Arizona Department of Environmental Quality

2021 Regional Haze Four Factor Initial Control Determination

Facility: ASARCO Ray Operations

Air Quality Division
November 23, 2020

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1.1 ADEQ Initial Control Determination for ASARCO Ray Operations

ADEQ's initial determination is to find that it is reasonable not to require additional controls on ASARCO Ray Operations during this planning period.

1.2 ADEQ Control Determination Finalization Timeline

In order to meet the State rulemaking process timeframe for proposed rule inclusion in the July 31st, 2021 Regional Haze state implementation plan (SIP) submittal, ADEQ must finalize all four factor analyses as expeditiously as possible. To provide an opportunity for interested stakeholders to review and comment on ADEQ's initial decision prior to finalization, the department intends to post initial decisions on the agency webpage along with the original source submitted four factor analyses. Once ADEQ has reviewed relevant stakeholder comments, the agency will revise its initial decisions if necessary and post final decisions (see Figure 1). ADEQ welcomes feedback on these initial decisions and invites any interested party to send their comments by **December 31st, 2020** to:

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Please note that this review and feedback opportunity does not constitute an official state implementation plan or state rulemaking comment period. The agency intends to provide an official 30 day comment period on any proposed SIP or rulemaking action in accordance with Arizona Revised Statutes §§ 41-1023, 49-425, and 49-444.

Figure 1: Four Factor Control Determination Process Map

2 ADEQ Four Factor Analysis

2.1 Summary

ADEQ identified five processes that are subject to the four factor analysis for ASARCO LLC (Asarco) Ray Operations: i) trucks hauling ore and waste rock; ii) miscellaneous vehicles traveling on unpaved roads; iii) dumps and tailings windblown dust; iv) dozing mine areas, dumps and stockpiles; and v) blasting ore and waste rock.

Asarco completed and submitted a four factor analysis report for the five processes in December 2019. As requested by ADEQ, Asarco further provided additional information in March 2020. Following Guidance on Regional Haze State Implementation Plans for the Second Implementation Period[1], ADEQ reviewed the Asarco's submittals and performed additional analyses. ADEQ's initial determination is that the emission controls Asarco is implementing for these processes reflect current best management practices for mining industry, and that it is reasonable not to require additional controls during this planning period.

2.2 Facility Overview

2.2.1 Process Description

The Asarco Ray Operations is located at State Highway 177, 8 miles north of Kearny, Arizona. This facility is located in an area designated as nonattainment for PM_{10}. At 59 FR 36116 (7/15/94), the EPA approved a plan for the "Hayden Township" TSP/PM_{10} non-attainment area. However, the plan lacks any recognition of the Ray Operations, or any limitation or obligation that applies to this source.

The Ray Operations consists of a 250,000 ton/day open pit mine with a 30,000 ton/day concentrator, a 103 million pound/year solvent extraction-electrowinning (SX-EW) operation, and associated maintenance, warehouse and administrative facilities. Cathode copper produced in the SX-EW operation is shipped to outside customers and the Asarco Amarillo Copper Refinery. A local railroad, Copper Basin Railway, transports ore from the mine to the Hayden concentrator, concentrate from the Ray concentrator to the smelter, and sulphuric acid from the smelter to the leaching facilities.

The nearest Class I area is Superstition Wilderness, which is located approximately 25 km from the facility.

[1] https://www.epa.gov/sites/production/files/2019-08/documents/8-20-2019_-_regional_haze_guidance_final_guidance.pdf

2.2.2 Emissions Inventory

Table 1 summarizes the facility-wide emissions during 2015-2018.

	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	NO_x (tpy)	SO_2 (tpy)	CO (tpy)	VOC (tpy)
2015	430.87	58.80	166.67	19.41	647.85	13.48
2016	426.64	55.97	64.37	6.99	236.23	13.63
2017	289.01	42.24	68.74	7.57	256.38	11.77
2018	360.31	48.49	82.43	8.89	299.84	12.18

Table 1 Emission Inventory for Years 2015-2018

2.3 ADEQ Screening Methodology

ADEQ applied a screening process to determine which emission units would undergo four-factor analysis. Any processes that were identified as being effectively controlled were deferred from consideration for the current implementation period. A four-factor analysis would be conducted on the remaining processes that make up the top 80% of NOx, SO_2, and PM_{10} emissions at the source. The detailed screening methodology is presented in ADEQ 2021 Regional Haze SIP Planning website.[2]

In September 2019, ADEQ informed Asarco that a four-factor analysis must be performed for the following processes and pollutants at the Ray Operations:

- PM_{10} emissions from trucks hauling ore and waste rock;
- PM_{10} emissions from miscellaneous vehicles traveling on unpaved roads;
- PM_{10} emissions from dumps and tailings windblown dust;
- PM_{10} emissions from dozing mine areas, dumps and stockpiles; and
- NOx emissions from blasting ore and waste rock.

2.4 Existing Controls and Baseline Emissions Projection

2.4.1 Baseline Control Scenario (Projected 2028 Emissions Profile)

Baseline emissions represent a realistic depiction of anticipated annual emissions for the source. Per the EPA's Guidance on Regional Haze Implementation Plans for the Second Implementation Period, the projected 2028 emissions can be a reasonable and convenient

[2] https://static.azdeq.gov/aqd/haze/4_factor_screening_approach.pdf

choice for use as the baseline emissions. ADEQ has developed a framework for projecting the 2028 emissions for selected permitted facilities in Arizona.[3]

To project the 2018 emissions for the Ray Operations, ADEQ used the emissions data from 2015 - 2017 and the throughput data from 2016 - 2018. A complete review of the 2018 emission data was not finalized prior to the August 31st deadline for ADEQ to provide modeling inputs to the Western Regional Air Partnership (WRAP). ADEQ determined that the source's operation and emissions during 2015-2017 were representative.

A scaling factor was determined for each pollutant and emission unit by dividing the annual emissions by the annual throughput. Then the average scaling factor over the three-year period (2015-2017) was calculated. In addition, the average process throughput for the three-year period (2016-2018) was calculated. The projected annual emissions for each unit process was determined by multiplying the average scaling factor (2015-2017) by the average process throughput (2016-2018).

Table 2 summarizes the 2028 projected emissions for five processes that are subject to four-factor analysis.

2.4.2 Existing Controls and Control Efficiencies

2.4.2.1 Unpaved Roads

As discussed in the AP-42 Section 13.2.2, a wide variety of options exist to control emissions from unpaved roads. Options fall into the following three groupings:

- Vehicle restrictions that limit the speed, weight or number of vehicles on the road;
- Surface improvement, by measures such as (i) paving or (ii) adding gravel or slag to a dirt road; and
- Surface treatment, such as watering (wet suppression) or treatment with chemical dust suppressants (chemical stabilization/treatment).

According to Asarco, the speed limit for haul trucks and miscellaneous vehicles at the Ray Operations is 35 miles per hour (mph). Although the vehicle speed restriction is one of the control options, the AP-42 Section 13.2.2 does not take the vehicle speed into account for estimating the PM_{10} emissions for vehicles traveling on unpaved surfaces at industrial sites.

The air permit issued by Pinal County Air Quality Control District (PCAQCD) for the Ray Operations requires Asarco to control emissions from unpaved roads by watering and applying chemical dust suppressants if needed.[4] The permit requires that a minimum of 2,500 gallons of water shall be sprayed on the unpaved roads each day if the roads are not visibly moist due to

[3] https://static.azdeq.gov/aqd/haze/2028_emission_project_methodology.pdf

[4] https://www.pinalcountyaz.gov/AirQuality/Documents/TitleV/Asarco%20LLC.PERMIT.pdf Pgs 23-24.

rainfall. Water spray is currently applied to the haul roads inside and outside the pit at the Ray Operations. A control efficiency of 75% has been used in Asarco's emissions inventories for haul roads. The Ray Operations does not apply chemical dust suppressants to haul roads because they will interfere with the solvent extraction and electrowinning (SX/EW) process. Additionally, watering in combination with chemical dust suppressant is applied to the unpaved non-haul roads. A control efficiency of 80% has been used in Asarco's emissions inventories for unpaved non-haul roads.

As indicated in the AP-42 Section 13.2.2, watering may achieve up to 95% control efficiency, depending on the resulting increase in surface moisture. The AP-42 Section 13.2.2 also reports that chemical dust suppressants provide a control efficiency of about 80% when applied at regular intervals of 2 weeks to 1 month. In general, ADEQ accepts a control efficiency of up to 90% for the use of water to suppress dust from unpaved roads.

2.4.2.2 Dumps and Tailings Windblown Dust

The air permit issued by PCAQCD for the Ray Operations requires Asarco to use best management practices to control fugitive emissions from two tailings storage facilities (Elder Gulch and Ripsey Wash).[5] A combination of water and chemical dust suppressants is currently applied to the dumps and tailings of the Ray Operations, for which a PM_{10} control efficiency of 95-99% has been used in Asarco's emissions inventories. Each dump is an aquifer protection-permitted leach facility with solution rotating through different areas of the facility. Once the leach circuit is started, the fine material is rinsed into the coarser run-of-mine material. The probability of dust being generated is extremely low once raffinate is added. Asarco actively regulates the tops of the tailings to keep them intrinsically moist or encrusted. The active side slopes are sprayed with a polymer to prevent windblown dust and the inactive side slopes are concurrently reclaimed. The appurtenant roads are covered with Vernier and a hot asphalt emulsion is applied.

2.4.2.3 Dozing Mine Areas, Dumps and Stockpiles

Water cannot be applied during dozing on the tops of the dumps because water trucks cannot gain access to the tops of the dumps, the dozing on the dumps is too dynamic to allow for another watering method, and adding water during dozing at the tops of the dumps would pose unacceptable safety risks. The dozing within the pit that facilitates the ore loading operations is currently watered to control dust from the dozing.

2.4.2.4 Blasting Ore and Waste Rock

No control measures are available to decrease NOx emissions from blasting ore and waste rock at the Ray Operations.

[5] https://www.pinalcountyaz.gov/AirQuality/Documents/TitleV/Asarco%20LLC.PERMIT.pdf
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Table 2 Emissions for Baseline Control Scenario (2028 Projected Emissions) for Processes that are subject to Four-Factor Analysis

Emission source	Throughputs[1]	PM_{10} or NOx emissions (tpy)	Scaling Factor	2016-2018 Average Throughput	2028 Projected Emissions (tpy)
Trucks hauling ore and waste rock – PM_{10}					
2015	341,131	194.27	0.000609019	259,874	158
2016	210,268	132.30			
2017	230,707	144.97			
2018	338,646				
Miscellaneous vehicles traveling on unpaved roads – PM_{10}					
2015	1,742,410	124.8	7.74983E-05	1,121,557	87
2016	1,771,334	139.0			
2017	718,464	59.2			
2018	874,874				
Dumps and tailings windblown dust – PM_{10}					
2015	7,620	41.46	0.0054	7,620	41
2016	7,620	41.47			
2017	7,620	41.49			
2018	7,620	41.60			
Dozing mine areas, dumps and stockpiles – PM_{10}					
2015	29,610	11.14	0.001207717	17,241	21
2016	15,619	44.84			
2017	15,742	5.92			
2018	20,361				
Blasting ore and waste rock - NOx					
2015	159	164.16	0.65478581	136.7	89
2016	138	58.94			
2017	127	64.11			
2018	145	74.76			

[1]Units for throughputs:
Haul truck and miscellaneous vehicles - VMT;
Dumps and tailing windblown dust - acres;
Dozing mine areas, dumps and stockpiles – hours; and
Blasting ore and waste rock – blasts.

2.5 Four Factor Analysis Review

2.5.1 Technical Feasibility and Emission Reductions

2.5.1.1 PM_{10} Emissions from Trucks Hauling Ore and Waste Rock

Asarco has identified the following PM_{10} control technologies based on a review of the RACT/BACT/LAER Clearinghouse ("RBLC") database, technical literature, practices and engineering experience at open-pit copper mines:

- Reduce the speed limit for haul trucks;
- Apply additional water to haul roads;
- Increase freeboard in the haul trucks;
- Apply chemical dust suppressant to haul roads;
- Apply and maintain surface gravel on haul roads;
- Require haul trucks to be covered; and
- Paving the haul roads and maintain the pavement.

2.5.1.1.1 Reduce the speed limit for haul trucks from 35 mph to 25 mph

Speed reduction for haul trucks will result in reduction of haul road emissions. However, reducing the speed limit for haul trucks would significantly impact overall operations, considering that haul truck travel is critical to the ore throughput. If a stricter speed limit were to be enforced, then Asarco would deploy additional haul trucks to maintain the same level of operations. This control option is technically feasible.

As previously discussed, the AP-42 Section 13.2.2 does not take the truck speed into account for estimating the PM_{10} emissions for vehicles traveling on unpaved surfaces at industrial sites. ADEQ used a historical unpaved road emission factor equation in AP-42 to evaluate the control efficiency resulted from the truck speed reduction. [6] As indicated in this equation, emission is linearly proportional to truck speed. Currently, the speed limit for haul trucks and other vehicles at the Ray Operations is 35 mph. If the speed for haul trucks reduces from 35 mph to 25 mph, the control efficiency would be 28.6%, resulting in an emission reduction of 45 tpy for PM_{10}.

Due to the complexity, ADEQ is unable to evaluate the changes in fuel consumption and tailpipe emissions associated with additional haul trucks. It is likely that adding more haul trucks would increase the fuel consumption and tailpipes emissions (such as $PM_{2.5}$ and NOx emissions), which could compromise the benefits from the truck speed restrictions.

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[6] https://www3.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02-2.pdf Equation 2-1

2.5.1.1.2 Apply additional water to haul roads

According to Asarco, additional watering to the haul roads outside the pit is feasible. However, additional watering to the haul roads inside the pit is considered technically infeasible. Too much watering could lead to traction problems between the haul trucks and the haul roads. Asarco has concerns that the application of additional water to the haul roads inside the pit would pose safety concerns due to slippage over inclines/declines inside the pit. Contrary to the Asarco's concerns, Freeport-McMoRan consider additional watering as a technically feasible control regardless of whether haul roads are inside or outside the pit in their four-factor analysis for two open-pit copper mines. For this reason, ADEQ has examined two scenarios for the Ray Operations: (i) only haul truck emissions outside the pit can be reduced from additional watering, and (ii) haul truck emissions both inside and outside the pit can be reduced from additional watering.

A control efficiency of 75% for watering has been used in Asarco's emissions inventories. Based on the air permits from existing open-pit copper mines in Arizona, a control efficiency of 90% is achievable for the use of water to suppress dust from haul roads. Asarco estimates that 50% of haul truck traffic occurs on haul roads outside the pit. Therefore, an increase in the control efficiency from 75% to 90% by additional watering would result in an emission reduction of 47 tpy for PM_{10} outside the pit. Comparatively, assuming that haul truck emissions both inside and outside the pit can be reduced from additional watering, an increase in the control efficiency from 75 to 90% would reduce the PM_{10} emissions by 95 tpy.

AP-42 Figure 13.2.2-2 provides a relationship between the control efficiency and the moisture ratio for unpaved travel surfaces.[7] In order to increase the control efficiency from 75% to 90%, the moisture ratio should increase from 2 to 4.2 (110% increase in water moisture). ADEQ assumed that the amount of additional water needed was proportional to the increase in moisture ratio.

2.5.1.1.3 Increase freeboard in the haul trucks

Increasing freeboard could potentially reduce the amount of spillage onto haul roads, which can be a source of PM_{10} emissions from vehicular traffic. This control option is technically feasible. Per email communications between ADEQ and the EPA Region 9, no data is available for the PM_{10} control efficiency for this measure.[8] Since the emissions reductions could not be quantified, this control option is not considered further in the cost of compliance analysis.

2.5.1.1.4 Application of chemical dust suppressant to haul roads

The application of chemical dust suppressant to Ray Operations' haul roads would interfere with the solvent extraction and electrowinning (SX/EW) process when the roads are eventually included in layback mining. Chemical dust suppressants with ionic bonds, such as magnesium chloride, when introduced into the electrowinning process, cause cathodes to smoke. Long-

[7] https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf Pg. 13.2.2-12

[8] Email communication between Ryan Templeton (ADEQ) and Panah Stauffer (EPA Region 9)

chain polymer suppressants would cause crud buildup that interferes with the solvent extraction and the ion exchange of the electrowinning process. This would adversely affect the yield of the SX/EW process to a degree that cannot be precisely quantified, but which would be substantial due to loss of efficiency and cathode quality. For these reasons, applying chemical dust suppressant to the Ray Operations' haul roads would be technically infeasible.

2.5.1.1.5 Application of surface gravel on haul roads

The haul trucks weigh from 300,000 pounds to 800,000 pounds. As per Asarco, the force of the trucks will either quickly obliterate the gravel to dust or push the gravel to the side of the roads. Constant application of new gravel would be needed to replace the gravel destroyed by the trucks. Therefore, this control measure would be technically infeasible.

2.5.1.1.6 Covering of haul trucks

Haul truck covers are not commercially available to accommodate the size of the haul trucks. Covers would either have to be made in-house or a new type of cover would have to be prototyped and sourced. In addition, covering and uncovering loaded haul trucks could be accomplished only with manual labor and would pose unacceptable safety risks that could not be harmonized with applicable Mine Safety and Health Act ("MSHA") rules. For these reasons, covering haul trucks would be technically infeasible.

2.5.1.1.7 Paving haul roads

Paving unpaved roads in an effort to reduce PM_{10} emissions from haul truck traffic would require a substantial capital investment. Moreover, paving is not feasible for industrial roads subject to very heavy vehicles and/or spillage of material in transport. Due to the weight of the haul trucks at the Ray Operations, which ranges up to 800,000 pounds, constant replacement of the pavement would be required, since the pavement would quickly be degraded by the weight and movement of the trucks. Therefore, paving the haul roads and maintaining the pavement would be technically infeasible.

Table 3 provides a summary of the technically feasible controls for PM_{10} emissions from trucks hauling ore and waste rock.

Table 3 Technically Feasible Control Options for PM10 Emissions from Truck Hauling Ore and Waste Rock

Control Options	PM_{10} Emissions Reduction (tpy)	Note
Reduce the speed limit for haul trucks from 35 mph to 25 mph	45	Tailpipe emissions were not estimated
	47	Apply additional water to haul roads outside the pit only

Apply additional water to haul roads (increasing the control efficiency from 75% to 90%)	95	Apply additional water to haul roads both inside and outside the pit
Increase freeboard in the haul trucks	Emissions reductions could not be quantified	This control option is not considered further in the cost of compliance analysis

2.5.1.2 PM_{10} Emissions from Miscellaneous Vehicles Traveling on Unpaved Roads

Asarco has identified the following PM_{10} control technologies based on a review of the RACT/BACT/LAER Clearinghouse ("RBLC") database, technical literature, practices and engineering experience at open-pit copper mines:

- Reduce the speed limit for miscellaneous vehicles;
- Apply additional water to unpaved non-haul roads;
- Apply chemical dust suppressant to unpaved non-haul roads;
- Apply and maintain surface gravel on unpaved non-haul roads; and
- Paving the unpaved non-haul roads and maintain the pavement.

2.5.1.2.1 Reduce the speed limit for miscellaneous vehicles from 35 mph to 15 mph

According to Asarco, even though the speed limit for all vehicles at the Ray Operations is 35 mph, the average traveling speed of miscellaneous vehicles is 15 mph. Therefore, lowering the speed limit to 25 mph for miscellaneous vehicles is technically feasible.

2.5.1.2.2 Apply additional water to unpaved non-haul roads

Applying more water to unpaved non-haul roads would require Asarco to deploy additional water trucks, as there are often summer months when the current fleet is used at full capacity. Too much watering could also lead to traction problems between the miscellaneous vehicles and the roads, thus reducing the fuel economy of miscellaneous vehicles and the roads. Applying more water to unpaved non-haul roads is technically feasible.

A PM_{10} control efficiency of 80% has been used in Asarco's emissions inventories for unpaved non-haul roads. Additional watering can increase the control efficiency from 80% to 90%, which would yield an emission reduction of approximately 39 tpy for PM_{10}.

In order to increase the control efficiency from 80% to 90%, the moisture ratio should increase from 2.5 to 4.2 (68% increase in water moisture). ADEQ assumed that the amount of additional water needed was proportional to the increase in the moisture ratio.

2.5.1.2.3 Apply chemical dust suppressant to unpaved non-haul roads

Chemical dust suppressant is already applied in combination with water to the unpaved non-haul roads. The force of the miscellaneous vehicles substantially decreases the effectiveness of the magnesium chloride. In addition, chemical dust suppressants cause tire slippage, especially when the miscellaneous vehicles make turns or travel on inclines/declines. Therefore, applying additional chemical dust suppressant to the unpaved non-haul roads, beyond that which is already applied, would be technically infeasible.

2.5.1.2.4 Apply and maintain surface gravel on unpaved non-haul roads

Application and maintenance of surface gravel on the unpaved non-haul roads is technically feasible. However, the miscellaneous vehicles would still degrade the gravel over time at a rate faster than normal vehicle traffic, due to the weight of the miscellaneous vehicles. This would necessitate periodic replacement of the gravel.

Per AP-42 Section 13.2.2 Equation 1(a), surface material silt content (%) is one of the key variables for estimating PM_{10} emission factor.[9] Asarco currently utilizes a silt content of 6.9% in its emission inventories for the unpaved roads. A silt content of 6.4% could be achieved by adding more gravel to the unpaved roads.[10] A decrease in the silt content from 6.9% to 6.4% would reduce the PM_{10} emission by 5.1 tpy.

2.5.1.2.5 Paving unpaved non-haul roads

It has been reported that certain other copper mines in the United States have paved some of their non-haul roads. Paving the unpaved non-haul roads for the Ray Operations would be technically feasible. However, paving unpaved roads in an effort to reduce PM_{10} emissions from miscellaneous vehicles would require a substantial capital investment. Additionally, Asarco anticipates that the non-haul roads, once paved, would be covered fairly quickly by dust, which would necessitate regular removal of the accumulated dust and make it difficult to attribute with confidence a control efficiency for the pavement.

Paving of unpaved non-haul roads may achieve a control efficiency of 99%. The pavement of the unpaved non-haul roads could yield a reduction of 74 tpy for PM_{10}.

Table 4 provides a summary of the technically feasible controls for PM_{10} emissions from miscellaneous vehicles traveling on unpaved non-haul roads.

Table 4 Technically Feasible Control Options for PM10 Emissions from Miscellaneous Vehicles Traveling on Unpaved Non-Haul Roads

Control Options	PM_{10} Emissions Reduction (tpy)	Note
Reduce the speed limit for miscellaneous Vehicles from 35 mph to 25 mph		Currently the average traveling speed of miscellaneous Vehicles is 15 mph

9 https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

10 "Emission Factor Documentation for AP-42 Section 13.2.2, Unpaved Roads, Final Report," U.S. EPA Office of Air Quality Planning and Standards Emissions Factor and Inventory Group (September 1998) at p. 4-29.

Apply additional water to unpaved non-haul roads (increasing the control efficiency from 80% to 90%)	39	
Apply and maintain surface gravel on unpaved non-haul roads (decreasing the silt content from 6.9% to 6.4%)	5.1	
Paving unpaved non-haul roads	74	

2.5.1.3 PM_{10} Emissions from Dumps and Tailings Windblown Dust

Asarco has identified the following PM_{10} control technologies based on a review of the RACT/BACT/LAER Clearinghouse ("RBLC") database, technical literature, practices and engineering experience at open-pit copper mines:

- Apply additional water or chemical dust suppressants to the dumps and tailings;
- Cover the dumps and tailings with tarps;
- Enhance the vegetation of the dumps and tailings; and
- Employ a windbreak around the dumps and tailings.

2.5.1.3.1 Apply additional water or chemical dust suppressants to the dumps and tailings

A combination of water and chemical dust suppressants is already applied to the dumps and tailings of the Ray Operations, for which a PM_{10} control efficiency of 95-99% has been used in Asarco's emissions inventories. A greater PM_{10} control efficiency has not been reported in the literature for dumps and tailings. It would not be technically feasible to achieve additional control efficiency by adding more water or chemical dust suppressants to the dumps or tailings.

2.5.1.3.2 Cover the dumps and tailings with tarps

Using tarps on the surfaces of the dumps and tailings in order to control PM_{10} emissions from them would be technically infeasible for several reasons: (i) the dumps and tailings are too large to be covered with tarps, covering over 7,000 acres; (ii) the materials comprising the dumps and tailings are not amenable to physical coverage; (iii) large parts of the dumps and tailings remain active, which would necessitate continuous removal and replacement of tarps; and (iv) any attempt to cover the dumps and tailings with tarps would necessitate manual labor, which could not be squared with MSHA's Safe Access Standard.

2.5.1.3.3 Enhance the vegetation of the dumps and tailings

The dumps and tailings are already subject to the Ray Operations' mined land reclamation plans. The plans and permit include concurrent reclamation, closure, and post-closure reclamation components that maximizes the degree to which vegetation can be achieved on the dumps and tailings. No further vegetation of the dumps and tailings is technically feasible.

2.5.1.3.4 Employ a windbreak around the dumps and tailings

The dumps and tailings cover over 7,000 acres and are hundreds of feet in height. Therefore, employing an artificial windbreak, such as a wall or fence, or a natural windbreak comprised of trees and shrubs around the dumps and tailings would be technically infeasible. In addition, a windbreak would not be able to control against wind-blown dust within the vast interiors of the dumps and tailings.

2.5.1.4 PM_{10} Emissions from Dozing Mine Areas, Dumps and Stockpiles

Asarco has identified the following PM_{10} control technologies based on a review of the RACT/BACT/LAER Clearinghouse ("RBLC") database, technical literature, practices and engineering experience at open-pit copper mines:

- Apply additional water to control dust from dozing;
- Apply chemical dust suppressant to surfaces being dozed; and
- Curtail dozing during high winds.

2.5.1.4.1 Apply additional water to control dust from dozing

Most of the dozing at the Ray Operations occurs in the pit and on the tops of the dumps. Water cannot be applied during dozing on the tops of the dumps because water trucks cannot gain access to the tops of the dumps, the dozing on the dumps is too dynamic to allow for another watering method, and adding water during dozing at the tops of the dumps would pose unacceptable safety risks. The dozing within the pit that facilitates the ore loading operations is already watered to control dust from the dozing. Applying more water than that already applied would mean dedicating a water truck to each of the ore loading locations. Applying additional water to the dozing that facilitates ore loading operations and the other dozing at the Ray Operations, except the dozing on the tops of dumps, would be technically feasible.

The moisture content of the material being dozed would increase from 7.9%, on which Asarco's emissions inventories are based, to 16.8% which is the reported upper range of moisture content for overburden material.[11] Increasing the moisture content of the material being dozed from 7.9% to 16.8% would yield a reduction of 13.7 tpy for PM_{10} based on AP-42 Section 11.9 Table 11.9-1.

[11] AP-42 Table 11.9-3. https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf

2.5.1.4.2 Apply chemical dust suppressant to surfaces being dozed

Application of chemical dust suppressant to the surfaces being dozed would be technically infeasible because the suppressant: (i) would interfere with the SX/EW process and (ii) would not be durable in the face of the dozing and would cause safety concerns.

2.5.1.4.3 Curtail dozing during high winds

Curtailing dozing during high winds would significantly impact overall operations, considering that dozing is critical to the ore throughput of the Ray Operations. If dozing were to be curtailed during high winds, then Asarco would have to increase dozing at other times in order to make up for the loss in production or accept reduced throughput at the mine as a result of the curtailed dozing.

While curtailing dozing during high winds is technically feasible, PM_{10} emission reductions as a result of the curtailed dozing during high winds cannot be estimated. Asarco is unable to decide whether they must accept reduced throughput or increase dozing at other times as a result of the curtailed dozing because the grade of the ore and the market price of copper fluctuate substantially over time. The degree to which PM_{10} emissions might be reduced as a result of the curtailed dozing cannot be estimated if the decision-making above cannot be reasonably assessed. Since the emissions reductions could not be quantified, this control option is not considered further in the cost of compliance analysis.

Table 5 provides a summary of the technically feasible controls for PM_{10} emissions from dozing mine areas, dumps and stockpiles

Table 5 Technically Feasible Control Options for PM10 Emissions from dozing mine areas, dumps and stockpiles

Control Options	PM_{10} Emissions Reduction (tpy)	Note
Apply additional water to control dust from dozing (increasing moisture content from 7.9% to 16.8%)	13	
Curtail dozing during high winds	Emissions reductions could not be quantified	This control option is not considered further in the cost of compliance analysis

2.5.1.5 NOx Emissions from Blasting Ore and Waste Rock

No control measures are available to decrease NOx emissions from blasting ore and waste rock at the Ray Operations. This is based on a review of the RBLC database, other technical literature, practices at other cement manufacturing facilities, and engineering experience both generally and at the Ray Operations.

2.5.2 Cost of Compliance

2.5.2.1 Cost Calculation Methodology

In general, the cost calculation methodologies ADEQ employed follow the recommendations in the EPA Air Pollution Control Cost Manual, specifically the concepts and methodology as discussed in chapter 2 of section 1.[12] ADEQ recognized that the generic cost estimate information for the processes in mining industry is very limited in the EPA documentation. Therefore, ADEQ mainly relied on the source-specific estimates Asarco provided. For example, the capital costs for new haul trucks and water trucks were directly from the vendor budgetary quotes, and the Operation and Maintenance (O&M) cost of trucks were estimated based on the actual costs in the Ray Operations during the most recent years. Interest rates and the useful life for amortization purposes are discussed as follows.

As recommended in the EPA Control Cost Manual, the bank prime rate can be an appropriate estimate for interest rates if firm-specific nominal interest rates are not available. Upon reviewing the most recent years of the bank prime rates, ADEQ selected a bank prime rate of 4.75% as the default value for the cost of compliance analysis for Arizona sources if a source is unable to provide a site-specific interest rate.[13] Since Asarco did not provide a site-specific interest rate, the rate of 4.75% was used for the Ray Operations.

The concept of remaining useful life of source is typically used in the context of a discrete emission unit and new emission control systems. According to Asarco, the remaining useful life of the Ray Operations may be 25 years, possibly longer depending on drill data, ore reserves and the developing market price of copper.

A haul truck or water truck may last 10-12 years without a major refurbish. However, the rebuild process can significantly extend the useful life of trucks.[14] Asarco proposed a useful life of 12 years for both haul trucks and water trucks. ADEQ determined that a useful life of trucks of 20 years would be appropriate, considering the useful life of trucks could be extended through the rebuild process.

For pavement that is regularly traversed by miscellaneous vehicles, Asarco employed a useful life of 35 years for amortization purposes in the four-factor analysis. This is potentially a conservative estimate given the facility useful life is an expected 25 years. According to Arizona Department of Transportation (ADOT), a minimum 35 years analysis period should be used for a life cycle cost analysis for highway pavement structures.[15] It is expected that pavement that is regularly traversed by heavy industrial vehicles would have a shorter useful life than highway pavement structures.

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[12] https://www.epa.gov/sites/production/files/2017-12/documents/epaccmcostestimationmethodchapter_7thedition_2017.pdf

[13] 4.75% represents the approximate monthly average reported bank prime rate for the three years ending in May 2020 (the time of estimation and implementation).

[14] https://www.cat.com/en_US/campaigns/awareness/mining-truck-rebuilds.html

[15] Pavement Design Manual. (2017). Section 2.4. Arizona Department of Transportation. https://apps.azdot.gov/files/materials-manuals/Preliminary-Engineering-Design/PavementDesignManual.pdf

The useful life of surface gravel applied to the unpaved non-haul roads, before the gravel would need to be replaced, is estimated at 3 years. A document from The U.S. Department of Transportation Federal Highway Administration (FHWA) suggests that re-graveling is necessary every 3 years for cost estimation purposes.[16]

2.5.2.2 Evaluation Criteria for Cost-Effectiveness

ADEQ performed an analysis to determine a reasonable cost-effectiveness ($/ton) threshold for Arizona emission sources that are subject to the four factor analysis in the regional haze second planning period. ADEQ gathered data on Round 1 Regional Haze Best Available Retrofit Technology (BART) and Reasonable Progress determinations through research of previous submittals and EPA determinations and through outreach to EPA, Federal Land Managers (FLMs), Western States, and WRAP. While EPA did not explicitly state whether they used cost and visibility thresholds or not for their determinations on Round 1, EPA generally rejected cases with a cost-effectiveness of greater than 5,000 $/ton regardless of whether a visibility benefit was significant or not. ADEQ found that none of the implemented cost-effectiveness values in Round 1 exceeded 5,300 $/ton. Adjusting the cost for inflation, ADEQ determined that any controls having an average cost-effectiveness of 6,500 $/ton would be cost excessive and could be rejected without further justification.

2.5.2.3 Results of Cost-Effectiveness Analysis

Table 6 provides a summary of cost effectiveness for control options for PM_{10} emissions from trucks hauling ore and waste rock. Table 7 provides a summary of cost effectiveness for control options for PM_{10} emissions from miscellaneous vehicles traveling on unpaved non-haul roads. Table 8 provides a summary of cost effectiveness for control options for PM_{10} emissions from dozing mine areas, dumps and stockpiles. For detailed cost-effectiveness estimate, please see the attached spreadsheet.

2.5.2.3.1 Control options for PM_{10} emissions from trucks hauling ore and waste rock

- As shown in Table 6, the speed reduction option for haul trucks has an average cost-effectiveness of $431,942/ton. ADEQ has determined that this control option was cost excessive.
- The control option of additional water spray on haul roads has an average cost-effectiveness of 9,658 $/ton, significantly higher than the threshold of 6,500 $/ton as discussed above. As such, ADEQ has determined that this control option was cost excessive.

[16] "Gravel Roads Construction and Maintenance Guide" (2015). Figure 17. The U.S. Department of Transportation Federal Highway Administration (FHWA). https://www.fhwa.dot.gov/construction/pubs/ots15002.pdf

2.5.2.3.2 Control options for PM_{10} emissions from miscellaneous vehicles traveling on unpaved roads

- There would be no additional cost since the average traveling speed of miscellaneous vehicles at the Ray Operations is 15 mph, below the speed limit of 25 mph.
- As shown in Table 7, the other three control options (additional watering, surface gravel, and paving) have an average cost-effectiveness ranging from $36,401/ton to $66,960/ton. ADEQ has determined that all of the three control options were cost excessive.

2.5.2.3.3 Control options for PM_{10} emissions from dozing mine areas, dumps and stockpiles

- As shown in Table 8, the control option of additional water spray on dozing areas has an average cost-effectiveness of 109,742$/ton. As such, ADEQ has determined that this control option was cost excessive.

Table 6 Cost Effectiveness for Control Options for PM_{10} Emissions from Trucks Hauling Ore and Waste Rock

Control option	Capital cost ($)	Annualized capital cost ($/yr)[1]	Annual operating & maintenance cost ($/yr)	Total annual cost ($/yr)	Emission reduction (tpy)	Average Cost-effectiveness ($/ton)
Reduce the speed limit for haul trucks to 25 mph	83,244,838	6,538,921	12,993,494	19,532,415	45.22	431,942
Apply additional water to haul roads outside the pit	1,810,644	142,227	316,358	$458,585	47.48	9,658
Apply additional water to haul roads both inside and outside the pit[2]	$3,621,288	$284,454	$632,716	$917,170	94.96	$9,658

[1] Capital Recovery Factor = 7.86% based on an interest rate of 4.75 and a useful life of 20 years.
[2]Although ASARCO has a concern that the application of additional water to the haul roads inside the pit would pose safety concerns due to slippage over inclines/declines inside the pit, ADEQ re-calculated the average cost-effectiveness assuming that haul truck emissions both inside and outside the pit can be reduced from increasing the water spray control efficiency from 75% to 90%.

Table 7 Cost Effectiveness for Control Options for PM_{10} Emissions from Miscellaneous Vehicles Traveling on Unpaved Roads

Control option	Capital cost ($)	Annualized capital cost ($/yr)	Annual operating & maintenance cost ($/yr)	Total annual cost ($/yr)	Emission reduction (tpy)	Average Cost-effectiveness ($/ton)
Reduce the speed limit to 25 mph						0[1]
Apply additional water to unpaved non-haul roads	8,695,247	683,016[2]	1,519,245	2,202,260	39.15	56,252
Application of surface gravel on unpaved non-haul roads	460,124	168,170[3]	18,405	186,575	5.13	36,401
Paving of unpaved non-haul road	50,231,360	2,971,584[4]	2,009,254	4,980,838	74.39	66,960

[1] *There is no additional cost since the average traveling speed of at ASARCO Ray Operations is 15 mph, below the speed limit of 25 mph.*
[2] *Capital Recovery Factor = 7.86% based on an interest rate of 4.75% and a useful life of 20 years*
[3] *Capital Recovery Factor = 36.55% based on an interest rate of 4.75% and a useful life of 3 years*
[4] *Capital Recovery Factor = 5.92% based on an interest rate of 4.75% and a useful life of 35 years*

Table 8 Cost Effectiveness for Control Options for PM_{10} Emissions from Dozing Mine Areas, Dumps and Stockpiles

Control option	Capital cost ($)	Annualized capital cost ($/yr)	Annual operating & maintenance cost ($/yr)	Total annual cost ($/yr)	Emission reduction (tpy)	Average Cost-effectiveness ($/ton)
Apply additional water to control dust from dozing	$7,500,000	$834,301[1]	$668,910	$1,503,211	13.7	$109,742

[1]*Capital Recovery Factor = 7.86% based on an interest rate of 4.75% and a useful life of 20 years*

2.5.3 Time Necessary for Compliance

There is no requirement that controls determined to be necessary under 40 C.F.R. § 51.308 must be installed as expeditiously as practicable; rather, such controls should be in place by 2028, unless ADEQ concludes that the control cannot reasonably be installed and become operational until after 2028. Further evaluation of the time necessary for compliance was not evaluated given the controls identified were either currently implemented or cost excessive.

2.5.4 Energy and Non-Air Quality Impacts

Adding more haul trucks or water trucks may potentially increase the consumption of fuel. Additional water spray on the haul roads or non-haul unpaved roads will increase the water consumption. For other controls options, the energy and non-air quality impacts are considered negligible.

2.5.5 Remaining Useful Life of Source

As previously discussed, the remaining useful life of the Ray Operations may be 25 years, possibly longer depending on drill data, ore reserves and the developing market price of copper. ADEQ has determined the following useful lives for varied equipment/processes:

Haul trucks: 20 years;

Water trucks: 20 years;

Pavement that is regularly traversed by rubber tire rigs: 35 years; and

Surface gravel applied to the unpaved non-haul roads: 3 years.

2.5.6 Visibility Impact

Asarco performed a Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model to determine the probability that emissions from the Ray Operations impact a Class I area when it experiences its 20% worst visibility days. The results of the HYSPLIT model indicate that the probability of emissions from the Ray Operations impacting the Superstition Wilderness Area is less than 2.0%.