hr while operating on coal.

Unit 4 is required by Approval Order and Title V Operating Permit to operate on natural gas during the winter months between November 1 and February 28/29. Between March 1 and October 31, the unit is operated on coal. KUC operated Unit 4 on coal during the 2017 non-winter season.

The Utah Division of Air Quality (UDAQ) has requested a nitrogen oxide (NO_X) and particulate matter (PM) Best Available Control Technology (BACT) analysis for Unit 4 to support the ongoing $PM_{2.5}$ State Implementation Plan (SIP) development for the Salt Lake City nonattainment area.

Formation of NO_x

During coal combustion, NO_x is formed in three different ways. The dominant source of NO_x formation is the oxidation of fuel-bound nitrogen (fuel NO_x), where a portion of the fuel-bound nitrogen is released from the coal with the volatile matter while the remaining fuel-bound nitrogen is retained in the solid portion (char). The nitrogen released from the coal is partially oxidized to nitrogen oxides (NO and NO_2 – referred to as NO_x) and partially reduced to molecular nitrogen (N_2). A small portion of NO_x formation is due to high temperature fixation of atmospheric nitrogen in the combustion air (thermal NO_x). A very small amount of NO_x is called "prompt" NO_x that results from an interaction of hydrocarbon radicals, nitrogen, and oxygen.

In a conventional pulverized coal burner, air is introduced with turbulence to promote good mixing of fuel and air, which provides stable combustion. However, not all of the oxygen in the air is used for combustion. Some of the oxygen combines with the fuel-bound nitrogen to form NO_x.

NO_X BACT for Unit 4 Operating on Coal

The following BACT analysis has been developed for NOx emissions from the Unit 4 boiler while operating on coal.

Step 1: Identify All Available Control Technologies

The RBLC identifies the following as potential technologies for NO_x control from coal fired boiler:

- Over-fired air (OFA)
- OFA with Selective Non-catalytic Reduction (SNCR)
- OFA with Selective Catalytic Reduction (SCR)

OFA System. The mechanism used to lower NO_x is to stage the combustion process and provide a fuel-rich condition initially; this is so oxygen needed for combustion is not diverted to combine with nitrogen and form NO_x. Fuel-rich conditions favor the conversion of fuel nitrogen to N_2 instead of NO_x. Additional air (or OFA) is then introduced downstream in a lower temperature zone to complete the combustion process. Based on past experience and studies, OFA system on Unit 4 would reduce emissions by about 30 percent from baseline levels.

SNCR. Selective non-catalytic reduction is generally utilized to achieve modest NO_x reductions on smaller units. With SNCR, an amine-based reagent such as ammonia or urea is injected into the boiler within a temperature range of 1,600°F to 2,100°F, where it reduces NO_x to nitrogen and water. From past project experience and studies, 60 percent reduction in NO_x emissions from baseline levels was estimated for this analysis.

SCR. SCR works on the same chemical principle as SNCR, but SCR uses a catalyst to promote the chemical reaction. Ammonia or urea is injected into the flue-gas stream, where it reduces NO_x to nitrogen and water. Unlike the high temperatures required for SNCR, in SCR the reaction takes place on the surface of a vanadium/titanium-based catalyst at a temperature range between 580° F and 750° F. Due to the catalyst, the SCR process is more efficient than SNCR and results in lower NO_x emissions. Based on past experience and studies, LNBs, OFA and SCR system on Unit 4 would reduce emissions by about 80 percent from baseline levels.

Step 2: Eliminate Technically Infeasible Options

All control technologies are technically feasible for Unit 4.

Step 3: Evaluate Control Effectiveness of Remaining Control Technologies

The control effectiveness of the control technologies are listed below. The emission rates listed below are obtained from the Unit 4 study.

TABLE 1
NO_x Control Technology Emission Rate Ranking

Technology	Reduction in NOx Emissions from Baseline Levels	NO_x Emission Rate (lb/mmBtu)
OFA	35%	-
OFA & SNCR	60%	0.12
OFA & SCR	80%	0.06

Step 4: Evaluate Energy and Non-Air Quality Impacts

Energy Impacts. The identified control technologies are not anticipated to have significant energy impacts.

Environmental Impacts. SNCR and SCR installation can impact the salability of fly ash due to ammonia levels, although UPP ash is not currently sold. Unreacted ammonia (ammonia slip) may potentially create a visible stack plume, which may negate other visibility improvements. Other environmental impacts involve the storage of ammonia, especially if anhydrous ammonia is used, and the transportation of the ammonia to the power plant site.

Economic Impacts. Costs for the identified control technologies were developed using vendor data and engineering estimates. A comparison of the technologies on the basis of costs is shown below.

TABLE 2
NO_x Control Technology Cost Analysis

Name of Control Technology	Annualized Cost of Control Option	Tons of NO_x Removed (ton/year)	Costs per Ton of NO_x Removed
OFA	$246,665	150	$1,649
OFA and SNCR	$1,214,758	257	$4,736
OFA and SCR	$5,932,361	342	$17,346

All control technologies are identified as cost-effective based on thresholds established by UDAQ.

Step 5: Select BACT

Based upon the technical and economic evaluation completed above, OFA and SCR with an emission rate of 0.06 lb/mmBtu are identified as BACT for NO_x control on Unit 4.

Formation of Particulate Matter

Particulate matter (PM_{10}/$PM_{2.5}$) forms during the combustion process and is primarily dependent on organic and inorganic matter in the fuel.

PM BACT for Unit 4 Operating on Coal

The following BACT analysis has been developed for PM_{10}/$PM_{2.5}$ emissions from the Unit 4 boiler.

Step 1: Identify All Available Control Technologies

The RBLC identifies the following as potential technologies for PM_{10}/$PM_{2.5}$ control for a coal fired boiler:

- Electrostatic Precipitator (ESP)
- Fabric Filter (FF)

Electrostatic Precipitator. The ESP removes particles from the flue gas by applying a high voltage electrostatic charge and collecting the particles on charged plates. Unit 4 is currently equipped with an ESP to minimize particulate emissions.

Fabric Filter. In the Fabric Filter control technology, flue gas is filtered by bags made of different materials. Based on past experience and studies, FF on Unit 4 would reduce emissions by about 99 percent from uncontrolled levels.

Step 2: Eliminate Technically Infeasible Options

All control technologies are technically feasible for Unit 4. Unit 4 is equipped with ESP to minimize emissions and an upgrade of existing ESP is not further evaluated.

Step 3: Evaluate Control Effectiveness of Remaining Control Technologies

The control effectiveness of the technically feasible control technology is listed below. The emission rates listed below are obtained from the Unit 4 study.

TABLE 1
SO_2 Control Technology Emission Rate Ranking

Technology	Reduction in NOx Emissions from Baseline Levels	NO_x Emission Rate (lb/mmBtu)
FF	99%	0.01

Step 4: Evaluate Energy and Non-Air Quality Impacts

This step involves the consideration of energy, environmental, and economic impacts associated with each control technology. The remaining useful life of the plant is also considered during the evaluation.

Energy Impacts. No energy impacts are associated with fabric filters when compared to the baseline ESP energy impacts.

Environmental Impacts. No new environmental impacts are associated with fabric filters.

Economic Impacts. Costs for the implementation of FF control technology was developed using vendor data and engineering estimates and assumes a 40 percent incremental increase in $PM_{10}/PM_{2.5}$ control above the current ESP emission control effectiveness. A comparison of the FF technology on the basis of costs is shown below.

TABLE 2
$PM_{10}/PM_{2.5}$ Control Technology Cost Analysis

Name of Control Technology	Annualized Cost of Control Option	Tons of NO_x Removed (ton/year)	Costs per Ton of NO_x Removed
FF	$1,682,532	10.4	$161,720

Fabric filters are not economically feasible based thresholds developed by UDAQ.

Step 5: Select BACT

Based upon the technical and economic evaluation completed above, existing ESP is identified as BACT for $PM_{10}/PM_{2.5}$ control on Unit 4.