

Attachment E – Supporting Emission Calculations

Attachment E-1 – Cooling Tower

Cooling Tower Maintenance Emissions
Boeing Portland CAO Emission Calculations

Cooling Tower Particulate Emission Calculations

Parameter	Value	Units
Number of Cooling Towers	10	unitless
Water Circulation Rate	6	gpm
Total Liquid Drift	0.002	%
TDS of Circulated Water ^a	1,200	ppmw
Fraction of TDS as PM ₁₀	70%	mass fraction
Fraction of TDS as PM _{2.5}	42%	mass fraction
Emissions		
TSP ^b	7.21E-04	lbs/hr
PM ₁₀ ^c	5.05E-04	lbs/hr
PM _{2.5} ^c	3.03E-04	lbs/hr

ppmw = part(s) per million by weight

gpm = gallon(s) per minute

lbs/hr = pound(s) per hour

TDS = Total Dissolved Solids

TSP = Total Suspended Particulates

^a To be conservative, assumed to be the maximum conductivity reading provided.

^b TSP emission rate calculated based on EPA's AP-42, Section 13.4, Table 13.4-1 (EPA 1995).

^c PM₁₀ and PM_{2.5} emission rates calculated consistent with the TSP emission rate, assuming only a fraction of TDS is PM₁₀ or PM_{2.5}, respectively.

Fraction TDS based on 'South Coast Air Quality Management District. 2006. Final- Methodology to Calculate Particulate Matter (PM) 2.5 and PM 2.5 Significance Thresholds. Appendix A. October.

Cooling Tower Maintenance Emissions
Boeing Portland CAO Emission Calculations

Cooling Tower TAC Emission Calculations

Parameter	Value	Units
Number of Cooling Towers	10	unitless
Cooling Tower Recirculation Rate	6	gpm
Drift Eliminator Efficiency	0.002	%
<i>Example Material: CL1432 Cooling Water Treatment</i>		
CL1432 Concentration	160	ppm
Density	11.14	lbs/gal
Phosphoric acid (7664-38-2) Weight Fraction	10	%
<i>Example Material: CL497 Cooling Water Treatment</i>		
CL497 Concentration	10	ppm
Density	10.9	lbs/gal
Sodium hydroxide (1310-73-2) Weight Fraction	5	%

Emissions

Constituents	Concentration Analyzed in Condensate	Hourly Emissions ^a
Non-Volatile Compound Calculations		
Pollutant	(µg/L)	(lbs/hr)
Phosphoric acid (7664-38-2)	21,358	1.28E-05
Sodium hydroxide (1310-73-2)	653	3.92E-07

µg/L = microgram(s) per liter

gpm = gallon(s) per minute

lbs/gal = pound(s) per gallon

lbs/hr = pound(s) per hour

ppm = parts per million

^a Emissions were estimated as follows:

Emissions Rate (lbs/hr) = Recirculation Rate (gpm) * 60 min/hr * 3.785 liters/gal * TAC

Concentration (µg/L) * 1 lb / 453.6 g * 1 g / 10⁶ µg * Drift Fraction

Attachment E-2 – Penetrant Dye

Penetrant Testing Dye Developer Emissions

Boeing Portland CAO Emission Calculations

	Example Material	Example SDS	TAC CAS	TAC Name	Max % weight	Uncontrolled		Controlled	
						lb/day	lb/year	lb/day	lb/year
Penerant Testing Dye Developer	ZP-4P	308619	1344-28-1	Aluminum oxide (fibrous forms)	5%	0.5	4.74	0.075	0.711

Notes:

Max Daily usage 10 lb Maximum daily usage

Max Annual usage 94.8 lb Maximum yearly usage from 2019, converting 1 scoop = 1 lb and adding 20% safety factor

Control:

<https://www.epa.gov/indoor-air-quality-iaq/what-merv-rating>

Example Filter: Donaldson Torit Ultra Web Cartridge Merv 15 filter

85 % control

Attachment E-3 – Hand Finishing

Insignificant Activities Emission Calculations

Hand Finishing Booths

Boeing - Portland

Emission estimates based on filter control efficiency, scrubber water evaporation rate and metals content of water.

Hand Finishing Filter Data

Hand Finishing Areas Control Equipment								Control Device						
Unit Type ¹	Asset MSS# ¹	Description ¹	Manufacturer ¹	Model #	BLDG - Main ¹	Col ¹	Production type ¹	Asset # ¹	Description ¹	Manufacturer	Model #	Number of Units ¹	Airflow (cfm/Unit) ¹	Total Flow (cfm) ¹
Hand Finish Booth	Z084	Booth with Wet filter	Filter 1	DHYD-1-95-15-10-4R	85-001	G10	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	1	9500	9500
Hand Finish Booth	Z085	Booth with Wet filter	Filter 1	DHYD-1-95-15-10-4R	85-001	G10	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	1	9500	9500
Hand Finish Booth	Z109	Booth with Wet filter	Filter 1	DHYD1-15-10	85-001	G12	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	1	9500	9500
Hand Finish Booth	Z422	Booth with Wet filter	Filter 1	DHYD-1-50-10-4-4R-VF	85-001	G4	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	1	5000	5000
Hand Finish Booth	Z423	Booth with Wet filter	Filter 1	DHYD-1-50-10-4-3R-VF	85-001	G3	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	1	5000	5000
Hand Finish Booth	Z425	Booth with Wet filter	Filter 1	DHYD-1-95-15-10-3.5-MO	85-001	K37	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	1	9500	9500
Hand Finish Booth	Z065	Booth with Wet filter	Filter 1	HPB 14-3X10-MO-CS-VF	85-105	C6N	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	3	5,500	16500
Hand Finish Booth	Z068	Booth with Wet filter	Filter 1	HPB 14-3X10-MO-CS-VF	85-105	B6N	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	3	5,500	16500
Hand Finish Booth	Z100	Booth with Wet filter	Filter 1	NG HPB26-4-4X10-CS-VF	85-105	B6G-C6N	Al, Ti, SS parts	Same	Wet filter	Hydrotron	TBD	4	5,500	22000

Notes:

1.) Information obtained during Jacobs site visit April 2024.

2.) Hand Finish Booth Z119 in BLDG 85-105 was not included because it only processes Titanium.

Hand Finishing Metal Grinding and Cutting PM Emissions

Unit Type ¹	Asset MSS# ¹	Description ¹	Control Device	Number of Units ¹	Airflow (cfm/Unit) ¹	Control Efficiency ² (%)	Evaporation ³ (gal/hr)	Total Metals ⁴ (PM in mg/L)	Uncontrolled - Inlet to Filter		Controlled	
									PM Emissions (lbs/hr)	PM Emissions (TPY)	PM Emissions (lbs/hr)	PM Emissions (TPY)
Hand Finish Booth	Z423	Booth with Wet filter	Wet filter	1	5,000	99%	3.9	1.03	0.0000	0.0001	3.3E-07	1.5E-06
Hand Finish Booth	Z422	Booth with Wet filter	Wet filter	1	5,000	99%	3.9	1.03	0.0000	0.0001	3.3E-07	1.5E-06
Hand Finish Booth	Z085	Booth with Wet filter	Wet filter	1	9,500	99%	7.4	1.03	0.0001	0.0003	6.3E-07	2.8E-06
Hand Finish Booth	Z084	Booth with Wet filter	Wet filter	1	9,500	99%	7.4	1.03	0.0001	0.0003	6.3E-07	2.8E-06
Hand Finish Booth	Z109	Booth with Wet filter	Wet filter	1	9,500	99%	7.4	1.03	0.0001	0.0003	6.3E-07	2.8E-06
Hand Finish Booth	Z425	Booth with Wet filter	Wet filter	1	9,500	99%	7.4	1.03	0.0001	0.0003	6.3E-07	2.8E-06
Hand Finish Booth	Z100	Booth with Wet filter	Wet filter	4	5,500	99%	4.3	1.03	0.0001	0.0006	1.5E-06	6.5E-06
Hand Finish Booth	Z068	Booth with Wet filter	Wet filter	3	5,500	99%	4.3	1.03	0.0001	0.0005	1.1E-06	4.8E-06
Hand Finish Booth	Z065	Booth with Wet filter	Wet filter	3	5,500	99%	4.3	1.03	0.0001	0.0005	1.1E-06	4.8E-06
Total Emissions:									0.001	0.003	6.9E-06	3.0E-05

Notes:

¹ Information obtained during Jacobs site visit April 2024.

² Filter 1 - Manufacturer provided Hydrotron efficiency is at 99% for particles in the range of 10 microns. Particles are mostly above 10 microns (600 grit) in metal finishing processes.

³ Clean Air Consultants, Hydrotron Water Consumption chart at 72 F and 50% RH final state and 62 F and 72% RH at sea level

⁴ Eurofins Analytical Report Generated 12/3/2025 Job Number 580-155911-1

Conversions as follows:

Unit Conversions	
liters/gallon	3.79E+00
lb/mg	2.20E-06
min/hr	60
tons/lb	0.0005
hr/yr	8760

Hand Finishing Booths
 Water Samples from Wet Collectors
 Eurofins Analytical Report December 3, 2025

Metal Compound	Sample ID			Reporting Limit (mg/L)	Average (mg/L)	Percent of Total (%)
	P00119 (mg/L)	Z0100 (mg/L)	Z068 (mg/L)			
Aluminum	0.37	1.3	0.4	0.025	0.69	67.15%
Barium	0.053	0.096	0.033	0.002	0.06	5.90%
Cadmium	0.0005	0.0046	0.0005	0.001	0.00	0.18%
Chromium	0.008	0.044	0.031	0.002	0.03	2.69%
Copper	0.075	0.052	0.025	0.002	0.05	4.93%
Manganese	0.036	0.025	0.016	0.002	0.03	2.50%
Nickel	0.041	0.001	0.001	0.002	0.01	1.39%
Zinc	0.13	0.12	0.22	0.02	0.16	15.25%
Total	0.71	1.64	0.73		1.03	100%

Notes:

Numbers in blue were ND and reported at 1/2 the reporting limit.

Arsenic, Lead, Nickle, Selenium, and Mercury were ND for all three samples and therefore excluded from the emissions calculation.