

**DRY SORBENT INJECTION
COST ESTIMATE
ID FAN BACKUP COSTS**



Quotation

No: 24257DM22

Date: 06/07/2022

Validity: 30 days

Page: 1 of 7

A Twin City Fan Company ~ 5959 Trenton Lane ~ Minneapolis ~ MN 55442 ~ Tel (763) 551-7600 ~ Fax (763) 551-7601

To: Mario Jahn, Mechanical Engineer

From: Darren Miller, Senior Sales Application Engineer

Project: Feasibility Study - Replacement of Clarage S0# 711053-3-1.

Customer Reference: University of Alaska Fairbanks (UAF), I.D. Fan System Upgrade

Clarage Proposal: 24257DM22

We refer to our above and are pleased to offer the attached pricing and construction of the Clarage Fan. This proposal is good for 30 days from date above for placement of order.

Pricing is based on fans being ordered within the above time frame. Shipping terms are. FCA - Point of Manufacture Pulaski TN for fans & supplier's works for buy outs per INCOTERMS 2010. No freight is included unless otherwise stated in this proposal. Export boxing if required is by others unless otherwise stated in this proposal. All products are subject to a weekly storage fee of \$0.025/pound starting 5 business days after notification of readiness to ship.

Price quoted is valid for 30 days from the date above for placement of order and is good for shipment of the product within 6 months of order. Shipment after 6 months from order date is subject to pricing escalation.

General Arrangement Approval Drawings: 3 – 4 weeks after receipt of approved Purchase Order. Fan Manufacturing: 22 – 24 weeks after drawing approval and subject to motor lead time if supplied by Clarage. Add another two weeks for Mechanical Run and / or Performance Testing if required. Delivery dates above are subject to motor and other vendor lead times. Delivery does not reflect customer approval time.

Clarage proposes the following contract payment terms subject to Clarage's Credit department's approval:

Clarage proposes the following progress payments for quotations over \$75,000.00 subject to credit approval:

- 10% Invoiced Upon Customer Receipt of Approval Drawings
- 40% Invoiced Upon Customer Release to Production
- 30% Invoiced Upon Notification of Clarage's Readiness to Ship
- 20% Invoiced Upon Shipment

- See Exceptions and clarifications for deviations.

Scope of fan supply and pricing is as listed in the following pages.

This quotation is per Clarage's attached terms and conditions.

We trust this information is complete. Should you require additional information, contact undersigned at

Darren Miller

Senior Sales Application Engineer | Clarage
202 Commerce Way | Pulaski, TN 38478
Cell: 931.787.2921 | Main: 931.424.2500
Web: clarage.com | Email: dmiller@clarage.com



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Clarage Fan Selection:

Input Parameters:

Static Pressure: 54 inches w.g.
Volume: 120,000 cfm
Density: 0.0536 lb/ft³
Temperature: 170°F
Elevation: 450 ft above sea level

Fan Model: 5123-AF
Fan Size: 102.75" Airfoil
Design Speed: 1200 RPM
Design Temperature: 400°F

Features:

- Fan housing constructed of: 0.5 in. ASTM A-36
- Fan housing discharge: 90 deg. (Customer to determine at later date)
- Inlet piece of: ASTM A-36
- Inlet box constructed of: 0.5 in. ASTM A-36
- Inlet box inlet angle: 360 deg. (Customer to determine at later date)
- Impeller material: ASTM A-514S or equal.
- Shaft material: SAE 1045 Forge or equal
- Hub material: SAE 1026 Forge or equal
- Impeller rotation: CW. (Customer to determine at later date)
- Sandblast and Paint entire fan
 - Surface Prep: SSPC-SP-2 – Hand Tool Cleaning
 - Paint: One coat of Stabler 4559A heat resistant dark gray primer at 2.0 - 3.0 mils per coat DFT.
- Housing & inlet box split for wheel removal (split location to be determined after order)
- Access doors, drain w/plugs (1 per inlet box, and 1 per housing), inlet box and outlet flanges.
- Outlet area: 26.3 ft²
- Motor and Bearing support pedestal. Arrangement: 7
- Volume control: SPD (Speed control by others)
- OSHA approved guards
- Sandblast and Paint entire fan
- Bearings: Dodge Sleeve RL.
- Coupling: Renold/Holset Series PM size 60 or equivalent.
- Shaft seal: single

Price for one (1) fan with above features: **\$425,808.00**

Option features and pricing:

Motor

- Motor: Frame: 500C, 1250hp, 1200rpm. Motor is designed for full voltage starting only unless otherwise stated. To confirm reduced voltage starting capability, please consult factory.

Price for one (1) motor with above features: **\$142,071.00**



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Project Reference:

1. Fan Details:	Quantity	Price Each	Extended Price
	1	\$425,808.00	\$425,808.00
Fan Type:	5123-AF SWSI	Volume:	120000 cfm
Blade Design:	Airfoil	Static Pressure	54 in.wg
Diameter:	102.75 in	Density:	0.0536 lb/ft3
Width:	100 %	Temperature:	170 F
Speed:	1180 rpm	Elevation:	450 ft
Brake Horsepower:	1231 hp	Outlet Area:	26.3 ft2
Static Efficiency:	83 %		

2. Fan Configuration:

Rotation:	CW	Inlet Angle:	360 deg.
Volume Control:	SPD	Discharge Angle:	90 deg.
Arrangement:	7		

3. Construction Details:

Impeller Material:	ASTM A-514S or equal.	Liners:	No blade liners
Housing Material:	0.5 in. ASTM A-36	Shaft Material:	SAE 1045 Forge or equal
Bearings:	Dodge Sleeveoil RTL.	Coupling:	Renold Series PM size 60
		Optional Motor:	Frame: 500C, 1250hp, 1200rpm

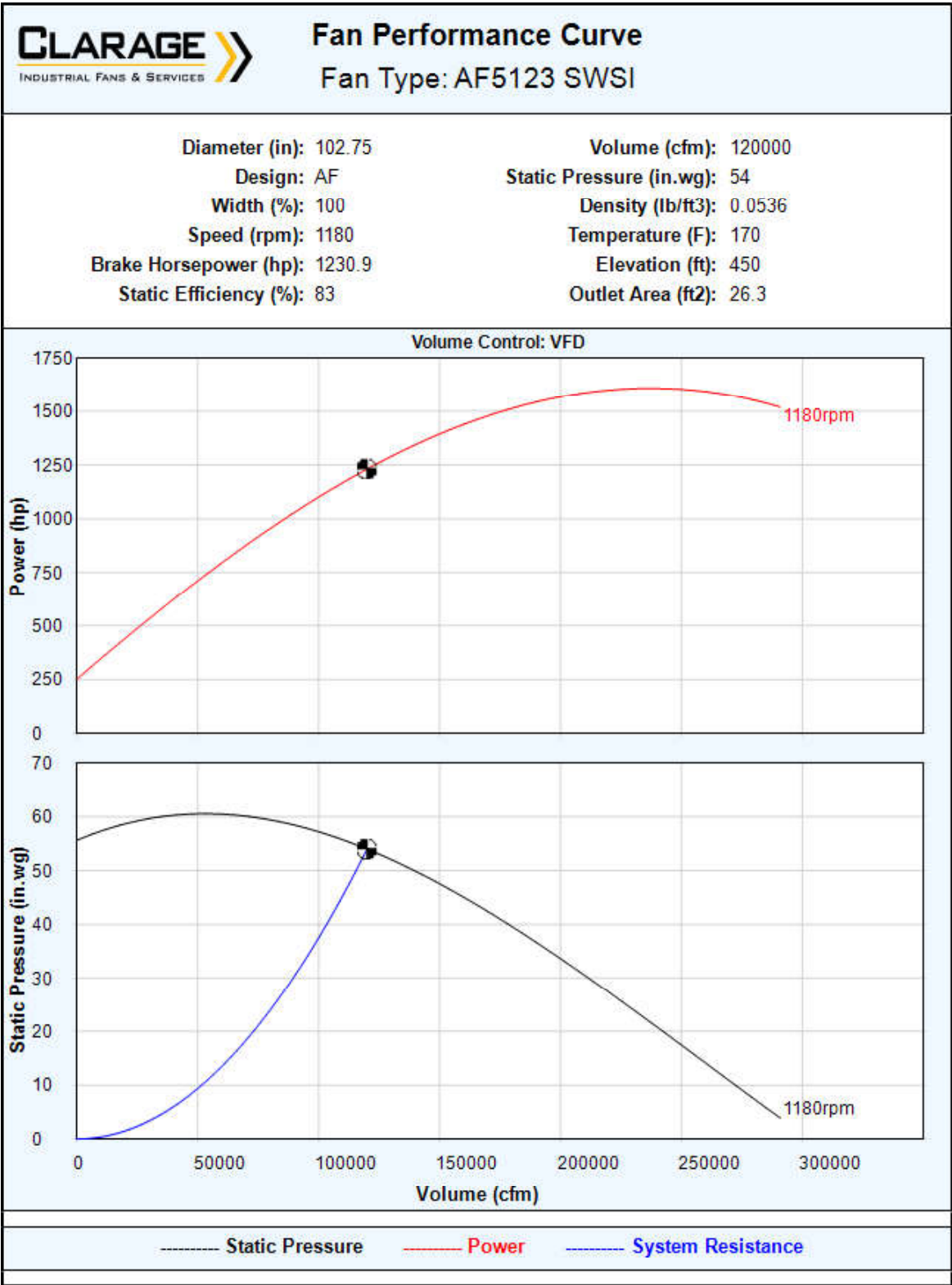
4. Performance Ratings

Ratings	Rating Point
Volume:	120000 cfm
Static Pressure:	54 in.wg
Density:	0.0536 lb/ft3
Temperature:	170 F
Speed:	1180 rpm
Brake Horsepower:	1231 hp
Static Efficiency:	83 %
Noise Level:	111 dBA



Quotation

A Twin City Fan Company ~ 5959 Trenton Lane ~ Minneapolis ~ MN 55442 ~ Tel (763) 551-7600 ~ Fax (763) 551-7601



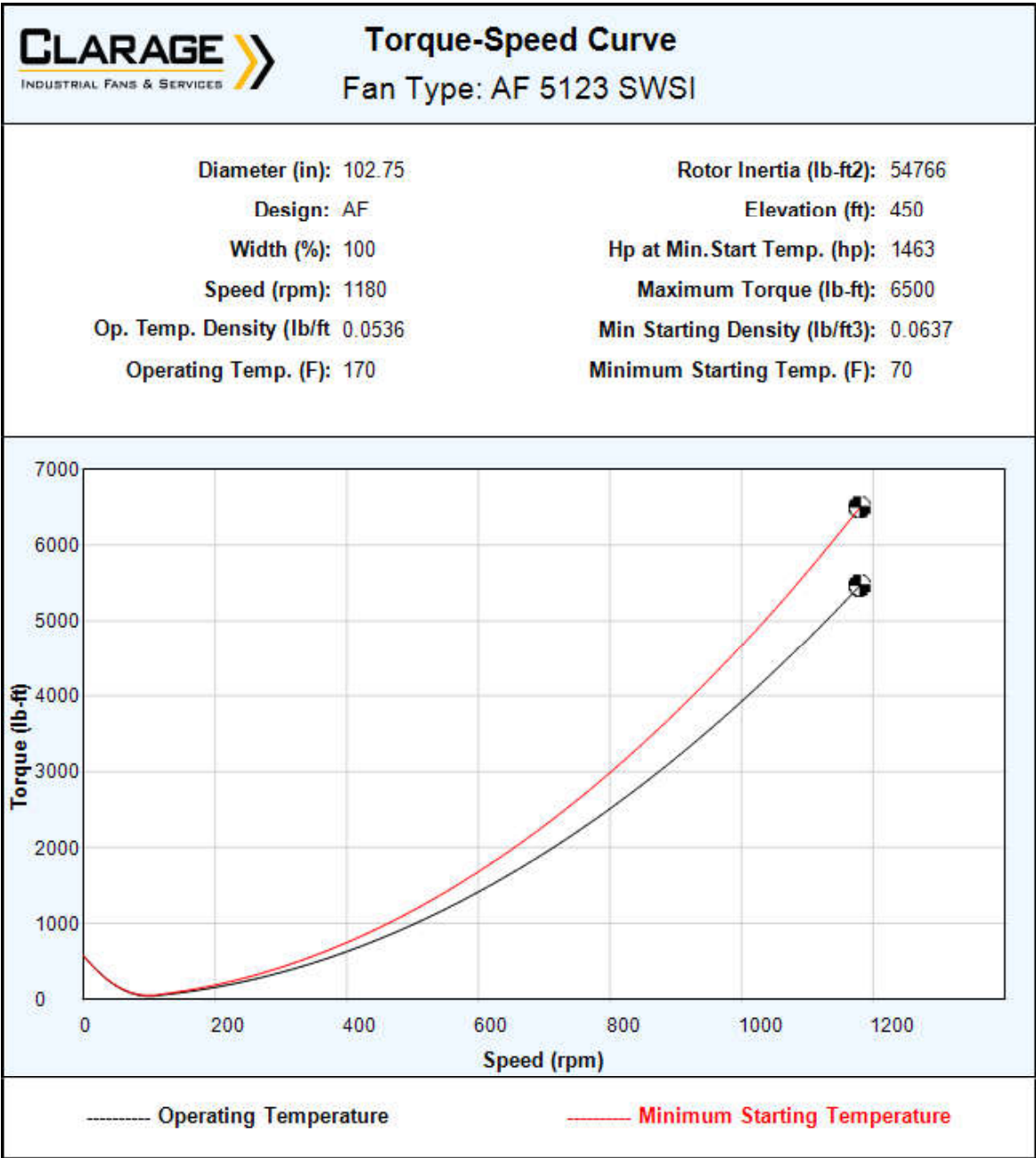
Upgraded ID Fan



Quotation

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CLARAGE ID Fan Upgrade



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7. Fan Noise Levels:

Fan sound power levels are certified by Clarage to have been tested and rated in accordance with AMCA Standard 300. Sound pressure levels are estimates based on the installation conditions and attenuations as shown with noise from all other sources such as fan drives, duct radiation, etc. considered to be more than 8 db lower, and that on-job sound measurements are made off-axis of any air system inlet or outlet. Exception is taken to specifications requiring guarantee of sound pressure level because on-site conditions beyond Clarage control may deviate from the conditions below.

Noise levels based on Free Field conditions.
Directivity = 1, Measurement Distance = 3 ft

Point	dBA	Sound Type	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
		Sound Pwr. (Lw dB)	125	123	125	116	114	111	104	99
Rating Point	111	Sound Pres. (Lp dB)	112	112	115	106	104	101	94	89

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A. Exceptions and Clarifications:

Clarage standard welding is to AWS standards including the allowances for weld splatter per AWS. Any additional requirements not included unless expressly mentioned as an alternative in the proposal. Standard paint is a Stabler 4559A heat resistant dark gray primer. which provides good adhesion and toughness to ferrous metal surfaces. This primer is weldable which renders it an ideal coating for field erected equipment. Alternative coatings must be expressly mentioned as an alternative in the proposal.

B. Optional Extended Warranty:

Clarage offers to extend the Standard Parts Only warranty for up to 48 months from delivery at an additional cost of ¼ % of the contract price per month of requested extension period (3% per year).

Additional warranty coverage for costs beyond the Clarage Standard Parts Only warranty is also available for purchase:

1. Site labor for the repair or replacement (excluding equipment rentals and access charges such as a crane and any costs for plant or closures), - add 5% to the proposal price.
2. All costs of the warranty repair or replacement, - add 10% to the proposal price.

TERMS AND CONDITIONS OF SALE:

Twin City Clarage, LLC's offer is expressly limited to the express terms of this offer, which are located at <https://clarage.com/terms-conditions> and any purported acceptance that that modifies, omits, or alters the terms of this offer regardless of whether the change is material or immaterial shall be not be a valid acceptance.



LARGE FANS MAY REQUIRE REMOVAL OF THE TOP OF THE FAN HOUSING FOR TRANSPORTATION PURPOSES AND WILL REQUIRE ASSEMBLY AT THE JOBSITE

[illegible]

**DRY SORBENT INJECTION
COST ESTIMATE
CONTROL SYSTEM BACKUP COSTS**

 Stanley Consultants Inc. Computed by <u>A. Szalaj</u> Date <u>10-Sep-22</u> Checked by _____ Date _____ Approved by _____ Date _____		Job No. <u>30431.01.00</u> Page No. _____		
		Subject <u>UAF - BACT Analysis Control System</u>		
		Sheet No. <u>1</u> of <u>1</u>		
Item Description	Quantity		Unit Cost	Total Cost
	No. of Unit	UOM		
<u>Control System</u>				
Fiber Communication Link	300.0	ea	\$ 43.98	\$ 13,193
I/O programming	50.0	ea	1400	\$ 70,000
Field Time for Integration	40	hrs	422.5	\$ 16,900
				\$ 100,093
			Location Factor 14.3%	\$ 12,427
			Contractor Overhead - 10%	\$ 11,252
			Contractor Profit - 15%	\$ 18,566
			Subtotal	\$ 142,338
			TOTAL COST	\$ 142,338
			PROBABLE CONSTRUCTION COST	\$ 142,000

Cost Estimate Basis:

1. Pricing for Fiber Communication Link was obtained from 2017 UAF Estimate.
2. Fiber Link unit cost was escalated by CEPCI index between 2017 and 2021 (708/767.5)
3. I/O programming and Field Time costs were obtained from a project that Stanley helped design in 2016. Plant was located in Iowa.
4. I/O programming and field time costs were escalated by 30% to coincide with CEPCI ratio between 2021 and 2016 (708/541.7 = 1.3)
5. Location factor was included for Fairbanks Alaska as the reference plant was taken from a project in Iowa. Location factor is in accordance with RS Means City Cost Index. Location Factor was not applied to Fiber Communication Link line item as those costs were from the UAF estimate.

NSE Estimate No.: N1412075

Date: 01/22/2015

Customer: Stanley Consultants

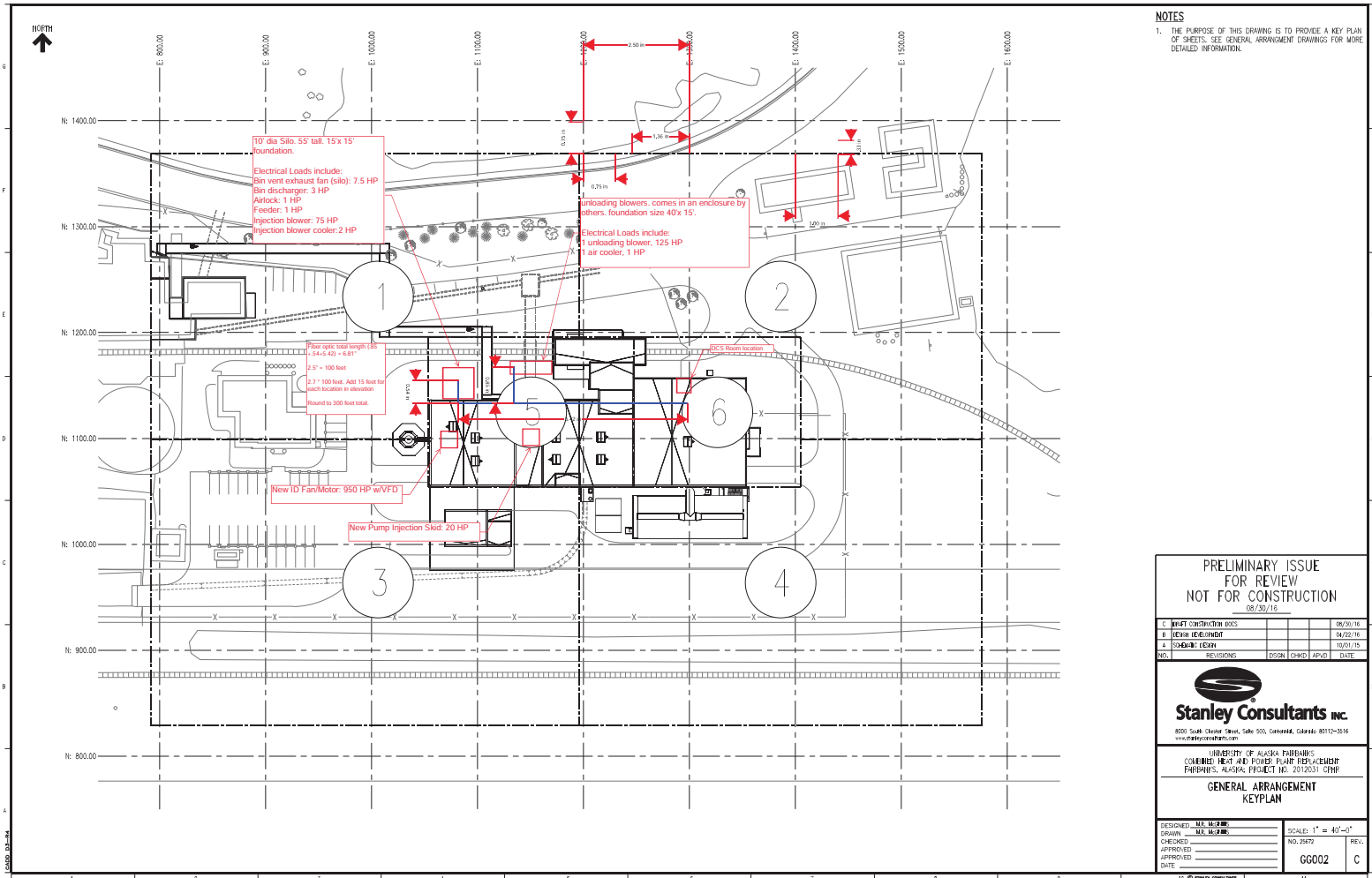
Location: University of Alaska Fairbanks
Fairbanks, AK

ESTIMATE SUMMARY:

Electrical

Revision: 03/06/2017

DESCRIPTION		QUANTITY	EQUIPMENT		MATERIAL		LABOR				UNIT COST		TOTAL COST	
		No. UNITS	UNIT PRICE	EQUIP COST	PER UNIT	MATERIAL COST	HRS/ UNIT	MULT FACT	TOTAL HRS.	LABOR RATE				
	Communications cable	21,033	ft	\$ -	\$ -	\$ 1	\$ 21,033	0.1	1.00	2,103	\$88.43	\$ 185,968	\$ 9.84	\$ 207,001
	Grounding Cable - A/G	153	cfl	\$ -	\$ -	\$ 425	\$ 65,025	2.8	1.00	428	\$88.43	\$ 37,848	\$ 672.37	\$ 102,873
	Grounding Cable - U/G	115	cfl	\$ -	\$ -	\$ 425	\$ 48,875	2.8	1.00	322	\$88.43	\$ 28,474	\$ 672.60	\$ 77,349
	Ground Rods - 20'	46	ea	\$ -	\$ -	\$ 77	\$ 3,542	0.1	1.00	5	\$88.43	\$ 442	\$ 86.61	\$ 3,984
	Cable Tray	0	ft	\$ -	\$ -	\$ 36	\$ -	0.3	1.00	-	\$88.43	\$ -	#DIV/0!	\$ -
	6" Cable Tray	106	ft	\$ -	\$ -	\$ 40	\$ 4,240	0.6	1.00	64	\$88.43	\$ 5,660	\$ 93.40	\$ 9,900
	12" Cable Tray	3,125	ft	\$ -	\$ -	\$ 40	\$ 125,000	0.6	1.00	1,875	\$88.43	\$ 165,806	\$ 93.06	\$ 290,806
	18" Cable Tray	62	ft	\$ -	\$ -	\$ 40	\$ 2,480	0.6	1.00	37	\$88.43	\$ 3,272	\$ 92.77	\$ 5,752
	24" Cable Tray	2,216	ft	\$ -	\$ -	\$ 40	\$ 88,640	0.6	1.00	1,330	\$88.43	\$ 117,612	\$ 93.07	\$ 206,252
	36" Cable Tray	1,435	ft	\$ -	\$ -	\$ 50	\$ 71,750	0.6	1.00	861	\$88.43	\$ 76,138	\$ 103.06	\$ 147,888
	Aboveground Conduit	50,000	ft	\$ -	\$ -	\$ 9	\$ 450,000	0.3	1.00	15,000	\$88.43	\$ 1,326,450	\$ 35.53	\$ 1,776,450
	Belowground Conduit	15,494	ft	\$ -	\$ -	\$ 39	\$ 604,266	0.4	1.00	6,198	\$88.43	\$ 548,089	\$ 74.37	\$ 1,152,355
I&C and COMM Cables Termination														
26.05.13	12/C#14	120	EA	\$ -	\$ -	\$ 0.25	\$ 30	0.20	1.00	24	\$88.43	\$ 2,122	\$ 17.93	\$ 2,152
26.05.13	1TSP#16	4404	EA	\$ -	\$ -	\$ 0.25	\$ 1,101	0.20	1.00	881	\$88.43	\$ 77,907	\$ 17.94	\$ 79,008
26.05.13	1TSP#16TCJ	456	EA	\$ -	\$ -	\$ 0.25	\$ 114	0.20	1.00	91	\$88.43	\$ 8,047	\$ 17.90	\$ 8,161
26.05.13	2/C#12	60	EA	\$ -	\$ -	\$ 0.25	\$ 15	0.20	1.00	12	\$88.43	\$ 1,061	\$ 17.93	\$ 1,076
26.05.13	2/C#14	116	EA	\$ -	\$ -	\$ 0.25	\$ 29	0.20	1.00	23	\$88.43	\$ 2,034	\$ 17.78	\$ 2,063
26.05.13	2/C#18	20	EA	\$ -	\$ -	\$ 0.25	\$ 5	0.20	1.00	4	\$88.43	\$ 354	\$ 17.95	\$ 359
26.05.13	2TSP#16	3456	EA	\$ -	\$ -	\$ 0.25	\$ 864	0.20	1.00	691	\$88.43	\$ 61,105	\$ 17.93	\$ 61,969
26.05.13	3/C#12	90	EA	\$ -	\$ -	\$ 0.25	\$ 23	0.20	1.00	18	\$88.43	\$ 1,592	\$ 17.94	\$ 1,615
26.05.13	3/C#14	24	EA	\$ -	\$ -	\$ 0.25	\$ 6	0.20	1.00	5	\$88.43	\$ 442	\$ 18.67	\$ 448
	4/C#12	1392	EA	\$ -	\$ -	\$ 0.25	\$ 348	0.20	1.00	278	\$88.43	\$ 24,584	\$ 17.91	\$ 24,932
	4/C#14	120	EA	\$ -	\$ -	\$ 0.25	\$ 30	0.20	1.00	24	\$88.43	\$ 2,122	\$ 17.93	\$ 2,152
	4TSP#14	3648	EA	\$ -	\$ -	\$ 0.25	\$ 912	0.20	1.00	730	\$88.43	\$ 64,554	\$ 17.95	\$ 65,466
	5/C#14	90	EA	\$ -	\$ -	\$ 0.25	\$ 23	0.20	1.00	18	\$88.43	\$ 1,592	\$ 17.94	\$ 1,615
	7/C#12	14	EA	\$ -	\$ -	\$ 0.25	\$ 4	0.20	1.00	3	\$88.43	\$ 265	\$ 19.21	\$ 269
	7/C#14	196	EA	\$ -	\$ -	\$ 0.25	\$ 49	0.20	1.00	39	\$88.43	\$ 3,449	\$ 17.85	\$ 3,498
	8TSP#18	1872	EA	\$ -	\$ -	\$ 0.25	\$ 468	0.20	1.00	374	\$88.43	\$ 33,073	\$ 17.92	\$ 33,541
	9/C#14	18	EA	\$ -	\$ -	\$ 0.25	\$ 5	0.20	1.00	4	\$88.43	\$ 354	\$ 19.94	\$ 359
	1 TST#16	16	EA	\$ -	\$ -	\$ 0.25	\$ 4	0.20	1.00	3	\$88.43	\$ 265	\$ 16.81	\$ 269
	2 TST#16	80	EA	\$ -	\$ -	\$ 0.25	\$ 20	0.20	1.00	16	\$88.43	\$ 1,415	\$ 17.94	\$ 1,435
	4 TST#16	64	EA	\$ -	\$ -	\$ 0.25	\$ 16	0.20	1.00	13	\$88.43	\$ 1,150	\$ 18.22	\$ 1,166
	4 PAIR FIBER/MULTI-MODE	248	EA	\$ -	\$ -	\$ 0.25	\$ 62	0.40	1.00	99	\$88.43	\$ 8,755	\$ 35.55	\$ 8,817
	12 PAIR FIBER/MULTI-MODE	48	EA	\$ -	\$ -	\$ 0.25	\$ 12	0.40	1.00	19	\$88.43	\$ 1,680	\$ 35.25	\$ 1,692
	48 PAIR FIBER/MULTI-MODE	384	EA	\$ -	\$ -	\$ 0.25	\$ 96	0.40	1.00	154	\$88.43	\$ 13,618	\$ 35.71	\$ 13,714
	Cat 6 Ethernet cable	28	EA	\$ -	\$ -	\$ 0.25	\$ 7	8.00	1.00	224	\$88.43	\$ 19,808	\$ 707.68	\$ 19,815
MV Cables Terminations														
	15kV, 3(1C/750 kCMIL SHIELD) w/GND,	30	EA	\$ -	\$ -	\$ 250	\$ 7,500	2.00	1.00	60	\$88.43	\$ 5,306	\$ 426.87	\$ 12,806
	15kV, 3(1C/500 kCMIL SHIELD) w/GND	25	EA	\$ -	\$ -	\$ 250	\$ 6,250	2.00	1.00	50	\$88.43	\$ 4,422	\$ 426.88	\$ 10,672



**DRY SORBENT INJECTION
COST ESTIMATE
ID FAN SHIPPING BACKUP COSTS**

Jahn, Mario

From: Darren Miller <DMiller@clarage.com>
Sent: Friday, June 24, 2022 7:30 AM
To: Jahn, Mario
Subject: RE: QUOTE: Upgrade Feasibility Study on Existing Clarage ID Fan - - Clarage Quote 24257DM22

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

Sorry for the delay. We will need at least 2 stepdecks for these pieces. They will cost around \$56,000 per truck. At least one escort will be required in the US and at least 2 escorts once they cross into Canada for the width.

This is just a budgetary estimate at this time.

Regards,

Darren Miller

Senior Sales Application Engineer | Clarage
202 Commerce Way | Pulaski, TN 38478
Cell: 931.787.2921 | Main: 931.424.2500
Web: clarage.com | Email: dmiller@clarage.com



All quotes are valid for 30 days unless otherwise noted and Clarage's offer is expressly limited to the express terms of this offer, which are located at <https://www.clarage.com/terms-and-conditions/> and any purported acceptance that modifies, omits, or alters the terms of this offer regardless of whether the change is material or immaterial shall be not be a valid acceptance.

From: Darren Miller
Sent: Thursday, June 16, 2022 3:32 PM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Subject: RE: QUOTE: Upgrade Feasibility Study on Existing Clarage ID Fan - - Clarage Quote 24257DM22

Mario,

I have your request out for quote. I'll quote once I have feedback.

Regards,

Darren Miller

Senior Sales Application Engineer | Clarage
202 Commerce Way | Pulaski, TN 38478
Cell: 931.787.2921 | Main: 931.424.2500
Web: clarage.com | Email: dmiller@clarage.com



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From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Tuesday, June 14, 2022 5:45 PM
To: Darren Miller <DMiller@clarage.com>
Subject: RE: QUOTE: Upgrade Feasibility Study on Existing Clarage ID Fan - - Clarage Quote 24257DM22

EXTERNAL EMAIL

Darren,

Any luck on shipping prices yet?

Thanks,
Mario

From: Darren Miller <DMiller@clarage.com>
Sent: Thursday, June 9, 2022 10:53 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Subject: RE: QUOTE: Upgrade Feasibility Study on Existing Clarage ID Fan - - Clarage Quote 24257DM22

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

I was out a little and will get shipping pricing for you. Do you have an address or port you want shipping to?

Regards,

Darren Miller

Senior Sales Application Engineer | Clarage
202 Commerce Way | Pulaski, TN 38478
Cell: 931.787.2921 | Main: 931.424.2500
Web: clarage.com | Email: dmiller@clarage.com



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From: Jahn, Mario <JahnMario@stanleygroup.com>

Sent: Wednesday, June 8, 2022 9:34 AM

To: Darren Miller <DMiller@clarage.com>

Subject: RE: QUOTE: Upgrade Feasibility Study on Existing Clarage ID Fan - - Clarage Quote 24257DM22

EXTERNAL EMAIL

Darren,

Thank you very much for putting this together. I'm assuming this does not include shipping to Fairbanks? Would you be able to find a rough estimate number we can plug in for shipping?

Thanks,
Mario

From: Darren Miller <DMiller@clarage.com>

Sent: Tuesday, June 7, 2022 11:03 AM

To: Jahn, Mario <JahnMario@stanleygroup.com>

Subject: QUOTE: Upgrade Feasibility Study on Existing Clarage ID Fan - - Clarage Quote 24257DM22

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

Per our conversation, please see attached budgetary quote for you upgrade project. The drawing provided is for proposal use only and not for construction.

If you have any questions or need additional information please let me know.

Regards,

Darren Miller

Senior Sales Application Engineer | Clarage

202 Commerce Way | Pulaski, TN 38478

Cell: 931.787.2921 | Main: 931.424.2500

Web: [clarage.com](https://www.clarage.com) | Email: dmiller@clarage.com



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From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Tuesday, June 7, 2022 10:30 AM
To: Darren Miller <DMiller@clarage.com>
Cc: Clarage Sales <sales@clarage.com>
Subject: RE: Existing Clarage ID Fan

EXTERNAL EMAIL

Darren,

This is just a feasibility study at the moment, and we don't have a lot of hard numbers that I can share with you. We definitely know that the fan would need to be able to handle another 30" W.C. Based on the drawing I sent you earlier I don't believe that the fan can do the dP given its current configuration. Are there options for a larger rotor that would get us that dP?

As far as temperature is concerned, we do know that the flue gas temperature will be lower than the design for the original fan. I would guess it would be closer to 170 degF. Same flows.

Would this be enough information to see if the existing fan can be retrofitted or would need to be replaced by a new fan?

Thanks,
Mario

From: Darren Miller <DMiller@clarage.com>
Sent: Tuesday, June 7, 2022 7:58 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Cc: Clarage Sales <sales@clarage.com>
Subject: RE: Existing Clarage ID Fan

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

I can't answer that question until we know what the performance requirements will be. Depending on what is required, we could determine what possible options we might have.

Do you know the new flow, pressure, operating temp etc...? I assume you are adding negative pressure resistance that the fan needs to overcome. Need to determine as this impacts density.

You will also be limited by your existing 650 HP 1200 RPM motor potentially depending on your new requirements.

Anything you can provide will help.

Regards,

Darren Miller

Senior Sales Application Engineer | Clarage
202 Commerce Way | Pulaski, TN 38478
Cell: 931.787.2921 | Main: 931.424.2500



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From: Jahn, Mario <JahnMario@stanleygroup.com>

Sent: Tuesday, June 7, 2022 9:31 AM

To: Darren Miller <DMiller@clarage.com>

Cc: Clarage Sales <sales@clarage.com>

Subject: RE: Existing Clarage ID Fan

EXTERNAL EMAIL

Good Morning Darren,

I've attached the drawing that I have for the fan. The fan is installed at the University of Alaska Fairbanks (UAF). We are in the process of evaluating additional backend emission controls for the power generation unit which means there would be additional pressure drop that the fan would need to make up for new ducting and equipment. Can this fan handle an increase in pressure drop with a impeller changeout?

Thanks,



Mario Jahn, Mechanical Engineer

STANLEYCONSULTANTS, 8000 South Chester Street Suite 500, Centennial, CO 80112

T: 303.649.7895 | M: 303.725.1361 | stanleyconsultants.com

From: Darren Miller <DMiller@clarage.com>

Sent: Tuesday, June 7, 2022 6:26 AM

To: Jahn, Mario <JahnMario@stanleygroup.com>

Cc: Clarage Sales <sales@clarage.com>

Subject: RE: Existing Clarage ID Fan

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

I have one reference for a fan in Fairbanks, AK. It is for an ID fan on our SO 711053 (713845). You can confirm this is the correct SO by the information in the fan nameplate.

How can we assist?

Regards,

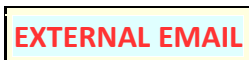
Darren Miller

Senior Sales Application Engineer | Clarage
202 Commerce Way | Pulaski, TN 38478
Cell: 931.787.2921 | Main: 931.424.2500
Web: clarage.com | Email: dmiller@clarage.com



All quotes are valid for 30 days unless otherwise noted and Clarage's offer is expressly limited to the express terms of this offer, which are located at <https://www.clarage.com/terms-and-conditions/> and any purported acceptance that modifies, omits, or alters the terms of this offer regardless of whether the change is material or immaterial shall be not be a valid acceptance.

From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Monday, June 6, 2022 4:45 PM
To: Clarage Sales <sales@clarage.com>
Subject: Existing Clarage ID Fan
Importance: High



To whom it may concern,

I'm looking to get in touch with somebody with regards to an existing Clarage ID Fan installed in Fairbanks Alaska. Can somebody please reach out to me as soon as they can?

Thank you in advance.

Regards,

Mario Jahn
Mechanical Engineer
Stanley Consultants, Inc.
Phone: (303) 649-7895

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**DRY SORBENT INJECTION
COST ESTIMATE
STRUCTURAL BACKUP COSTS**

 Stanley Consultants INC.		Job No. <u>30431.01.00</u>		Page No. _____	
		Subject <u>UAF - BACT Analysis Structural</u>			
Computed by <u>L.G. Jensen</u>	Date <u>19-Jul-22</u>				
Checked by _____	Date _____				
Approved by _____	Date _____				
		Sheet No. <u>1</u>		of <u>1</u>	

Item Description	Quantity		Unit Cost	Total Cost
	No. of Unit	UOM		
Concrete				
DSI Unloading Building Foundation	67	CY	\$ 700.00	\$ 46,900
DSI Silo Foundation	25	CY	\$ 700.00	\$ 17,500
ID Fan Foundation	19	CY	\$ 700.00	\$ 13,300
Pump Skid Foundation	7	CY	\$ 700.00	\$ 4,900
				\$ 64,400
			Location Factor 14.3%	\$ 9,209
			Inflation - 5.4%	\$ 3,975
			Contractor Overhead - 10%	\$ 7,758
			Contractor Profit - 15%	\$ 12,801
			Subtotal	\$ 98,144
			TOTAL COST	\$ 98,144
			PROBABLE CONSTRUCTION COST	\$ 98,000

Cost Estimate Basis:

1. Material quantities were calculated based on a preliminary layout of equipment.
2. Material and Labor costs are from 2022 RS Means
3. Location Factor for Fairbanks Alaska was used in accordance with 2022 RS Mean City Cost Index
4. Inflation was calculated using online CPI Inflation Calculator as published by U.S. Bureau of Labor Statistics. The inflation accounts for the increase in price between 2022 RS Means costs (January) and July when this estimate was assembled.

 Stanley Consultants Inc.		Job No. <u>30431.01.00</u> Page No. _____	
		Subject <u>UAF - BACT Analysis Structural</u>	
Computed by <u>L.G. Jensen</u>	Date <u>19-Jul-22</u>		
Checked by _____	Date _____		
Approved by _____	Date _____		
		Sheet No. <u>1</u> of <u>1</u>	

Item Description	Quantity		Unit Cost	Total Cost
	No. of Unit	UOM		
Steel				
Supply Duct Supports				
Medium (>20-≤40lb/ft)	6.4	TON	\$ 6,000.00	\$ 38,400
Light (≤20lb/ft)	2.4	TON	\$ 7,000.00	\$ 16,800
				\$ 55,200
			Location Factor 14.3%	\$ 7,894
			Inflation - 5.4%	\$ 3,407
			Contractor Overhead - 10%	\$ 6,650
			Contractor Profit - 15%	\$ 10,973
			Subtotal	\$ 84,123
			TOTAL COST	\$ 84,123
			PROBABLE CONSTRUCTION COST	\$ 84,000

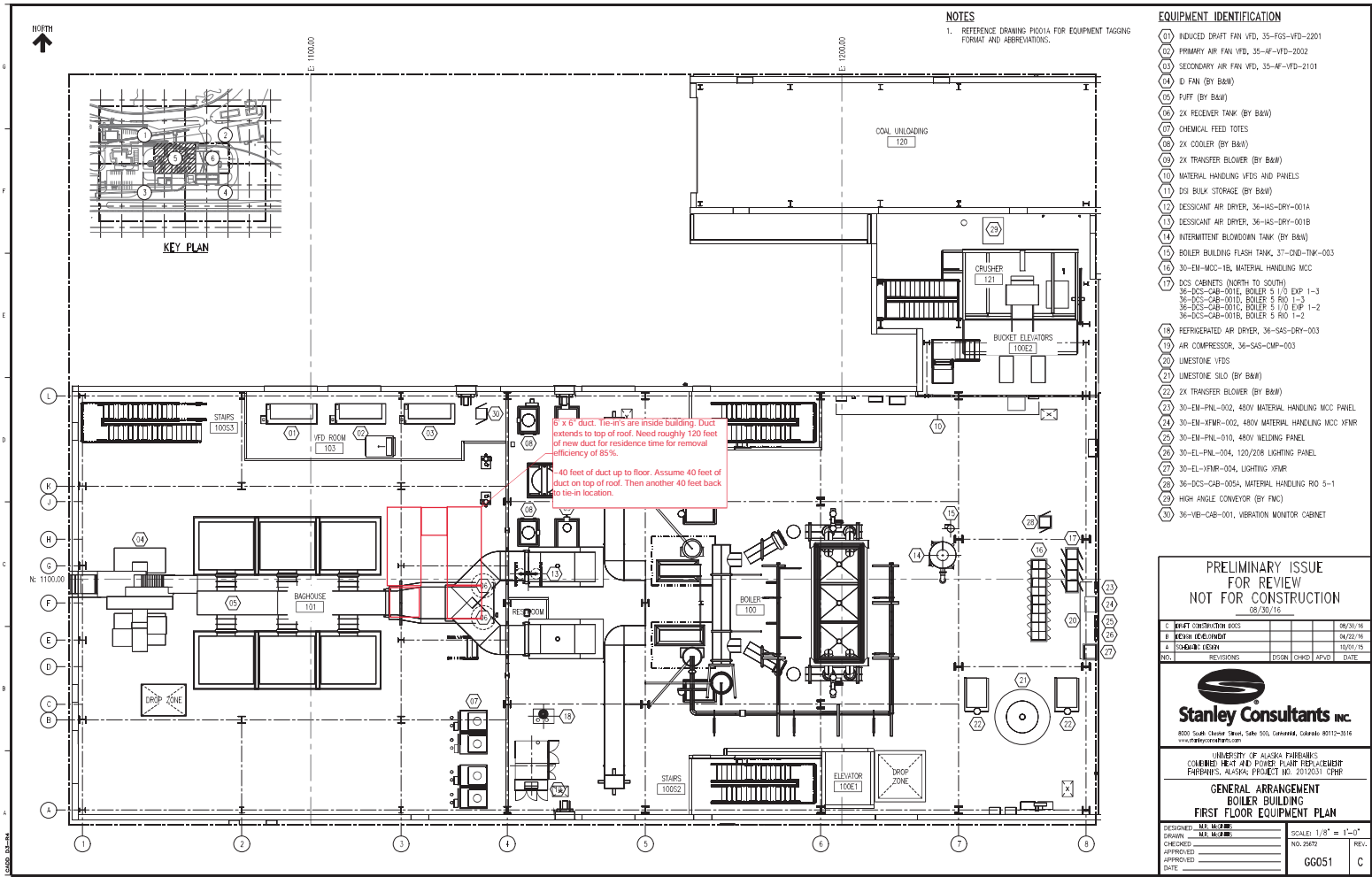
Cost Estimate Basis:

1. Material quantities were calculated based on preliminary layout of equipment.
2. Material and Labor costs are from 2022 RS Means
3. Location Factor for Fairbanks Alaska was used in accordance with 2022 RS Mean City Cost Index
4. Inflation was calculated using online CPI Inflation Calculator as published by U.S. Bureau of Labor Statistics. The inflation accounts the increase in price between 2022 RS Means costs (January) and July when this estimate was assembled.

Vibro compaction total in 2015 dollars	
\$ 1,730,000.00	
Vibro compaction total square footage	
71,300.00	
Total Vibro Compaction costs/ square foot in 2015 dollars	
24.26367461	
2021 CEPCI Index	
708	
2015 Base Case CEPCI Index	
556.8	
CEPCI Factor from 2015 to 2021	
1.271551724	
Updated 2021 Vibro Compaction \$/sqft	
\$ 30.85	
New DSI square footage	
1,000.00	
New Vibro Price for DSI	
\$ 30,852.52	
PROBABLE CONSTRUCTION COSTS	
\$ 31,000	

Cost Estimate Basis:

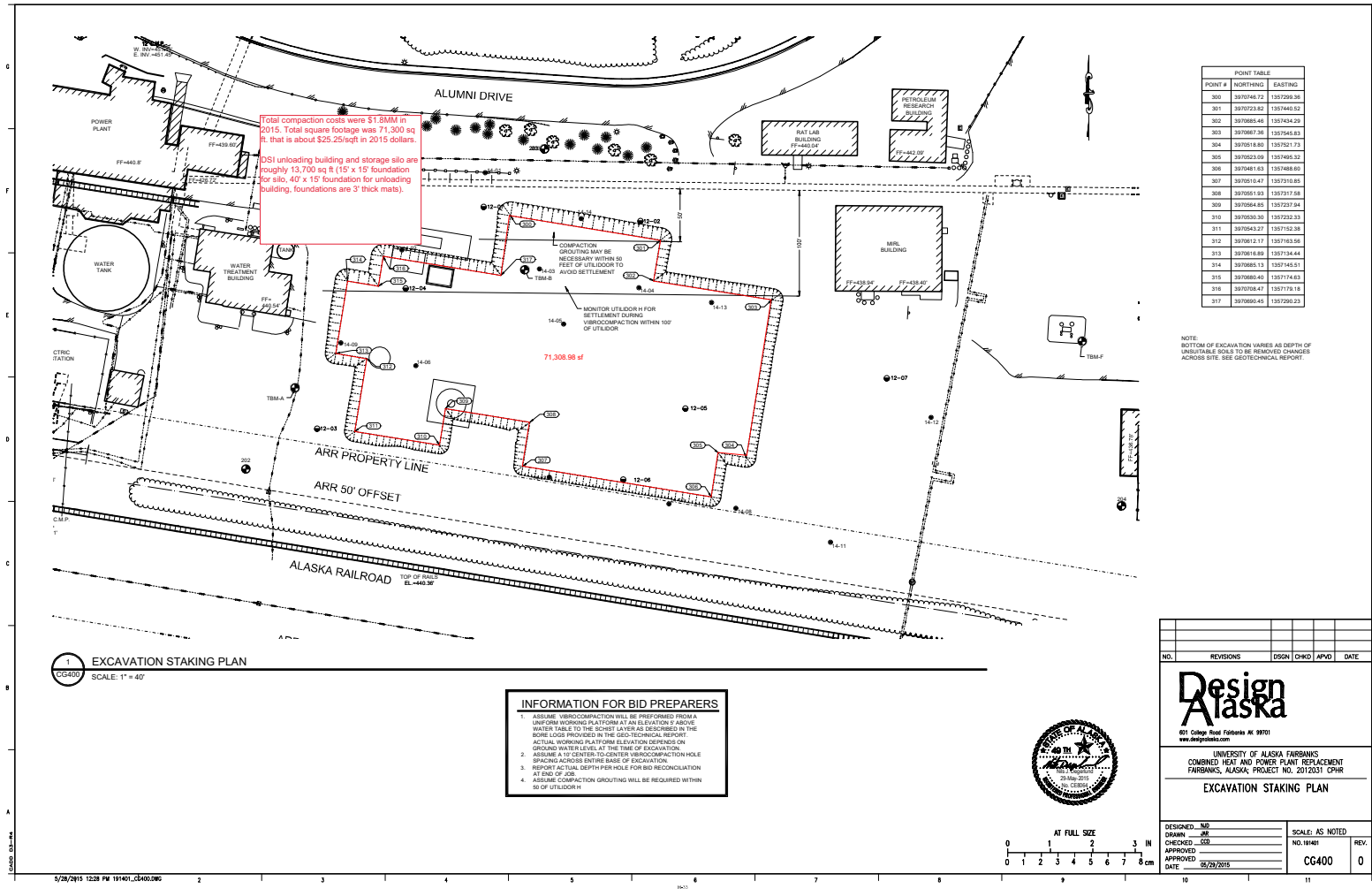
1. Vibro Compaction costs from 2015 were obtained from the original UAF cost estimate and broken down into a price/square foot.
2. 2015 vibro compaction price/square foot was escalated using the CEPCI cost index ratio number between 2015 and 2021 year end.
3. The 2015 number was multiplied by the CEPCI index ratio to obtain 2021 vibro compaction costs/ square foot.
4. A drawing of the site was marked up to obtain the square footage of the DSI system that requires vibro compaction. The area includes the DSI unloading blowers and silo storage area.
5. The new DSI square footage was multiplied by the CEPCI index ratio to obtain a vibro compaction cost for the DSI system.

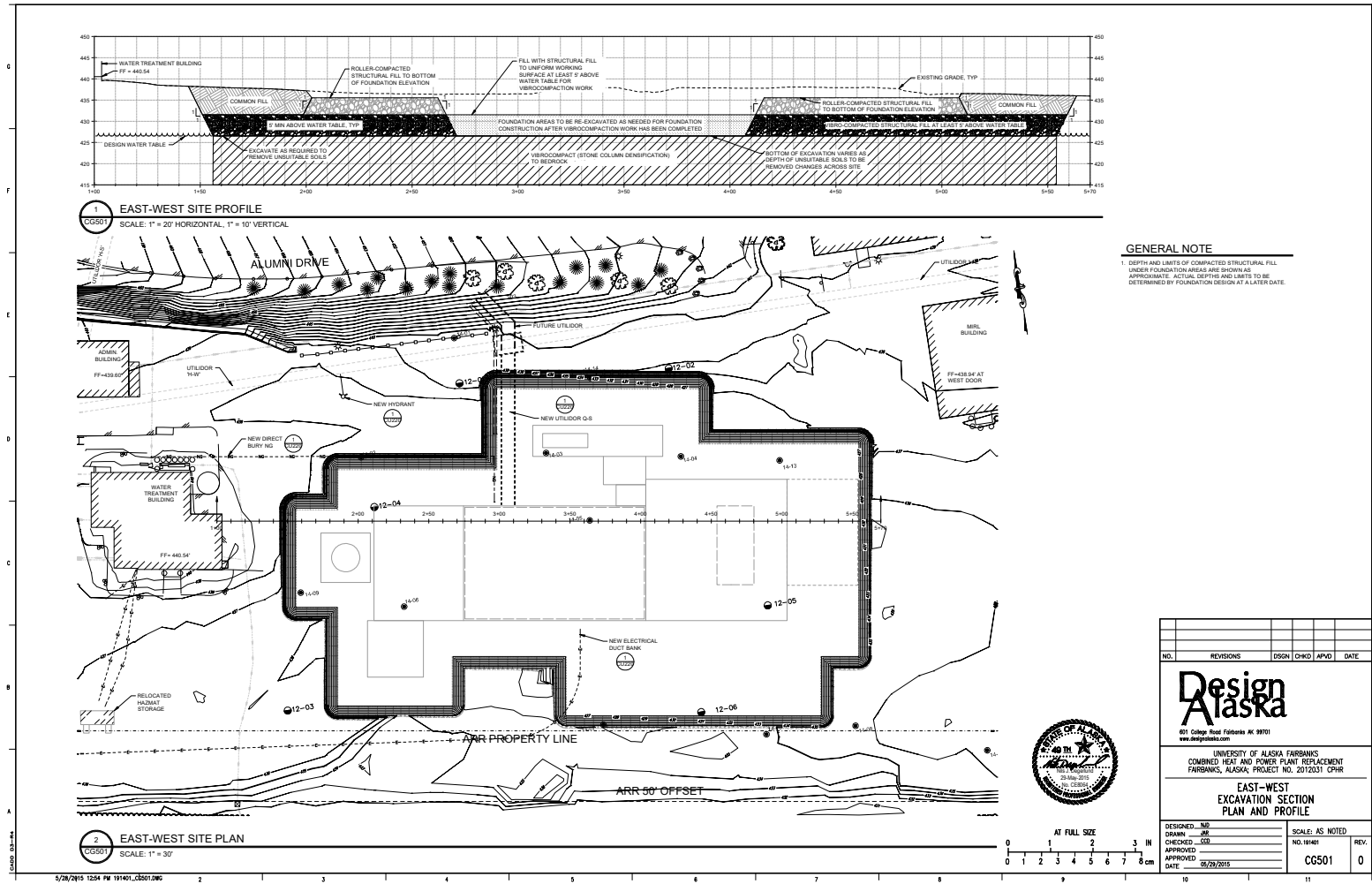


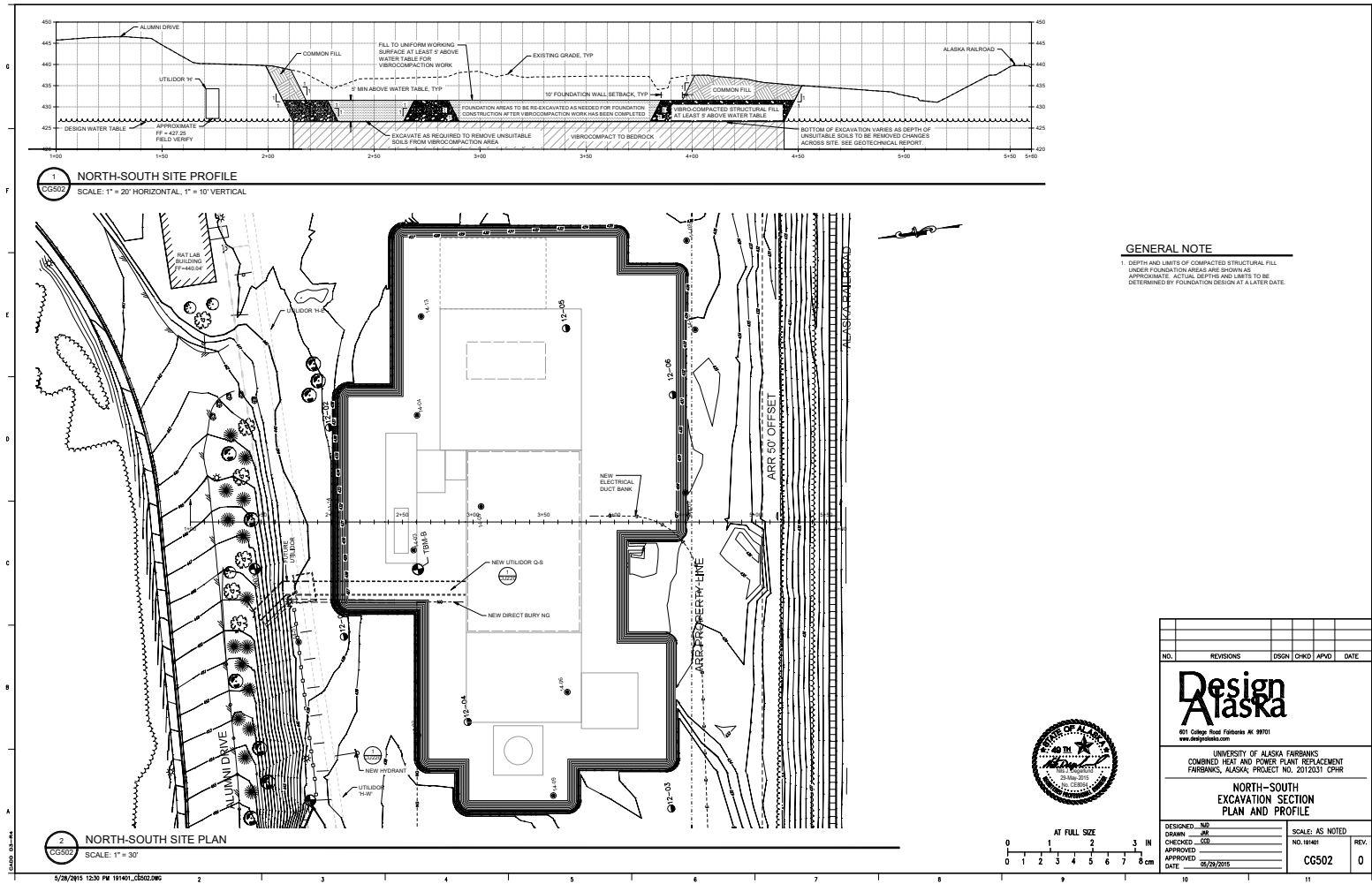
H-31

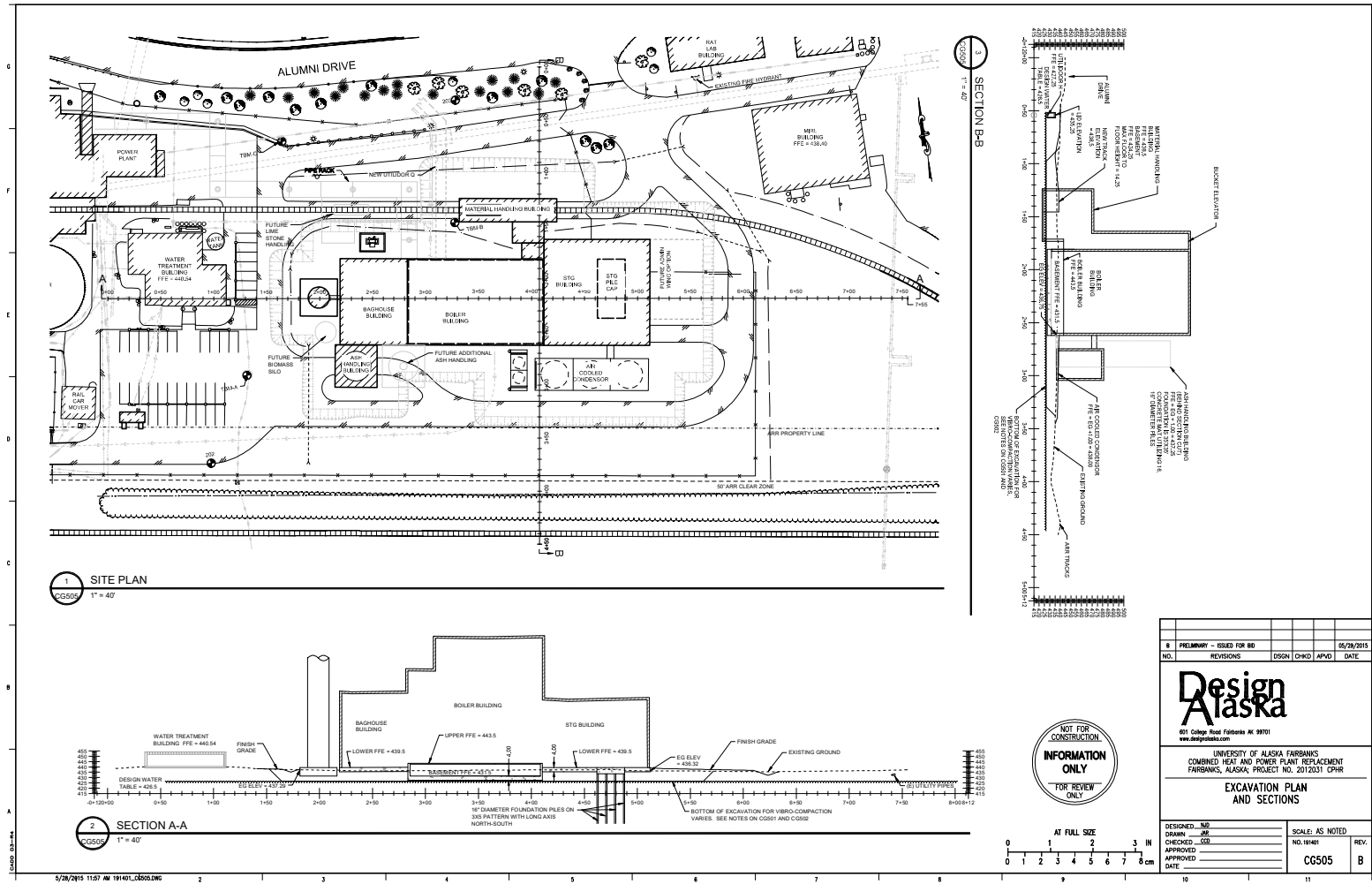
FAIRBANKS, ALASKA; PROJECT NO.: 2012031 CPHR

5/28/2015 9:26 AM 191401 GOCO - GENERAL INFORMATION.DWG









**DRY SORBENT INJECTION
COST ESTIMATE
ELECTRICAL BACKUP COSTS**

Cost Estimate Basis:

1. Hours for labor were estimated based on equipment being installed and historical data.
2. Labor costs were escalated from 2017 UAF cost estimate by 25% based on CEPCI ratio for 2021 and 2017 (708/567.5)

 Stanley Consultants Inc. Computed by _____ Checked by _____ Approved by _____					
	Job No. <u>30431.01.00</u>		Page No. _____		
	Subject <u>UAF - BACT Analysis Electrical</u>		_____		
	_____		_____		
D. Akselrod		Date <u>12-Sep-22</u>			
_____		Date _____			
_____		Date _____			
		Sheet No. <u>1</u>	of	<u>1</u>	

Item Description	Quantity		Unit Cost	Total Cost
	No. of Unit	UOM		
Equipment Costs				
MV VFD - 950 hp; 12470 input/4160 output	1	ea	\$ 275,000.00	\$ 275,000
480 MCC, MLO, 4 vertical sections	1	ea	\$ 40,000.00	\$ 40,000
MV cable 2/0; 15kV; CU; MV-105	175	feet	\$ 50.00	\$ 8,750
MV VFD cable 2/0; 5kV; CU; MV-105	125	feet	\$ 55.00	\$ 6,875
LV cable 500 MCM; 600V; CU	600	feet	\$ 29.00	\$ 17,400
LV cable 4/0 AWG; 600V; CU	125	feet	\$ 24.00	\$ 3,000
Misc power cable	400	feet	\$ 12.00	\$ 4,800
Bare copper ground cable 2/0	100	feet	\$ 6.00	\$ 600
Misc. Conduit	400	feet	\$ 25.00	\$ 10,000
Misc. Cable tray	400	feet	\$ 25.00	\$ 10,000
Misc. Hardware (tray hangers, fittings, etc.)	1	lot	\$ 15,000.00	\$ 15,000
Heat Tracing	1	lot	\$ 27,400.00	\$ 27,400
				\$ 418,825
			Contractor Overhead - 10%	\$ 41,883
			Contractor Profit - 15%	\$ 69,106
			Subtotal	\$ 529,814
			TOTAL COST	\$ 529,814
			PROBABLE CONSTRUCTION COST	\$ 530,000

Cost Estimate Basis:

1. VFD costs were estimated based on internet research and linear interpolation of historical project data
2. Quantities were estimated based preliminary DSI layout.
3. Equipment and Material costs were escalated from 2017 UAF cost estimate by 25% based on CEPCI ratio for 2021 and 2017 (708/567.5)

Also ID Fan 950 HP



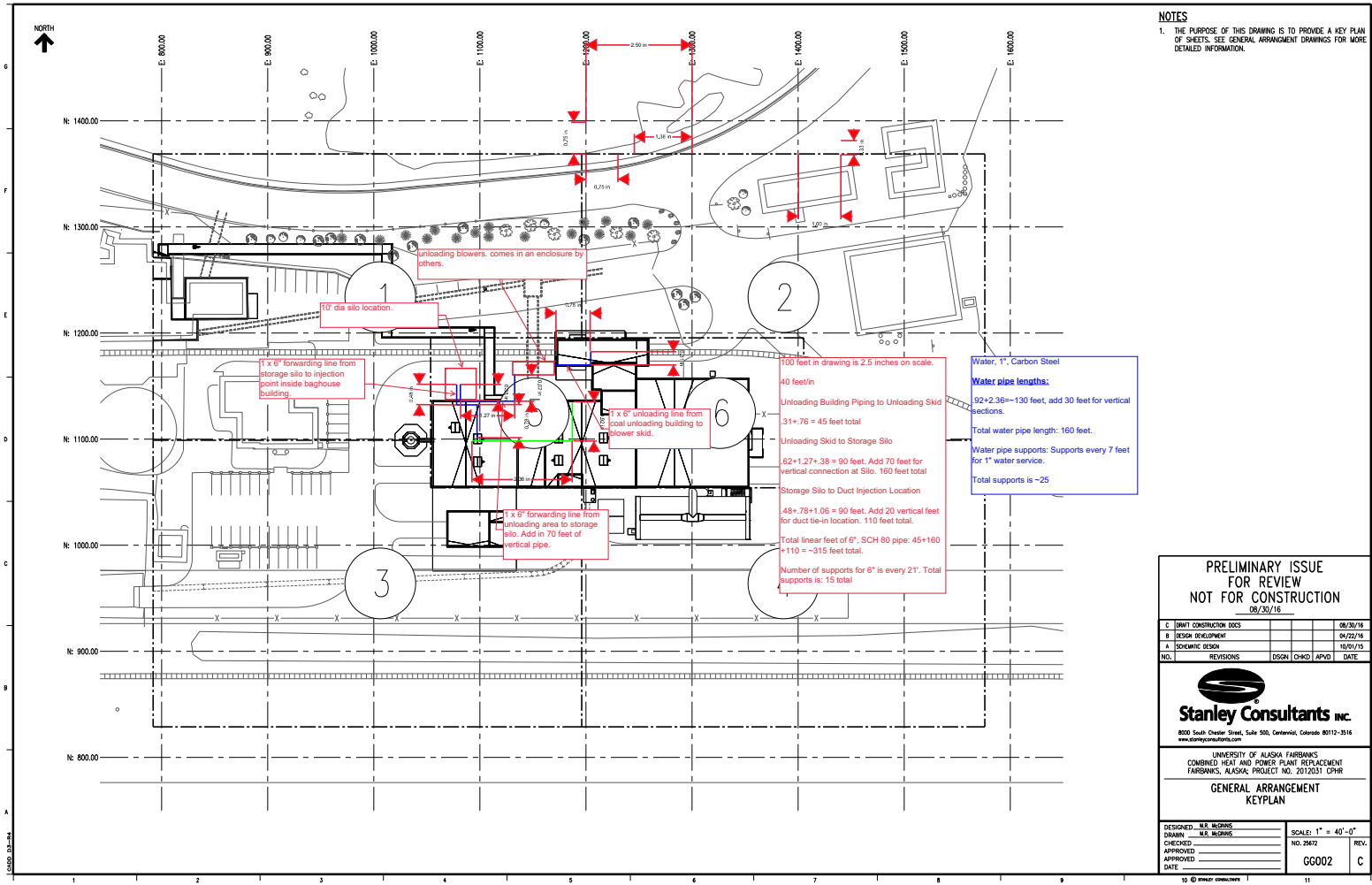
**DRY SORBENT INJECTION
COST ESTIMATE
PIPING BACKUP COSTS**

 Stanley Consultants Inc.		Job No. <u>30431.01.00</u> Page No. _____	
		Subject <u>UAF - BACT Analysis Mechanical</u>	
Computed by <u>M. Jahn</u>	Date <u>14-Sep-22</u>		
Checked by _____	Date _____		
Approved by _____	Date _____		
		Sheet No. <u>1</u> of <u>1</u>	

Item Description	Quantity		Unit Cost	Total Cost
	No. of Unit	UOM		
<u>Mechanical Piping</u>				
Reagent Handling Pipe, 6", SCH80 CS	315	feet	\$ 570.77	\$ 179,793
Air Pipe Supports	15	ea	\$ 2,240.65	\$ 33,610
Water Pipe, 1", CS	160	feet	\$ 127.88	\$ 20,460
Water Pipe Supports	25	ea	\$ 2,240.65	\$ 56,016
				\$ 289,879
		Contractor Overhead - 10%	\$	28,988
		Contractor Profit - 15%	\$	47,830
		Subtotal	\$	366,697
		TOTAL COST	\$	366,697
		PROBABLE CONSTRUCTION COST	\$	367,000

Cost Estimate Basis:

1. Material quantities were calculated based on preliminary general arrangement of DSI system and location at UAF site.
2. Costs were obtained from original UAF cost estimate and escalated from 2017 costs with CEPCI ratio to 2021 costs.



NSE Estimate No.: N1412075

Date: 01/22/2015

Customer: Stanley Consultants

Location: University of Alaska Fairbanks

Fairbanks, AK

CEPCI Index 2022 708.0
CEPCI Index 2017 567.5

Scale Factor 1.247577093

ESTIMATE SUMMARY:

Electrical Power Generation

Revision: 03/06/2017

DESCRIPTION		QUANTITY		EQUIPMENT		MATERIAL		LABOR				UNIT		TOTAL		Scaled Unit costs
		No.	UNITS	UNIT	EQUIP/	PRICE	MATERIAL	HRS/	MULT	TOTAL	LABOR	LABOR	COST	COST	COST	
				PRICE	COST	PER UNIT	COST	UNIT	FACT	HRS.	RATE	COST				
41.22.13.13	Bridge Cranes	1.0	EA	\$ -	\$ -	\$ 160,000.00	\$ 160,000.00		1.00	-	\$88.00	\$ -	\$ 160,000.00	\$	160,000	
41.22.13.13	Bridge Cranes	1.0	EA	\$ -	\$ -	\$ -	\$ -	500.0	1.00	500	\$88.00	\$ 44,000	\$ 44,000.00	\$	44,000	
	Misc. Hoist & Monorails	8.0	EA	\$ -	\$ -	\$ 15,000.00	\$ 120,000.00	40.0	1.00	320	\$ 88.00	\$ 28,160	\$ 18,520.00	\$	148,160	
22.15.19	Station/ Instrument air receivers (using B&Ws)	-	EA	\$ -	\$ -	\$ 20,000.00	\$ -	40.0	1.00	-	\$ 88.00	\$ -	#DIV/0!	\$	-	\$ 24,951.54
	125PSI, 629 CFM Air Compressor	2.0	LS	\$ -	\$ -	\$ 130,000.00	\$ 260,000.00	1.00	-	-	\$ 88.00	\$ -	\$ 130,000.00	\$	260,000	
	125PSI, 629 CFM Air Compressor	2.0	LS	\$ -	\$ -	\$ -	\$ -	20.0	1.00	40	\$ 88.00	\$ 3,520	\$ 1,760.00	\$	3,520	
	150PSI, 300 CFM Air Compressor	1.0	LS	\$ -	\$ -	\$ 25,000.00	\$ 25,000.00	1.00	-	-	\$ 88.00	\$ -	\$ 25,000.00	\$	25,000	
	150PSI, 300 CFM Air Compressor	1.0	LS	\$ -	\$ -	\$ -	\$ -	20.0	1.00	20	\$ 88.00	\$ 1,760	\$ 1,760.00	\$	1,760	
	Silencer in Transition Duct (Provided by B&W)	1	EA	\$ -	\$ -	\$ -	\$ -	320	1.00	320	\$ 88.00	\$ 28,160	\$ 28,160	\$	28,160	
	Fuel Gas Tie & PRV/Metering Sta	1	EA	\$ -	\$ -	\$ 40,000	\$ 40,000	120	1.00	120	\$ 88.00	\$ 10,560	\$ 50,560	\$	50,560	
23.12.13	Fuel Oil Forwarding Skid (With Misc Pumps)	1	EA	\$ -	\$ -	\$ 20,000	\$ 20,000	1.00	-	-	\$ 88.00	\$ -	\$ 20,000	\$	20,000	
23.12.13	Fuel Oil Forwarding Skid (With Misc Pumps)	1	EA	\$ -	\$ -	\$ -	\$ -	60	1.00	60	\$ 88.00	\$ 5,280	\$ 5,280	\$	5,280	
23.22.16	Feedwater Heater1-DA	1	EA	\$ -	\$ -	\$ 190,000	\$ 190,000	1.00	-	-	\$ 88.00	\$ -	\$ 190,000	\$	190,000	
23.22.16	Feedwater Heater1-DA	1	EA	\$ -	\$ -	\$ -	\$ -	320	1.00	320	\$ 88.00	\$ 28,160	\$ 28,160	\$	28,160	
23.22.16	Feedwater Heater2	1	EA	\$ -	\$ -	\$ 140,000	\$ 140,000	1.00	-	-	\$ 88.00	\$ -	\$ 140,000	\$	140,000	
23.22.16	Feedwater Heater2	1	EA	\$ -	\$ -	\$ -	\$ -	320	1.00	320	\$ 88.00	\$ 28,160	\$ 28,160	\$	28,160	
23.22.16	Condensate Receiver	1	EA	\$ -	\$ -	\$ 82,000	\$ 82,000	1.00	-	-	\$ 88.00	\$ -	\$ 82,000	\$	82,000	
23.22.16	Condensate Receiver	1	EA	\$ -	\$ -	\$ -	\$ -	40	1.00	40	\$ 88.00	\$ 3,520	\$ 3,520	\$	3,520	
23.22.16	Condensate Polishers	1	EA	\$ -	\$ -	\$ 200,000	\$ 200,000	1.00	-	-	\$ 88.00	\$ -	\$ 200,000	\$	200,000	
23.22.16	Condensate Polishers	1	EA	\$ -	\$ -	\$ -	\$ -	60	1.00	60	\$ 88.00	\$ 5,280	\$ 5,280	\$	5,280	
23.22.23	Hotwell Forwarding Pumps (Vertical)	2	EA	\$ -	\$ -	\$ 67,000	\$ 134,000	1.00	-	-	\$ 88.00	\$ -	\$ 67,000	\$	134,000	
23.22.23	Hotwell Forwarding Pumps (Vertical)	2	EA	\$ -	\$ -	\$ -	\$ -	40	1.00	80	\$ 88.00	\$ 7,040	\$ 3,520	\$	7,040	
23.22.23	Condensate Pumps (With Misc Pumps)	2	EA	\$ -	\$ -	\$ 55,000	\$ 110,000	1.00	-	-	\$ 88.00	\$ -	\$ 55,000	\$	110,000	
23.22.23	Condensate Pumps (With Misc Pumps)	2	EA	\$ -	\$ -	\$ -	\$ -	40	1.00	80	\$ 88.00	\$ 7,040	\$ 3,520	\$	7,040	
23.22.23	Aux Cooling Water Pumps (With Misc Pumps)	2	EA	\$ -	\$ -	\$ 10,000	\$ 20,000	1.00	-	-	\$ 88.00	\$ -	\$ 10,000	\$	20,000	
23.22.23	Aux Cooling Water Pumps (With Misc Pumps)	2	EA	\$ -	\$ -	\$ -	\$ -	60	1.00	120	\$ 88.00	\$ 10,560	\$ 5,280	\$	10,560	
23.22.23	Steam Desuperheating Pumps (With Misc Pumps)	2	EA	\$ -	\$ -	\$ 50,000	\$ 100,000	1.00	-	-	\$ 88.00	\$ -	\$ 50,000	\$	100,000	
23.22.23	Steam Desuperheating Pumps (With Misc Pumps)	2	EA	\$ -	\$ -	\$ -	\$ -	60	1.00	120	\$ 88.00	\$ 10,560	\$ 5,280	\$	10,560	
23.22.23	Misc Pumps	12	EA	\$ -	\$ -	\$ 10,000	\$ 120,000	1.00	-	-	\$ 88.00	\$ -	\$ 10,000	\$	120,000	
23.22.23	Misc Pumps	12	EA	\$ -	\$ -	\$ -	\$ -	30	1.00	360	\$ 88.00	\$ 31,680	\$ 2,640	\$	31,680	
23.53.13	Boiler Feed Pumps	2	EA	\$ -	\$ -	\$ 192,000	\$ 384,000	1.00	-	-	\$ 88.00	\$ -	\$ 192,000	\$	384,000	
23.53.13	Boiler Feed Pumps	2	EA	\$ -	\$ -	\$ -	\$ -	100	1.00	200	\$ 88.00	\$ 17,600	\$ 8,800	\$	17,600	
23.57.16	Aux Cooling Water Heat Exchanger	1	EA	\$ -	\$ -	\$ 195,000	\$ 195,000	1.00	-	-	\$ 88.00	\$ -	\$ 195,000	\$	195,000	
23.57.16	Aux Cooling Water Heat Exchanger	1	EA	\$ -	\$ -	\$ -	\$ -	100	1.00	100	\$ 88.00	\$ 8,800	\$ 8,800	\$	8,800	
23.57.16	Wet Water Heat Recovery Heat Ex	1	EA	\$ -	\$ -	\$ 25,000	\$ 25,000	100	1.00	100	\$ 88.00	\$ 8,800	\$ 33,800	\$	33,800	
23.57.16	Air comp Heat Exchanger and Fan fan	1	LS	\$ -	\$ -	\$ 90,000	\$ 90,000	1.00	-	-	\$ 88.00	\$ -	\$ 90,000	\$	90,000	
23.57.16	Air comp Heat Exchanger and Fan fan	1	LS	\$ -	\$ -	\$ -	\$ -	200	1.00	200	\$ 88.00	\$ 17,600	\$ 17,600	\$	17,600	
	Sample Panels	1	EA	\$ -	\$ -	\$ 100,000	\$ 100,000	1.00	-	-	\$ 88.00	\$ -	\$ 100,000	\$	100,000	
	Sample Panels	1	EA	\$ -	\$ -	\$ -	\$ -	400	1.00	400	\$ 88.00	\$ 35,200	\$ 35,200	\$	35,200	
	Chemical Feed	1	EA	\$ -	\$ -	\$ 99,000	\$ 99,000	1.00	-	-	\$ 88.00	\$ -	\$ 99,000	\$	99,000	
	Chemical Feed	1	EA	\$ -	\$ -	\$ -	\$ -	200	1.00	200	\$ 88.00	\$ 17,600	\$ 17,600	\$	17,600	
	Oil/Water Separator	1	EA	\$ -	\$ -	\$ 32,000	\$ 32,000	1.00	-	-	\$ 88.00	\$ -	\$ 32,000	\$	32,000	
	Oil/Water Separator	1	EA	\$ -	\$ -	\$ -	\$ -	80	1.00	80	\$ 88.00	\$ 7,040	\$ 7,040	\$	7,040	
	Steam Driven Feedwater Pump	1	LS	\$ -	\$ -	\$ 215,000	\$ 215,000	1.00	-	-	\$ 88.00	\$ -	\$ 215,000	\$	215,000	
	Steam Driven Feedwater Pump	1	LS	\$ -	\$ -	\$ -	\$ -	100	1.00	100	\$ 88.00	\$ 8,800	\$ 8,800	\$	8,800	
	Material Handling Equip	Mn-Hrs		\$ -	\$ -	\$ 4,024,000	\$ 4,024,000	1.00	-	-	\$ 88.00	\$ -	#DIV/0!	\$	4,024,000	
	Material Handling Equip (was 38K man hours) & 77 Tons of Steel	23,500	Mn-Hrs	\$ -	\$ -	\$ -	\$ -	1.0	1.00	23,500	\$ 88.00	\$ 2,068,000	\$ 88	\$	2,068,000	
	Ash Limestone Handling	Mn-Hrs		\$ -	\$ -	\$ 2,751,000	\$ 2,751,000	1.00	-	-	\$ 88.00	\$ -	#DIV/0!	\$	2,751,000	
	Ash Limestone Handling (was 35K man-hours) & 70-90 Tons of Steel	28,000	Mn-Hrs	\$ -	\$ -	\$ -	\$ -	1.0	1.00	28,000	\$ 88.00	\$ 2,464,000	\$ 88	\$	2,464,000	
48.11.13	Boiler Erection	105,600	Mn-Hrs	\$ -	\$ -	\$ -	\$ -	1	1.00	105,600	\$ 93.50	\$ 9,873,600	\$ 93.50	\$	9,873,600	
48.11.13	Seal Weld Tubes	ea		\$ -	\$ -	\$ -	\$ -	13	1.00	-	\$ 88.00	\$ -	#DIV/0!	\$	-	
48.11.13	PJFF, Duct, ID Fan, Ash Silos	30,000	Mn-Hrs	\$ -	\$ -	\$ -	\$ -	1	1.00	30,000	\$ 93.50	\$ 2,805,000	\$ 93.50	\$	2,805,000	
	Refract supply & install	1	ls	\$ -	\$ -	\$ 1,000,000	\$ 1,000,000	-	1.00	-	\$ 79.31	\$ -	\$ 1,000,000	\$	1,000,000	
	Scaffolding	1	ls	\$ -	\$ -	\$ 792,000	\$ 792,000	27,000.0	1.00	27,000	\$ 79.31	\$ 2,141,370	\$ 2,933,370	\$	2,933,370	
48.11.16	Surface Water Condenser	-	EA	\$ -	\$ -	\$ 300,000.00	\$ -	120	1.00	-	\$ 88.00	\$ -	#DIV/0!	\$	-	
48.11.16	Air Cooled Condenser	1	EA	\$ -	\$ -	\$ -	\$ -	14,500	1.00	14,500	\$ 88.00	\$ 1,276,000	\$ 1,276,000	\$	1,276,000	
48.11.19	Steam Turbine 22Mw Skid	1,000	Mn-Hrs	\$ -	\$ -	\$ -	\$ -	1	1.00	1,000	\$ 88.00	\$ 88,000	\$ 88,000	\$	88,000	
48.11.26	Generator Skid (w/ ST)	1,000	Mn-Hrs	\$ -	\$ -	\$ -	\$ -	1	1.00	1,000	\$ 88.00	\$ 88,000	\$ 88,000	\$	88,000	
41.67.13	Lube Oil Pkg w/instr, aux, pump	1	EA	\$ -	\$ -	\$ -	\$ -	500	1.00	500	\$ 88.00	\$ 44,000	\$ 44,000.00	\$	44,000	
	Stack Supply & Install	1	EA	\$ -	\$ -	\$ 958,150	\$ 958,150	-	1.00	-	\$ 88.00	\$ -	\$ 958,150	\$	958,150	

NSE Estimate No.: N1412075

Date: 01/22/2015

Customer: Stanley Consultants

Location: University of Alaska Fairbanks

Fairbanks, AK

CEPCI Index 2022 708.0
CEPCI Index 2017 567.5

Scale Factor 1.247577093

ESTIMATE SUMMARY:

Electrical Power Generation

Revision: 03/06/2017

DESCRIPTION	QUANTITY	EQUIPMENT	MATERIAL		LABOR			UNIT COST	TOTAL COST	Scaled Unit costs			
			UNIT PRICE	EQUIP COST	PRICE PER UNIT	MATERIAL COST	HRS/ UNIT				MULT FACT	TOTAL HRS.	LABOR RATE
Modeled Piping													
40.11.13 ACC System 6" Sch 40	90	LF	\$ -	\$ -	\$ 57.00	\$ 5,130	3.2687	1.00	294.18	\$ 93.50	\$ 27,506	\$ 362.62	\$ 32,636
40.11.13 ACC System 4" Sch 40	97	LF	\$ -	\$ -	\$ 33.00	\$ 3,201	3.1200	1.00	302.64	\$ 93.50	\$ 28,297	\$ 324.72	\$ 31,498
40.11.13 Aux Cooling Water System 10" Sch 40	289	LF	\$ -	\$ -	\$ 123.00	\$ 35,547	4.2730	1.00	1,234.90	\$ 93.50	\$ 115,463	\$ 522.53	\$ 151,010
40.11.13 Aux Cooling Water System 8" Sch 40	253	LF	\$ -	\$ -	\$ 87.00	\$ 22,011	3.9000	1.00	986.70	\$ 93.50	\$ 92,236	\$ 451.65	\$ 114,267
40.11.13 Aux Cooling Water System 6" Sch 40	183	LF	\$ -	\$ -	\$ 57.00	\$ 10,431	3.2687	1.00	598.17	\$ 93.50	\$ 55,929	\$ 362.62	\$ 66,360
40.11.13 Aux Cooling Water System 4" Sch 40	68	LF	\$ -	\$ -	\$ 33.00	\$ 2,244	3.1200	1.00	212.16	\$ 93.50	\$ 19,837	\$ 324.72	\$ 22,081
40.11.13 Aux Cooling Water System 3" Sch 40	569	LF	\$ -	\$ -	\$ 22.50	\$ 12,803	2.3158	1.00	1,317.69	\$ 93.50	\$ 123,204	\$ 239.03	\$ 136,007
40.11.13 Boiler Feed System 10" Sch 40	47	LF	\$ -	\$ -	\$ 123.00	\$ 5,781	4.2730	1.00	200.83	\$ 93.50	\$ 18,778	\$ 522.53	\$ 24,559
40.11.13 Boiler Feed System 8" Sch 80	0	LF	\$ -	\$ -	\$ 141.00	\$ -	4.9280	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Boiler Feed System 6" Sch 40	245	LF	\$ -	\$ -	\$ 87.00	\$ 21,315	3.9000	1.00	955.50	\$ 93.50	\$ 89,339	\$ 451.65	\$ 110,654
40.11.13 Boiler Feed System 6" Sch 80	307	LF	\$ -	\$ -	\$ 93.00	\$ 28,551	3.8980	1.00	1,196.69	\$ 93.50	\$ 111,891	\$ 457.47	\$ 140,442
40.11.13 Boiler Feed System 4" Sch 80	5	LF	\$ -	\$ -	\$ 45.00	\$ 225	3.2800	1.00	16.40	\$ 93.50	\$ 1,533	\$ 351.60	\$ 1,758
40.11.13 Boiler Feed System 4" Sch 40	54	LF	\$ -	\$ -	\$ 33.00	\$ 1,782	3.1200	1.00	168.48	\$ 93.50	\$ 15,753	\$ 324.72	\$ 17,535
40.11.13 Boiler Feed System 3" Sch 80	18	LF	\$ -	\$ -	\$ 30.00	\$ 540	2.8472	1.00	51.25	\$ 93.50	\$ 4,792	\$ 296.22	\$ 5,332
40.11.13 Boiler Feed System 3" Sch 40	330	LF	\$ -	\$ -	\$ 22.50	\$ 7,425	2.3158	1.00	764.21	\$ 93.50	\$ 71,454	\$ 239.03	\$ 78,879
40.11.13 Boiler Feed System 2" Sch 80	0	LF	\$ -	\$ -	\$ 15.00	\$ -	2.6118	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Boiler Feed System 2" Sch 40	0	LF	\$ -	\$ -	\$ 12.00	\$ -	1.5116	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Boiler Feed System 1.5" Sch 80	0	LF	\$ -	\$ -	\$ 12.00	\$ -	1.6794	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Boiler Feed System 1" Sch 80	33	LF	\$ -	\$ -	\$ 9.00	\$ 297	1.0000	1.00	33.00	\$ 93.50	\$ 3,086	\$ 102.52	\$ 3,383
40.11.13 Boiler Drains 6" Sch 80	12	LF	\$ -	\$ -	\$ 93.00	\$ 1,116	3.8980	1.00	46.78	\$ 93.50	\$ 4,374	\$ 457.50	\$ 5,490
40.11.13 Boiler Drains 4" Sch 80	69	LF	\$ -	\$ -	\$ 45.00	\$ 3,105	3.2800	1.00	226.32	\$ 93.50	\$ 21,161	\$ 351.68	\$ 24,266
40.11.13 Boiler Drains 2.5" Sch 80	143	LF	\$ -	\$ -	\$ 22.50	\$ 3,218	2.7120	1.00	387.82	\$ 93.50	\$ 36,261	\$ 276.08	\$ 39,479
40.11.13 Boiler Drains 2" Sch 80	26	LF	\$ -	\$ -	\$ 12.00	\$ 312	1.5116	1.00	39.30	\$ 93.50	\$ 3,675	\$ 153.35	\$ 3,987
40.11.13 Boiler Drains 1.5" Sch 80	2	LF	\$ -	\$ -	\$ 12.00	\$ 24	1.2114	1.00	2.42	\$ 93.50	\$ 226	\$ 125.00	\$ 250
40.11.13 Boiler System 1" Sch 40	202	LF	\$ -	\$ -	\$ 9.00	\$ 1,818	0.8946	1.00	180.71	\$ 93.50	\$ 16,896	\$ 92.64	\$ 18,714
40.11.13 Blowdown System 18" Sch 40	43	LF	\$ -	\$ -	\$ 206.00	\$ 8,858	8.1099	1.00	348.73	\$ 93.50	\$ 32,606	\$ 964.28	\$ 41,464
40.11.13 Blowdown System 8" Sch 40	105	LF	\$ -	\$ -	\$ 87.00	\$ 9,135	3.9000	1.00	409.35	\$ 93.50	\$ 38,288	\$ 451.65	\$ 47,423
40.11.13 Blowdown System 4" Sch 40	66	LF	\$ -	\$ -	\$ 33.00	\$ 2,178	3.1200	1.00	205.92	\$ 93.50	\$ 19,254	\$ 324.73	\$ 21,432
40.11.13 Blowdown System 2.5" Sch 80	87	LF	\$ -	\$ -	\$ 22.50	\$ 1,958	2.7120	1.00	235.94	\$ 93.50	\$ 22,000	\$ 276.07	\$ 24,018
40.11.13 Blowdown System 1.5" Sch 40	0	LF	\$ -	\$ -	\$ 12.00	\$ -	1.2114	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Chilled Water System 8" Sch 40	740	LF	\$ -	\$ -	\$ 87.00	\$ 64,380	3.9000	1.00	2,886.00	\$ 93.50	\$ 269,841	\$ 451.65	\$ 334,221
40.11.13 Chilled Water System 6" Sch 40	17	LF	\$ -	\$ -	\$ 57.00	\$ 969	3.2687	1.00	55.57	\$ 93.50	\$ 5,196	\$ 362.65	\$ 6,165
40.11.13 Condensate System 10" Sch 40	0	LF	\$ -	\$ -	\$ 123.00	\$ -	4.2730	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System 10" Sch 80	152	LF	\$ -	\$ -	\$ 153.00	\$ 23,256	5.4000	1.00	820.80	\$ 93.50	\$ 76,746	\$ 504.50	\$ 57,292
40.11.13 Condensate System 6" Sch 40	42	LF	\$ -	\$ -	\$ 87.00	\$ 3,654	3.9000	1.00	163.80	\$ 93.50	\$ 15,318	\$ 362.62	\$ 39,933
40.11.13 Condensate System 6" Sch 80	0	LF	\$ -	\$ -	\$ 57.00	\$ -	3.2687	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System 6" Sch 40	238	LF	\$ -	\$ -	\$ 93.00	\$ 22,134	3.8980	1.00	927.72	\$ 93.50	\$ 86,746	\$ 451.65	\$ 132,939
40.11.13 Condensate System 4" Sch 80	215	LF	\$ -	\$ -	\$ 33.00	\$ 7,095	3.1200	1.00	670.80	\$ 93.50	\$ 62,728	\$ 324.72	\$ 36,303
40.11.13 Condensate System 4" Sch 40	258	LF	\$ -	\$ -	\$ 45.00	\$ 11,610	3.2800	1.00	846.24	\$ 93.50	\$ 79,121	\$ 351.68	\$ 42,959
40.11.13 Condensate System 3" Sch 40	223	LF	\$ -	\$ -	\$ 22.50	\$ 5,018	2.3158	1.00	516.42	\$ 93.50	\$ 48,285	\$ 239.03	\$ 53,303
40.11.13 Condensate System 2.5" Sch 40	0	LF	\$ -	\$ -	\$ 18.75	\$ -	1.9137	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System 2" Sch 40	0	LF	\$ -	\$ -	\$ 12.00	\$ -	1.5116	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System 2" Sch 80	8	LF	\$ -	\$ -	\$ 15.00	\$ 120	2.6118	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System 1.5" Sch 40	0	LF	\$ -	\$ -	\$ 12.00	\$ -	1.2114	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System 1" Sch 40	100	LF	\$ -	\$ -	\$ 3.00	\$ 300	0.8946	1.00	39.00	\$ 93.50	\$ 3,647	\$ 102.51	\$ 3,988
40.11.13 Condensate System .5" Sch 40	0	LF	\$ -	\$ -	\$ 3.00	\$ -	0.8946	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Condensate System .5" SST tubing	0	LF	\$ -	\$ -	\$ 3.00	\$ -	0.8946	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Fuel Gas System 8" Sch 40	0	LF	\$ -	\$ -	\$ 87.00	\$ -	3.9000	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Fuel Gas System 6" Sch 40	165	LF	\$ -	\$ -	\$ 57.00	\$ 9,405	3.2687	1.00	539.34	\$ 93.50	\$ 50,428	\$ 362.62	\$ 59,833
40.11.13 High Pressure Steam 12" Sch 40	0	LF	\$ -	\$ -	\$ 195.00	\$ -	6.1300	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 High Pressure Steam 12" Sch 80	298	LF	\$ -	\$ -	\$ 135.00	\$ 40,230	4.8541	1.00	1,446.52	\$ 93.50	\$ 135,250	\$ 588.86	\$ 175,480
40.11.13 High Pressure Steam 10" Sch 80	0	LF	\$ -	\$ -	\$ 153.00	\$ -	5.4000	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 High Pressure Steam 10" Sch 40	200	LF	\$ -	\$ -	\$ 123.00	\$ 24,600	4.2730	1.00	854.60	\$ 93.50	\$ 79,909	\$ 522.53	\$ 104,505
40.11.13 High Pressure Steam 8" Sch 40	92	LF	\$ -	\$ -	\$ 141.00	\$ 12,972	4.9280	1.00	453.38	\$ 93.50	\$ 42,391	\$ 601.77	\$ 55,363
40.11.13 High Pressure Steam 6" Sch 80	2	LF	\$ -	\$ -	\$ 93.00	\$ 186	3.8980	1.00	7.80	\$ 93.50	\$ 729	\$ 457.50	\$ 915
40.11.13 High Pressure Steam 6" Sch 40	68	LF	\$ -	\$ -	\$ 57.00	\$ 3,876	3.2687	1.00	222.21	\$ 93.50	\$ 20,782	\$ 362.62	\$ 24,658
40.11.13 High Pressure Steam 4" Sch 80	0	LF	\$ -	\$ -	\$ 45.00	\$ -	3.2800	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 High Pressure Steam 3" Sch 40	2	LF	\$ -	\$ -	\$ 22.50	\$ 45	2.3158	1.00	4.63	\$ 93.50	\$ 433	\$ 239.00	\$ 478

Costs scaled to 2021
costs using CEPCI
factorCosts used for 6"
reagent handling line

NSE Estimate No.: N1412075

Date: 01/22/2015

Customer: Stanley Consultants

Location: University of Alaska Fairbanks

Fairbanks, AK

CEPCI Index 2022

708.0

CEPCI Index 2017

567.5

Scale Factor

1.247577093

ESTIMATE SUMMARY:

Electrical Power Generation

Revision: 03/06/2017

Scaled Unit costs													
DESCRIPTION	QUANTITY	EQUIP	MATERIAL		LABOR			UNIT	TOTAL				
			NO. UNITS	PRICE	UNIT EQUIP	PRICE	MATERIAL			HRS/ UNIT	MULT FACT	TOTAL HRS	LABOR RATE
40.11.13 High Pressure Steam 2" Sch 80	210	LF	\$ -	\$ -	\$ 15.00	\$ 3,150	2.6118	1.00	548.48	\$ 93.50	\$ 51,283	\$ 239.20	\$ 54,433
40.11.13 High Pressure Steam 1.5" Sch 80	175	LF	\$ -	\$ -	\$ 12.00	\$ 2,100	1.6794	1.00	293.90	\$ 93.50	\$ 27,480	\$ 169.03	\$ 29,580
40.11.13 High Pressure Steam 1" Sch 80	195	LF	\$ -	\$ -	\$ 9.00	\$ 1,755	1.0000	1.00	195.00	\$ 93.50	\$ 18,233	\$ 102.50	\$ 19,988
40.11.13 High Pressure Steam 3/4" Sch 80	261	LF	\$ -	\$ -	\$ 9.00	\$ 2,349	1.0000	1.00	261.00	\$ 93.50	\$ 24,404	\$ 102.50	\$ 26,753
40.11.13 HVAC System 3" Sch 40	195	LF	\$ -	\$ -	\$ 22.50	\$ 4,398	2.3158	1.00	451.58	\$ 93.50	\$ 42,223	\$ 239.03	\$ 46,611
40.11.13 IAS System 3" SST Sch 40	122	LF	\$ -	\$ -	\$ 22.50	\$ 2,745	2.3158	1.00	282.53	\$ 93.50	\$ 26,417	\$ 239.03	\$ 29,162
40.11.13 Inert Bed Material 4" Sch 40	226	LF	\$ -	\$ -	\$ 33.00	\$ 7,458	3.1200	1.00	705.12	\$ 93.50	\$ 65,929	\$ 324.72	\$ 73,387
40.11.13 Low Pressure Steam 24" Sch 40	215	LF	\$ -	\$ -	\$ 304.00	\$ 65,360	10.7800	1.00	2,317.70	\$ 93.50	\$ 216,705	\$ 1,311.93	\$ 282,065
40.11.13 Low Pressure Steam 20" Sch 40	167	LF	\$ -	\$ -	\$ 200.00	\$ 33,400	8.0000	1.00	1,336.00	\$ 93.50	\$ 124,916	\$ 948.00	\$ 158,316
40.11.13 Low Pressure Steam 12" Sch 40	11	LF	\$ -	\$ -	\$ 135.00	\$ 1,485	4.8541	1.00	53.40	\$ 93.50	\$ 4,993	\$ 588.91	\$ 6,478
40.11.13 Low Pressure Steam 10" Sch 40	49	LF	\$ -	\$ -	\$ 123.00	\$ 6,027	4.2730	1.00	209.38	\$ 93.50	\$ 19,577	\$ 522.53	\$ 25,604
40.11.13 Low Pressure Steam 8" Sch 40	93	LF	\$ -	\$ -	\$ 87.00	\$ 8,091	3.9000	1.00	362.70	\$ 93.50	\$ 33,912	\$ 451.65	\$ 42,003
40.11.13 Low Pressure Steam 6" Sch 40	232	LF	\$ -	\$ -	\$ 57.00	\$ 13,224	3.2687	1.00	758.34	\$ 93.50	\$ 70,905	\$ 362.63	\$ 84,129
40.11.13 Low Pressure Steam 4" Sch 40	0	LF	\$ -	\$ -	\$ 33.00	\$ -	3.1200	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Medium Pressure Steam 12" Sch 80	0	LF	\$ -	\$ -	\$ 196.00	\$ -	6.1300	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Medium Pressure Steam 8" Sch 80	0	LF	\$ -	\$ -	\$ 141.00	\$ -	4.9280	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Medium Pressure Steam 8" Sch 40	12	LF	\$ -	\$ -	\$ 87.00	\$ 1,044	3.9000	1.00	46.80	\$ 93.50	\$ 4,374	\$ 588.91	\$ 6,478
40.11.13 Medium Pressure Steam 6" Sch 80	0	LF	\$ -	\$ -	\$ 93.00	\$ -	3.8980	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Medium Pressure Steam 6" Sch 40	173	LF	\$ -	\$ -	\$ 57.00	\$ 9,861	3.2687	1.00	565.49	\$ 93.50	\$ 52,874	\$ 306.63	\$ 68,938
40.11.13 Medium Pressure Steam 4" Sch 80	0	LF	\$ -	\$ -	\$ 45.00	\$ -	3.2800	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Medium Pressure Steam 3" Sch 80	0	LF	\$ -	\$ -	\$ 30.00	\$ -	2.8472	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 Medium Pressure Steam 3" Sch 40	2	LF	\$ -	\$ -	\$ 22.50	\$ 45	2.3158	1.00	4.63	\$ 93.50	\$ 433	\$ 239.03	\$ 478
40.11.13 Medium Pressure Steam 1.5" Sch 80	123	LF	\$ -	\$ -	\$ 12.00	\$ 1,476	1.6794	1.00	206.57	\$ 93.50	\$ 19,314	\$ 169.02	\$ 20,790
40.11.13 Medium Pressure Steam 3/4" Sch 40	54	LF	\$ -	\$ -	\$ 9.00	\$ 486	0.8946	1.00	48.31	\$ 93.50	\$ 4,517	\$ 92.65	\$ 5,003
40.11.13 SAS System 4" Sch 40	119	LF	\$ -	\$ -	\$ 33.00	\$ 3,927	3.1200	1.00	371.28	\$ 93.50	\$ 34,715	\$ 324.72	\$ 38,642
40.11.13 SAS System 3" Sch 40	78	LF	\$ -	\$ -	\$ 33.00	\$ 2,574	1.00	180.63	\$ 93.50	\$ 16,889	\$ 239.03	\$ 18,644	\$ 19,888
40.11.13 SAS System 2.5" Sch 40	5	LF	\$ -	\$ -	\$ 33.00	\$ 165	1.00	9.57	\$ 93.50	\$ 895	\$ 197.80	\$ 217.37	\$ 226.94
40.11.13 STG Systems 24" Sch 40	26	LF	\$ -	\$ -	\$ 135.00	\$ 3,510	1.00	280.28	\$ 93.50	\$ 26,206	\$ 1,311.92	\$ 1,311.92	\$ 1,311.92
40.11.13 STG Systems 18" Sch 40	44	LF	\$ -	\$ -	\$ 206.00	\$ 9,064	8.1099	1.00	359.84	\$ 93.50	\$ 33,365	\$ 964.30	\$ 10,240
40.11.13 STG Systems 12" Sch 40	5	LF	\$ -	\$ -	\$ 135.00	\$ 675	4.8541	1.00	24.27	\$ 93.50	\$ 2,269	\$ 588.80	\$ 2,944
40.11.13 STG Systems 8" Sch 80	0	LF	\$ -	\$ -	\$ 141.00	\$ -	4.9280	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 STG Systems 8" Sch 40	64	LF	\$ -	\$ -	\$ 141.00	\$ 9,024	4.9280	1.00	315.39	\$ 93.50	\$ 29,489	\$ 601.77	\$ 38,513
40.11.13 STG Systems 6" Sch 40	8	LF	\$ -	\$ -	\$ 57.00	\$ 456	3.2687	1.00	26.15	\$ 93.50	\$ 2,445	\$ 362.63	\$ 2,901
40.11.13 STG Systems 3" Sch 80	0	LF	\$ -	\$ -	\$ 30.00	\$ -	2.8472	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 STG Systems 3" Sch 40	53	LF	\$ -	\$ -	\$ 22.50	\$ 1,193	2.3158	1.00	122.74	\$ 93.50	\$ 11,476	\$ 239.04	\$ 12,669
40.11.13 STG System 2" Sch 80	5	LF	\$ -	\$ -	\$ 15.00	\$ 75	2.6118	1.00	13.06	\$ 93.50	\$ 1,221	\$ 259.20	\$ 1,296
40.11.13 STG System 2" Sch 40	0	LF	\$ -	\$ -	\$ 12.00	\$ -	1.5116	1.00	0.00	\$ 93.50	\$ -	#DIV/0!	\$ -
40.11.13 STG System 1" Sch 80	170	LF	\$ -	\$ -	\$ 9.00	\$ 1,530	1.0000	1.00	170.00	\$ 93.50	\$ 15,895	\$ 102.50	\$ 17,425
40.11.13 Service Water System 4" Sch 40	328	LF	\$ -	\$ -	\$ 33.00	\$ 10,824	3.1200	1.00	1,023.36	\$ 93.50	\$ 95,684	\$ 324.72	\$ 106,508
40.11.13 Service Water System 3" Sch 40	18	LF	\$ -	\$ -	\$ 22.50	\$ 405	2.3158	1.00	41.68	\$ 93.50	\$ 3,897	\$ 239.00	\$ 4,302
40.11.13 Service Water System 2.5" Sch 40	37	LF	\$ -	\$ -	\$ 18.75	\$ 694	1.9137	1.00	70.81	\$ 93.50	\$ 6,621	\$ 197.70	\$ 7,315
Piping estimated outside the model													
40.11.13 ACC System 1" Sch 40	450	LF	\$ -	\$ -	\$ 9.00	\$ 4,050	0.8946	1.00	402.57	\$ 93.50	\$ 37,640	\$ 92.64	\$ 41,690
40.11.13 Aux Cooling Water System 2" Sch 40	85	LF	\$ -	\$ -	\$ 14.00	\$ 1,190	1.5116	1.00	128.49	\$ 93.50	\$ 12,014	\$ 153.34	\$ 13,034
40.11.13 Aux Cooling Water System 1" & 1.25 Sch 40	320	LF	\$ -	\$ -	\$ 9.00	\$ 2,880	0.8946	1.00	286.27	\$ 93.50	\$ 26,766	\$ 92.64	\$ 29,646
40.11.13 Additional SB Piping- Aux Cooling Water System	495	LF	\$ -	\$ -	\$ 14.00	\$ 6,930	1.50	1.00	742.50	\$ 93.50	\$ 69,424	\$ 152.25	\$ 75,364
40.11.13 Boiler Feed System 2" Sch 40	87	LF	\$ -	\$ -	\$ 12.00	\$ 1,044	1.5116	1.00	131.51	\$ 93.50	\$ 12,296	\$ 153.33	\$ 13,340
40.11.13 Boiler Feed System 1" Sch 40	175	LF	\$ -	\$ -	\$ 9.00	\$ 1,575	0.8946	1.00	156.56	\$ 93.50	\$ 14,638	\$ 92.65	\$ 16,213
40.11.13 Additional SB Piping- Boiler Feed System	103	LF	\$ -	\$ -	\$ 12.00	\$ 1,236	1.50	1.00	154.50	\$ 93.50	\$ 14,446	\$ 152.25	\$ 15,682
40.11.13 Boiler Feed System SST tubing	150	LF	\$ -	\$ -	\$ 16.00	\$ 2,400	0.8	1.00	120.00	\$ 93.50	\$ 11,220	\$ 92.80	\$ 13,920
40.11.13 Additional SB Piping- Boiler System	600	LF	\$ -	\$ -	\$ 12.00	\$ 7,200	1.50	1.00	900.00	\$ 93.50	\$ 84,150	\$ 152.25	\$ 91,350
40.11.13 Boiler System 3/4" SST tubing	393	LF	\$ -	\$ -	\$ 18.00	\$ 7,074	0.8	1.00	314.40	\$ 93.50	\$ 29,396	\$ 92.80	\$ 36,470
40.11.13 Blowdown System 2" Sch 40	60	LF	\$ -	\$ -	\$ 12.00	\$ 720	1.5116	1.00	90.70	\$ 93.50	\$ 8,480	\$ 153.33	\$ 9,200
40.11.13 Chem Feed 5" SST tubing	1800	LF	\$ -	\$ -	\$ 16.00	\$ 28,800	0.8	1.00	1,440.00	\$ 93.50	\$ 134,640	\$ 92.80	\$ 167,040
40.11.13 Additional SB Piping- Chilled Water System	60	LF	\$ -	\$ -	\$ 12.00	\$ 720	1.50	1.00	90.00	\$ 93.50	\$ 8,415	\$ 152.25	\$ 9,135
40.11.13 Additional SB Piping- Condensate System	840	LF	\$ -	\$ -	\$ 12.00	\$ 10,080	1.50	1.00	1,260.00	\$ 93.50	\$ 117,810	\$ 152.25	\$ 127,890
40.11.13 Demin Water System 2" Sch 40 304L	500	LF	\$ -	\$ -	\$ 12.00	\$ 6,000	1.5116	1.00	755.80	\$ 93.50	\$ 70,667	\$ 153.33	\$ 76,667
40.11.13 Demin Water System 1" Sch 40 304L	100	LF	\$ -	\$ -	\$ 9.00	\$ 900	0.8946	1.00	89.46	\$ 93.50	\$ 8,365	\$ 92.65	\$ 9,265
40.11.13 Fuel Gas System 2" Sch 40	200	LF	\$ -	\$ -	\$ 12.00	\$ 2,400	1.5116	1.00	302.32	\$ 93.50	\$ 28,267	\$ 153.34	\$ 30,667
40.11.13 Fuel Gas System 1" Sch 40	100	LF	\$ -	\$ -	\$ 9.00	\$ 900	0.8946	1.00	89.46	\$ 93.50	\$ 8,365	\$ 92.65	\$ 9,265

**DRY SORBENT INJECTION
COST ESTIMATE
CEPCI INDEX BACKUP**

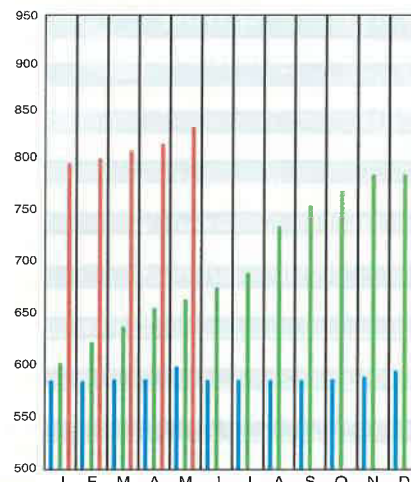
2020 2021 2022

Download the CEPCI two weeks sooner at www.chemengonline.com/pci

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957-59 = 100)	May '22 Prelim.	Apr. '22 Final	May '21 Final	Annual Index:
CE Index	831.7	816.3	686.7	2014 = 576.1
Equipment	1,057.1	1,037.1	848.5	2015 = 556.8
Heat exchangers & tanks	902.4	876.0	726.6	2016 = 541.7
Process machinery	1,074.9	1,063.9	862.9	2017 = 567.5
Pipe, valves & fittings	1,496.7	1,472.8	1,160.6	2018 = 603.1
Process instruments	575.5	573.5	507.5	2019 = 607.5
Pumps & compressors	1,255.1	1,248.9	1,115.6	2020 = 596.2
Electrical equipment	757.3	751.8	601.0	2021 = 708.0
Structural supports & misc.	1,176.8	1,144.7	915.0	
Construction labor	354.6	348.3	341.7	
Buildings	847.2	827.0	739.2	
Engineering & supervision	311.5	311.8	310.4	

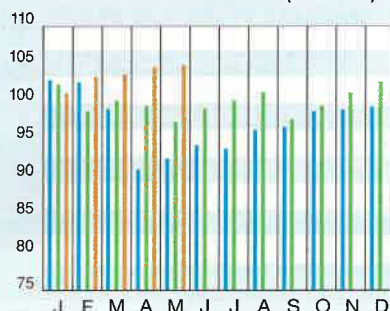
Starting in April 2007, several data series for labor and compressors were converted to accommodate series IDs discontinued by the U.S. Bureau of Labor Statistics (BLS). Starting in March 2018, the data series for chemical industry special machinery was replaced because the series was discontinued by BLS (see *Chem. Eng.*, April 2018, p. 76-77.)



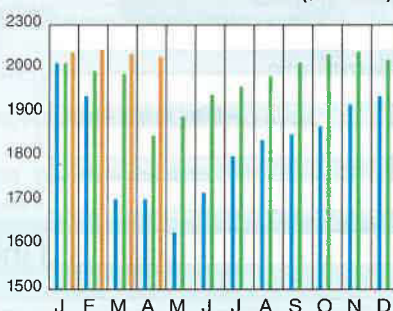
CURRENT BUSINESS INDICATORS

	LATEST	PREVIOUS	YEAR AGO
CPI output index (2017 = 100)	May '22 = 101.7	Apr. '22 = 101.3	Mar. '22 = 101.0
CPI value of output, \$ billions	Apr. '22 = 2,082.8	Mar. '22 = 2,088.1	Feb. '22 = 2,004.7
CPI operating rate, %	May '22 = 80.8	Apr. '22 = 80.5	Mar. '22 = 80.3
Producer prices, industrial chemicals (1982 = 100)	May '22 = 367.8	Apr. '22 = 358.5	Mar. '22 = 354.2
Industrial Production in Manufacturing (2017 = 100)*	May '22 = 103.1	Apr. '22 = 103.2	Mar. '22 = 102.4
Hourly earnings index, chemical & allied products (1992 = 100)	May '22 = 199.6	Apr. '22 = 196.7	Mar. '22 = 195.9
Productivity index, chemicals & allied products (1992 = 100)	May '22 = 91.8	Apr. '22 = 93.8	Mar. '22 = 93.5

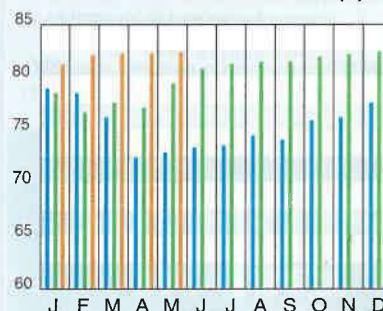
CPI OUTPUT INDEX (2017 = 100)†



CPI OUTPUT VALUE (\$ BILLIONS)



CPI OPERATING RATE (%)



*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
†For the current month's CPI output index values, the base year was changed from 2012 to 2017
Current business indicators provided by Global Insight, Inc., Lexington, Mass.

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27206

CURRENT TRENDS

The preliminary value for the CE Plant Cost Index (CEPCI; top) for May 2022 (most recent available) is once again higher than the previous month's value, continuing the string of monthly increases that has been observed since autumn 2020. In May of this year, increases occurred in the Equipment, Buildings and Construction Labor sub-indices, while the Engineering & Supervision subindices saw a very small decrease. The current CEPCI value now sits at 21.1% higher than the corresponding value from May 2021. Meanwhile, the Current Business Indicators (middle) show increases in the CPI output index and the CPI operating rate for May 2021, and a small decrease in the CPI value of output for April 2021.

**DRY SORBENT INJECTION
COST ESTIMATE
INFLATION CALCULATOR BACKUP**

[Bureau of Labor Statistics](#) > [Data Tools](#) > [Charts and Applications](#) > Inflation Calculator

CPI Inflation Calculator

CPI Inflation Calculator

\$ 1,000.00

in January ▼ 2022 ▼

has the same buying power as

\$1,053.81

in July ▼ 2022 ▼

Calculate

About the CPI Inflation Calculator

The CPI inflation calculator uses the [Consumer Price Index](#) for All Urban Consumers (CPI-U) U.S. city average series for all items, not seasonally adjusted. [This data](#) represents changes in the prices of all goods and services purchased for consumption by urban households.

U.S. BUREAU OF LABOR STATISTICS Postal Square Building 2 Massachusetts Avenue NE Washington, DC 20212-0001

Telephone:1-202-691-5200_ Telecommunications Relay Service:7-1-1_ www.bls.gov [Contact Us](#)

**DRY SORBENT INJECTION
COST ESTIMATE
CITY COST INDEX BACKUP**

City Cost Indexes

DIVISION		UNITED STATES			ALABAMA														
		30 CITY			ANNISTON			BIRMINGHAM			BUTLER			DECATUR			DOTHAN		
		AVERAGE			362			350 - 352			369			356			363		
MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL		
015433	CONTRACTOR EQUIPMENT	100.0	100.0	100.0	99.3	99.3		104.4	104.4		97.0	97.0		99.3	99.3		97.0	97.0	
0241, 31 - 34	SITE & INFRASTRUCTURE, DEMOLITION	100.0	100.0	100.0	100.7	85.6	90.4	99.5	94.2	95.9	116.3	81.8	92.8	90.4	85.2	86.9	113.4	81.8	91.9
0310	Concrete Forming & Accessories	100.0	100.0	100.0	86.2	65.3	69.4	99.6	68.3	74.3	81.1	67.6	70.2	99.0	64.2	70.9	93.1	67.8	72.7
0320	Concrete Reinforcing	100.0	100.0	100.0	88.4	69.0	82.2	99.0	69.2	89.4	93.2	69.9	85.7	92.2	66.8	84.1	93.2	69.3	85.5
0330	Cast-In-Place Concrete	100.0	100.0	100.0	88.0	66.6	80.6	106.8	69.9	94.0	85.8	66.8	79.2	99.1	66.5	87.8	85.8	67.0	79.3
03	CONCRETE	100.0	100.0	100.0	92.1	68.2	82.5	100.0	70.4	88.2	93.1	69.4	83.6	93.6	67.2	83.0	92.9	69.5	83.5
04	MASONRY	100.0	100.0	100.0	98.2	61.2	74.8	98.0	62.9	75.9	103.1	61.2	76.7	92.3	61.0	72.5	104.7	62.7	78.2
05	METALS	100.0	100.0	100.0	101.3	94.2	99.6	99.3	91.7	97.5	100.2	95.1	99.0	101.1	92.9	99.2	100.3	95.3	99.1
06	WOOD, PLASTICS & COMPOSITES	100.0	100.0	100.0	80.7	65.9	74.6	95.8	68.7	84.6	74.9	68.5	72.2	99.1	64.0	84.6	88.7	68.3	80.3
07	THERMAL & MOISTURE PROTECTION	100.0	100.0	100.0	98.2	60.7	81.8	99.5	66.5	85.0	98.2	64.3	83.3	96.5	63.8	82.1	98.3	63.9	83.2
08	OPENINGS	100.0	100.0	100.0	91.0	66.9	85.2	98.2	68.9	91.1	91.0	68.9	85.7	102.8	65.7	93.9	91.1	68.7	85.7
0920	Plaster & Gypsum Board	100.0	100.0	100.0	89.6	65.6	74.6	99.7	68.0	79.9	85.5	68.2	74.7	99.1	63.7	76.9	103.6	68.1	81.4
0950, 0980	Ceilings & Acoustic Treatment	100.0	100.0	100.0	90.1	65.6	74.2	104.0	68.0	80.7	90.1	68.2	75.9	101.3	63.7	76.9	90.1	68.1	75.8
0960	Flooring	100.0	100.0	100.0	85.9	66.7	80.0	99.4	68.1	89.8	89.6	66.7	82.6	93.1	66.7	85.0	93.5	69.4	86.1
0970, 0990	Wall Finishes & Painting/Coating	100.0	100.0	100.0	96.3	52.3	69.5	101.8	52.3	71.6	96.3	44.3	64.6	90.3	58.9	71.2	96.3	80.7	86.8
09	FINISHES	100.0	100.0	100.0	89.6	64.2	75.8	100.7	66.4	82.0	92.4	64.8	77.4	95.3	63.8	78.2	96.1	69.3	81.5
COVERS	DVS. 10 - 14, 25, 28, 41, 43, 44, 46	100.0	100.0	100.0	100.0	83.7	96.5	100.0	85.2	96.8	100.0	84.8	96.7	100.0	81.5	96.0	100.0	84.9	96.7
21, 22, 23	FIRE SUPPRESSION, PLUMBING & HVAC	100.0	100.0	100.0	102.8	50.6	81.4	100.8	63.9	85.7	98.5	62.8	83.8	100.9	63.2	85.4	98.5	62.8	83.9
26, 27, 3370	ELECTRICAL, COMMUNICATIONS & UTIL.	100.0	100.0	100.0	96.9	55.5	77.0	96.4	64.9	81.2	98.3	55.7	77.7	93.5	62.7	78.7	97.5	74.8	86.6
MF2018	WEIGHTED AVERAGE	100.0	100.0	100.0	97.5	65.3	84.4	99.4	71.0	87.8	97.4	68.2	85.5	98.1	68.6	86.1	97.8	71.7	87.1

DIVISION		ALABAMA																	
		EVERGREEN			GADSDEN			HUNTSVILLE			JASPER			MOBILE			MONTGOMERY		
		364			359			357 - 358			355			365 - 366			360 - 361		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
015433	CONTRACTOR EQUIPMENT		97.0	97.0		99.3	99.3		99.3	99.3		99.3	99.3		97.0	97.0		105.1	105.1
0241, 31 - 34	SITE & INFRASTRUCTURE, DEMOLITION	116.8	81.7	93.0	97.5	85.6	89.4	90.1	85.5	87.0	97.4	85.6	89.4	107.6	81.8	90.1	105.9	95.5	98.8
0310	Concrete Forming & Accessories	77.0	65.5	67.7	87.7	65.8	70.0	99.0	66.5	72.8	95.2	65.7	71.4	91.8	67.5	72.2	98.0	68.0	73.8
0320	Concrete Reinforcing	93.3	69.9	85.7	97.4	69.2	88.3	92.2	77.2	87.4	92.2	69.1	84.8	91.5	69.9	84.6	100.5	69.2	90.5
0330	Cast-In-Place Concrete	85.8	66.8	79.2	99.1	66.8	88.0	96.5	66.7	86.2	109.9	66.8	95.0	90.0	66.9	82.0	89.9	69.5	82.8
03	CONCRETE	93.2	68.5	83.3	97.3	68.5	85.7	92.5	70.1	83.5	100.6	68.4	87.7	90.0	69.4	81.7	92.8	70.2	83.7
04	MASONRY	103.1	61.2	76.7	90.9	61.9	72.6	93.7	61.8	73.6	88.9	61.2	71.4	101.9	62.1	76.8	101.9	62.2	76.9
05	METALS	100.2	94.9	99.0	98.7	94.7	97.8	101.1	97.7	100.3	98.6	94.6	97.7	102.6	95.0	100.8	101.8	91.7	99.4
06	WOOD, PLASTICS & COMPOSITES	70.9	65.9	68.9	87.0	65.9	78.3	99.1	66.9	85.8	95.5	65.9	83.3	86.8	68.3	79.2	90.8	68.7	81.6
07	THERMAL & MOISTURE PROTECTION	98.1	63.3	82.8	96.6	64.2	82.4	96.4	64.3	82.3	96.7	63.5	82.2	97.9	63.8	82.9	98.9	66.2	84.6
08	OPENINGS	91.0	67.5	85.4	99.7	67.3	91.9	102.6	69.9	94.7	99.7	67.3	91.9	93.4	68.9	87.5	92.1	68.9	86.5
0920	Plaster & Gypsum Board	84.5	65.6	72.7	86.2	65.6	73.3	99.1	66.6	78.8	93.4	65.6	76.0	97.1	68.1	78.9	99.1	68.0	79.7
0950, 0980	Ceilings & Acoustic Treatment	90.1	65.6	74.2	93.8	65.6	75.5	102.8	66.6	79.3	93.8	65.6	75.5	98.5	68.1	78.7	100.5	68.0	79.5
0960	Flooring	87.9	66.7	81.4	89.8	68.1	83.1	93.1	68.1	85.4	91.6	66.7	84.0	93.5	68.1	85.7	93.0	68.1	85.4
0970, 0990	Wall Finishes & Painting/Coating	96.3	44.3	64.6	90.3	52.3	67.1	90.3	60.2	72.0	90.3	52.3	67.1	99.4	44.3	65.8	101.8	52.3	71.6
09	FINISHES	91.8	63.3	76.3	91.1	64.5	76.6	95.6	65.9	79.5	92.7	64.2	77.2	96.3	65.0	79.3	99.0	66.2	81.2
COVERS	DVS. 10 - 14, 25, 28, 41, 43, 44, 46	100.0	84.6	96.6	100.0	83.8	96.5	100.0	81.8	96.0	100.0	83.7	96.5	100.0	84.9	96.7	100.0	85.0	96.7
21, 22, 23	FIRE SUPPRESSION, PLUMBING & HVAC	98.5	56.7	81.3	104.1	63.9	87.6	100.8	63.6	85.6	104.1	63.3	87.4	100.8	59.9	84.0	100.8	62.9	85.3
26, 27, 3370	ELECTRICAL, COMMUNICATIONS & UTIL.	96.5	55.7	76.8	93.7	64.9	79.8	94.3	62.6	79.0	93.3	55.5	75.1	99.0	59.2	79.8	99.2	71.9	86.1
MF2018	WEIGHTED AVERAGE	97.2	66.4	84.7	98.2	69.8	86.6	98.1	70.1	86.7	98.7	68.2	86.3	98.4	68.2	86.1	98.8	71.7	87.8

DIVISION		ALABAMA												ALASKA			IDAHO		
		PHENIX CITY			SELMA			TUSCALOOSA			ANCHORAGE			FAIRBANKS			JUNEAU		
		368			367			354			995 - 996			997			998		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
015433	CONTRACTOR EQUIPMENT		97.0	97.0		97.0	97.0		99.3	99.3		105.0	105.0		109.7	109.7		105.0	105.0
0241, 31 - 34	SITE & INFRASTRUCTURE, DEMOLITION	121.3	81.8	94.5	113.1	81.8	91.9	90.7	85.6	87.2	138.8	112.8	121.2	136.6	119.0	124.7	153.4	112.8	125.9
0310	Concrete Forming & Accessories	86.1	67.3	71.0	82.9	65.8	69.1	99.0	67.6	73.7	103.0	111.1	109.5	108.9	110.7	110.4	105.0	111.1	109.9
0320	Concrete Reinforcing	93.2	66.6	84.7	93.2	69.1	85.5	92.2	69.2	84.8	124.6	118.4	122.6	120.1	118.4	119.5	124.6	118.4	122.6
0330	Cast-In-Place Concrete	85.8	66.8	79.2	85.8	66.8	79.2	100.5	66.9	88.9	131.5	113.6	125.3	130.3	110.8	123.6	131.4	113.6	125.2
03	CONCRETE	95.9	68.7	85.0	92.1	68.5	82.7	94.2	69.3	84.3	117.6	112.7	115.6	110.3	111.7	110.9	122.4	112.7	118.5
04	MASONRY	103.1	61.2	76.7	107.6	61.2	78.3	92.6	62.1	73.4	202.3	114.5	147.0	202.5	113.4	146.4	182.0	114.5	139.5
05	METALS	100.2	93.7	98.7	100.2	94.7	98.9	100.4	94.8	99.1	127.5	103.2	121.8	122.6	105.7	118.7	122.7	103.2	118.1
06	WOOD, PLASTICS & COMPOSITES	80.5	68.0	75.3	77.0	65.9	72.4	99.1	68.3	86.4	100.5	108.4	103.8	113.4	108.3	111.3	105.0	108.4	106.4
07	THERMAL & MOISTURE PROTECTION	98.6	64.2	83.6	98.0	64.0	83.1	96.5	64.6	82.5	134.6	111.6	124.5	143.8	110.2	129.1	145.8	111.6	130.8
08	OPENINGS	91.0	67.8	85.4	91.0	67.3	85.3	102.6	68.6	94.4	125.9	112.2	122.6	128.4	111.6	124.4	126.8	112.2	123.3
0920	Plaster & Gypsum Board	92.0	67.7	76.8	88.6	65.6	74.2	99.1	68.0	79.7	116.5	108.6	111.6	167.2	108.6	130.6	168.8	108.6	131.1
0950, 0980	Ceilings & Acoustic Treatment	90.1	67.7	75.6	90.1	65.6	74.2	102.8											

**DRY SORBENT INJECTION
COST ESTIMATE
UAF FACILITY COSTS**

FS Utility Rates

FY	Utility	Rate
22Q4	Electric	\$ 0.205000 per 1 Kilowatt Hour
	Sewer	\$ 10.810000 per 1000 Gallons
	Steam	\$ 12.390000 per 1000 Pounds
	Water	\$ 12.170000 per 1000 Gallons
2022	Electric	\$ 0.197000 per 1 Kilowatt Hour
	F&A	38.500000 %
	Sewer	\$ 10.150000 per 1000 Gallons
	Steam	\$ 11.640000 per 1000 Pounds
	Water	\$ 11.300000 per 1000 Gallons
2021	Electric	\$ 0.208000 per 1 Kilowatt Hour
	F&A	38.500000 %
	Sewer	\$ 8.020000 per 1000 Gallons
	Steam	\$ 16.130000 per 1000 Pounds
	Water	\$ 8.500000 per 1000 Gallons
2020	Electric	\$ 0.214000 per 1 Kilowatt Hour
	F&A	38.500000 %
	Sewer	\$ 7.350000 per 1000 Gallons
	Steam	\$ 16.250000 per 1000 Pounds
	Water	\$ 7.460000 per 1000 Gallons
2019	Electric	\$ 0.203000 per 1 Kilowatt Hour
	F&A	37.200000 %
	Sewer	\$ 7.000000 per 1000 Gallons
	Steam	\$ 15.470000 per 1000 Pounds
	Water	\$ 7.100000 per 1000 Gallons
2018		

H-54

**DRY SORBENT INJECTION
COST ESTIMATE
HYDRATED LIME COST**

Jahn, Mario

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Tuesday, May 31, 2022 9:12 PM
To: Jahn, Mario
Cc: PEETOOM Brad; DILLON Marty
Subject: Budgetary Bulk Pebble Lime and Hydrated Lime Pricing into Anchorage, AK from Langley, BC

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

Am also including Lhoist colleague and Canada Sales Manager, Mr. Brad Petoom, on this reply. Pricing for bulk quick lime and bulk hydrated lime are as presented in the tables below. Pricing is based on a 0.79 CAD per (\$1) US\$. The rates shown below do not include: (1.) truck fuel surcharge (FSC) (currently @ 44% of freight rate for May '22 and fluctuates monthly in accordance with the US Department of Energy policy), (2.) Energy Surcharge (FSC) (currently at \$9.20/ST for May '22 and fluctuates monthly with the cost of kiln fuel) or (3.) Canadian carbon offset tax which is currently at \$20.35/ST. Quick lime deliveries are ~40MT / 44ST whereas hydrated lime deliveries are 35MT / 39ST. Based on the cost of freight, highly recommend sizing storage vessels to be able to accommodate at least 1.5 deliveries.

Product @ FOB Shipment Location in Langley, BC	US\$/ST
Bulk Quick Lime	\$345
Bulk Quick Lime Freight	\$574
Product @ FOB Shipment Location in Langley, BC	US\$/ST
Bulk Hydrated Lime	\$402
Bulk Quick Lime Freight	\$656

For example with the applicable surcharges, for May 2022, quick lime would have a landed / delivered cost \$1,201.45/ST whereas hydrated lime would have a landed / delivered cost of \$1376.98/ST

Please feel free to reach out with any questions or comments and sincerely appreciate your patience and pricing inquiry!

Best,

Marty

Martin Dillon, P.E.

Lhoist North America

Manager, Flue Gas Treatment Applications
(720) 509-9484

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Tuesday, May 31, 2022 8:04 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Subject: Re: Pebble Lime and Hydrated Lime Pricing

Mario,

Apologize - a few of our folks in Canada have been on vacation and just hit them up again on getting this wrapped up.

Best,

Marty

Sent from my iPhone

On May 31, 2022, at 7:05 AM, Jahn, Mario <JahnMario@stanleygroup.com> wrote:

Caution! External email. Do not open any links or attachments unless you trust the sender and know the content is safe. If unsure, please report the message with the **PhishAlarm** button in Outlook.

Good Morning Marty,

I hope you had a good holiday weekend. Have you gotten pricing yet? Let me know.

Regards,
Mario

From: Jahn, Mario
Sent: Friday, May 20, 2022 8:05 AM
To: DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

No worries. It happens all the time.

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Friday, May 20, 2022 8:03 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Cc: DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Mario,

Apologize for calling you John, I misread your name in Outlook.

Best,

Marty

Martin Dillon, P.E.
Lhoist North America
Manager, Flue Gas Treatment Applications
(720) 509-9484

From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Friday, May 20, 2022 8:01 AM

To: DILLON Marty <Marty.Dillon@lhoist.com>

Subject: RE: Pebble Lime and Hydrated Lime Pricing

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Yes,

USD and ST's would be great. Thank you.

Mario

From: DILLON Marty <Marty.Dillon@lhoist.com>

Sent: Friday, May 20, 2022 8:00 AM

To: Jahn, Mario <JahnMario@stanleygroup.com>

Cc: DILLON Marty <Marty.Dillon@lhoist.com>

Subject: RE: Pebble Lime and Hydrated Lime Pricing

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John,

Sorry should have typed it out. ST = short tons (2000 lbs) vs. MT = metric tons (1000 kg/ 1104 lbs)

Best,

Marty

Martin Dillon, P.E.

Lhoist North America

Manager, Flue Gas Treatment Applications
(720) 509-9484

From: Jahn, Mario <JahnMario@stanleygroup.com>

Sent: Friday, May 20, 2022 7:55 AM

To: DILLON Marty <Marty.Dillon@lhoist.com>

Subject: RE: Pebble Lime and Hydrated Lime Pricing

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Can you remind me what ST's are?

-Mario

From: DILLON Marty <Marty.Dillon@lhoist.com>

Sent: Friday, May 20, 2022 7:53 AM

To: Jahn, Mario <JahnMario@stanleygroup.com>

Cc: DILLON Marty <Marty.Dillon@lhoist.com>

Subject: RE: Pebble Lime and Hydrated Lime Pricing

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

John,

Many thanks and that helps. We try to track projects like these to ensure we have resources lined up in advance. Just pinged our logistics folks on the freight quote. Given this is for AK, and unless you direct otherwise, will quote in \$USD and ST's.

Best,

Marty

Martin Dillon, P.E.

Lhoist North America

Manager, Flue Gas Treatment Applications
(720) 509-9484

From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Friday, May 20, 2022 7:50 AM
To: DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

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It's budgetary. Construction would probably be at least a year, plus the tie-in. First order of lime would be closer to Q1, 2024 would be my guess.

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Friday, May 20, 2022 7:47 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Cc: DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

John,

Understand. Is there an anticipated project timing or is just a study and/or budgetary?

Best,

Marty

Martin Dillon, P.E.

Lhoist North America

Manager, Flue Gas Treatment Applications
(720) 509-9484

From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Friday, May 20, 2022 7:44 AM
To: DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

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Marty,

Today's prices will work for us.

Regards,
Mario

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Friday, May 20, 2022 7:41 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Cc: Knapper, Kelly <KnapperKelly@stanleygroup.com>; DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

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John,

Apologize and thanks for the heads up n Mark's retirement. Let me check on the status of the freight component. Would you happen to know the anticipated startup timing if the project moves forward.

Best,

Marty

Martin Dillon, P.E.
Lhoist North America
Manager, Flue Gas Treatment Applications
(720) 509-9484

From: Jahn, Mario <JahnMario@stanleygroup.com>
Sent: Friday, May 20, 2022 7:03 AM
To: DILLON Marty <Marty.Dillon@lhoist.com>; Knapper, Kelly <KnapperKelly@stanleygroup.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

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Marty,

Have you had a chance to get some pricing both lime types yet? Let us know how it's going.

Just an FYI, Mark Fritz retired last week and I will be taking over his duties. We appreciate your continued support on this project. Let me know if you have any questions or concerns.

Regards,

**Mario Jahn, Mechanical Engineer****STANLEYCONSULTANTS**, 8000 South Chester Street Suite 500, Centennial, CO 80112
T: 303.649.7895 | M: 303.725.1361 | stanleyconsultants.com

From: Fritz, Mark <FritzMark@stanleygroup.com>
Sent: Friday, May 13, 2022 10:57 AM
To: DILLON Marty <Marty.Dillon@lhoist.com>; Knapper, Kelly <KnapperKelly@stanleygroup.com>
Cc: Jahn, Mario <JahnMario@stanleygroup.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

Bulk pneumatic.

Mark

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Friday, May 13, 2022 11:03 AM
To: Knapper, Kelly <KnapperKelly@stanleygroup.com>
Cc: Jahn, Mario <JahnMario@stanleygroup.com>; Fritz, Mark <FritzMark@stanleygroup.com>; DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

***** EXTERNAL EMAIL - Use caution and verify authenticity before trusting any contents. *****

Kelly,

Is this for bulk pneumatic quantities or super sacks?

Best,

Marty

Martin Dillon, P.E.

Lhoist North America

Manager, Flue Gas Treatment Applications
(720) 509-9484

From: Knapper, Kelly <KnapperKelly@stanleygroup.com>
Sent: Friday, May 13, 2022 10:33 AM
To: DILLON Marty <Marty.Dillon@lhoist.com>
Cc: Jahn, Mario <JahnMario@stanleygroup.com>; Fritz, Mark <FritzMark@stanleygroup.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

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Marty,

The attached data sheet contains information for free moisture and % availability of hydrated lime, could we get a delivery price for 400 tons/year of hydrated lime and quick lime to Fairbanks, Alaska?

Thank You,
Kelly Knapper

From: Fritz, Mark <FritzMark@stanleygroup.com>
Sent: Friday, May 13, 2022 10:28 AM
To: Knapper, Kelly <KnapperKelly@stanleygroup.com>
Cc: Jahn, Mario <JahnMario@stanleygroup.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

Kelly,

Please send the data sheet to Marty from Lhoist as ask him for a delivered price for quicklime and hydrated lime to Fairbanks. Include the information that we will use about 400 tons a year.

Mark

From: Knapper, Kelly <KnapperKelly@stanleygroup.com>
Sent: Friday, May 13, 2022 10:11 AM
To: Jahn, Mario <JahnMario@stanleygroup.com>
Cc: Fritz, Mark <FritzMark@stanleygroup.com>
Subject: FW: Pebble Lime and Hydrated Lime Pricing

Mario,

Here is the hydrated lime info, would you also be able to determine the quick lime info from this sheet?

Thanks!
Kelly

From: Fritz, Mark <FritzMark@stanleygroup.com>
Sent: Friday, May 13, 2022 10:01 AM
To: Knapper, Kelly <KnapperKelly@stanleygroup.com>
Subject: FW: Pebble Lime and Hydrated Lime Pricing

From: DILLON Marty <Marty.Dillon@lhoist.com>
Sent: Wednesday, February 16, 2022 9:04 AM
To: Fritz, Mark <FritzMark@stanleygroup.com>
Cc: DILLON Marty <Marty.Dillon@lhoist.com>
Subject: RE: Pebble Lime and Hydrated Lime Pricing

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Mark,

Hope this email finds you well. Wanted to check in on getting information on product type (e.g. quicklime, LS, or hydrated lime) and sizing (for QL and LS) for the project in Fairbanks.

Best,

Marty

Martin Dillon, P.E.

Lhoist North AmericaManager, Flue Gas Treatment Applications
(720) 509-9484

From: Fritz, Mark <FritzMark@stanleygroup.com>**Sent:** Thursday, January 20, 2022 8:28 AM**To:** DILLON Marty <Marty.Dillon@lhoist.com>**Subject:** Pebble Lime and Hydrated Lime Pricing

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Marty,

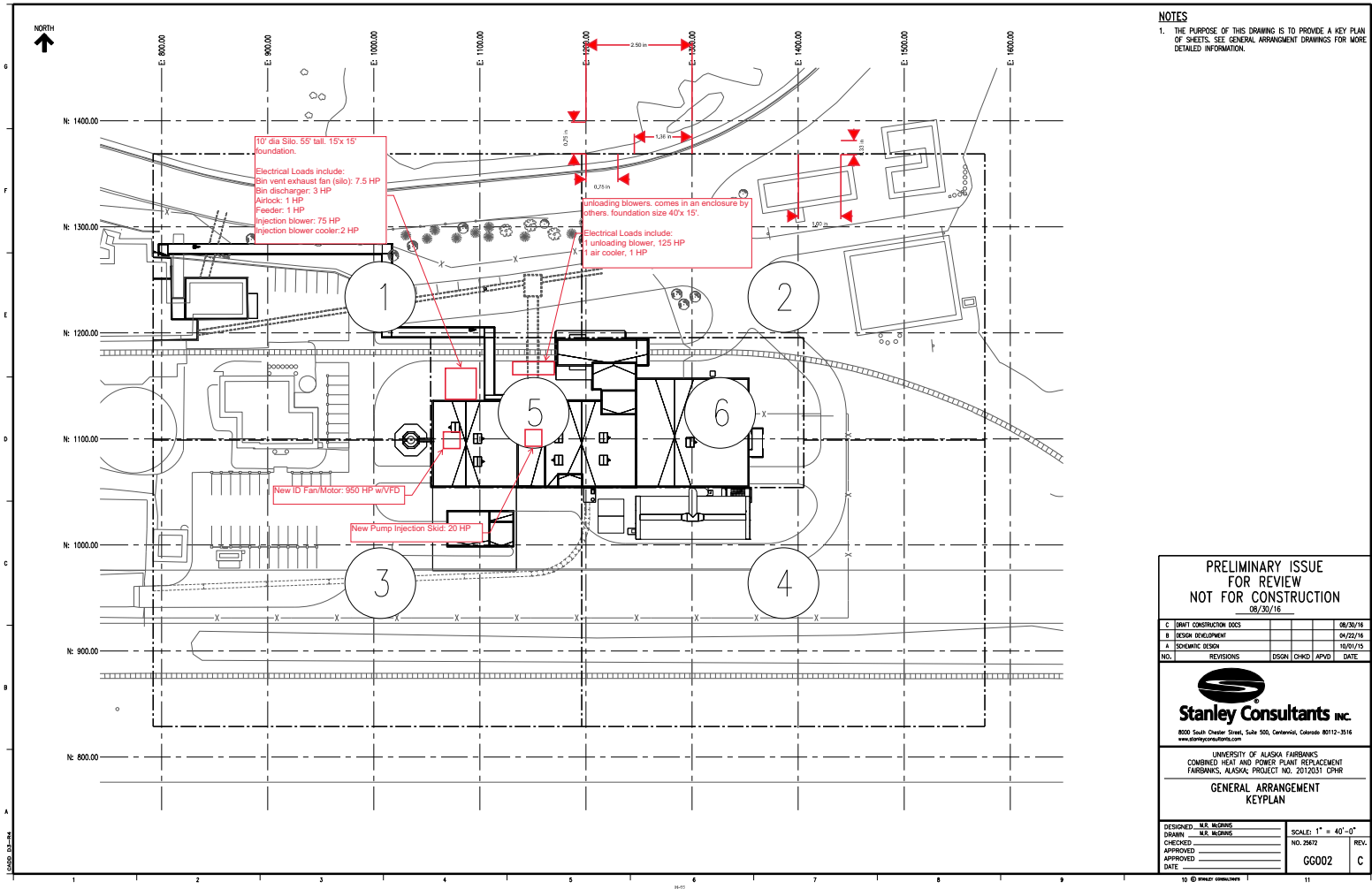
Stanley Consultants has worked with you before to get lime pricing for use in desulfurization pollution control equipment associated with coal boilers. We are looking for pebble and hydrated lime pricing for a project located in Fairbanks, AK. Are you still the contact to get some pricing? Please call to discuss the details.

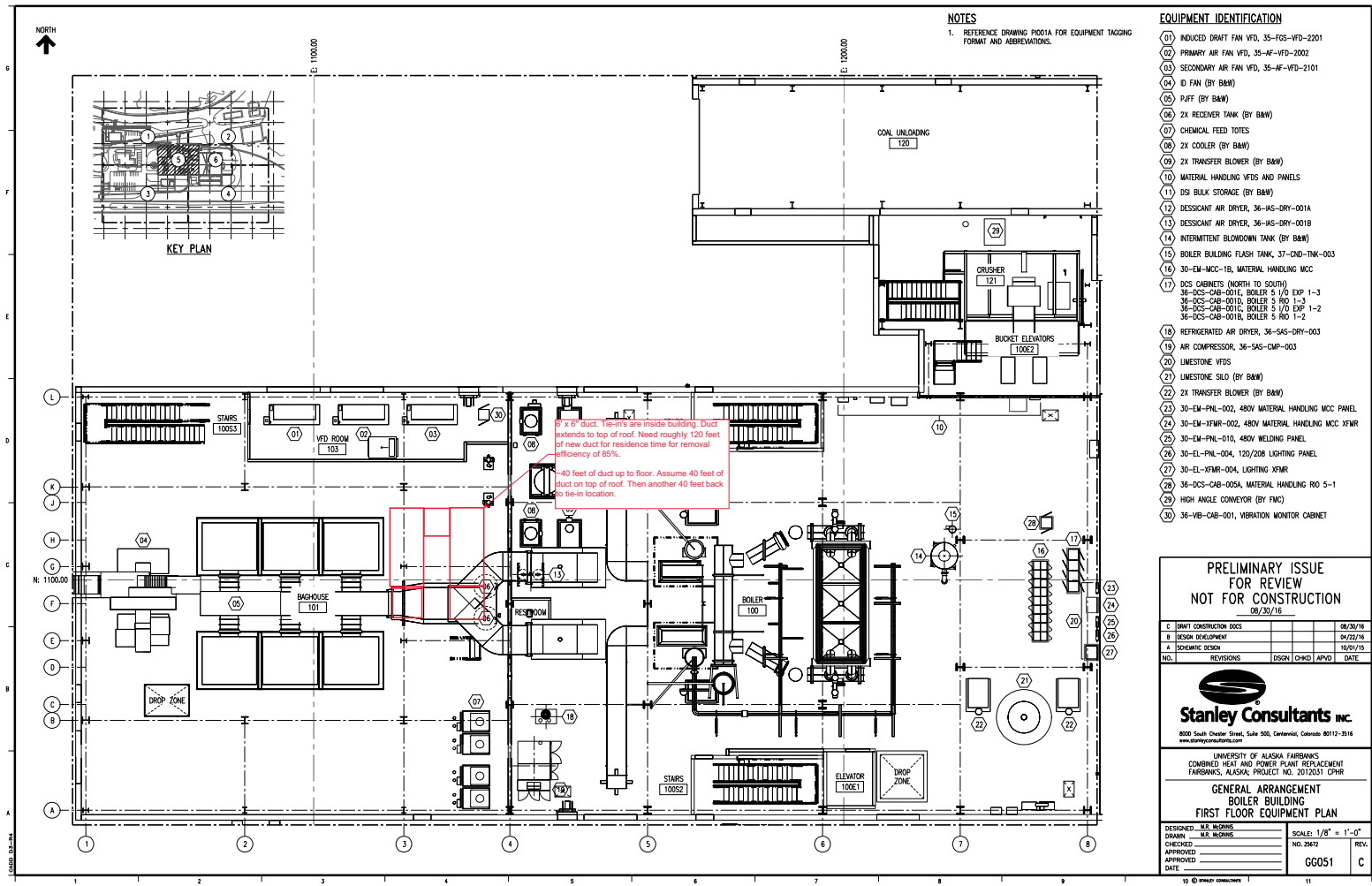
Mark

**Mark Fritz, Principal Mechanical Engineer****STANLEYCONSULTANTS**, 225 Iowa Avenue, Muscatine, Iowa 52657T: 563.264.6473 | M: 563-607-1430 | stanleyconsultants.com

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**DRY SORBENT INJECTION
COST ESTIMATE
PRELIMINARY SITE ARRANGMENT**





University of Alaska Fairbanks

Combined Heat and Power Plant

PROJECT CASE HISTORY

Babcock & Wilcox (B&W) designed and manufactured an internal recirculation circulating fluidized-bed (CFB) boiler and air quality control equipment for a new combined heat and power (CHP) plant for the University of Alaska Fairbanks (UAF).

Plant Name

University of Alaska Fairbanks

Location

Fairbanks, Alaska

B&W Scope

Steam supply

- Circulating fluidized-bed (CFB) boiler
- Power island building structural steel
- Coal silos
- Feeders and chutes

Air quality control equipment supply

- Limestone injection
- Dry sorbent injection
- Multiclone® dust collector
- Pulse jet fabric filter

Other

- Allen-Sherman-Hoff® bottom and fly ash handling systems
- Material transport systems
- B&W SPIG air-cooled condensers

Boiler Specifications

Capacity: 17 MW

Steam flow: 240,000 lb/hr (30.24 kg/s) steam

Steam pressure: 740 psig (5.1 MPa)

Steam temperature: 750F (399C)

Fuel: Alaskan subbituminous coal; flexibility to fire up to 15% biomass



Project Facts and Results

Boiler hydrostatic testing: October 2017

Construction completion: Fall 2018

First natural gas fire: Fall 2018

First coal fire: end of 2018

Boiler tuning: Fall 2019

UAF replaced the existing boilers originally built in 1964. The replacement CFB boiler will meet current power and steam demands as well as future growth requirements of the university.

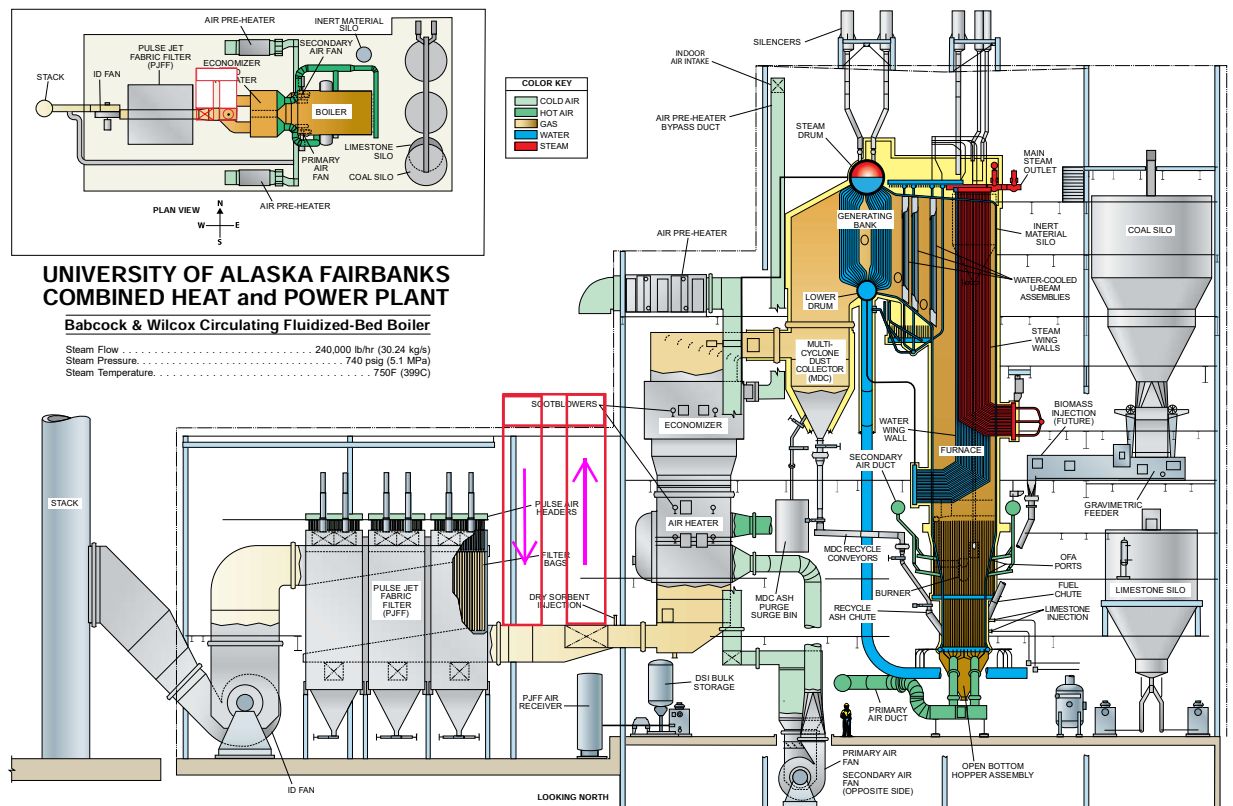
The electricity and low-pressure steam generated will power and provide heating and chilled water to the university's numerous buildings, classrooms, research facilities, and student housing located on approximately 3 million ft² (nearly 69 acres, or 28 hectares) of campus property.

The sub-arctic climate in Fairbanks created unique scheduling challenges as steel construction was required to stop when temperatures dropped below -15F (-26C), and all work stopped at temperatures of -30F (-34C).

Shipping and logistics were challenging due to the location of Fairbanks (360 miles [579 km]) from the port city of Anchorage.

Emissions results indicate the unit is capable of meeting nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate emissions permit limits throughout its load range.

continued ►



B&W's internal recirculation CFB boiler provides power plant owners with economy, reliability and flexibility. Our design employs a two-stage particle separation system to provide high-solids loading and a uniform furnace temperature profile. Additional features include reduced refractory (and thus, reduced maintenance), reduced tube erosion, and fuel and sorbent flexibility.

The benefits of this technology include superior combustion efficiency, low emissions, low maintenance, low pressure drop, and high turndown, resulting in improved overall plant performance.

The Babcock & Wilcox Company

1200 E Market Street, Suite 650
 Akron, Ohio, U.S.A. 44305
 Phone: +1 330.753.4511

www.babcock.com



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**CIRCULATING DRY SCRUBBER
COST ESTIMATE
UAF OPERATING AND MAINTENANCE LABOR COSTS**

Jahn, Mario

From: Payne, Mark
Sent: Friday, July 8, 2022 10:35 AM
To: Solan, John; Jahn, Mario
Subject: FW: Labor rate

Is this what you were expecting? Will it work?

Mark



Mark Payne, PE, PMP, Senior Project Manager
STANLEYCONSULTANTS, 8000 South Chester St, Suite 500, Centennial, CO 80112
T: 303.925.8375 | M: 720.240.3271 | stanleyconsultants.com

From: Frances Isgrigg <fisgrigg@alaska.edu>
Sent: Friday, July 8, 2022 10:28 AM
To: Courtney Kimball <ckimball@boreal-services.com>; Payne, Mark <PayneMark@stanleygroup.com>
Subject: Labor rate

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Please see below from our accounting department.

For each CT3, Step 1: salary (\$69,300) + staff benefits (\$32,800) is about \$102,100. This includes the new salary grid in effect for FY23 with the CBA extension agreement. It also includes the 12% Utilities shift premium. This does not include exceptional placement (if we hired at anything higher than Step 1) or any overtime.

Frances

--

Frances M. Isgrigg, PE
Division of Design and Construction
907-590-5809

Annual burdened salary = \$102,100
Divide by 2,080 work hours per year.
Hourly rate = \$49.09/hr

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**CIRCULATING DRY SCRUBBER
COST ESTIMATE
RS MEANS CONTINGENCY TABLE**

01 21 Allowances										
01 21 16 Contingency Allowances										
50	0010	CONTINGENCIES, Add to estimate								50
	0020	Conceptual stage			Project			20.0%	20.0%	
	0050	Schematic stage			Project			15.0%	15.0%	
	0100	Preliminary working drawing stage (Design Dev.)			Project			10.0%	10.0%	
	0150	Final working drawing stage			Project			3.0%	3.0%	

Screenshot from 2022 RS Means Contingency options.

**CIRCULATING DRY SCRUBBER
COST ESTIMATE
UAF CONSTRUCTION OUTAGE COSTS**

UAF Calculations - Daily Plant Outage Costs

Actual & Estimated Costs				
Cost per Day			Notes/Assumptions	Reference
<i>These costs/savings are associated with a turbine outage that began on Dec 28, 2021 and ended on June 3, 2022. Support invoicing can be provided if requested.</i>				
<u>Costs</u>				
Electricity	\$	8,002	Purchase of Electricity	Table A
Fuel	\$	54,066	Purchase of Diesel	Table B
Natural Gas	\$	1,794	Boilers go down, we need to light them for a longer duration. In prior year, no natural gas was used during these months	Table C
<u>Avoided Costs</u>				
Coal Delivery	\$	(2,459)		Table D
Coal	\$	(10,255)		Table E
Ash Haul	\$	(1,712)		Table F
Limestone	\$	(1,408)		Table G
Grand Total	\$	48,028		

This spreadsheet does not include the lost revenue from electricity sales to Golden Valley Electric.

Table A.
UAF Plant Outage Costs - Electricity

Vendor: GVEA	Utility	Usage	Cost Break Down	Total	Days per Month
01/01/2022- 02/01/2022	ELECTRIC				
		Fuel & Purchased	4,690,000 kwh @ \$0.1045	\$ 490,105.00	
		Utility Charge	4,690,000 kwh @ \$0.01257	\$ 58,953.30	
		Demand Charge	7207.2 KW @30.06	\$ 216,648.43	
		RCC	4,690,000 kwh @ \$0.001016	\$ 4,765.04	
		Customer Charge		\$ 220.00	
		Total:		\$ 770,691.77	31
		(About \$24,861.02 per day)	1/28-1/31 (4 days)	\$99,444.08	
02/01/2022- 03/01/2022	Electric	Fuel & Purchased	4,424,000 kwh @ \$0.12969	\$573,748.56	
		Utility Charge	4,424,000 kwh @ \$0.01257	\$55,609.68	
		Demand Charge	7737.80 KW @30.06	\$232,598.27	
		RCC	4424000 kwh @ \$0.001016	\$4,494.78	
		Customer Charge		\$220.00	
		Total:		\$866,671.29	28
		(About \$30,952.55 per day)			
03/01/2022- 04/01/2022	Electric	Fuel & Purchased	4,564,000 kwh @0.12969	\$591,905.16	
		Utility Charge	4,564,000 kwh @0.01257	\$57,369.48	
		Demand Charge	6941.20 KW @30.06	\$208,652.47	
		RCC	4,564,000 kwh @0.001016	\$4,637.02	
		Customer Charge		\$220.00	
		Total:		\$862,784.13	31
		(About \$27,831.75 per day)			
04/01/2022- 05/01/2022	Electric	Fuel & Purchased	4,368,000 kwh @0.12969	\$566,485.92	
		Utility Charge	4,368,000 kwh @0.01257	\$54,905.76	
		Demand Charge	6,844.6 KW @30.06	\$205,748.68	
		RCC	4,368,000 kwh @0.001016	\$4,437.89	
		Customer Charge		\$220.00	
		Total:		\$831,798.25	30
		(About \$27,726.61 per day)			
05/01/2022- 06/01/2022	Electric	Fuel & Purchased	3,906,000 kwh @0.14036	\$548,246.16	
		Utility Charge	3,906,000 kwh @0.01257	\$49,098.42	
		Demand Charge	7,267.4 KW @30.06	\$218,458.04	
		RCC	3,906,000 kwh @0.001016	\$3,968.50	
		Customer Charge		\$220.00	
		Total:		\$819,991.12	31
		(About \$26,637.69 per day)			
06/01/2022- 07/01/2022	Electric	Fuel & Purchased	42,000 kwh @0.14036	\$5,895.12	
		Utility Charge	42,000 kwh @0.01257	\$527.94	
		Demand Charge	7,827.4 KW @30.06	\$235,291.64	
		RCC	42,000 kwh @0.000893	\$37.51	
		Customer Charge		\$220.00	
		Total:		\$241,972.21	30
		(About \$146,282.96 per day)			
Grand Electric Total (1/28-6/3/22): \$ 3,722,661.08					181 total Days
Remove "Customer Charge" \$ (1,320.00)				Paid monthly regardless of usage	
Electric Costs (1/28-6/3/22) \$ 3,721,341.08					
12/01/2021- 01/01/2022	ELECTRIC				
		Fuel & Purchased	1,694,000 kwh @ \$0.1045	\$ 177,023.00	
		Utility Charge	1,694,000 kwh @ \$0.01257	\$ 21,293.58	
		Demand Charge	6,804 KW @30.06	\$ 204,528.24	
		RCC	1,694,000 kwh @ \$0.001016	\$ 1,721.10	
		Customer Charge		\$ 220.00	
		Total:		\$ 404,785.92	4 Days

01/01/2022- 02/01/2022 ELECTRIC

Fuel & Purchased	4,690,000 kwh @ \$0.1045	\$	490,105.00
Utility Charge	4,690,000 kwh @ \$0.01257	\$	58,953.30
Demand Charge	7207.2 KW @30.06	\$	216,648.43
RCC	4,690,000 kwh @ \$0.001016	\$	4,765.04
Customer Charge		\$	220.00
Total:		\$	770,691.77
(About \$24,861.02 per day)	1/1-1/27 (27 days)		\$671,247.54

Grand Electric Total (12/19/21-1/27/22): \$ 1,076,033.46

Remove "Customer Charge" \$ (440.00) Paid monthly regardless of usage

Electric Costs (12/19/21-1/27/22) \$ 1,075,593.46

Total Electric costs (12/19/2021 - 6/3/2022) \$ 1,480,379.38

Total Days \$ 185.00

Cost Per Day \$ 8,002.05

Table B.
UAF Plant Outage Costs - Diesel Fuel

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
Alaska Petroleum		Gallons	per gal & SOA Fee		
21-Dec	651087	8,904	\$2.87	\$ 25,936.35	10
21-Dec	651088	8,900	\$2.87	\$ 25,924.70	
24-Dec	677512	8,206	\$3.02	\$ 25,180.01	
24-Dec	677513	8,204	\$3.02	\$ 25,173.87	
24-Dec	677514	8,204	\$3.02	\$ 25,173.87	
26-Dec	677518	6,801	\$3.02	\$ 20,868.78	
26-Dec	677517	7,120	\$3.02	\$ 21,847.63	
28-Dec	681603	9,598	\$3.02	\$ 29,451.34	
28-Dec	681602	9,599	\$3.02	\$ 29,454.41	
29-Dec	677526	3,802	\$3.08	\$ 11,897.93	
29-Dec	677527	3,802	\$3.08	\$ 11,897.93	
29-Dec	677528	3,802	\$3.08	\$ 11,897.93	
29-Dec	677636	11,067	\$3.08	\$ 34,632.93	
30-Dec	677633	10,622	\$3.10	\$ 33,383.74	
30-Dec	677635	9,801	\$3.10	\$ 30,803.43	
30-Dec	672948	9,703	\$3.10	\$ 30,495.43	
30-Dec	672949	9,602	\$3.10	\$ 30,178.00	
31-Dec	616240	9,602	\$3.12	\$ 30,372.92	
1-Jan	677544	8,705	\$3.09	\$ 27,284.61	
1-Jan	672918	9,603	\$3.09	\$ 30,099.26	
1-Jan	616239	9,602	\$3.09	\$ 30,096.13	
1-Jan	616241	9,602	\$3.09	\$ 30,096.13	
2-Jan	672919	9,603	\$3.09	\$ 30,099.26	
2-Jan	672499	9,603	\$3.09	\$ 30,099.26	
3-Jan	672920	9,607	\$3.09	\$ 30,111.80	
3-Jan	672925	9,603	\$3.09	\$ 30,099.26	
3-Jan	672926	9,608	\$3.09	\$ 30,114.94	
3-Jan	677553	8,705	\$3.09	\$ 27,284.61	
4-Jan	672910	9,606	\$3.22	\$ 31,347.90	
4-Jan	672908	9,605	\$3.22	\$ 31,344.64	
5-Jan	672922	9,602	\$3.30	\$ 32,130.13	
5-Jan	672497	9,602	\$3.30	\$ 32,130.13	
6-Jan	672911	9,605	\$3.34	\$ 32,545.73	
6-Jan	672921	9,604	\$3.34	\$ 32,542.34	
7-Jan	672913	9,603	\$3.34	\$ 32,578.91	
7-Jan	672914	9,605	\$3.34	\$ 32,585.70	
8-Jan	672887	9,703	\$3.34	\$ 32,918.17	
8-Jan	672923	9,703	\$3.34	\$ 32,918.17	
8-Jan	672888	9,703	\$3.34	\$ 32,918.17	
11-Jan	676832	9,703	\$3.40	\$ 33,526.81	
11-Jan	676833	9,703	\$3.40	\$ 33,526.81	
11-Jan	676834	9,705	\$3.40	\$ 33,533.72	
12-Jan	676835	9,704	\$3.43	\$ 33,782.41	
12-Jan	676836	9,703	\$3.43	\$ 33,778.93	

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
12-Jan	676837	9,704	\$3.43	\$ 33,782.41	
13-Jan	676838	9,703	\$3.40	\$ 33,476.58	
13-Jan	676839	9,700	\$3.40	\$ 33,466.23	
13-Jan	676840	9,699	\$3.40	\$ 33,462.78	
14-Jan	676841	9,698	\$3.44	\$ 33,811.73	
14-Jan	676842	9,700	\$3.44	\$ 33,818.70	
14-Jan	676843	9,700	\$3.44	\$ 33,818.70	
15-Jan	676844	9,602	\$3.43	\$ 33,477.03	
15-Jan	676845	9,603	\$3.43	\$ 33,480.51	
15-Jan	676846	9,451	\$3.43	\$ 32,950.57	
15-Jan	676847	9,450	\$3.43	\$ 32,947.09	
15-Jan	677560	9,396	\$3.43	\$ 32,758.82	
16-Jan	676848	9,792	\$3.43	\$ 34,139.46	
16-Jan	676849	9,790	\$3.43	\$ 34,132.48	
16-Jan	676850	9,802	\$3.43	\$ 34,174.32	
16-Jan	676851	9,958	\$3.43	\$ 34,718.21	
17-Jan	677565	8,300	\$3.43	\$ 28,937.65	
19-Jan	677574	8,200	\$3.45	\$ 28,738.82	
19-Jan	677575	8,200	\$3.45	\$ 28,738.82	
19-Jan	677576	8,205	\$3.45	\$ 28,756.34	
20-Jan	677577	8,200	\$3.43	\$ 28,568.20	
20-Jan	677578	8,200	\$3.43	\$ 28,567.20	
20-Jan	677579	8,200	\$3.43	\$ 28,568.20	
21-Jan	676852	9,453	\$3.45	\$ 33,119.70	
21-Jan	676853	9,453	\$3.45	\$ 33,119.70	
21-Jan	676854	9,453	\$3.45	\$ 33,119.70	
22-Jan	676855	8,802	\$3.45	\$ 30,838.84	
22-Jan	676856	8,803	\$3.45	\$ 30,842.35	
24-Jan	676857	8,971	\$3.34	\$ 30,394.74	
24-Jan	670007	9,053	\$3.34	\$ 30,672.57	
24-Jan	670008	9,058	\$3.34	\$ 30,689.51	
25-Jan	670009	9,275	\$3.38	\$ 31,817.29	
25-Jan	670010	9,285	\$3.38	\$ 31,851.60	
25-Jan	670011	9,286	\$3.38	\$ 31,855.03	
26-Jan	670012	9,309	\$3.45	\$ 32,641.63	
26-Jan	670013	9,302	\$3.45	\$ 32,617.09	
26-Jan	670014	9,294	\$3.45	\$ 32,589.04	
27-Jan	670017	9,294	\$3.50	\$ 33,018.26	
27-Jan	670018	9,307	\$3.50	\$ 33,064.44	
28-Jan	670019	9,307	\$3.49	\$ 32,979.42	
28-Jan	670020	9,308	\$3.49	\$ 32,982.96	
28-Jan	670021	9,315	\$3.49	\$ 33,007.77	
29-Jan	670022	9,309	\$3.49	\$ 32,986.51	
31-Jan	670028	9,324	\$3.46	\$ 32,790.76	
31-Jan	670027	9,338	\$3.46	\$ 32,840.00	
3-Feb	670050	9,342	\$3.45	\$ 32,667.27	
3-Feb	670051	9,335	\$3.45	\$ 32,642.79	
3-Feb	675818	4,509	\$3.45	\$ 15,767.15	

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
4-Feb	670055	9,328	\$3.48	\$ 32,955.37	28
7-Feb	670060	8,929	\$3.41	\$ 30,914.03	
16-Feb	686694	8,901	\$3.31	\$ 29,932.61	
23-Feb	686728	9,512	\$3.28	\$ 31,714.08	
25-Feb	686734	9,092	\$3.36	\$ 31,008.65	
25-Feb	686735	9,094	\$3.36	\$ 31,015.47	
25-Feb	686736	9,084	\$3.36	\$ 30,981.36	
28-Feb	686548	9,506	\$3.52	\$ 34,005.88	
1-Mar	680982	9,705	\$3.74	\$ 36,882.92	
1-Mar	680983	4,500	\$3.74	\$ 17,101.82	
1-Mar	680984	5,214	\$3.74	\$ 19,815.30	
1-Mar	680985	5,526	\$3.74	\$ 21,001.03	
1-Mar	671050	8,584	\$3.74	\$ 32,622.66	
1-Mar	671051	8,481	\$3.74	\$ 32,231.22	
1-Mar	680553	9,812	\$3.74	\$ 37,289.56	
5-Mar	686765	8,373	\$4.45	\$ 37,792.74	
5-Mar	686766	8,364	\$4.45	\$ 37,752.12	
5-Mar	686767	8,355	\$4.45	\$ 37,711.50	
7-Mar	687520	8,352	\$4.62	\$ 39,183.17	
7-Mar	676634	8,172	\$4.62	\$ 38,338.71	
7-Mar	671017	8,159	\$4.62	\$ 38,277.72	
8-Mar	687522	8,350	\$5.15	\$ 43,630.08	
8-Mar	687523	8,346	\$5.15	\$ 43,609.18	
9-Mar	687835	9,310	\$4.17	\$ 39,451.72	
9-Mar	660744	8,953	\$4.17	\$ 37,938.91	
9-Mar	660745	8,951	\$4.17	\$ 37,930.44	
10-Mar	687537	9,069	\$4.02	\$ 36,975.15	
10-Mar	687538	9,068	\$4.02	\$ 36,971.08	
10-Mar	687539	9,067	\$4.02	\$ 36,967.00	
12-Mar	687544	9,083	\$4.15	\$ 38,243.64	
12-Mar	687545	9,086	\$4.15	\$ 38,256.27	
12-Mar	687546	9,080	\$4.15	\$ 38,231.01	
13-Mar	687856	9,093	\$4.15	\$ 38,285.75	
13-Mar	687857	9,067	\$4.15	\$ 38,176.27	
14-Mar	687549	9,089	\$3.97	\$ 36,642.48	
14-Mar	687550	9,083	\$3.97	\$ 36,618.29	
14-Mar	688722	8,624	\$3.97	\$ 34,767.82	
14-Mar	688723	8,619	\$3.97	\$ 34,747.66	
14-Mar	687859	9,335	\$3.97	\$ 37,634.23	
16-Mar	688291	9,381	\$3.80	\$ 36,141.95	
16-Mar	688292	9,370	\$3.80	\$ 36,099.58	
17-Mar	687551	9,090	\$4.30	\$ 38,640.32	
17-Mar	687552	9,073	\$4.30	\$ 38,568.06	
18-Mar	687554	9,082	\$4.30	\$ 39,626.77	
18-Mar	687555	9,073	\$4.30	\$ 39,587.51	
19-Mar	687556	9,097	\$4.30	\$ 39,692.22	
19-Mar	687557	9,088	\$4.30	\$ 39,652.95	
19-Mar	687558	9,079	\$4.30	\$ 39,613.68	

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
20-Mar	671021	9,382	\$4.30	\$ 40,935.74	
20-Mar	671022	9,390	\$4.30	\$ 40,970.65	
21-Mar	687928	9,081	\$4.50	\$ 41,491.66	
22-Mar	671026	8,682	\$4.56	\$ 40,226.42	
22-Mar	671027	8,682	\$4.56	\$ 40,226.42	
22-Mar	671028	8,688	\$4.56	\$ 40,254.22	
22-Mar	688435	8,377	\$4.56	\$ 38,813.26	
22-Mar	687933	9,359	\$4.56	\$ 43,363.17	
24-Mar	687936	9,085	\$4.81	\$ 44,345.48	
24-Mar	687937	9,076	\$4.81	\$ 44,301.55	
24-Mar	687938	9,067	\$4.81	\$ 44,257.62	
24-Mar	670083	8,375	\$4.81	\$ 40,879.85	
24-Mar	670084	8,359	\$4.81	\$ 40,801.75	
27-Mar	687943	9,046	\$4.77	\$ 43,798.86	
27-Mar	687944	9,038	\$4.77	\$ 43,760.13	
28-Mar	687566	9,047	\$4.44	\$ 40,762.39	
28-Mar	687567	9,042	\$4.44	\$ 40,739.87	
28-Mar	687568	9,032	\$4.44	\$ 40,694.81	
29-Mar	687570	8,846	\$4.37	\$ 39,252.50	
29-Mar	687571	8,834	\$4.37	\$ 39,199.25	
29-Mar	687572	8,824	\$4.37	\$ 39,154.88	
29-Mar	669595	8,333	\$4.37	\$ 36,976.16	
30-Mar	687573	9,050	\$4.14	\$ 38,007.33	
30-Mar	687574	9,047	\$4.14	\$ 37,994.73	31
2-Apr	671033	8,502	\$4.13	\$ 35,680.00	
5-Apr	687963	9,060	\$4.18	\$ 38,428.19	
5-Apr	687964	9,051	\$4.18	\$ 38,390.02	
6-Apr	687576	9,049	\$4.06	\$ 37,251.82	
6-Apr	671036	8,848	\$4.06	\$ 36,424.36	
6-Apr	671037	8,829	\$4.06	\$ 36,346.15	
6-Apr	671038	8,834	\$4.06	\$ 36,366.73	
7-Apr	687970	8,540	\$3.98	\$ 34,485.52	
7-Apr	688837	9,063	\$3.98	\$ 36,597.45	
7-Apr	688838	9,046	\$3.98	\$ 36,528.80	
7-Apr	688839	9,051	\$3.98	\$ 36,548.99	
8-Apr	672486	9,877	\$4.03	\$ 40,383.73	
8-Apr	672487	9,882	\$4.03	\$ 40,404.17	
9-Apr	672485	9,919	\$4.03	\$ 40,555.45	
9-Apr	474187	9,874	\$4.03	\$ 40,371.46	
10-Apr	687972	9,067	\$4.03	\$ 37,071.91	
11-Apr	671042	9,141	\$3.93	\$ 36,424.39	
13-Apr	671046	8,630	\$4.37	\$ 38,314.18	
13-Apr	671047	8,614	\$4.37	\$ 38,243.15	
13-Apr	688847	9,034	\$4.37	\$ 40,107.80	
13-Apr	688848	9,043	\$4.37	\$ 40,147.76	
14-Apr	688849	9,046	\$4.51	\$ 41,413.46	
14-Apr	688850	9,032	\$4.51	\$ 41,349.37	
14-Apr	688851	9,018	\$4.51	\$ 41,285.28	

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
15-Apr	688852	9,048	\$4.51	\$ 41,422.62	30
15-Apr	688853	9,039	\$4.51	\$ 41,381.42	
15-Apr	688854	9,028	\$4.51	\$ 41,331.06	
17-Apr	663673	9,026	\$4.51	\$ 41,321.90	
18-Apr	663607	8,607	\$4.51	\$ 39,062.97	
18-Apr	671049	8,624	\$4.51	\$ 39,140.12	
19-Apr	688866	9,019	\$4.42	\$ 40,485.19	
19-Apr	688867	9,002	\$4.42	\$ 40,408.88	
20-Apr	688869	9,023	\$4.53	\$ 41,521.56	
20-Apr	688870	9,006	\$4.53	\$ 41,443.33	
21-Apr	688871	9,040	\$4.46	\$ 40,936.39	
21-Apr	688872	9,024	\$4.46	\$ 40,863.94	
21-Apr	688873	8,999	\$4.46	\$ 40,750.73	
22-Apr	688878	3,828	\$4.50	\$ 17,481.44	
25-Apr	669938	8,798	\$4.65	\$ 41,538.11	
26-Apr	688887	8,992	\$4.62	\$ 42,193.02	
26-Apr	688888	3,816	\$4.62	\$ 17,905.76	
27-Apr	651134	8,484	\$4.65	\$ 40,040.12	
27-Apr	688891	8,993	\$4.65	\$ 42,442.34	
27-Apr	688892	8,995	\$4.65	\$ 42,451.78	
28-Apr	651137	4,037	\$4.71	\$ 19,316.04	
28-Apr	688893	9,008	\$4.71	\$ 43,101.03	
28-Apr	688894	8,997	\$4.71	\$ 43,048.40	
28-Apr	688895	8,969	\$4.71	\$ 42,914.43	
29-Apr	688899	3,836	\$4.72	\$ 18,388.57	
30-Apr	688900	9,009	\$4.72	\$ 43,186.29	
30-Apr	688901	8,975	\$4.72	\$ 43,023.30	
3-May	688904	8,966	\$4.79	\$ 43,621.74	
3-May	688905	8,960	\$4.79	\$ 43,592.55	
5-May	688906	8,993	\$4.75	\$ 43,329.57	
5-May	688907	8,970	\$4.75	\$ 43,218.75	
5-May	688908	8,976	\$4.75	\$ 43,247.66	
9-May	688922	8,992	\$4.54	\$ 41,440.96	
11-May	672428	9,831	\$4.66	\$ 46,468.11	
11-May	672429	9,805	\$4.66	\$ 46,345.22	
12-May	672837	9,832	\$4.60	\$ 45,873.07	
12-May	672837	9,821	\$4.60	\$ 45,821.75	
13-May	672839	9,837	\$4.71	\$ 47,045.63	
13-May	672840	9,823	\$4.71	\$ 46,978.67	
17-May	662097	8,955	\$4.56	\$ 41,355.88	
17-May	662098	8,974	\$4.56	\$ 41,443.63	
18-May	662101	8,960	\$4.42	\$ 40,185.79	
18-May	662102	8,953	\$4.42	\$ 40,154.39	
19-May	662105	8,948	\$4.62	\$ 41,983.83	
19-May	662106	8,932	\$4.62	\$ 41,908.76	
21-May	676350	9,664	\$4.60	\$ 45,167.71	
21-May	676351	9,647	\$4.60	\$ 45,088.26	
21-May	676352	9,649	\$4.60	\$ 45,097.60	

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
23-May	662118	8,922	\$4.69	\$ 42,466.77	
24-May	662275	8,411	\$4.70	\$ 40,145.51	
26-May	662125	8,936	\$4.89	\$ 44,340.16	
26-May	662126	8,917	\$4.89	\$ 44,245.88	
26-May	662127	8,906	\$4.89	\$ 44,191.30	
29-May	662136	8,681	\$4.98	\$ 43,888.13	
31-May	662245	8,704	\$5.03	\$ 44,399.32	
31-May	662139	3,792	\$5.03	\$ 19,343.09	
31-May	662140	3,787	\$5.03	\$ 19,317.58	31
Totals		2,170,984			

Fuel Delivered (12/21/22-5/31/22):

NET EXPENSE

Total Fuel Expenses	8,704,637
Total Days	161

Cost Per Day	\$ 54,066
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Table C.
UAF Plant Outage Costs - Natural Gas

Vendor	Utility	Usage (CCF)	Cost (per CCF)	Total	Days in a month
Interior Gas Utilty	Natural Gas				
2022-01		5,855	\$ 19.50	\$ 114,172.50	31
2022-01				\$ 500.00	
2022-02		4,360	\$ 19.50	\$ 85,020.00	28
2022-02				\$ 500.00	
2022-03		992	\$ 19.50	\$ 19,344.00	31
2022-03				\$ 500.00	
2022-04		0		\$ 500.00	
2022-05		1,397	\$ 19.50	\$ 27,241.50	31
2022-05				\$ 500.00	

Total Natural Gas Charges (1/28-6/03/22) \$ 219,536.50

Remove "Service Charge" \$ (2,500.00) Paid monthly regardless of usage

NET EXPENSE

NG Expense	\$ 217,036.50
Total Days	121

Cost per Day	\$ 1,793.69
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Table D.
UAF Plant Outage Costs - Coal Transport (Avoided Cost Calculation)

Vendor	Utility	Usage	AKRR Invoices	Invoice #	Tons	Cost (per ton)	Total
Usibelli	Coal		1/31/2022	226005543	442.2	14.39	6,363.26
1/28-1/31/21		931.00	2/1/2022	226005646	265.8		3,824.86
Feb 2021		9,117.80	2/3/2022	226005655	271.4		3,905.45
Mar 2021		8,887.50	2/7/2022	226005662	262		3,770.19
April 2021		6,848.20	2/8/2022	226005669	730.55		10,512.62
May 2021		1,718.40	2/9/2022	226005786	258		3,712.62
6/1-6/3/21		1,216.30	2/11/2022	226005794	459		6,605.01
			2/14/2022	226005809	262.8		3,781.69
			2/15/2022	226005813	357.3		5,141.54
			2/16/2022	226005825	261.5		3,763.00
			2/17/2022	226005844	351.85		5,063.12
			2/18/2022	226005854	341.8		4,918.50
			2/22/2022	226005858	425.95		6,129.42
			2/23/2022	226005881	339.85		4,890.44
			2/24/2022	226005883	364.55		5,245.87
			2/25/2022	226005887	454.7		6,543.13
			2/28/2022	226005907	357.5		5,144.43
			5/16/2022	226006619	582.7		8,385.06
			5/25/2022	226006728	178.9		2,574.37
			5/26/2022	226006737	183.05		2,634.09
			5/31/2022	226006768	540.2		7,773.48
			6/1/2022	226006878	551.5		7,936.09
			6/2/2022	226006881	452.45		6,510.76
			6/3/2022	226006896	526.8		7,580.65
			Actual Spent 1/28-6/3				132,709.65

Table E.
UAF Plant Outage Costs - Coal (Avoided Cost Calculation)

Vendor	Utility	Usage
Usibelli	Coal	
	1/28-1/31/21	931.00
	Feb 2021	9,117.80
	Mar 2021	8,887.50
	April 2021	6,848.20
	May 2021	1,718.40
	6/1-6/3/21	1,216.30
Average Daily Burn:		226.14
	Average Daily Burn:	226.14
	Cost per ton (UCM): \$	60.00
Days coal would be burned (1/28/22-6/3/22):		127
Would be consumed Coal (tons):		28,719.20
Cost (UCM):		<u>1,723,152.00</u>
Net Savings (1/28-6/3/22):		<u>1,169,811.00</u>
Days coal would be burned (12/19/21-1/27/22):		40
Would be consumed Coal (tons):		9,045.42
Cost (UCM):		<u>542,725.04</u>
Net Savings (12/19/21-1/27/22):		<u>542,725.04</u>
Net Savings		
Total Coal Expenses \$		1,712,536
Total Days		167
Total Net Savings per Day \$		10,255

Invoices	Invoice #	Tons	Invoice Amount
1/31/2022	70775	442.20	26,532.00
2/1/2022	70779	265.80	15,948.00
2/3/2022	70789	271.40	16,284.00
2/7/2022	70793	262.00	15,720.00
2/8/2022	70797	730.55	43,833.00
2/9/2022	70801	258.00	15,480.00
2/11/2022	70808	459.00	27,540.00
2/14/2022	70812	262.80	15,768.00
2/15/2022	70816	357.30	21,438.00
2/16/2022	70820	261.50	15,690.00
2/17/2022	70824	351.85	21,111.00
2/18/2022	70828	341.80	20,508.00
2/22/2022	70832	425.95	25,557.00
2/23/2022	70836	339.85	20,391.00
2/24/2022	70840	364.55	21,873.00
2/25/2022	70844	454.70	27,282.00
2/28/2022	70848	357.50	21,450.00
5/16/2022	70995	582.70	34,962.00
5/25/2022	71007	178.90	10,734.00
5/26/2022	71011	183.05	10,983.00
5/31/2002	71015	540.20	32,412.00
6/1/2022	71021	551.50	33,090.00
6/2/2022	71025	452.45	27,147.00
6/3/2022	71031	526.80	31,608.00
Total Spent 1/28-6/3/22			553,341.00

Table F.
UAF Plant Outage Costs - Ash Hauling (Avoided Cost Calculation)

Vendor	Utility	Usage (truckful)	Cost (per truckful)	Total	Days/Month
Aurora Energy	Ash Haul				
2nd half	December 2020	22.00	\$880.00	\$19,360.00	15.5
	January 2021	48.00	\$880.00	\$42,240.00	31
	February 2021	58.00	\$880.00	\$51,040.00	28
	March 2021	60.00	\$880.00	\$52,800.00	31
	April 2021	56.00	\$880.00	\$49,280.00	30
	May 2021	12.00	\$880.00	\$10,560.00	31
	June 2021	50.00	\$880.00	\$44,000.00	30
	July 2021	59.00	\$880.00	\$51,920.00	31
	Aug 2021	81.00	\$880.00	\$71,280.00	31
	Sept 2021	74.00	\$880.00	\$65,120.00	30
	Oct 2021	66.00	\$880.00	\$58,080.00	31
	Nov 2021	69.00	\$880.00	\$60,720.00	30
1st half	Dec 2021	55.00	\$880.00	\$48,400.00	15.5

NET SAVINGS

Ash Haul Expenses	\$624,800
Total Days	\$365

Savings per Day	\$ 1,712
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Table G.
UAF Plant Outage Costs - Limestone (Avoided Cost Calculation)

Vendor	Utility	Usage (tons or hours)	Cost (per ton)	Total	Days in Month
Globe Creek	Limestone				
	July 2021	206.79 tons	\$290.86	\$60,146.94	31
	July 2021	13.25 hours	\$182.85	\$2,422.76	
	Aug 2021	194.92 tons	\$287.63	\$56,064.84	31
	Aug 2021	12.25 hours	\$180.42	\$2,210.15	
	Sept 2021	114.10 tons	\$287.63	\$32,818.58	30
	Sept 2021	7.25 hours	\$180.42	\$1,308.05	
	Oct 2021	171.28 tons	\$287.63	\$49,265.27	31
	Oct 2021	10.75 hours	\$180.42	\$1,939.52	
	Nov 2021	214.27 tons	\$287.63	\$61,630.48	30
	Nov 2021	14.75 hours	\$180.42	\$2,661.20	
1st half	Dec 2021	84.22 tons	\$287.63	\$24,224.20	15.5
1st half	Dec 2021	3.75 hours	\$180.42	\$676.58	
Total Spent 7/1-12/14				\$270,467.77	

			Average monthly tons:	180.27
			Average monthly hours:	11.65
			Cost per ton:	\$287.63
			Cost per hour:	\$180.42
			Months of usage (1/28/22-06/03/22):	4.23
			Expected tons:	763
			Expected hours:	49
			Total Cost (1/28/22-06/03/22):	228,223.42

Total cost for Limestone (Savings Projection): \$228,223.42

Vendor	Utility	U/M	Usage	Rate	Total	Invoice #
Globe Creek	Limestone					
	2/4/2022	hours	27	\$175.00	\$4,725.00	21102
	2/8/2022	tons	30	\$287.63	\$8,628.90	21105
	2/8/2022	hours	2	\$180.42	\$360.84	21105
	2/16/2022	tons	50.04	\$287.63	\$14,393.01	21106
	2/16/2022	hours	3	\$180.42	\$541.26	21106
	2/22/2022	tons	27.52	\$287.63	\$7,915.58	21108
	2/22/2022	hours	1.75	\$180.42	\$315.74	21108
Total Spent 1/28-6/3			27		\$36,880.32	

Net Savings (1/28-6/3/22): \$191,343.11

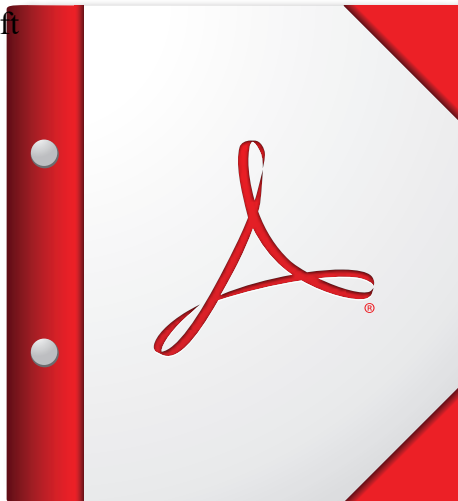
Vendor	Utility	U/M	Usage	Cost (per ton)	Total	Invoice #
Globe Creek	Limestone					
12/21/2021	Dec-21	tons	28.02	\$287.63	\$8,059.39	21098
12/21/2021	Dec-21	hours	1.75	\$180.42	\$315.74	21098
Total Spent 1/28-6/3			198.08		\$8,375.13	

				Months of usage (12/19/21-01/	1.33
				Expected tons:	240
				Expected hours:	16
				Total Cost (12/19/21-01/27/22)	71,938.04
				Net Savings (12/19/21-1/27/22):	\$63,562.91

Total Net Saving (112/19/21 - 6/3/22) \$ 254,906

Total Days 181

Totals Net Saving per Day \$ 1,408



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Air Pollution Control Cost Estimation Spreadsheet For Wet and Dry Scrubbers for Acid Gas Control

U.S. Environmental Protection Agency
Air Economics Group
Health and Environmental Impacts Division
Office of Air Quality Planning and Standards
(May 2021)

This spreadsheet allows users to estimate the capital and annualized costs for installing and operating scrubbers for reducing sulfur dioxide and acidic gas emissions from fossil fuel-fired combustion units and other industrial sources of acid gases.

The calculation methodologies used in this spreadsheet are those presented in the U.S. EPA's Air Pollution Control Cost Manual. This spreadsheet is intended to be used in combination with the acid gas absorber chapter and cost estimation methodology in the Control Cost Manual. For a detailed description of acid gas absorbers and the cost methodologies, see Section 5, Chapter 1 (Wet and Dry Scrubbers for Acid Gas Control) of the Air Pollution Control Cost Manual (as updated in 2021). A copy of the Control Cost Manual is available on the U.S. EPA's "Technology Transfer Network" website at: <https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution>.

This spreadsheet can be used to estimate capital and annualized costs for three types of acid gas scrubbers:

- (1) Wet flue gas desulfurization (WFGD) systems used to control SO₂ emissions from coal-fired utility boilers over 100 MW.
- (2) Spray dryer absorber (SDA) used to control SO₂ emissions from coal-fired utility boilers of equal to or greater than 50 MW.
- (3) Wet packed-bed scrubbers used to control acid gases from industrial emission sources of any size.

WFGD and SDA Control Systems

The methodologies for WFGD and SDA systems are based on those from the U.S. EPA Clean Air Markets Division (CAMD)'s Integrated Planning Model (IPM version 6). The size and costs of a WFGD and SDA are based primarily on the size of the combustion unit and the sulfur content of the coal burned. The WFGD methodology include cost algorithms for capital and operating cost for wastewater treatment consisting of chemical pretreatment, low hydraulic residence time biological reduction and ultrafiltration to treat wastewater generated by the WFGD system. The IPM equations estimate the purchased equipment cost and the direct and indirect installation costs based on cost data for multiple lump-sum contracts. Turnkey contracts where the price is fixed at the time the contract is signed and the contractor undertakes responsibility for the completion of the project, are generally 10 to 15% higher than the multiple lump-sum contracts. For additional information regarding the IPM, see the EPA Clean Air Markets webpage at <http://www.epa.gov/airmarkets/power-sector-modeling>.

Users should complete the Wet & Dry FGD Data Inputs tab to estimate costs for WFGD and SDA systems.

Packed-Bed Scrubbers

The cost methodology for wet packed-bed scrubbers can be used for estimating costs for any size of packed tower absorber used to control flue gas containing any acidic pollutants (e.g., HCl and HF). The capital and operating costs are based on the waste gas composition and properties of the pollutant and sorbent. The waste gas is assumed to comprise a two-component waste gas mixture (pollutant/air), where the pollutant consists of a single compound present in dilute quantities. The waste gas is assumed to behave as an ideal gas and the solvent is assumed to behave as an ideal solution. Heat effects associated with absorption are considered to be minimal due to the low pollutant concentration. The procedures also assume that, in chemical absorption, the process is not reaction rate limited, i.e., the reaction of the pollutant with the solvent is considered fast compared to the rate of absorption of the pollutant into the solvent.

Users should complete the PB Scrubber Data Inputs tab to estimate costs for packed-bed scrubbers.

The calculations provide study-level estimates ($\pm 30\%$) of capital and annual costs. Default values included in the spreadsheet are taken from the Control Cost Manual and other sources, such as the U.S. Energy Information Administration (EIA), and are included only as an example of how to complete the data inputs sheets. The actual costs may vary from those calculated here due to site-specific conditions. Selection of the most cost-effective control option should be based on a detailed engineering study and cost quotations from control system suppliers.

Instructions

Step 1: Please select the **FGD Data Inputs** or **PB Scrubber Data Inputs** tab. Click the **Reset Form** button at the top of the sheet to reset all parameters to default values.

Step 2: Complete the cells highlighted in yellow. The highlighted cells are pre-populated with example or default values. Users should replace the pre-populated values with current values for each parameter that are specific to the facility. All data entry fields in the **PB Scrubber Data Inputs** tab should be completed. While most fields in the **FGD Data Inputs** tab apply to both WFGD and SDA systems, a few data entry fields are specific to the type of control system and may be left blank if the user does not wish to estimate costs for both systems. References documenting the source of each value should be documented in the **Data Sources for Default Values Used in Calculations** located on the **FGD Data Inputs** and **PB Scrubber Data Inputs** tabs.

Step 3: Once all of the data fields are complete, select the **SDA Design Parameters**, **WFGD Design Parameters**, or **PB Scrubber Design Parameters** tab (as applicable) to see the calculated design parameters. Select the **SDA Cost Estimate**, **WFGD Cost Estimate**, or **PB Scrubber Cost Estimate** tabs to view the calculated cost data for the installation and operation of the scrubber.

Data Inputs for Spray Dryer Absorber and Wet FGD

Enter the following data for your combustion unit:

Is the FGD for a new boiler or retrofit of an existing boiler?

Retrofit

Please enter a retrofit factor. Enter 1 for projects of average difficulty. Enter values >1 for more difficult retrofits and enter <1 for less difficult retrofits.

1

Directions: Enter data in highlighted data fields.

What is the gross MW rating at full load capacity (A)?

29.50 MW

Provide the following information for the coal burned:

Select type of coal burned:

Sub-Bituminous

Enter the sulfur content (%S)

percent by weight

OR

SO₂ Emissions (SO_{2out})

0.20 lb/MMBtu

Outlet SO₂ Emissions (SO_{2out})

0.01 lb/MMBtu

What is the higher heating value of the fuel (HHV)?

Btu/lb

*HHV is the weighted average value calculated using the values entered in the coal blend composition table.

*Note: You do not need to enter a value for the HHV since you entered SO₂ emissions in lb/MMBtu above

What is the estimated actual annual MWh output?

258,463 MWh

Waste from a WFDG system disposed in an onsite or offsite landfill?

Offsite Landfill

Gross heat input rate (GHR)

10.02 MMBtu/MWh

Enter the following design parameters for the proposed FGD System:

Number of hours the scrubber operates (t_{BS})

8760 Hours

Number of hours the boiler operates (t_{plant})

8760 Hours

Plant Elevation

446 Feet above sea level

Number of Full Time Operators (FT):

SDA System

WFGD system

6

Estimated equipment life:

SDA System

Years

Wet FGD System

30 Years

Estimated equipment life for mercury monitor for wastewater treatment system for Wet FGD Systems

6 Years

Enter the cost data for the proposed FGD System:

Desired dollar-year for Capital Costs

2022

CEPCI for 2022

708 Enter the CEPCI value for 2022

541.7

2016 CEPCI*

Annual Interest Rate (i)

7.5 Percent

Sorbent Cost:

Lime (for SDA)

\$/ton of Lime

Limestone (for Wet FGD)

288.00 \$/ton of Limestone

Water (Cost_{water})

0.0122 \$/gallon

Electricity (Cost _{elec})	0.2050 \$/kWh
Waste Disposal cost (Cost _{waste})	257.00 \$/ton
Labor Rate	49.00 \$/hour
Purchase Equipment Cost for Mercury Monitor for wastewater treatment System (MMCost)	- \$/monitor

*Note: CEPCI = Chemical Engineering Plant Cost Index. The use of CEPCI in this spreadsheet is not an endorsement of the index, but is there merely to allow for availability of a well-known cost index to spreadsheet users. Use of other well-known cost indexes (e.g., M&S) is acceptable.

Data Sources for Default Values Used in Calculations:

Data Element	Default Value	Sources for Default Value	If you used your own site-specific values, please enter the value used and the reference source . . .	Recommended data sources for site-specific information
Lime (\$/ton)	125	U.S. Environmental Protection Agency (EPA). Documentation for EPA's Power Sector Modeling Platform v6 Using the Integrated Planning Model. Office of Air and Radiation. January 2017. Available at: https://www.epa.gov/airmarkets/documentation-epas-power-sector-modeling-platform-v6 .	Not applicable	N/A
Limestone (\$/ton)	30	U.S. Environmental Protection Agency (EPA). Documentation for EPA's Power Sector Modeling Platform v6 Using the Integrated Planning Model. Office of Air and Radiation. January 2017. Available at: https://www.epa.gov/airmarkets/documentation-epas-power-sector-modeling-platform-v6 .	\$288/ton was used. This information was provided by UAF personnel for the limestone currently delivered to site and being burned in the boiler. Additional refinement needs to be accounted for as the current limestone particle sizes are too big for the a WFGD slurry feed stream. It is assumed that any particle refinement is being accounted for in the Reagent Preparation Equipment Costs that are calculated in the "WFGD Cost Estimate" tab. It is not fully understood what equipment is included in the EPA provided costs. If additional milling is not part of the Reagent Preparation Equipment Costs, then additional pricing of a mill should be included. For this scenario, additional pricing for a mill was not included.	Check with reagent vendors for current prices.
Water Cost (\$/gallon)	0.00420	Average water rates for industrial facilities (compiled by Black & Veatch. See "50 Largest Cities Water/Wastewater Rate Survey - 2018-2019." Available at www.bv.com/sites/default/files/2019-10/50_Largest_Cities_Rate_Survey_2018_2019_Report.pdf .	\$0.0122/gallon of water pricing was provided by UAF Facility Services Utility Rates for 2022	Plant's utility bill or Black & Veatch's "50 Largest Cities Water/Wastewater Rate Survey." Available at http://www.saws.org/who_we_are/community/RAC/docs/2014/50-largest-cities-brochure-water-wastewater-rate-survey.pdf .
Electricity Cost (\$/kWh)	0.0361	U.S. Energy Information Administration. Electric Power Annual 2016, Table 8.4, Published December 2017. Available at: https://www.eia.gov/electricity/annual/pdf/epa.pdf	\$0.2050/kWh electricity pricing was provided by UAF Facility Services Utility Rates for 2022	Plant's utility bill or use U.S. Energy Information Administration (EIA) data for most recent year. Available at http://www.eia.gov/electricity/data.cfm#sales .
Waste Disposal Cost (\$/ton)	30	U.S. Environmental Protection Agency (EPA). Documentation for EPA's Power Sector Modeling Platform v6 Using the Integrated Planning Model. Office of Air and Radiation. January 2017. Available at: https://www.epa.gov/airmarkets/documentation-epas-power-sector-modeling-platform-v6 .	\$257/ton. Ash hauling rates provided by UAF personnel ranged from \$220-\$293/ton. The variance is mostly attributed to the moisture content in the ash as well as the water added prior to load out to mitigate dust during transportation. \$257 was used as it was an average of the low and high value. Email dated 7/8/22 from Frances Isgrigg (UAF) to Mark Payne (SCI) and Courtney Kimball (Boreal). It should be noted that the ash disposal does not include any additional costs for regulated or hazardous waste pollutants that may be captured during the WFGD process. The ash hauling rates being used in the spreadsheet may or may not increase due to additional pollutants in the ash. We believe that using the current average ash hauling rate will provide a conservatively low effective cost for SO ₂ removal per year.	Check with reagent vendors for current prices.
Higher Heating Value (HHV) (Btu/lb)	8,826	Average HHV based 2016 coal data compiled by the Office of Oil, Gas, and Coal Supply Statistics, U.S. Energy Information Administration (EIA) from data reported on EIA Form EIA-923, Power Plant Operations Report. Available at http://www.eia.gov/electricity/data/eia923/ .	N/A. Value was not needed as SO ₂ content was specified as lb/MMBtu.	Fuel supplier or use U.S. Energy Information Administration (EIA) data for most recent year. Available at http://www.eia.gov/electricity/data/eia923/ .
Average Sulfur Content (%)	0.41	Average sulfur content based on U.S. coal data for 2016 compiled by the U.S. Energy Information Administration (EIA) from data reported on EIA Form EIA-923, Power Plant Operations Report. Available at http://www.eia.gov/electricity/data/eia923/ .	Sulfur content is not being used because inlet SO ₂ emissions are provided instead. The inlet SO ₂ emission rate is 0.20 lb/MMBtu per Condition 13.1 of Permit AQ0316MSS06 Revision 2. That emission rate is the basis of the SO ₂ PTE for EU 113 (258.9 tpy per Condition 13 of Permit AQ0316MSS06 Revision	Fuel supplier or use U.S. Energy Information Administration (EIA) data for most recent year. Available at http://www.eia.gov/electricity/data/eia923/ .

Interest Rate	3.25	Default bank prime rate March 2, 2021 (available as the rates listed under 'bank prime loan' at https://www.federalreserve.gov/releases/h15/).	7.50%. Updated prime rate as of December 27, 2022.	Use current bank prime rate available at https://www.federalreserve.gov/releases/h15/ .
Hourly Labor Rate (\$/hour)	60	U.S. Environmental Protection Agency (EPA). Documentation for EPA's Power Sector Modeling Platform v6 Using the Integrated Planning Model. Office of Air and Radiation. January 2017. Available at: https://www.epa.gov/airmarkets/documentation-epas-power-sector-modeling-platform-v6 .	\$49/hour. Value provided by Frances Isgrigg (UAF). This is a burdened rate of an individual who would be working on this equipment at the plant.	Plant data.
Data Element	Default Value	Sources for Default Value	If you used your own site-specific values, please enter the value used and the reference source . . .	Recommended data sources for site-specific information
Gross MW rating at full load capacity	N/A	The facility at UAF was designed and constructed as a Combined Heat Power facility which serves the University in two ways; providing distribution steam for campus heating and other processes, and electricity for electrical demand on the campus. The Boiler and Steam Turbine at UAF were design as a bottoming cycle facility which means that the boiler is ramped as needed to meet the amount of steam heating that is required on campus. The left over steam is sent to the steam turbine to convert the remaining energy to electricity. This differs to a traditional power plant that uses all of it's generated steam to generate electricity with little to no distribution of steam for processes or users. In order to utilize the EPA spreadsheet, a theoretical MW value needed to be calculated for the CHP facility. To calculate an electrical generation power plant equivalency, we used the BTU input of the Boiler (total coal flow into the boiler), then using the Boiler efficiency which equates the amount of BTU's that the boiler captures in the steam cycle. These BTU's were then divided by the Steam Turbine efficiency, also know has Heat Rate (BTU/kW) which yields a theoretical MW value based on how the steam turbine can convert BTU's to kW. The resultant was used as a electrical "equivalent" in the spreadsheet. It should be noted that the facility has no way of generating the calculated theoretical MW value as the existing Steam Turbine cannot operate beyond it's 17MW nameplate.	Value used: 29.5 MW "CHPP MW Equivalent" = Boiler BTU Input x Boiler Efficiency / Steam Turbine Heat Rate. Boiler input: 295,600,000 lb/hr (Provided by B&W) Boiler efficiency: 85.73% (Provided by B&W) Steam Turbine efficiency: 8,589 Btu/kWh (Provided by Shin Nippon)	
Cell C10				
Outlet SO2 Emissions (SO2out) (lb/mmbtu)	N/A	SO2 output emissions	0.01 lb/mmbtu was entered to show the WFGD efficiency at 95%	
C17				
Annual MWH output	N/A	This calculates the total MWh produced by the boiler. This was calculated using electrical capacity equivalent MW (rating) and multiplying by 8,760 hours per year for an annual MWh output	258,463 MWh Annual MWh output = Capacity x hours of operation/year Annual MWh output = 29.50MW x 8,760 hours/year	
Cell C34				
Gross heat input rate	N/A	This calculates the total amount of heat input into the boiler by the coal per MW electrical capacity. Values of the equation include: Permitted Maximum Heat Input into the Boiler (MMBtu/hr) / MW capacity	10.02 MMBTU/MWh Gross Heat Input Rate (GHIR) = Max Heat Input / MW capacity GHIR = 295.6 MMBtu/hr / 29.5 MW GHIR = 10.02 MMBTU/MWh	
Cell C38				
Number of hours of Scrubber Operation	N/A	Value set at total hours that Scrubber can operate per year, but no more than Boiler operation.	8,760 hours in one year.	
Cell C44				
Number of hours of Boiler Operation	N/A	Value set at total hours that Boiler can operate per year.	8,760 hours in one year.	
Cell C45				
SDA System Full Time Operators	8	EPA recommended default value of 8 operators for SDA system.	Not applicable	
Cell C47				
WFDG System Full Time Operators	12	EPA recommended default value of 12 operators for WFGD system (<500MW plant size)	Value used: 6 The EPA default value is 12 for a plant that is between 100 MW and 500 MW. The theoretical electrical capacity of the UAF CHPP is 29.5 MW. Based on the size of the equipment and the EPA recommendation, the value was set at 6 operators. The plant operates and staff's the plants operation for Monday thru Sunday, 24 hours per day. The plant has a total of 4 shifts available during the week (2 weekly sections, with each weekly section staffed during the day and separately at night). WFGD's are material handling intensive and require support during material offloading, material transfer, material batching and during operational hours. 6 Full time operators averages to 1.25 fulltime equivalents during each shift. It should be noted that the sensitivity of operators on a WFGD cost effectiveness result is some what small. The difference in effectiveness between the currently used 6 operators and using no new additional operators is roughly \$2,500/ton of SO2 removed (\$28,500 to \$26,000).	
Cell C48				

Cell C57

CEPCI for 2022	N/A	Provide latest Chemical Engineering Plant Cost Index (CEPCI)	Value used: 708 Value was taken from Chemical Engineering magazine, August 2022 Issue. Value was provided as a final 2021 index number.	
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Wet FGD Design Parameters

The following design parameters for the wet FGD system were calculated based on the values entered on the *FGD Data Inputs* tab. These values were used to prepare the costs shown on the *Wet FGD*

Parameter	Equation	Calculated Value	Units
Maximum Annual Heat Input Rate (Q_B) =	$A \times \text{GHR} =$	296	MMBtu/hour
Maximum Annual MWh Output (B_{MW}) =	$A \times 8760 =$	258,463	MWh
Estimated Actual Annual MWh Output (B_{output}) =	Value entered by user	258,463	MWh
Heat Rate Factor (HRF) =	Gross Plant Heat Rate/10 =	1.00	
Total System Capacity Factor (CF_{total}) =	$(B_{\text{output}}/B_{\text{mw}}) \times (t_{\text{ABS}}/t_{\text{plant}}) =$	1.000	fraction
Total effective operating time for the scrubber (t_{op}) =	$CF_{\text{total}} \times 8760 =$	8,760	hours
SO ₂ Removal Efficiency (EF) =	$(SO_{2\text{in}} - SO_{2\text{out}})/SO_{2\text{in}} =$	95	percent
SO ₂ removed per hour =	$SO_{2\text{in}} \times \text{EF} \times Q_B =$	56	lb/hour
Total SO ₂ removed per year =	$(SO_{2\text{in}} \times \text{EF} \times Q_B \times t_{\text{op}})/2000 =$	246.00	tons/year
Coal Factor (Coal_F) =	1 for bituminous; 1.05 for sub-bituminous; 1.07 for lignite (weighted average is used for coal blends)	1.05	
Inlet SO ₂ Emissions ($SO_{2\text{in}}$) =	Value entered by user	0.20	lb/MMBtu
Elevation Factor (ELEV) =	14.7 psia/P =		
Atmospheric pressure at 446 feet above sea level (P) =	$2116 \times [(59 - (0.00356 \times h) + 459.7)/518.6]^{5.256} \times (1/144)^* =$	14.5	psia
Retrofit Factor (RF) =	Retrofit to existing boiler	1.00	

Not applicable;
elevation factor does
not apply to plants
located at elevations

* Equation is from the National Aeronautics and Space Administration (NASA), Earth Atmosphere Model. Available at <https://spaceflightsystems.grc.nasa.gov/education/rocket/atmos.html>.

Capital Recovery Factor:

Parameter	Equation	Calculated Value	
Capital Recovery Factor (CRF) =	$i (1 + i)^n / (1 + i)^n - 1 =$ Where n = Equipment Life and i = Interest Rate	0.0847	Wet FGD System
		0.2130	Mercury Monitor for Wastewater Treatment System

Parameter	Equation	Calculated Value	Units
Electricity Usage: Electricity Consumption (P) =	$0.0112e^{0.155 \times S} \times \text{CoalF} \times \text{HRF} \times A \times 1,000 =$	359	kW

Water Usage: Water consumption (q_{water}) =	$[(1.674 \times S + 74.68) \times A \times \text{CoalF} \times \text{HRF}]/1,000$	2.3	kgallons/hour
Limestone Usage: Limestone consumption rate ($Q_{\text{Limestone}}$) =	$[17.52 \times A \times S \times \text{HRF}]/2,000 \times (\text{EF}/0.98) =$	0.05	tons/hour
Waste Generation: Waste generation rate (q_{waste}) =	$[1.811 \times Q_{\text{Limestone}} \times (\text{EF}/0.98) =$	0.1	tons/hour
Wastewater Flow Rate: Wastewater flow rate (F) =	$A \times (0.4 \text{ gallons/min/MW}) =$	12	gallons/minute

Wet FGD Cost Estimate

Total Capital Investment (TCI)

$$TCI = 1.3 \times (ABS_{cost} + RPE_{cost} + WHE_{cost} + BOP_{cost}) + WWT_{cost}$$

Capital costs for the absorber (ABS_{cost}) =	\$8,478,739
Reagent Preparation Equipment Costs (RPE_{cost}) =	\$1,839,172
Waste Handling Equipment (WHE_{cost}) =	\$758,320
Balance of Plant Costs (BOP_{cost}) =	\$16,102,837
Wastewater Treatment Facility Costs (WWT_{cost}) =	\$13,565,812
Total Capital Investment (TCI) =	\$52,968,345 in 2022 dollars with disposal at offsite landfill

Wet FGD Capital Costs (ABS_{cost})

$$ABS_{cost} = 584,000 \times (A)^{0.716} \times (CoalF \times HRF)^{0.6} \times (S/2)^{0.02} \times ELEVF \times RF$$

Wet FGD Capital Costs (ABS_{cost}) =	\$8,478,739 in 2022 dollars
--	-----------------------------

Reagent Preparation Costs (RPE_{cost})

$$RPE_{cost} = 202,000 \times A^{0.716} \times (S \times HRF)^{0.3} \times RF$$

Reagent Preparation (RPE_{cost}) =	\$1,839,172 in 2022 dollars
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Waste Handling Equipment (WHE_{cost})

$$WHE_{cost} = 106,000 \times A^{0.716} \times (S \times HRF)^{0.45} \times RF$$

Waste Recycling/Handling (WHE_{cost}) =	\$758,320 in 2022 dollars
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Balance of Plant Costs (BOP_{cost})

$$BOP_{cost} = 1,070,000 \times (A)^{0.716} \times (CoalF \times HRF)^{0.4} \times ELEVF \times RF$$

Balance of Plant Costs (BOP_{cost}) =	\$16,102,837 in 2022 dollars
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Wastewater Treatment Facility Costs (WWT _{cost})	
Wastewater Treatment Facility Costs with Onsite Landfill	$WWT_{cost} = (41.36 F + 11,157,588) \times RF \times 0.898$
Wastewater Treatment Facility Costs with Offsite Landfill	$WWT_{cost} = (41.16 F + 11,557,843) \times RF \times 0.898$
Wastewater Treatment Facility Costs (WWT _{cost}) =	\$13,565,812 in 2022 dollars with disposal at offsite landfill

Total Annual Cost (TAC)	
TAC = Direct Annual Costs + Indirect Annual Costs	

Direct Annual Costs (DAC) =	\$3,075,590
Indirect Annual Costs (IDAC) =	\$4,514,299
Total annual costs (TAC) = DAC + IDAC	\$7,589,888 in 2022 dollars

Direct Annual Costs (DAC)		
DAC = Annual Maintenance Cost + Annual Operator Cost + Annual Reagent Cost + Annual Make-up Water Cost + Annual Waste Disposal Cost + Annual Auxiliary Power Cost + Annual Wastewater Treatment		
Annual Maintenance Cost =	$0.015 \times TCI =$	\$794,525
Annual Operator Cost =	$FT \times 2,080 \times \text{Hourly Labor Rate}$	\$611,520
Annual Reagent Cost =	$Q_{\text{limestone}} \times \text{Cost}_{\text{limestone}} \times t_{\text{op}} =$	\$126,658
Annual Electricity Cost =	$P \times \text{Cost}_{\text{elect}} \times t_{\text{op}} =$	\$643,921
Annual Make-up Water Cost =	$q_{\text{water}} \times \text{Cost}_{\text{water}} \times t_{\text{op}} =$	\$248,219
Annual Waste Disposal Cost =	$q_{\text{waste}} \times \text{Cost}_{\text{fuel}} \times t_{\text{op}} =$	\$198,422
Annual Wastewater Treatment Cost =	$(6.3225F + 472,080) \times 0.958 \times CF_{\text{total}} \times \text{ESC} =$	\$452,324 (with disposal at offsite landfill)
Replacement Cost for Mercury Monitor =	$CF_{\text{mm}} \times MM_{\text{Cost}} =$	\$0 (replaced once every 6 years.)
Direct Annual Cost =		\$3,075,590 in 2022 dollars

Indirect Annual Cost (IDAC)		
IDAC = Administrative Charges + Capital Recovery Costs		
Administrative Charges (AC) =	$0.03 \times (\text{Annual Operator Cost} + 0.4(\text{Annual Maintenance Cost})) =$	\$27,880
Capital Recovery Costs (CR) =	$CRF \times TCI =$	\$4,486,419
Indirect Annual Cost (IDAC) =	$AC + CR =$	\$4,514,299 in 2022 dollars

Cost Effectiveness = Total Annual Cost/ SO ₂ Removed/year	
Total Annual Cost (TAC) =	\$7,589,888 per year in 2022 dollars
SO ₂ Removed =	246 tons/year
Cost Effectiveness =	\$30,853 per ton of SO ₂ removed in 2022 dollars

Typical Costs for Random Packing Materials (1991\$)

Nominal Diameter (inches)	Construction Material	Packing Type	Packing cost (\$/ft ³)	
			<100 ft ³	>100 ft ³
1	304 stainless steel	Pall rings, Raschig rings, Ballast rings	70-109	65-99
1	Ceramic	Raschig rings, Berl saddles	33-44	26-36
1	Polypropylene	Tri-Pacs®, Pall rings, Ballast rings, Flexisaddles	14-37	Dec-34
2	Ceramic	Berl saddles, Raschig rings	13-32	30-Oct
2	Polypropylene	Tri-Pacs®, Lanpac®, Flexiring, Flexisaddle Tellerette®	20-Mar	19-May
3.5	304 stainless steel	Ballast rings	30	27
3.5	Polypropylene	Tri-packs®, Lanpace®, Ballast rings	14-Jun	12-Jun

Typical Packing Factors for Various Packing Materials for Wet Packed Tower Absorbers

Packing Type	Construction Level	Nominal Diameter (inches)	Fp	a
Raschig rings	Ceramic	0.5	640	111
		0.625	380	100
		0.75	255	80
		1.0	160	58
		1.5	95	38
		2.0	65	28
Raschig rings	Metal	3.0	37	
		0.5	410	118
		0.625	290	
		0.75	230	72
		1.0	137	57
		1.5	83	41
Pall rings	Metal	2.0	57	31
		3.0	32	21
		0.625	70	131
		1.0	48	66
		1.5	28	48
		2.0	20	36
Pall rings	Polypropylene	3.5	16	
		0.625	97	110
		1.0	52	63
		1.5	32	39
Berl saddles	Ceramic	2.0	25	31
		0.5	240	142
		0.75	170	82
		1.0	110	76
Intalox saddles	Ceramic	1.5	65	44
		2.0	45	32
		0.5	200	190
		0.75	145	102
Tri-Packs®	Plastic	1.0	98	78
		1.5	52	60
		2.0	40	36
		3.0	22	
Tri-Packs®	Plastic	2.0	16	48
		3.5	12	38

Packing Constants Used to Estimate H_G For Wet Packed Tower Absorbers

Packing Type	Size (inches)	Packing Constants			Applicable Range ^a	
		a	B	γ	G _{GR}	L _{GR}
Raschig Rings	0.625	2.32	0.45	0.47	200-500	500-1,500
	1.0	7	0.39	0.58	200-800	400-500
	1.0	6.41	0.32	0.51	200-600	500-4,500
	1.5	1.73	0.38	0.66	200-700	500-1,500
	1.5	2.58	0.38	0.4	200-700	1,500-4,500
	2.0	3.82	0.41	0.45	200-800	500-4,500
Berl Saddles	0.5	32.4	0.3	0.74	200-700	500-1,500
	0.5	0.81	0.3	0.24	200-700	1,500-4,500
	1.0	1.97	0.36	0.4	200-800	400-4,500
	1.5	5.05	0.32	0.45	200-1,000	400-4,500
Partition Rings	3.0	640	0.58	1.06	150-900	3,000-10,000
LanPac®	2.3	7.6	0.33	-0.48	400-3,000	500-8,000
Tri-Packs®	2.0	1.4	0.33	0.4	100-900	500-10,000
	3.5	1.7	0.33	0.45	100-2,000	500-10,000

^a Units of lb/hr-ft²Packing Constants Used to Estimate H_L For Wet Packed Tower Absorbers

Packing Type	Size (inches)	Packing Constants		Applicable Range ^a
		a	b	
Raschig Rings	0.375	0.00182	0.46	400-15,000
	1.0	0.00357	0.35	400-15,000
	1.5	0.01	0.22	400-15,000
	2.5	0.0111	0.22	400-15,000
	2.0	0.0125	0.22	400-15,000
Berl Saddles	0.5	0.00666	0.28	400-15,000
	1.0	0.00588	0.28	400-15,000
	1.5	0.00625	0.28	400-15,000
Partition Rings	3.0	0.0625	0.09	3,000-14,000
LanPac®	2.3	0.0039	0.33	500-8,000
	3.5	0.0042	0.33	500-8,000
Tri-Packs®	2.0	0.0031	0.33	500-10,000
	3.5	0.004	0.33	500-10,000

^a Units of lb/hr-ft²

Packing Constants Used to Estimate Pressure Drop For Wet Packed Tower Absorbers

Packing Type	Construction Material	Nominal Diameter (inches)	c	j
Raschig rings	ceramic	0.5	3.1	0.41
		0.75	1.34	0.26
		1	0.97	0.25

Physical Properties of Common Pollutants

Pollutant	Molecular Weight	Diffusivity in Air at 25°C (cm ² /sec)	Diffusivity in Water at 20°C (cm ² /sec x 10 ⁵)
Ammonia	17	0.236	1.76
Methanol	32	0.159	1.28
Ethyl Alcohol	46	0.119	1
Propyl Alcohol	60	0.1	0.87
Butyl Alcohol	74	0.09	0.77
Acetic Acid	60	0.133	0.88
Hydrogen Chloride	36	0.187	2.64
Hydrogen Bromide	36	0.129	1.93
Hydrogen Fluoride	20	0.753	3.33

		1.25	0.57	0.23
		1.5	0.39	0.23
		2	0.24	0.17
Raschig rings	metal	0.625	1.2	0.28
		1	0.42	0.21
		1.5	0.29	0.2
		2	0.23	0.135
Pall rings	metal	0.625	0.43	0.17
		1	0.15	0.16
		1.5	0.08	0.15
		2	0.06	0.12
Berl saddles	ceramic	0.5	1.2	0.21
		0.75	0.62	0.17
		1	0.39	0.17
		1.5	0.21	0.13
Intalox saddles	ceramic	0.5	0.82	0.2
		0.75	0.28	0.16
		1	0.31	0.16
		1.5	0.14	0.14

* Units of lb/hr-ft²

Total Capital Investment - CDS (Circulating Dry Scrubber)					Shaded cells indicate user inputs.	
Project: UAF - BACT Analysis		Date: 12/28/2022		Prepared By: M. Jahn		
Vendor: Andritz		Updated By: C. Kimball		Rev: B		
Capital Costs						
DIRECT COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST
(1) Purchased equipment and material costs						
(a) Basic equipment						
CDS System	1	EA	\$	16,950,000.00		
ID Fan	1	EA	\$	567,879.00		
Fire System	1	EA	\$	134,000.00		
HVAC	1	EA	\$	445,000.00		
Demo of existing Water Treatment Building	1	EA	\$	500,000.00		
Total CDS System						TOTAL = \$ 18,596,879
(b) Instrumentation						
Total Instrumentation	1	EA	\$	760,000.00		TOTAL = \$ 760,000
(c) Freight						
ID Fan System Freight	1	LOT	\$	112,000.00		TOTAL = \$ 112,000
(d) Extended Outage Costs						
Additional days beyond a typical 3 week outage	21	days	\$	48,028.00		TOTAL = \$ 1,008,588
(e) Vendor representatives fees						
Onsite Vendor Representatives fees (enter no. of days and daily rate)	7	Days		2000		\$ 14,000
						TOTAL = \$ 14,000
Purchased Equipment and Material Cost (PEMC)					PEMC = \$	20,491,467
(2) Direct Installation Costs						
(a) Concrete (CDS Building, Duct Supports)	1	LOT	\$	800,000.00		\$ 800,000
(b) Site Vibro Compaction (CDS Building, Supports)	1	LOT	\$	423,000.00		\$ 423,000
(c) Structural Steel (CDS Building, Supports, Duct)	1	LOT	\$	3,064,000.00		\$ 3,064,000
(d) Electrical	1	LOT	\$	883,000.00		\$ 883,000
(e) Insulation	1	LOT	\$	66,000.00		\$ 66,000
(f) Abovegrade piping	1	LOT	\$	442,000.00		\$ 442,000
(g) Golden Heart Utility Relocation	1	LOT	\$	856,212.16		\$ 856,212
Direct Installation Costs (DIC) - Estimate for new building, foundation, piping, electrical, etc.					DIC = \$	6,534,212
Total Direct Costs (TDC)					TDC = (PEMC) + (DIC) = \$	27,025,679
INDIRECT COSTS						
(3) Engineering, Procurement & Construction Support Services	10%	% TDC			\$ 2,702,568	
(4) Performance tests	1	EA	\$	75,000	\$ 75,000	
Total Indirect Costs (TIC)					TIC = \$	2,777,568
MANAGEMENT AND CONTINGENCY COSTS						
(5) Contingency	10%	% TDC			\$ 2,702,568	
Total Management and Contingency Costs (TM&CC)					TM & CC = \$	2,702,568
TOTAL CAPITAL INVESTMENT (TCI)					TCI = (TDC)+(TIC)+(TM&CC) = \$	32,505,815

Line Number/Description	Title	Comment
Line Number 1a	Total CDS System	CDS price provided by OEM Vendor. Cost includes equipment supply and installation costs. Andritz provided a rough installation factor based on material supply. Assumed installation costs were the same as equipment supply.
Line Number 1a	ID Fan	Pricing provided by Clarage for new ID Fan. Fan shipping is provided in line number 1c.
Line Number 1a	Fire System	Fire System costs for the new CDS Building. Costs were derived from the original UAF estimate and scaled based on a cost/square foot and escalated using CEPCI.
Line Number 1a	HVAC	HVAC costs for the new CDS Building. Costs were derived from the original UAF estimate and scaled based on a cost/square foot and escalated using CEPCI.
Line Number 1a	Water Treatment Building Demolition	Water Treatment Building Demolition costs to demolish the existing water treatment building. The new CDS building will be built in it's place. Estimated costs were derived on a level of effort basis
Line Number 1b	Total Instrumentation	Total costs for new cabinets and integrating CDS I/O into existing UAF DCS.
Line Number 1c	ID Fan Shipping Costs	Costs to ship ID fan to site.
Line Number 1d	Extended Outage Costs	UAF typically schedules for a 3 week outage on Boiler #5. A CDS outage will take 6 weeks and University will incur 3 additional weeks of outage costs that include purchasing electric power and running additional boilers for steam generation. Costs per day were provided by UAF personnel. The daily outage cost calculations are presented in the last section of Appendix G beginning on page G-73.
Line Number 1e	Vendor Representative Costs	Costs incurred for OEM to send a Field Technician to the field to confirm installation and provide technical guidance if needed. Cost per day includes hourly burdened rate for employee daily allowances and travel expenses. Based on general engineering and project experience.
Line Number 2a thru 2g	Direct Install Costs	Costs broken down into individual disciplines for balance of plant equipment, materials and labor for the CDS System. Cost estimate basis for each discipline are provided as attachments.
Line Number 3	Engineering Services	Costs for Preliminary Engineering costs to assist the University in soliciting bidders with specifications, preliminary drawings and procurement support for the AQCS system. Additional services include home office support for shop drawing review and occasional site support during construction for potential issues. Engineering is a percentage of the Total Direct Costs of the Project.
Line Number 4	Performance Test	Costs for a 3rd party performance testing company to validate emissions and performance guarantees by CDS vendor during operation
Line Number 5	Construction Contingency	Construction Contingency is an allotment for additional or unexpected costs during the project. RS Means defines contingency allowances and ranges between 3-20% depending on what design stage the project is in. A 10% contingency is a project that is in Design Development, whereas a Conceptual Design phase allows for a 20% contingency. A 10% contingency for this cost estimate is considered low as the project is still in a Development phase.

Shaded cells indicate user inputs

Total Annualized Costs - CDS (Circulating Dry Scrubber)

Date: 12/28/2022

Project: UAF - BACT Analysis

Prepared By: M. Jahn

Vendor: Andritz

Updated By: C. Kimball

Rev: B

Annualized Costs

DIRECT ANNUAL COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST	TOTAL
(1)	Operating Labor	8,864	MH	49.09	Excluded	\$ 435,134	\$ 435,134
(2)	Supervisory Labor		MH		Excluded	Excluded	Excluded
(3)	Maintenance Labor	520	MH	49.09	Excluded	\$ 25,527	\$ 25,527
(4)	Maintenance Materials	1	LOT	25,527	\$ 25,527	Excluded	\$ 25,527
(5)	Utilities						
(a)	Reagent:		TON	-	N/A	N/A	N/A
(b)	Electricity:	5,452,399	kWh	0.205	\$ 1,117,742	Excluded	\$ 1,117,742
(c)	Water:	8,935	(K) Gallons	11.30	\$ 100,968	Excluded	\$ 100,968

Total Direct Annual Costs (TDAC)**TDAC = \$ 1,704,897****INDIRECT ANNUAL COSTS**

(6)	Overhead	1%	%		\$ 325,058	\$ 325,058
(7a)	Administrative Charges, Insurance	3%	% total capital		\$ 975,174	\$ 975,174
(7b)	Capital Recovery Factor [see inputs below]	0.0847				
(8)	Capital Recovery					CRF * TCI = \$ 2,752,308

Total Indirect Annual Costs (TIAC)**TIAC = \$ 4,052,540****TOTAL ANNUALIZED COSTS (TAC)****TAC = (TDAC) + (TIAC) = \$ 5,757,437****Data Inputs for Capital Recovery Factor:**

Annual Interest Rate (EPA OAQPS Control Cost Manual)

7.50

%

Project Life (EPA OAQPS Control Cost Manual)

30

years

Line Number/Description	Title	Comment
Line Number 1 and 3	Operating/Maintenance Labor	Provided by UAF. Rate is burdened rate for level of personnel operating and performing maintenance on this type of equipment. Additional FT operations person is assumed per shift. Four total shifts per week. Quarter FT maintenance persons is assumed for the new CDS system.
Line Number 4	Maintenance Material	Allotment for maintenance materials. Item is equal to the maintenance labor allotment in line 3.
Line Number 5a	Reagent	CDS vendor will not require injection of reagent for SO ₂ reduction.
Line Number 5b	Electricity	Pricing provided by UAF for published utility rates on campus. Electrical consumption rate provided by CDS vendor. Additional consumption by larger ID Fan was also included.
Line Number 5c	Water	Pricing provided by UAF for published utility rates on campus. Water consumption rate provided by CDS vendor.
Line Number 6	Overhead	Calculated as percent of Total Capital Investment
Line Number 7a	Admin Charges, etc	Calculated as percent of Total Capital Investment
Line Number 7b	Capital Recovery Factor	EPA calculated factor using Interest Rate and Project Life Span
Line Number 8	Capital Recovery	Capital Recovery Factor times Total Capital Investment.
Annual Interest Rate (EPA OAQPS Control Cost Manual)	Annual Interest Rate	Latest federal prime rate. https://www.federalreserve.gov/releases/h15/
Project Life (EPA OAQPS Control Cost Manual)	Project Life	Project Life expectancy in years.

Total Capital Investment - DSI (Dry Sorbent Injection)						Shaded cells indicate user inputs.	
Project: UAF - BACT Analysis				Date: 12/28/2022		Prepared By: M. Jahn	
Vendor: BACT Process Systems, Inc.						Updated By: C. Kimball	
						Rev: B	
Capital Costs							
DIRECT COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST	
(1) Purchased equipment and material costs							
(a) Basic equipment							
DSI System		1	EA	5,875,000			
ID Fan		1	EA	431,588			
Total DSI System							TOTAL = \$ 6,306,588
(b) Instrumentation							
Total Instrumentation		1	EA	142,000			TOTAL = \$ 142,000
(c) Freight							
ID Fan Freight		1	EA	\$ 85,120			TOTAL = \$ 85,120
(d) Extended Outage Costs							
Additional days beyond a typical 3 week outage		35	Days	\$ 48,028.00			TOTAL = \$ 1,680,980
(e) Vendor representatives Costs							
Onsite Vendor Representatives Costs (enter no. of days and daily rate)		5	Days	2000			TOTAL = \$ 10,000
Purchased Equipment and Material Cost (PEMC)				All above costs included in vendor scope.		PEMC = \$	8,224,688
(2) Direct Installation Costs							
(a) Concrete		1	LOT	\$ 98,000		\$	98,000
(b) Site Vibro Compaction (DSI Unloading Building/Storage Silo)		1	LOT	\$ 31,000		\$	31,000
(c) Structural steel		1	LOT	\$ 84,000		\$	84,000
(d) Electrical		1	LOT	\$ 771,000		\$	771,000
(e) Abovegrade piping		1	LOT	\$ 367,000		\$	367,000
Direct Installation Costs (DIC) - Guess at new building, foundation, piping, electrical, etc.						DIC = \$	1,351,000
Total Direct Costs (TDC)						TDC = (PEMC) + (DIC) = \$	9,575,688
INDIRECT COSTS							
(3) Engineering, Procurement & Construction Support Services		10%	% TDC		\$	957,569	
(4) Performance tests		1	EA	\$ 75,000	\$	75,000	
Total Indirect Costs (TIC)						TIC = \$	1,032,569
MANAGEMENT AND CONTINGENCY COSTS							
(5) Contingency		10%	% TDC		\$	957,569	
Total Management and Contingency Costs (TM&CC)						TM & CC = \$	957,569
TOTAL CAPITAL INVESTMENT (TCI)						TCI = (TDC)+(TIC)+(TM&CC) = \$	11,565,826

Line Number/Description	Title	Comment
Line Number 1a	Total DSI System	DSI price provided by OEM Vendor. Cost includes equipment supply and installation costs. Installation costs of vendor supplied equipment was assumed to be 25% of equipment cost.
Line Number 1a	ID Fan	Pricing provided by Clarage for new ID Fan for CDS system. Fan pricing was scaled from 1250 HP to 950 HP. Fan shipping is provided in line number 1c.
Line Number 1b	Total Instrumentation	Total costs for new communication links and I/O integration into existing DCS room.
Line Number 1c	ID Fan Shipping Costs	Costs to ship ID fan to site. CDS pricing was used and scaled from 1250 HP to 950 HP.
Line Number 1d	Extended Outage Costs	UAF typically schedules for a 3 week outage on Boiler #5. A DSI outage will take 8 weeks and the University will incur 5 additional weeks of outage costs that include purchasing electric power and running additional boilers for steam generation. Costs per day were provided by UAF personnel. The daily outage cost calculations are presented in the last section of Appendix H beginning on page H-74.
Line Number 1e	Vendor Representative Costs	Costs incurred for OEM to send a Field Technician to the field to confirm installation and provide technical guidance if needed. Cost per day includes hourly burdened rate for employee daily allowances and travel expenses.
Line Number 2a thru 2e	Direct Install Costs	Costs broken down into individual disciplines for balance of plant equipment, materials and labor for the DSI System. Cost estimate basis for each discipline are provided as attachments.
Line Number 3	Engineering Services	Costs for Preliminary Engineering costs to assist the University in soliciting bidders with specifications, preliminary drawings and procurement support for the AQCS system. Additional services include home office support for shop drawing review and occasional site support during construction for potential issues. Engineering is a percentage of the Total Direct Costs of the Project.
Line Number 4	Performance Test	Costs for a 3rd party performance testing company to validate emissions and performance guarantees by DSI vendor during operation
Line Number 5	Construction Contingency	Construction Contingency is an allotment for additional or unexpected costs during the project. RS Means defines contingency allowances and ranges between 3-20% depending on what design stage the project is in. A 10% contingency is a project that is in Design Development, whereas a Conceptual Design phase allows for a 20% contingency. A 10% contingency for this cost estimate is considered low as the project is still in a Development phase.

Shaded cells indicate user inputs

Total Annualized Costs - DSI (Dry Sorbent Injection)

Date: 12/28/2022

Project: UAF - BACT Analysis

Prepared By: M. Jahn

Vendor: BACT Process Systems, Inc.

Updated By: C. Kimball

Rev: B

Annualized Costs

DIRECT ANNUAL COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST	TOTAL
(1)	Operating Labor	8,864	MH	49.09	Excluded	\$ 435,134	\$ 435,134
(2)	Supervisory Labor		MH		Excluded	Excluded	Excluded
(3)	Maintenance Labor	520	MH	49.09	Excluded	\$ 25,527	\$ 25,527
(4)	Maintenance Materials	1	LOT	25,527	\$ 25,527	Excluded	\$ 25,527
(5)	Utilities						
(a)	Hydrated Lime:	394	TON	1,377	\$ 542,813	Excluded	\$ 542,813
(b)	Electricity:	2,683,276	kWh	0.205	\$ 550,071	Excluded	\$ 550,071
(c)	Water:	8,935	(k)Gallons	11.30	\$ 100,968	Excluded	\$ 100,968

Total Direct Annual Costs (TDAC) **TDAC = \$ 1,680,040**

INDIRECT ANNUAL COSTS

(6)	Overhead	1%	%		\$ 115,658	\$ 115,658
(7a)	Administrative Charges, Insurance	3%	% total capital		\$ 346,975	\$ 346,975
(7b)	Capital Recovery Factor [see inputs below]	0.0847				
(8)	Capital Recovery				CRF * TCI =	\$ 979,293

Total Indirect Annual Costs (TIAC) **TIAC = \$ 1,441,926**

TOTAL ANNUALIZED COSTS (TAC) **TAC = (TDAC) + (TIAC) = \$ 3,121,966**

Cost per ton of SO2 removed (\$/ton) **\$ 14,184.31**

Data Inputs for Capital Recovery Factor:

Annual Interest Rate (EPA OAQPS Control Cost Manual)

7.50

%

Project Life (EPA OAQPS Control Cost Manual)

30

years

Line Number/Description	Title	Comment
Line Number 1 and 3	Operating/Maintenance Labor	Provided by UAF. Rate is burdened rate for level of personnel operating and performing maintenance on this type of equipment. Additional FT operations person is assumed per shift. Four total shifts per week. Quarter FT maintenance persons is assumed for the new DSI system.
Line Number 4	Maintenance Material	Allotment for maintenance materials. Item is equal to the maintenance labor allotment in line 3.
Line Number 5a	Hydrated Lime	Hydrated Lime consumption rates provided by DSI vendor. Hydrated Lime costs provided by L'hoist.
Line Number 5b	Electricity	Pricing provided by UAF for published utility rates on campus. Electrical consumption rate provided by DSI vendor. Additional consumption by larger ID Fan was also included.
Line Number 5c	Water	Pricing provided by UAF for published utility rates on campus. Water consumption rate provided by DSI vendor.
Line Number 6	Overhead	Calculated as percent of Total Capital Investment
Line Number 7a	Admin Charges, etc	Calculated as percent of Total Capital Investment
Line Number 7b	Capital Recovery Factor	EPA calculated factor using Interest Rate and Project Life Span
Line Number 8	Capital Recovery	Capital Recovery Factor times Total Capital Investment.
Annual Interest Rate (EPA OAQPS Control Cost Manual)	Annual Interest Rate	Latest federal prime rate. https://www.federalreserve.gov/releases/h15/
Project Life (EPA OAQPS Control Cost Manual)	Project Life	Project Life expectancy in years.

Total Capital Investment - DSI (Dry Sorbent Injection)

Shaded cells indicate user inputs.

Project: UAF - BACT Analysis
 Vendor: Tri-Mer

Date: 12/28/2022
 Prepared By: M. Jahn
 Updated By: C. Kimball
 Rev: B

Capital Costs						
DIRECT COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST
(1) Purchased equipment and material costs						
(a)	Basic equipment					
	DSI System	1	EA	978,475		
	ID Fan	1	EA	431,588		
	Total DSI System					TOTAL = \$ 1,410,063
(b)	Instrumentation					
	Total Instrumentation	1	EA	142,000		TOTAL = \$ 142,000
(c)	Freight					
	ID Fan Freight	1	EA	\$ 85,120		TOTAL = \$ 85,120
(d)	Extended Outage Costs					
	Additional days beyond a typical 3 week outage	35	MH	\$ 48,028.00		TOTAL = \$ 1,680,980
(e)	Vendor representatives fees					
	Onsite Vendor Representatives fees (enter no. of days and daily rate)	5	Days	2000	\$ 10,000	TOTAL = \$ 10,000
Purchased Equipment and Material Cost (PEMC)		All above costs included in vendor scope.				PEMC = \$ 3,328,163
(2) Direct Installation Costs						
(a)	Concrete	1	LOT	\$ 196,000	\$ 196,000	\$ 196,000
(b)	Site Vibro Compaction (DSI Unloading Building/Storage Silo)	1	LOT	\$ 62,000	\$ 62,000	\$ 62,000
(c)	Structural steel	1	LOT	\$ 42,000	\$ 42,000	\$ 42,000
(d)	Electrical	1	LOT	\$ 771,000	\$ 771,000	\$ 771,000
(e)	Abovegrade piping	1	LOT	\$ 367,000	\$ 367,000	\$ 367,000
Direct Installation Costs (DIC) - Guess at new building, foundation, piping, electrical, etc.						DIC = \$ 1,438,000
Total Direct Costs (TDC)					TDC = (PEMC) + (DIC) = \$ 4,766,163	
INDIRECT COSTS						
(3)	Engineering, Procurement & Construction Support Services	10%	% TDC		\$ 476,616	
(4)	Performance tests	1	EA	\$ 75,000	\$ 75,000	
Total Indirect Costs (TIC)						TIC = \$ 551,616
MANAGEMENT AND CONTINGENCY COSTS						
(5)	Contingency	10%	% TDC		\$ 476,616	
Total Management and Contingency Costs (TM&CC)					TM & CC = \$ 476,616	
TOTAL CAPITAL INVESTMENT (TCI)					TCI = (TDC)+(TIC)+(TM&CC) = \$ 5,794,396	

Line Number/Description	Title	Comment
Line Number 1a	Total DSI System	DSI price provided by OEM Vendor. Cost includes equipment supply and installation costs. Installation costs of vendor supplied equipment was assumed to be 25% of equipment cost.
Line Number 1a	ID Fan	Pricing provided by Clarge for new ID Fan for CDS system. Fan pricing was scaled from 1250 HP to 950 HP. Fan shipping is provided in line number 1c.
Line Number 1b	Total Instrumentation	Total costs for new communication links and I/O integration into existing DCS room.
Line Number 1c	ID Fan Shipping Costs	Costs to ship ID fan to site. CDS pricing was used and scaled from 1250 HP to 950 HP.
Line Number 1d	Extended Outage Costs	UAF typically schedules for a 3 week outage on Boiler #5. A DSI outage will take 8 weeks and the University will incur 5 additional weeks of outage costs that include purchasing electric power and running additional boilers for steam generation. Costs per day were provided by UAF personnel. The daily outage cost calculations are presented in the last section of Appendix H beginning on page H-74.
Line Number 1e	Vendor Representative Costs	Costs incurred for OEM to send a Field Technician to the field to confirm installation and provide technical guidance if needed. Cost per day includes hourly burdened rate for employee daily allowances and travel expenses.
Line Number 2a thru 2e	Direct Install Costs	Costs broken down into individual disciplines for balance of plant equipment, materials and labor for the DSI System. Cost estimate basis for each discipline are provided as attachments.
Line Number 3	Engineering Services	Costs for Preliminary Engineering costs to assist the University in soliciting bidders with specifications, preliminary drawings and procurement support for the AQCS system. Additional services include home office support for shop drawing review and occasional site support during construction for potential issues. Engineering is a percentage of the Total Direct Costs of the Project.
Line Number 4	Performance Test	Costs for a 3rd party performance testing company to validate emissions and performance guarantees by DSI vendor during operation
Line Number 5	Construction Contingency	Construction Contingency is an allotment for additional or unexpected costs during the project. RS Means defines contingency allowances and ranges between 3-20% depending on what design stage the project is in. A 10% contingency is a project that is in Design Development, whereas a Conceptual Design phase allows for a 20% contingency. A 10% contingency for this cost estimate is considered low as the project is still in a Development phase.

Shaded cells indicate user inputs

Total Annualized Costs - DSI (Dry Sorbent Injection)

Date: 12/28/2022

Project: UAF - BACT Analysis

Prepared By: M. Jahn

Vendor: Tri-Mer

Checked By: C. Kimball

Rev: B

Annualized Costs

DIRECT ANNUAL COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST	TOTAL
(1)	Operating Labor	8,864	MH	49.09	Excluded	\$ 435,134	\$ 435,134
(2)	Supervisory Labor		MH		Excluded	Excluded	Excluded
(3)	Maintenance Labor	520	MH	49.09	Excluded	\$ 25,527	\$ 25,527
(4)	Maintenance Materials	1	LOT	25,527	\$ 25,527	Excluded	\$ 25,527
(5)	Utilities						
(a)	Hydrated Lime:	2,466	TON	1,377	\$ 3,395,599	Excluded	\$ 3,395,599
(b)	Electricity:	2,380,180	kWh	0.205	\$ 487,937	Excluded	\$ 487,937
(c)	Water:	8,935	(k)Gallons	11.30	\$ 100,968	Excluded	\$ 100,968

Total Direct Annual Costs (TDAC) **TDAC = \$ 4,470,691**

INDIRECT ANNUAL COSTS

(6)	Overhead	1%	%		\$ 57,944	\$ 57,944
(7a)	Administrative Charges, Insurance	3%	% total capital		\$ 173,832	\$ 173,832
(7b)	Capital Recovery Factor [see inputs below]	0.0847				
(8)	Capital Recovery				CRF * TCI =	\$ 490,619

Total Indirect Annual Costs (TIAC) **TIAC = \$ 722,394**

TOTAL ANNUALIZED COSTS (TAC) **TAC = (TDAC) + (TIAC) = \$ 5,193,086**

Data Inputs for Capital Recovery Factor:

Annual Interest Rate (EPA OAQPS Control Cost Manual)

7.50

%

Project Life (EPA OAQPS Control Cost Manual)

30

years

Line Number/Description	Title	Comment
Line Number 1 and 3	Operating/Maintenance Labor	Provided by UAF. Rate is burdened rate for level of personnel operating and performing maintenance on this type of equipment. Additional FT operations person is assumed per shift. Four total shifts per week. Quarter FT maintenance persons is assumed for the new DSI system.
Line Number 4	Maintenance Material	Allotment for maintenance materials. Item is equal to the maintenance labor allotment in line 3.
Line Number 5a	Hydrated Lime	Hydrated Lime consumption rates provided by DSI vendor. Hydrated Lime costs provided by L'hoist.
Line Number 5b	Electricity	Pricing provided by UAF for published utility rates on campus. Electrical consumption rate provided by DSI vendor. Additional consumption by larger ID Fan was also included.
Line Number 5c	Water	Pricing provided by UAF for published utility rates on campus. Water consumption rate provided by DSI vendor.
Line Number 6	Overhead	Calculated as percent of Total Capital Investment
Line Number 7a	Admin Charges, etc	Calculated as percent of Total Capital Investment
Line Number 7b	Capital Recovery Factor	EPA calculated factor using Interest Rate and Project Life Span
Line Number 8	Capital Recovery	Capital Recovery Factor times Total Capital Investment.
Annual Interest Rate (EPA OAQPS Control Cost Manual)	Annual Interest Rate	Latest federal prime rate. https://www.federalreserve.gov/releases/h15/
Project Life (EPA OAQPS Control Cost Manual)	Project Life	Project Life expectancy in years.

Table A-1. Potential to Emit Calculations - SO₂ Emissions

EU ID	Description	Make/Model	SO ₂ Emission Factor	Maximum Rating	Allowable Annual Operation	Potential SO ₂ Emissions
113	Circulating Bed Boiler ¹	Babcock and Wilcox	0.20 lb/MMBtu ²	295.6 MMBtu/hr	8,760 hr/yr	258.9 tpy

Notes:

¹ EU 113 is permitted to combust coal and up to 20 percent woody biomass (see Item 15 of Section 2.2 in Technical Analysis Report to Permit AQ0316MSS06 Revision 2). EU 113 is currently configured for coal firing only, and combusts subbituminous coal from Usibelli Coal Mine in Healy, AK.

² SO₂ emission factor per 40 CFR 60.42b(k)(1) and Conditions 36.1 and 61.2 of Permit AQ0316TVP03.

THIS TABLE APPEARS IN APPENDIX A OF REPORT, NOT MAIN BODY OF REPORT

Table A-2. Actual SO₂ Emissions

EU ID	Description	Make/Model	CY2020	CY2021	Average Annual SO ₂ Emissions
113	Circulating Bed Boiler	Babcock and Wilcox	12.3 tpy ¹	8.5 tpy ²	10.4 tpy ³

Notes:

¹ CY 2020 SO₂ emissions per totaled CEMS data for CY 2020 in Table 1 of University of Alaska Fairbanks Assessable Emissions Estimate for FY 2022, submitted to ADEC March 12, 2021.

² CY 2021 SO₂ emissions per totaled CEMS data for CY 2021 provided by University of Alaska Fairbanks.

³ SO₂ emissions from 2022 are not included. EU 113 operated minimally between January and June 2022 as a result of an unplanned outage.

THIS TABLE APPEARS IN APPENDIX A OF REPORT, NOT MAIN BODY OF REPORT

TABLE 2
Available SO₂ Emission Control Technologies

Available SO ₂ Emission Control Technologies
WFGD
SDA
CDS
DSI
FBLI - Base Case

TABLE 3
Summary of Vendor Responses

Vendor	SO ₂ Control Technology			
	WFGD	SDA	CDS	DSI
B&W	Declined to quote without funded study.	Declined to quote without funded study.	Declined to quote without funded study.	Declined to quote without funded study.
Andritz	Declined to quote - Andritz deemed this technology to be not economical.	Declined to quote - Andritz stated cost would be similar to CDS with lower SO ₂ removal rate.	Provided quote.	Declined to quote.
BPE	Declined to quote without funded study, uncertain of feasibility.	Quote not requested.	Provided quote.	Quote not requested.
Tri-Mer	Provided quote for a caustic soda wet scrubber. SCI determined this technology was not technically feasible.	Quote not requested.	Provided quotes for two types of CDS.	Provided quote.
GE	Unable to quote within timeframe for this report.	Quote not requested.	Quote not requested.	Quote not requested.
Wood Group	Declined to quote.	Declined to quote.	Quote not requested.	Quote not requested.
BACT Inc	Quote not requested.	Quote not requested.	Quote not requested.	Provided quote.
GEA	Declined to quote.	Declined to quote.	Quote not requested.	Quote not requested.

TABLE 4

Technically Feasible SO₂ Emission Control Technologies

Technically Feasible SO ₂ Emission Control Technologies
WFGD
CDS
DSI
FBLI - Base Case

TABLE 5

Ranking of Technically Feasible SO₂ Emission Control Technologies

Control Technology	Control Efficiency (pct.)	Emission Rate (lb/MMBtu)	SO ₂ Emissions (tpy)	Emissions Reduction (tpy)
WFGD	95	0.01	12.9	246.0
CDS	90	0.02	25.9	233.0
DSI - Tri-Mer system	90	0.02	25.9	233.0
DSI - BACT, Inc system	85	0.03	38.8	220.1
FBLI - Base Case	0	0.20	258.9	0

TABLE 6

SO₂ Cost-Effectiveness Summary

Control Technology	Total Capital Investment (\$)	Total Annual Cost (\$/year)	Emissions Reduction (tpy) ¹	Cost-Effectiveness (\$/ton SO ₂ avoided)	Incremental Cost-Effectiveness (\$/ton SO ₂ avoided) ^{2,3}
WFGD	\$52,968,345	\$7,589,888	246.0	\$30,859	\$141,557
CDS	\$32,505,815	\$5,757,437	233.0	\$24,709	\$203,590
DSI - Tri-Mer system	\$5,794,396	\$5,193,086	233.0	\$22,287	\$159,994
DSI - BACT, Inc system	\$11,565,826	\$3,121,966	220.1	\$14,187	~
FBLI - Base Case	~	~	0.0	~	~

Notes:

¹Emissions reductions are calculated in Table 5.²Calculation of incremental cost-effectiveness: $\frac{\text{TAC of technology} - \text{TAC of next lowest removal technology}}{\text{[Emission reduction of technology} - \text{emission reduction of next lowest removal technology]}}$ ³ The incremental cost-effectiveness values for CDS and the Tri-Mer DSI system are each calculated in comparison to the DSI system proposed by BACT.

TABLE 7

Cost-Effectiveness Analysis Based on Actual Emissions

Control Technology	Control Efficiency (pct.)	SO ₂ Emissions (tpy) ¹	Emissions Reduction (tpy)	Total Annual Cost (\$/year)	Cost-Effectiveness (\$/ton SO ₂ avoided)
WFGD	95	0.5	9.9	\$7,589,888	\$768,207
CDS	90	1.0	9.4	\$5,757,437	\$615,111
DSI - Tri-Mer system	90	1.0	9.4	\$5,193,086	\$554,817
DSI - BACT, Inc system	85	1.6	8.8	\$3,121,966	\$353,164
FBLI - Base Case	0	10.4	0	~	~

Notes:

¹The FBLI base case actual emission rate is the 12-month average of CY2020 and CY2021 SO₂ emissions as calculated from the totalized CEMS data.

UAF Calculations - Daily Plant Outage Costs

Actual & Estimated Costs				
Cost per Day			Notes/Assumptions	Reference
<i>These costs/savings are associated with a turbine outage that began on Dec 28, 2021 and ended on June 3, 2022. Support invoicing can be provided if requested.</i>				
<u>Costs</u>				
Electricity	\$	8,002	Purchase of Electricity	Table A
Fuel	\$	54,066	Purchase of Diesel	Table B
Natural Gas	\$	1,794	Boilers go down, we need to light them for a longer duration. In prior year, no natural gas was used during these months	Table C
<u>Avoided Costs</u>				
Coal Delivery	\$	(2,459)		Table D
Coal	\$	(10,255)		Table E
Ash Haul	\$	(1,712)		Table F
Limestone	\$	(1,408)		Table G
Grand Total	\$	48,028		

This spreadsheet does not include the lost revenue from electricity sales to Golden Valley Electric.

Table A.
UAF Plant Outage Costs - Electricity

Vendor: GVEA	Utility	Usage	Cost Break Down	Total	Days per Month
01/01/2022- 02/01/2022	ELECTRIC				
		Fuel & Purchased	4,690,000 kwh @ \$0.1045	\$ 490,105.00	
		Utility Charge	4,690,000 kwh @ \$0.01257	\$ 58,953.30	
		Demand Charge	7207.2 KW @30.06	\$ 216,648.43	
		RCC	4,690,000 kwh @ \$0.001016	\$ 4,765.04	
		Customer Charge		\$ 220.00	
		Total:		\$ 770,691.77	31
		(About \$24,861.02 per day)	1/28-1/31 (4 days)	\$99,444.08	
02/01/2022- 03/01/2022	Electric				
		Fuel & Purchased	4,424,000 kwh @ \$0.12969	\$573,748.56	
		Utility Charge	4,424,000 kwh @ \$0.01257	\$55,609.68	
		Demand Charge	7737.80 KW @30.06	\$232,598.27	
		RCC	4424000 kwh @ \$0.001016	\$4,494.78	
		Customer Charge		\$220.00	
		Total:		\$866,671.29	28
		(About \$30,952.55 per day)			
03/01/2022- 04/01/2022	Electric				
		Fuel & Purchased	4,564,000 kwh @0.12969	\$591,905.16	
		Utility Charge	4,564,000 kwh @0.01257	\$57,369.48	
		Demand Charge	6941.20 KW @30.06	\$208,652.47	
		RCC	4,564,000 kwh @0.001016	\$4,637.02	
		Customer Charge		\$220.00	
		Total:		\$862,784.13	31
		(About \$27,831.75 per day)			
04/01/2022- 05/01/2022	Electric				
		Fuel & Purchased	4,368,000 kwh @0.12969	\$566,485.92	
		Utility Charge	4,368,000 kwh @0.01257	\$54,905.76	
		Demand Charge	6,844.6 KW @30.06	\$205,748.68	
		RCC	4,368,000 kwh @0.001016	\$4,437.89	
		Customer Charge		\$220.00	
		Total:		\$831,798.25	30
		(About \$27,726.61 per day)			
05/01/2022- 06/01/2022	Electric				
		Fuel & Purchased	3,906,000 kwh @0.14036	\$548,246.16	
		Utility Charge	3,906,000 kwh @0.01257	\$49,098.42	
		Demand Charge	7,267.4 KW @30.06	\$218,458.04	
		RCC	3,906,000 kwh @0.001016	\$3,968.50	
		Customer Charge		\$220.00	
		Total:		\$819,991.12	31
		(About \$26,637.69 per day)			
06/01/2022- 07/01/2022	Electric				
		Fuel & Purchased	42,000 kwh @0.14036	\$5,895.12	
		Utility Charge	42,000 kwh @0.01257	\$527.94	
		Demand Charge	7,827.4 KW @30.06	\$235,291.64	
		RCC	42,000 kwh @0.000893	\$37.51	
		Customer Charge		\$220.00	
		Total:		\$241,972.21	30
		(About \$146,282.96 per day)			
					181 total Days
Grand Electric Total (1/28-6/3/22):				\$ 3,722,661.08	
Remove "Customer Charge"				\$ (1,320.00)	Paid monthly regardless of usage
Electric Costs (1/28-6/3/22)				\$ 3,721,341.08	
12/01/2021- 01/01/2022	ELECTRIC				
		Fuel & Purchased	1,694,000 kwh @ \$0.1045	\$ 177,023.00	
		Utility Charge	1,694,000 kwh @ \$0.01257	\$ 21,293.58	
		Demand Charge	6,804 KW @30.06	\$ 204,528.24	
		RCC	1,694,000 kwh @ \$0.001016	\$ 1,721.10	
		Customer Charge		\$ 220.00	

Total: \$ **404,785.92** 4 Days

01/01/2022- 02/01/2022 ELECTRIC

Fuel & Purchased	4,690,000 kwh @ \$0.1045	\$	490,105.00
Utility Charge	4,690,000 kwh @ \$0.01257	\$	58,953.30
Demand Charge	7207.2 KW @30.06	\$	216,648.43
RCC	4,690,000 kwh @ \$0.001016	\$	4,765.04
Customer Charge		\$	220.00
Total:		\$	770,691.77
(About \$24,861.02 per day)	1/1-1/27 (27 days)		\$671,247.54

Grand Electric Total (12/19/21-1/27/22): \$ 1,076,033.46

Remove "Customer Charge" \$ (440.00) Paid monthly regardless of usage

Electric Costs (12/19/21-1/27/22) \$ 1,075,593.46

Total Electric costs (12/19/2021 - 6/3/2022) \$ 1,480,379.38

Total Days \$ 185.00

Cost Per Day \$ 8,002.05

Table B.
UAF Plant Outage Costs - Diesel Fuel

Vendor & Delivery Date	Invoice #	Delivery	Cost Break Down	Total	# Days/ Month
Alaska Petroleum		Gallons	per gal & SOA Fee		
21-Dec	651087	8,904	\$2.87	\$ 25,936.35	
21-Dec	651088	8,900	\$2.87	\$ 25,924.70	
24-Dec	677512	8,206	\$3.02	\$ 25,180.01	
24-Dec	677513	8,204	\$3.02	\$ 25,173.87	
24-Dec	677514	8,204	\$3.02	\$ 25,173.87	
26-Dec	677518	6,801	\$3.02	\$ 20,868.78	
26-Dec	677517	7,120	\$3.02	\$ 21,847.63	
28-Dec	681603	9,598	\$3.02	\$ 29,451.34	
28-Dec	681602	9,599	\$3.02	\$ 29,454.41	
29-Dec	677526	3,802	\$3.08	\$ 11,897.93	
29-Dec	677527	3,802	\$3.08	\$ 11,897.93	
29-Dec	677528	3,802	\$3.08	\$ 11,897.93	
29-Dec	677636	11,067	\$3.08	\$ 34,632.93	
30-Dec	677633	10,622	\$3.10	\$ 33,383.74	
30-Dec	677635	9,801	\$3.10	\$ 30,803.43	
30-Dec	672948	9,703	\$3.10	\$ 30,495.43	
30-Dec	672949	9,602	\$3.10	\$ 30,178.00	
31-Dec	616240	9,602	\$3.12	\$ 30,372.92	10
1-Jan	677544	8,705	\$3.09	\$ 27,284.61	
1-Jan	672918	9,603	\$3.09	\$ 30,099.26	
1-Jan	616239	9,602	\$3.09	\$ 30,096.13	
1-Jan	616241	9,602	\$3.09	\$ 30,096.13	
2-Jan	672919	9,603	\$3.09	\$ 30,099.26	
2-Jan	672499	9,603	\$3.09	\$ 30,099.26	
3-Jan	672920	9,607	\$3.09	\$ 30,111.80	
3-Jan	672925	9,603	\$3.09	\$ 30,099.26	
3-Jan	672926	9,608	\$3.09	\$ 30,114.94	
3-Jan	677553	8,705	\$3.09	\$ 27,284.61	
4-Jan	672910	9,606	\$3.22	\$ 31,347.90	
4-Jan	672908	9,605	\$3.22	\$ 31,344.64	
5-Jan	672922	9,602	\$3.30	\$ 32,130.13	
5-Jan	672497	9,602	\$3.30	\$ 32,130.13	
6-Jan	672911	9,605	\$3.34	\$ 32,545.73	
6-Jan	672921	9,604	\$3.34	\$ 32,542.34	
7-Jan	672913	9,603	\$3.34	\$ 32,578.91	
7-Jan	672914	9,605	\$3.34	\$ 32,585.70	
8-Jan	672887	9,703	\$3.34	\$ 32,918.17	
8-Jan	672923	9,703	\$3.34	\$ 32,918.17	
8-Jan	672888	9,703	\$3.34	\$ 32,918.17	
11-Jan	676832	9,703	\$3.40	\$ 33,526.81	
11-Jan	676833	9,703	\$3.40	\$ 33,526.81	
11-Jan	676834	9,705	\$3.40	\$ 33,533.72	
12-Jan	676835	9,704	\$3.43	\$ 33,782.41	
12-Jan	676836	9,703	\$3.43	\$ 33,778.93	
12-Jan	676837	9,704	\$3.43	\$ 33,782.41	
13-Jan	676838	9,703	\$3.40	\$ 33,476.58	
13-Jan	676839	9,700	\$3.40	\$ 33,466.23	
13-Jan	676840	9,699	\$3.40	\$ 33,462.78	
14-Jan	676841	9,698	\$3.44	\$ 33,811.73	
14-Jan	676842	9,700	\$3.44	\$ 33,818.70	
14-Jan	676843	9,700	\$3.44	\$ 33,818.70	

15-Jan	676844	9,602	\$3.43	\$ 33,477.03
15-Jan	676845	9,603	\$3.43	\$ 33,480.51
15-Jan	676846	9,451	\$3.43	\$ 32,950.57
15-Jan	676847	9,450	\$3.43	\$ 32,947.09
15-Jan	677560	9,396	\$3.43	\$ 32,758.82
16-Jan	676848	9,792	\$3.43	\$ 34,139.46
16-Jan	676849	9,790	\$3.43	\$ 34,132.48
16-Jan	676850	9,802	\$3.43	\$ 34,174.32
16-Jan	676851	9,958	\$3.43	\$ 34,718.21
17-Jan	677565	8,300	\$3.43	\$ 28,937.65
19-Jan	677574	8,200	\$3.45	\$ 28,738.82
19-Jan	677575	8,200	\$3.45	\$ 28,738.82
19-Jan	677576	8,205	\$3.45	\$ 28,756.34
20-Jan	677577	8,200	\$3.43	\$ 28,568.20
20-Jan	677578	8,200	\$3.43	\$ 28,567.20
20-Jan	677579	8,200	\$3.43	\$ 28,568.20
21-Jan	676852	9,453	\$3.45	\$ 33,119.70
21-Jan	676853	9,453	\$3.45	\$ 33,119.70
21-Jan	676854	9,453	\$3.45	\$ 33,119.70
22-Jan	676855	8,802	\$3.45	\$ 30,838.84
22-Jan	676856	8,803	\$3.45	\$ 30,842.35
24-Jan	676857	8,971	\$3.34	\$ 30,394.74
24-Jan	670007	9,053	\$3.34	\$ 30,672.57
24-Jan	670008	9,058	\$3.34	\$ 30,689.51
25-Jan	670009	9,275	\$3.38	\$ 31,817.29
25-Jan	670010	9,285	\$3.38	\$ 31,851.60
25-Jan	670011	9,286	\$3.38	\$ 31,855.03
26-Jan	670012	9,309	\$3.45	\$ 32,641.63
26-Jan	670013	9,302	\$3.45	\$ 32,617.09
26-Jan	670014	9,294	\$3.45	\$ 32,589.04
27-Jan	670017	9,294	\$3.50	\$ 33,018.26
27-Jan	670018	9,307	\$3.50	\$ 33,064.44
28-Jan	670019	9,307	\$3.49	\$ 32,979.42
28-Jan	670020	9,308	\$3.49	\$ 32,982.96
28-Jan	670021	9,315	\$3.49	\$ 33,007.77
29-Jan	670022	9,309	\$3.49	\$ 32,986.51
31-Jan	670028	9,324	\$3.46	\$ 32,790.76
31-Jan	670027	9,338	\$3.46	\$ 32,840.00
3-Feb	670050	9,342	\$3.45	\$ 32,667.27
3-Feb	670051	9,335	\$3.45	\$ 32,642.79
3-Feb	675818	4,509	\$3.45	\$ 15,767.15
4-Feb	670055	9,328	\$3.48	\$ 32,955.37
7-Feb	670060	8,929	\$3.41	\$ 30,914.03
16-Feb	686694	8,901	\$3.31	\$ 29,932.61
23-Feb	686728	9,512	\$3.28	\$ 31,714.08
25-Feb	686734	9,092	\$3.36	\$ 31,008.65
25-Feb	686735	9,094	\$3.36	\$ 31,015.47
25-Feb	686736	9,084	\$3.36	\$ 30,981.36
28-Feb	686548	9,506	\$3.52	\$ 34,005.88
1-Mar	680982	9,705	\$3.74	\$ 36,882.92
1-Mar	680983	4,500	\$3.74	\$ 17,101.82
1-Mar	680984	5,214	\$3.74	\$ 19,815.30
1-Mar	680985	5,526	\$3.74	\$ 21,001.03
1-Mar	671050	8,584	\$3.74	\$ 32,622.66
1-Mar	671051	8,481	\$3.74	\$ 32,231.22
1-Mar	680553	9,812	\$3.74	\$ 37,289.56

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5-Mar	686765	8,373	\$4.45	\$ 37,792.74
5-Mar	686766	8,364	\$4.45	\$ 37,752.12
5-Mar	686767	8,355	\$4.45	\$ 37,711.50
7-Mar	687520	8,352	\$4.62	\$ 39,183.17
7-Mar	676634	8,172	\$4.62	\$ 38,338.71
7-Mar	671017	8,159	\$4.62	\$ 38,277.72
8-Mar	687522	8,350	\$5.15	\$ 43,630.08
8-Mar	687523	8,346	\$5.15	\$ 43,609.18
9-Mar	687835	9,310	\$4.17	\$ 39,451.72
9-Mar	660744	8,953	\$4.17	\$ 37,938.91
9-Mar	660745	8,951	\$4.17	\$ 37,930.44
10-Mar	687537	9,069	\$4.02	\$ 36,975.15
10-Mar	687538	9,068	\$4.02	\$ 36,971.08
10-Mar	687539	9,067	\$4.02	\$ 36,967.00
12-Mar	687544	9,083	\$4.15	\$ 38,243.64
12-Mar	687545	9,086	\$4.15	\$ 38,256.27
12-Mar	687546	9,080	\$4.15	\$ 38,231.01
13-Mar	687856	9,093	\$4.15	\$ 38,285.75
13-Mar	687857	9,067	\$4.15	\$ 38,176.27
14-Mar	687549	9,089	\$3.97	\$ 36,642.48
14-Mar	687550	9,083	\$3.97	\$ 36,618.29
14-Mar	688722	8,624	\$3.97	\$ 34,767.82
14-Mar	688723	8,619	\$3.97	\$ 34,747.66
14-Mar	687859	9,335	\$3.97	\$ 37,634.23
16-Mar	688291	9,381	\$3.80	\$ 36,141.95
16-Mar	688292	9,370	\$3.80	\$ 36,099.58
17-Mar	687551	9,090	\$4.30	\$ 38,640.32
17-Mar	687552	9,073	\$4.30	\$ 38,568.06
18-Mar	687554	9,082	\$4.30	\$ 39,626.77
18-Mar	687555	9,073	\$4.30	\$ 39,587.51
19-Mar	687556	9,097	\$4.30	\$ 39,692.22
19-Mar	687557	9,088	\$4.30	\$ 39,652.95
19-Mar	687558	9,079	\$4.30	\$ 39,613.68
20-Mar	671021	9,382	\$4.30	\$ 40,935.74
20-Mar	671022	9,390	\$4.30	\$ 40,970.65
21-Mar	687928	9,081	\$4.50	\$ 41,491.66
22-Mar	671026	8,682	\$4.56	\$ 40,226.42
22-Mar	671027	8,682	\$4.56	\$ 40,226.42
22-Mar	671028	8,688	\$4.56	\$ 40,254.22
22-Mar	688435	8,377	\$4.56	\$ 38,813.26
22-Mar	687933	9,359	\$4.56	\$ 43,363.17
24-Mar	687936	9,085	\$4.81	\$ 44,345.48
24-Mar	687937	9,076	\$4.81	\$ 44,301.55
24-Mar	687938	9,067	\$4.81	\$ 44,257.62
24-Mar	670083	8,375	\$4.81	\$ 40,879.85
24-Mar	670084	8,359	\$4.81	\$ 40,801.75
27-Mar	687943	9,046	\$4.77	\$ 43,798.86
27-Mar	687944	9,038	\$4.77	\$ 43,760.13
28-Mar	687566	9,047	\$4.44	\$ 40,762.39
28-Mar	687567	9,042	\$4.44	\$ 40,739.87
28-Mar	687568	9,032	\$4.44	\$ 40,694.81
29-Mar	687570	8,846	\$4.37	\$ 39,252.50
29-Mar	687571	8,834	\$4.37	\$ 39,199.25
29-Mar	687572	8,824	\$4.37	\$ 39,154.88
29-Mar	669595	8,333	\$4.37	\$ 36,976.16
30-Mar	687573	9,050	\$4.14	\$ 38,007.33

30-Mar	687574	9,047	\$4.14	\$ 37,994.73
2-Apr	671033	8,502	\$4.13	\$ 35,680.00
5-Apr	687963	9,060	\$4.18	\$ 38,428.19
5-Apr	687964	9,051	\$4.18	\$ 38,390.02
6-Apr	687576	9,049	\$4.06	\$ 37,251.82
6-Apr	671036	8,848	\$4.06	\$ 36,424.36
6-Apr	671037	8,829	\$4.06	\$ 36,346.15
6-Apr	671038	8,834	\$4.06	\$ 36,366.73
7-Apr	687970	8,540	\$3.98	\$ 34,485.52
7-Apr	688837	9,063	\$3.98	\$ 36,597.45
7-Apr	688838	9,046	\$3.98	\$ 36,528.80
7-Apr	688839	9,051	\$3.98	\$ 36,548.99
8-Apr	672486	9,877	\$4.03	\$ 40,383.73
8-Apr	672487	9,882	\$4.03	\$ 40,404.17
9-Apr	672485	9,919	\$4.03	\$ 40,555.45
9-Apr	474187	9,874	\$4.03	\$ 40,371.46
10-Apr	687972	9,067	\$4.03	\$ 37,071.91
11-Apr	671042	9,141	\$3.93	\$ 36,424.39
13-Apr	671046	8,630	\$4.37	\$ 38,314.18
13-Apr	671047	8,614	\$4.37	\$ 38,243.15
13-Apr	688847	9,034	\$4.37	\$ 40,107.80
13-Apr	688848	9,043	\$4.37	\$ 40,147.76
14-Apr	688849	9,046	\$4.51	\$ 41,413.46
14-Apr	688850	9,032	\$4.51	\$ 41,349.37
14-Apr	688851	9,018	\$4.51	\$ 41,285.28
15-Apr	688852	9,048	\$4.51	\$ 41,422.62
15-Apr	688853	9,039	\$4.51	\$ 41,381.42
15-Apr	688854	9,028	\$4.51	\$ 41,331.06
17-Apr	663673	9,026	\$4.51	\$ 41,321.90
18-Apr	663607	8,607	\$4.51	\$ 39,062.97
18-Apr	671049	8,624	\$4.51	\$ 39,140.12
19-Apr	688866	9,019	\$4.42	\$ 40,485.19
19-Apr	688867	9,002	\$4.42	\$ 40,408.88
20-Apr	688869	9,023	\$4.53	\$ 41,521.56
20-Apr	688870	9,006	\$4.53	\$ 41,443.33
21-Apr	688871	9,040	\$4.46	\$ 40,936.39
21-Apr	688872	9,024	\$4.46	\$ 40,863.94
21-Apr	688873	8,999	\$4.46	\$ 40,750.73
22-Apr	688878	3,828	\$4.50	\$ 17,481.44
25-Apr	669938	8,798	\$4.65	\$ 41,538.11
26-Apr	688887	8,992	\$4.62	\$ 42,193.02
26-Apr	688888	3,816	\$4.62	\$ 17,905.76
27-Apr	651134	8,484	\$4.65	\$ 40,040.12
27-Apr	688891	8,993	\$4.65	\$ 42,442.34
27-Apr	688892	8,995	\$4.65	\$ 42,451.78
28-Apr	651137	4,037	\$4.71	\$ 19,316.04
28-Apr	688893	9,008	\$4.71	\$ 43,101.03
28-Apr	688894	8,997	\$4.71	\$ 43,048.40
28-Apr	688895	8,969	\$4.71	\$ 42,914.43
29-Apr	688899	3,836	\$4.72	\$ 18,388.57
30-Apr	688900	9,009	\$4.72	\$ 43,186.29
30-Apr	688901	8,975	\$4.72	\$ 43,023.30
3-May	688904	8,966	\$4.79	\$ 43,621.74
3-May	688905	8,960	\$4.79	\$ 43,592.55
5-May	688906	8,993	\$4.75	\$ 43,329.57
5-May	688907	8,970	\$4.75	\$ 43,218.75

31

30

5-May	688908	8,976	\$4.75	\$ 43,247.66	
9-May	688922	8,992	\$4.54	\$ 41,440.96	
11-May	672428	9,831	\$4.66	\$ 46,468.11	
11-May	672429	9,805	\$4.66	\$ 46,345.22	
12-May	672837	9,832	\$4.60	\$ 45,873.07	
12-May	672837	9,821	\$4.60	\$ 45,821.75	
13-May	672839	9,837	\$4.71	\$ 47,045.63	
13-May	672840	9,823	\$4.71	\$ 46,978.67	
17-May	662097	8,955	\$4.56	\$ 41,355.88	
17-May	662098	8,974	\$4.56	\$ 41,443.63	
18-May	662101	8,960	\$4.42	\$ 40,185.79	
18-May	662102	8,953	\$4.42	\$ 40,154.39	
19-May	662105	8,948	\$4.62	\$ 41,983.83	
19-May	662106	8,932	\$4.62	\$ 41,908.76	
21-May	676350	9,664	\$4.60	\$ 45,167.71	
21-May	676351	9,647	\$4.60	\$ 45,088.26	
21-May	676352	9,649	\$4.60	\$ 45,097.60	
23-May	662118	8,922	\$4.69	\$ 42,466.77	
24-May	662275	8,411	\$4.70	\$ 40,145.51	
26-May	662125	8,936	\$4.89	\$ 44,340.16	
26-May	662126	8,917	\$4.89	\$ 44,245.88	
26-May	662127	8,906	\$4.89	\$ 44,191.30	
29-May	662136	8,681	\$4.98	\$ 43,888.13	
31-May	662245	8,704	\$5.03	\$ 44,399.32	
31-May	662139	3,792	\$5.03	\$ 19,343.09	
31-May	662140	3,787	\$5.03	\$ 19,317.58	31
Totals		2,170,984			
Fuel Delivered (12/21/22-5/31/22):					

NET EXPENSE		
Total Fuel Expenses	8,704,637	
Total Days	161	
Cost Per Day	\$ 54,066	

Table C.
UAF Plant Outage Costs - Natural Gas

Vendor	Utility	Usage (CCF)	Cost (per CCF)	Total	Days in a month
Interior Gas Utilty	Natural Gas				
2022-01		5,855	\$ 19.50	\$ 114,172.50	31
2022-01				\$ 500.00	
2022-02		4,360	\$ 19.50	\$ 85,020.00	28
2022-02				\$ 500.00	
2022-03		992	\$ 19.50	\$ 19,344.00	31
2022-03				\$ 500.00	
2022-04		0		\$ 500.00	
2022-05		1,397	\$ 19.50	\$ 27,241.50	31
2022-05				\$ 500.00	

Total Natural Gas Charges (1/28-6/03/22) \$ 219,536.50

Remove "Service Charge" \$ (2,500.00) Paid monthly regardless of usage

NET EXPENSE

NG Expense	\$ 217,036.50
Total Days	121

Cost per Day	\$ 1,793.69
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Table D.
UAF Plant Outage Costs - Coal Transport (Avoided Cost Calculation)

Vendor	Utility	Usage	AKRR Invoices	Invoice #	Tons	Cost (per ton)	Total
Usibelli	Coal			1/31/2022	226005543	442.2	14.39 6,363.26
	1/28-1/31/21	931.00		2/1/2022	226005646	265.8	3,824.86
	Feb 2021	9,117.80		2/3/2022	226005655	271.4	3,905.45
	Mar 2021	8,887.50		2/7/2022	226005662	262	3,770.19
	April 2021	6,848.20		2/8/2022	226005669	730.55	10,512.62
	May 2021	1,718.40		2/9/2022	226005786	258	3,712.62
	6/1-6/3/21	1,216.30		2/11/2022	226005794	459	6,605.01
				2/14/2022	226005809	262.8	3,781.69
				2/15/2022	226005813	357.3	5,141.54
				2/16/2022	226005825	261.5	3,763.00
				2/17/2022	226005844	351.85	5,063.12
				2/18/2022	226005854	341.8	4,918.50
				2/22/2022	226005858	425.95	6,129.42
				2/23/2022	226005881	339.85	4,890.44
				2/24/2022	226005883	364.55	5,245.87
				2/25/2022	226005887	454.7	6,543.13
				2/28/2022	226005907	357.5	5,144.43
				5/16/2022	226006619	582.7	8,385.06
				5/25/2022	226006728	178.9	2,574.37
				5/26/2022	226006737	183.05	2,634.09
				5/31/2022	226006768	540.2	7,773.48
				6/1/2022	226006878	551.5	7,936.09
				6/2/2022	226006881	452.45	6,510.76
				6/3/2022	226006896	526.8	7,580.65
			Actual Spent 1/28-6/3		132,709.65		

Table E.
UAF Plant Outage Costs - Coal (Avoided Cost Calculation)

Vendor	Utility	Usage
Usibelli	Coal	
	1/28-1/31/21	931.00
	Feb 2021	9,117.80
	Mar 2021	8,887.50
	April 2021	6,848.20
	May 2021	1,718.40
	6/1-6/3/21	1,216.30
Average Daily Burn:		226.14
	Average Daily Burn:	226.14
	Cost per ton (UCM): \$	60.00
Days coal would be burned (1/28/22-6/3/22):		127
Would be consumed Coal (tons):		28,719.20
Cost (UCM):		1,723,152.00
Net Savings (1/28-6/3/22):		1,169,811.00
Days coal would be burned (12/19/21-1/27/22):		40
Would be consumed Coal (tons):		9,045.42
Cost (UCM):		542,725.04
Net Savings (12/19/21-1/27/22):		542,725.04
Net Savings		
Total Coal Expenses \$		1,712,536
Total Days		167
Total Net Savings per Day \$		10,255

Invoices	Invoice #	Tons	Invoice Amount
1/31/2022	70775	442.20	26,532.00
2/1/2022	70779	265.80	15,948.00
2/3/2022	70789	271.40	16,284.00
2/7/2022	70793	262.00	15,720.00
2/8/2022	70797	730.55	43,833.00
2/9/2022	70801	258.00	15,480.00
2/11/2022	70808	459.00	27,540.00
2/14/2022	70812	262.80	15,768.00
2/15/2022	70816	357.30	21,438.00
2/16/2022	70820	261.50	15,690.00
2/17/2022	70824	351.85	21,111.00
2/18/2022	70828	341.80	20,508.00
2/22/2022	70832	425.95	25,557.00
2/23/2022	70836	339.85	20,391.00
2/24/2022	70840	364.55	21,873.00
2/25/2022	70844	454.70	27,282.00
2/28/2022	70848	357.50	21,450.00
5/16/2022	70995	582.70	34,962.00
5/25/2022	71007	178.90	10,734.00
5/26/2022	71011	183.05	10,983.00
5/31/2002	71015	540.20	32,412.00
6/1/2022	71021	551.50	33,090.00
6/2/2022	71025	452.45	27,147.00
6/3/2022	71031	526.80	31,608.00
Total Spent 1/28-6/3/22			553,341.00

Table F.
UAF Plant Outage Costs - Ash Hauling (Avoided Cost Calculation)

Vendor	Utility	Usage (truckful)	Cost (per truckful)	Total	Days/Month
Aurora Energy Ash Haul					
2nd half	December 2020	22.00	\$880.00	\$19,360.00	15.5
	January 2021	48.00	\$880.00	\$42,240.00	31
	February 2021	58.00	\$880.00	\$51,040.00	28
	March 2021	60.00	\$880.00	\$52,800.00	31
	April 2021	56.00	\$880.00	\$49,280.00	30
	May 2021	12.00	\$880.00	\$10,560.00	31
	June 2021	50.00	\$880.00	\$44,000.00	30
	July 2021	59.00	\$880.00	\$51,920.00	31
	Aug 2021	81.00	\$880.00	\$71,280.00	31
	Sept 2021	74.00	\$880.00	\$65,120.00	30
	Oct 2021	66.00	\$880.00	\$58,080.00	31
	Nov 2021	69.00	\$880.00	\$60,720.00	30
1st half	Dec 2021	55.00	\$880.00	\$48,400.00	15.5

NET SAVINGS

Ash Haul Expenses	\$624,800
Total Days	\$365
Savings per Day	\$ 1,712

Table G.
UAF Plant Outage Costs - Limestone (Avoided Cost Calculation)

Vendor	Utility	Usage (tons or hours)	Cost (per ton)	Total	Days in Month		
Globe Creek	Limestone	July 2021	206.79 tons	\$290.86	\$60,146.94	31	
		July 2021	13.25 hours	\$182.85	\$2,422.76		
		Aug 2021	194.92 tons	\$287.63	\$56,064.84	31	
		Aug 2021	12.25 hours	\$180.42	\$2,210.15		
		Sept 2021	114.10 tons	\$287.63	\$32,818.58	30	
		Sept 2021	7.25 hours	\$180.42	\$1,308.05		
		Oct 2021	171.28 tons	\$287.63	\$49,265.27	31	
		Oct 2021	10.75 hours	\$180.42	\$1,939.52		
		Nov 2021	214.27 tons	\$287.63	\$61,630.48	30	
		Nov 2021	14.75 hours	\$180.42	\$2,661.20		
		1st half	Dec 2021	84.22 tons	\$287.63	\$24,224.20	15.5
		1st half	Dec 2021	3.75 hours	\$180.42	\$676.58	
	Total Spent 7/1-12/14				\$270,467.77		

Column C: please identify if the first line in the

				Average monthly tons:	180.27	
				Average monthly hours:	11.65	
				Cost per ton:	\$287.63	
				Cost per hour:	\$180.42	
				Months of usage (1/28/22-06/03/22):	4.23	
				Expected tons:	763	
				Expected hours:	49	
				Total Cost (1/28/22-06/03/22):	228,223.42	
Total cost for Limestone (Savings Projection):					228,223.42	
Vendor	Utility	U/M	Usage	Rate	Total	Invoice #
Globe Creek	Limestone					
	2/4/2022	hours	27	\$175.00	\$4,725.00	21102
	2/8/2022	tons	30	\$287.63	\$8,628.90	21105
	2/8/2022	hours	2	\$180.42	\$360.84	21105
	2/16/2022	tons	50.04	\$287.63	\$14,393.01	21106
	2/16/2022	hours	3	\$180.42	\$541.26	21106
	2/22/2022	tons	27.52	\$287.63	\$7,915.58	21108
	2/22/2022	hours	1.75	\$180.42	\$315.74	21108
Total Spent 1/28-6/3			27		\$36,880.32	
				Net Savings (1/28-6/3/22):	191,343.11	
Vendor	Utility	U/M	Usage	Cost (per ton)	Total	Invoice #
Globe Creek	Limestone					
	12/21/2021	Dec-21 tons	28.02	\$287.63	\$8,059.39	21098
	12/21/2021	Dec-21 hours	1.75	\$180.42	\$315.74	21098
Total Spent 1/28-6/3			198.08		\$8,375.13	
				Months of usage (12/19/21-01/27/22):	1.33	
				Expected tons:	240	
				Expected hours:	16	
				Total Cost (12/19/21-01/27/22):	71,938.04	
Net Savings (12/19/21-1/27/22):					63,562.91	

181 Total Days

Total Net Saving (112/19/21 - 6/3/22)				\$	254,906
Total Days					181
Totals Net Saving per Day				\$	1,408

Public Review Draft



August 19, 2024
Kellie Fritze, Associate Vice Chancellor
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Office of the Associate Vice Chancellor

University of Alaska Fairbanks, P.O. Box 757380, Fairbanks, Alaska 99775-7380

March 22, 2023

Matthew Jentgen
U.S. Environmental Protection Agency Region 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101

Subject: Comments on Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

Mr. Jentgen,

The University of Alaska Fairbanks (UAF) submits the enclosed comments addressing the Proposed Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan (Alaska Serious SIP). The proposed rule addresses Best Available Control Technology (BACT) determinations for the UAF Campus stationary source in the Alaska Serious SIP

UAF owns and operates emissions units at the UAF Campus under Title V Permit AQ0316TVP03. On May 5, 2021, the Alaska Department of Environmental Conservation (ADEC) issued Minor Permit AQ0316MSS08 which incorporates several of the Alaska Serious SIP requirements. The terms and conditions of this minor permit have been incorporated into Title V Permit AQ0316TVP03.

The U.S. Environmental Protection Agency (EPA) has proposed to disapprove several of the BACT determinations because the Alaska Serious SIP did not include the monitoring, recordkeeping, and reporting (MRR) requirements necessary to make the BACT requirements enforceable as a practical matter. Many of the enclosed comments explain that existing MRR requirements in the Title V permit can be incorporated into an implementation plan to address these SIP deficiencies.

UAF has addressed sulfur dioxide (SO₂) BACT requirements for Emissions Unit (EU) 113 in a separate comment submittal on Feb 20, 2023 under this proposed rulemaking action. The conclusion of the BACT analysis, which included wet flue gas flue gas desulfurization (WFGD), circulation dry scrubber (CDS), and dry sorbent injection (DSI), demonstrated that the cost effectiveness in dollars tons per ton of sulfur dioxide avoided was not economically feasible.

UAF appreciates the opportunity to submit comments on this proposed rulemaking action. Please contact Frances Isgrigg, P.E. at 907-590-5809 or fisgrigg@alaska.edu if you have any questions or concerns.

Naturally Inspiring.

Sincerely,

DocuSigned by:



864508AEDE3C4D0...
Kellie Fritze

Associate Vice Chancellor of Facilities Services

Encl: Comments: Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

cc:

Zach Hedgpeth, EPA

Larry Sorrels, EPA

Jason Brune, Commissioner, Alaska Department of Environment Conservation (ADEC)

Jason Olds, Acting Director, Air Quality Division ADEC

James Plosay, ADEC Permits Program

Julie Queen, UAF Vice-Chancellor for Administrative Services

Cameron Wohlford, Director, UAF Design and Construction

Frances Isgrigg, UAF Design and Construction

Tracey Martinson, Director, UAF Environmental, Health, Safety and Risk Management

Russ Steiger, UAF Environmental, Health, Safety and Risk Management

Courtney Kimball, Boreal Services

Public Review Draft



August 19, 2024
 Kellie Fritze, Associate Vice Chancellor
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May 26, 2023

Matthew Jentgen
 U.S. Environmental Protection Agency Region 10
 1200 Sixth Avenue, Suite 155
 Seattle, WA 98101

Subject: Supplemental Comments on Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

Mr. Jentgen,

On March 22, 2023, the University of Alaska Fairbanks (UAF) submitted comments addressing the Proposed Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan (Alaska Serious SIP). The proposed rule addresses Best Available Control Technology (BACT) determinations for the UAF Campus stationary source in the Alaska Serious SIP.

UAF has since noted that the comments submitted on March 22, 2023 contained discrepancies. UAF is submitting this supplemental comment to correct the discrepancies. Below are locations of the discrepancies in the original document. The updates are attached to this letter in Attachments (Attach) 1 and 2.

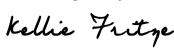
1. Emission Unit (EU) ID 24 (Section E, pages 9-10) presented comment language for EU 29 rather than EU 24. The correct information has been provided in Attach. 1, pg. 1 and 2, Section A.
2. EU ID 27 PM_{2.5} (Section E, Pages 10-11): Additional information on the cost of DPF was provided to UAF. The updated information is provided in Attach. 1, pg. 2-3, Section B and Attach. 2.
3. EU ID 27 (Section E, page 12): SO₂ BACT requirement on good combustion practices was omitted. The updates are provided in Attach. 1, pg. 3-4, Section C.
4. EU ID 114 (Section G, Page 15): The header 114 is incorrect; it should be EU ID 111. This is noted in Attach. 1, page 4 of the supplemental comments, Section D.

In addition to the above, UAF wants to clarify information provided to EPA in our original comments. UAF provided permit conditions from its Title V Air Quality Permit (AQ0316TVP03) to address EPA's comments in the January 10, 2023 Federal Register. The majority of the provided permit conditions are specific to the EU ID discussed in the comment.

However, for some of EU IDs, the permit condition provided is a proposed condition for the EU ID listed and would require a minor permit from the Alaska Department of Environmental Conservation.

We hope EPA will accept this supplement to our original comments. UAF understands that the EPA has no obligation to review these updates, however we believe this information will support EPA's efforts in its rule-making process regarding the State of Alaska PM_{2.5} Serious SIP. Please contact Frances Isgrigg, P.E. at 907-590-5809 or fisgrigg@alaska.edu if you have any questions or concerns.

Sincerely,

DocuSigned by:

964509AEDE3C4D0...

Kellie Fritze

Associate Vice Chancellor of Facilities Services

Attachments:

1. Supplemental Comments: Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115
2. University of Alaska Fairbanks Supplemental Cost Information on the Adjusted Cost Effectiveness for EU ID 27; Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

cc:

Zach Hedgpeth, EPA

Larry Sorrels, EPA

Jason Brune, Commissioner, Alaska Department of Environment Conservation (ADEC)

Jason Olds, Acting Director, Air Quality Division ADEC

James Plosay, ADEC Permits Program

Julie Queen, UAF Vice-Chancellor for Administrative Services

Cameron Wohlford, Director, UAF Design and Construction

Frances Isgrigg, UAF Design and Construction

Tracey Martinson, Director, UAF Environmental, Health, Safety and Risk Management

Russ Steiger, UAF Environmental, Health, Safety and Risk Management

Courtney Kimball, Boreal Environmental Services

ATTACHMENT 1

University of Alaska Fairbanks Supplemental Comments on Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

- A.** In the March 22, 2023 UAF submittal, the comment addressing proposed monitoring, recordkeeping, and reporting (MRR) requirements for Emissions Unit (EU) 24 on pages 9 and 10 inadvertently presented language addressing EU 29. Please disregard the original comment. The correct comment addressing proposed MRR for EU 24 is provided below.
1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} and SO₂ BACT determinations for EU 24 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating proposed MRR requirements as proposed below for each BACT requirement for EU 24.
 - a. PM_{2.5} and SO₂ BACT Requirement: Limit non-emergency operation to no more than 100 hours per year. Compliance with the operating hours limit will be demonstrated by monitoring and recording the number of hours operated on a monthly basis.
 - i. Condition 88.2 of Permit AQ0316TVP03 limits non-emergency operation to 100 hours per year. The MRR requirements are given in Conditions 88.4 and 88.5 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 88.4 and 88.5 of the Title V permit.
 - b. PM_{2.5} and SO₂ BACT Requirement: Maintain good combustion practices by following the manufacturer's maintenance procedures at all times of operation.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. Keep records of manufacturer required maintenance conducted on EU 24.
 2. Provide maintenance records to ADEC upon request in accordance with Condition 141 of Permit AQ0316TVP03.
 3. Certify compliance annually in the Annual Compliance Certification in accordance with Condition 144 of Permit AQ0316TVP03.
 - c. PM_{2.5} BACT Requirement: Demonstrate compliance with the numerical BACT emission limit of 1.0 g/hp-hr (3-hour average) by maintaining records of maintenance procedures conducted in accordance with the emissions unit operating manual.

- i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 - 1. Keep records of manufacturer required maintenance conducted on EU 24.
 - 2. Provide maintenance records to ADEC upon request in accordance with Condition 141 of Permit AQ0316TVP03.
 - 3. Certify compliance annually in the Annual Compliance Certification in accordance with Condition 144 of Permit AQ0316TVP03.
 - ii. UAF notes that the Alaska Serious SIP addresses several engine emissions units jointly, requiring demonstrating compliance “by maintaining records of maintenance procedures conducted in accordance with 40 CFR Subparts 60 and 63, [sic] and the EU operating manuals.” Because EU 24 is not subject to maintenance requirements in either 40 CFR 60 Subpart IIII or 40 CFR 63 Subpart ZZZZ, the operating manual is the only applicable source of maintenance procedures.
- B.** In the March 22, 2023 UAF submittal, UAF presented an updated cost analysis for a diesel particulate filter (DPF) for EU 27 on pages 10 and 11. This analysis was based on a proposed operating limit of 2,500 hours per rolling 12-month period to avoid a PM_{2.5} BACT requirement to install DPF. UAF had been working to obtain a current vendor quote for a DPF, but was unable to obtain one prior to the close of the public comment period for this proposed rulemaking that ended on March 22, 2023. Please disregard the proposed operating limit in the March 22, 2023 UAF submittal and instead consider the DPF cost analysis below which is **bold and underlined**.

Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations in the Alaska Serious SIP are not sufficient for EU 27 because an emission control device is cost effective. Section 9.1 of the EPA technical support memorandum¹ states that a diesel particulate filter (DPF) is recommended as a cost-effective control technology.

UAF believes that the Alaska Serious SIP PM_{2.5} BACT determinations for EU 27 are appropriate. EU 27 is a Tier 3 certified engine, combusts only ULSD, and per vendor-provided data, has potential PM_{2.5} emissions of 0.26 tpy. (UAF agrees that the correct basis for the cost-effectiveness calculation in the BACT analysis is the numerical BACT emission limit of 0.15 g/hp-hr in the Alaska Serious SIP.) Installation of a DPF on EU 27 is likely to result in only a nominal reduction in PM_{2.5} emissions.

On April 17, 2023, UAF received a vendor quote^{1,2} for a DPF system for EU 27 from NC Power Systems which provides cost for the equipment, material cost, freight to Fairbanks, and installation². UAF believes that the proposed operating limit of 2,500 hours per year is no longer necessary.

¹ Attached

² EU 27 is a Caterpillar C-15 engine. NC Power Systems carries Caterpillar engines and power system products and is the best source to advise on retrofitting a Tier 3 certified Caterpillar engine with additional emission controls.

The following table presents updated information regarding the cost-effectiveness calculation for implementing DPF emission control technology on EU 27, based on the existing operating limit of 4,380 hours per year.

	Values presented in March 2023 UAF comments to EPA	Values based on April 2023 NC Power quote
Total Capital Investment (TCI)	\$30,751	<u>\$78,210</u>
Capital Recovery Factor (CRF)	0.1000	<u>0.1000</u>
CRF Basis - Annual Interest Rate (%)	7.75	<u>7.75</u>
CRF Basis - Project life (years)	20	<u>20</u>
Total Annualized Cost = CRF x TCI	\$3,074	<u>\$7,818</u>
EU 27 operating hour limit (hr/yr)	2,500	<u>4,380</u>
EU 27 PM _{2.5} PTE (ton/yr)	0.21	<u>0.36</u>
<u>DPF Control Efficiency</u>	<u>85%</u>	<u>85%</u>
DPF - Tons PM _{2.5} avoided per year (ton/yr)	0.18	<u>0.31</u>
DPF Cost Effectiveness (\$ per ton avoided)	\$17,498	<u>\$25,401</u>

The Alaska Serious SIP PM_{2.5} BACT determination for EU 27 relies on a preliminary vendor quote from 2015. Because UAF has obtained a current vendor quote for DPF, UAF believes that a more restrictive operating limit is no longer necessary to demonstrate that DPF is not cost-effective. The April 2023 NC Power Systems quote and resulting cost-effectiveness calculation demonstrate that DPF is not an economically feasible PM_{2.5} emission control technology for EU 27.

- C. In the March 22, 2023 UAF submittal, the comment addressing the MRR requirements for the sulfur dioxide (SO₂) BACT determinations for EU 27 on page 12 omitted the good combustion practices requirement. The comment is presented below in its entirety, with the previously omitted text shown in **bold and underlined**.
1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the SO₂ BACT determinations for EU 27 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements for each BACT requirement for EU 27.
 - a. SO₂ BACT Requirement: Limit operation of EU 27 to no more than 4,380 hours per year.
 - i. Condition 28.1 of Permit AQ0316TVP03 limits EU 27 to 4,380 hours of operation in a rolling 12-month period. The MRR requirements are given in Condition 28.2 of

Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 28.2 of the Title V permit.

- b. SO₂ BACT Requirement: Combust only ULSD beginning no later than June 9, 2021. Compliance with the proposed SO₂ emission limit will be demonstrated through fuel shipment receipts and/or fuel testing for sulfur content.
 - i. Condition 43.2 of Permit AQ0316TVP03 requires the combustion of ULSD. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.
- c. **SO₂ BACT Requirement: Maintain good combustion practices by following the manufacturer's maintenance procedures at all times of operation.**
 - i. **Condition 79 of Permit AQ0316TVP03 requires operating according to Manufacturer's written instructions. The MRR requirements are given in Condition 82.3 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 82.3 of the Title V permit.**

- D. In the March 22, 2023 UAF submittal, the comment in Section G addressing PM_{2.5} BACT requirements for EU 111 on page 15 has an incorrect header (EU 114). The correct header is "EU 111."

ⁱ Hedgpeth, Z. (August 24, 2022). Review of Best Available Control Technology analyses submitted for the University of Alaska, Fairbanks as part of the Fairbanks PM_{2.5} Nonattainment SIP. U.S. Environmental Protection Agency, Region 10 Laboratory Services and Applied Science Division. Docket Document ID EPA-R10-OAR-2022-0115-0215, 000008_EPA Technical Support Document - UAF BACT TSD v20220824.

ATTACHMENT 2

University of Alaska Fairbanks Supplemental Cost Information on the Adjusted Cost Effectiveness for EU ID 27; Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

Pages 1 - 4: DPF Quote

Pages 5 - 8: Installation Drawings

Pages 9 - 20: Cat Retrofit DPF

From: [Erick Pomrenke](#)
To: [Ryan Coursey-Willis](#)
Cc: [Courtney Kimball](#)
Subject: RE: DPF Quote
Date: Friday, April 14, 2023 14:16:48
Attachments: [image002.png](#)
[Datasheet - DPF.pdf](#)
[A & I Guide for DPF installation.pdf](#)
[6275669DWF.ZIP](#)

Ryan,

Sorry for the delay.

Here's what we can provide.

- Critical grade DPF assembly.
- Monitor with 25 foot harness included.
- Insulated blanket included.

Attached is the spec sheet, drawing and installation guide.

Lead time is 20-24 weeks.

Sale price FOB Fairbanks Alaska – offloaded by others. \$78,210.00

Let me know if you need anything else.

Thank you

Erick Pomrenke
NC POWER SYSTEMS
GENERATOR / COMPRESSOR
RENTALS AND SALES
1-907-786-7565 OFFICE
1-907-632-6700 CELL
1-907-786-7567 FAX



From: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Sent: Tuesday, March 28, 2023 2:33 PM
To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Public Review Draft

August 19, 2024

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Yes, this will be FOB Fairbanks.

From: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Sent: Tuesday, March 28, 2023 2:29 PM

To: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Sure.

I'll work on the different freight quotes.

Is this FOB Fairbanks?

From: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Sent: Tuesday, March 28, 2023 2:27 PM

To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Can we quote both options?

Thanks

From: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Sent: Tuesday, March 28, 2023 11:15 AM

To: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Ryan,

I've got movement. Do you want silenced or non silenced?

Thank you

Erick Pomrenke

**NC POWER SYSTEMS
GENERATOR / COMPRESSOR
RENTALS AND SALES
1-907-786-7565 OFFICE
1-907-632-6700 CELL**

1-907-786-7567 FAX



From: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Sent: Thursday, March 23, 2023 5:36 PM
To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>
Cc: Courtney Kimball <ckimball@boreal-services.com>
Subject: Re: DPF Quote

Hi Erick,

Appreciate the heads up on this. That's good to know supply chain issues are a factor that needs to be taken into account on our end. Any major delays in procurement of equipment would be good to know about in the final quote as well.

Thank you for your time on this,
Ryan

From: Erick Pomrenke <EPomrenke@NCPowerSystems.com>
Sent: Thursday, March 23, 2023 2:38:20 PM
To: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Subject: RE: DPF Quote

Ryan,

I spoke with the folks at CAT earlier today.

They are working on it. They have some supply chain issues.

Just wanted to give you a heads up.

Thank you

Erick Pomrenke
**NC POWER SYSTEMS
GENERATOR / COMPRESSOR
RENTALS AND SALES
1-907-786-7565 OFFICE
1-907-632-6700 CELL
1-907-786-7567 FAX**



From: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Sent: Thursday, March 16, 2023 9:58 AM

To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Subject: DPF Quote

Hello Erick,

I wanted to touch base and see where you were at with the DPF quote for the C15 engine at UAF. Would we be able to get this today or tomorrow?

Thanks!

Ryan



Ryan Coursey-Willis

Project Engineer

Mobile: (907) 687-8446

Email: rcwillis@boreal-services.com

Address: 4300 B Street, Suite 510, Anchorage, AK 99503

CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 6275669 chg 00
DPF-BOX DESIGN

Attachment pricing arrangements found on drawing:

6168788 chg 00 6168789 chg 00 6233344 chg 00

6275669A.dwf = Top View, Left Side View, Front View, Right Side View, Bottom View of
6168788 CHG 00 Shown (sheet1)
Detail pf Exhaust Inlet/Outlet Flange

Attachments found on this sheet:

6168788 chg 00

6275669B.dwf = Top View, Left Side View, Front View, Right Side View, Bottom View of
6168789 CHG 00 Shown (sheet2)
Detail of Exhaust Inlet/Outlet Flange

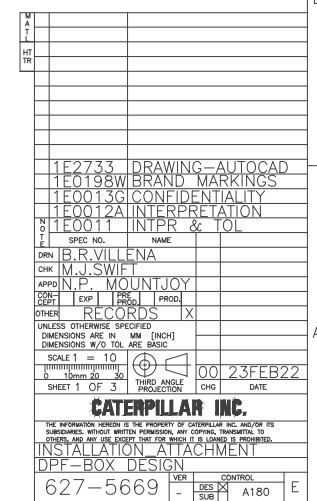
Attachments found on this sheet:

6168789 chg 00

6275669C.dwf = Top View, Left Side View, Front View, Right Side View, Bottom View of
6233344 CHG 00 Shown (sheet3)
Detail of Exhaust Inlet/Outlet Flange

Attachments found on this sheet:

6233344 chg 00





Appendix III.D.7.7-2265

[illegible]



1	2	3	4	5	6	7	8	9	10	11	12
HT	TR										
1E2733 DRAWING-AUTOCAD 1E0198W BRAND MARKINGS 1E0013G CONFIDENTIALITY 1E0012A INTERPRETATION 1E0011 INTPR & TOL N O SPEC. NO. NAME DRN R.V. VILLENA CHK M.E. SWIFT APP'D MOUNTJOY CON- SULT EXP (PROJ) OTHER RECORDS X UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MM [INCH] DIMENSIONS W/YD TOL ARE BASIC SCALE 1 = 10 10mm 20 30 SHEET 3 OF 3 THIRD ANGLE PROJECTION 00 23FE622 CHG DATE CATERPILLAR INC. THE INFORMATION HEREIN IS THE PROPERTY OF CATERPILLAR INC. AND/OR ITS SUBSIDIARIES. WITHOUT WRITTEN PERMISSION, ANY COPYING, TRANSMISSION, TO OTHERS, AND ANY USE EXCEPT THAT FOR WHICH IT IS ISSUED IS PROHIBITED. INSTALLATION ATTACHMENT DPF-ANALYSIS 627-5669 VER CONTROL DES A180 E											

Public Review Draft

CAT[®] RETROFIT DIESEL PARTICULATE FILTER (DPF)

For New and Existing Installations

August 19, 2024



Serviceability

- Cat[®] DPFs feature serviceable, fully removable catalysts with clamped catalyst filter modules for ease of service during maintenance checks.
- Large box design models feature access hatches that can be lifted by one technician without the need for cranes or other lifting devices.
- For models equipped with hatches, nut strips provide ease in securing of hatches after service.

Performance

- Optimized housing design maximizes emissions reduction while minimizing backpressure for increased efficiency.
- Integral silencer design provides high levels of sound reduction (most models).
- Insulation blanket increases heat retention for increased emissions reductions in demanding applications (optional).

Flexibility

- Slip-fit connectors on small models and flange connectors on medium to large models provide flexible and convenient connection options with existing exhaust piping.

Support

- Worldwide Cat dealer coverage – one source for you to trust.

Durability

- Housing is constructed of stainless steel for superior life in indoor and outdoor installations.
- Ceramic catalyzed substrate is resistant to high heat conditions.
- Specialized mounting feet allow natural thermal expansion during operation, reducing the potential for stress cracking (large box design models).

Ease of Installation

- Cat DPFs require minimal installation time and expertise to place into service.
- Medium and large models feature integral lifting eyes for easy lifting and placement.
- Cat Datalogging and Alarm System (DLAS) is pre-configured and easy to install for complete system monitoring (optional).

Safety

- Optional insulation blanket reduces surface temperature for additional safety.

CAT RETROFIT DIESEL PARTICULATE FILTER (DPF) For New and Existing Installations

August 19, 2024

Housing		
Construction	Stainless Steel	
Catalyst		
Construction	Catalyzed Ceramic Substrate	
Sulfur Tolerance (Diesel)	ULSD (<15 PPM)	
Biodiesel	Up to B20	
Emissions Reduction Capability		
Carbon Monoxide (CO)	Up to 95%	
Hydrocarbons (HC)	Up to 90%	
Particulate Matter (PM)	Over 85%	
Engine Applications		
Non-silenced	55-560 kW	80-750 hp
Industrial Grade Silencing	55-225 kW	80-300 hp
Critical Grade Silencing	225-4325 kW	300-5800 hp

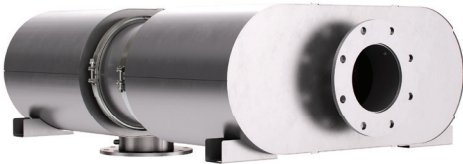
Datalogging and Alarm System (DLAS) (Optional)	
Monitoring Functions	Exhaust Temperature Exhaust Backpressure Date and Time
Cable Length	7.6 m / 25 ft.
Cable Length (Optional)	15.2 m / 50 ft.
Data Download	Ethernet Port

Housing Types

Non-silenced, 55 kW / 80 hp to 225 kW / 300 hp



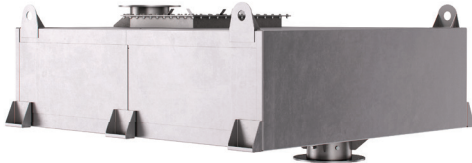
Non-silenced, 225 kW / 300 hp to 560 kW / 750 hp



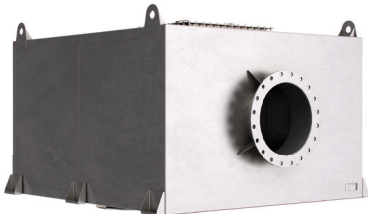
Industrial Grade Silencing, 55 kW / 80 hp to 225 kW / 300 hp



Critical Grade Silencing, 225 kW / 300 hp to 1045 kW / 1400 hp



Critical Grade Silencing, 930 kW / 1250 hp to 4325 kW / 5800 hp



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Appendix III.D.7.7-2268



Retrofit Diesel Particulate Filter (DPF) Reactor CARB Verified Level 3+ application & installation guide ES5 1-Up

LEBE0039-00



The information contained in this supplement is confidential and proprietary to Caterpillar. Distribution of this material must be limited to personnel whose duties require knowledge of such material and is intended exclusively for their information and training. Distribution of this material for other purposes is strictly prohibited.

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1.0 Introduction

Purpose

This document is intended as a reference and guide for the correct installation of the retrofit Diesel Particulate Filter (DPF) reactor. The primary purpose is to assist engineers and designers specializing in engine installations. The Engine Application and Installation Guide and Engine Data Sheets complement this booklet.

Note: The information in this document is subject to change as engine exhaust aftertreatments are revised, improved, and required for emission reduction standards.

Cat engines are designed and built to provide superior value; however, achieving the end user's value expectations depends greatly on the performance of the complete installation to assure proper function over the design life of the installation. This detail will allow the engine to produce its published rated power and fuel consumption and meet applicable emission standards.

Caterpillar exercises all reasonable effort to assure engine and Cat DPF perform properly. However, it is the responsibility of the OEM/installer to properly install the engine and Cat DPF reactor. Caterpillar assumes no responsibility for deficiencies in the installation. It is the responsibility of the OEM/installer to meet all Caterpillar requirements as provided in this Application and Installation Guide.

Caterpillar does not guarantee or approve the validity or correctness of any installation. Caterpillar's sole obligation with respect to any product is as set forth in the applicable Caterpillar warranty statement.

It is the installer's responsibility to consider and avoid possible hazardous conditions which could develop from the systems involved in the specific engine installation. The suggestions provided in this guide should be considered general examples only and are in no way intended to cover every possible hazard in every installation.

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Contact the appropriate application support group for the latest information on Cat DPF reactor guidelines and requirements.

Safety

Most accidents that involve product operation, maintenance, and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. An OEM installer must be alert to potential hazards. An OEM installer should also have the necessary training, skills, and tools to perform these functions properly.

The information in this publication was based upon current information at the time of publication. Check for the most current information before you start any job. Cat dealers will have the most current information.

Warning: Improper operation, maintenance, or repair of this product may be dangerous. Improper operation, maintenance, or repair of this product may result in injury or death. Do not operate or perform any maintenance or repair on this product until you have read and understood the operation, maintenance, and repair information. Burn and fire hazards are possible. Failure to properly connect the aftertreatment/regeneration device, if equipped, manage the regeneration gas temperature, or properly route the exhaust gases away from the module may result in personal injury or death.

Notice: Failure to properly connect the aftertreatment/regeneration device or manage the regeneration gas temperature may result in poor aftertreatment performance.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are not all inclusive. If a tool, a procedure, a work method, or an operating technique that is not specifically recommended by Caterpillar is used, you must be certain that it is safe for you and for other people. You must also be certain that the product will not be damaged. You must also be certain that the product will not be made unsafe by the procedures that are used.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury. Always wear a protective face shield, protective clothing, and protective shoes when cleaning components. The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded and used with effective chip guarding (if applicable) and personal protective equipment. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

High Pressure Wash

Notice: High pressure wash systems, including high pressure spray washers and water cannons, are now in frequent use by maintenance people. Connector seals will fail when hit directly with high pressure spray. Where direct exposure to high pressure wash systems cannot be avoided, protective shields will need to be designed and installed.

Welding

Warning Notice: Welding on DPF silencer frame/reactor body is prohibited.

Do not use electrical components (electronic controller or sensors) or electronic component grounding points for grounding a welder.

Painting

Painting of the Cat DPF is NOT recommended and strongly discouraged. Some components' skin temperatures on the DPF can get to as high as 650°F during operation and will cause charring or burning of the paint.

Replacement Parts



WARNING

When replacement parts are required for this product, Caterpillar recommends using Cat replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength, and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury, or death.

READ THROUGH THE ENTIRE MANUAL BEFORE PROCEEDING WITH ACTUAL INSTALLATION.

Emissions Requirements

This Installation Guide is intended for use for engines that must meet applicable emission standards. Proper fluids must be used to meet these requirements. Refer to the specific Operation and Maintenance Manual (OMM) for the engine model being installed for the proper fuel, lubricants, and coolants that are to be used. The proper fuels, lubricants, and coolants must be used to enable the engine to produce its published rated power and fuel consumption and meet applicable emission standards. JP8 fuel is not compatible with Cat DPF reactors.

Notice: Oils that have more than 1% total sulfated ash should not be used in aftertreatment device equipped engines. In order to achieve expected ash service intervals, performance, and life, aftertreatment device equipped diesel engines require the use of Cat DEO-ULS™ or oils meeting the Cat ECF-3 specification and the API CJ-4 oil category. Oils that meet the Cat ECF-2 specification and that have a maximum sulfated ash level of 1% are also acceptable for use in most aftertreatment equipped engines. Use of oils with more than 1% total sulfated ash in aftertreatment device equipped engines will cause the need for more frequent ash service intervals, and/or cause loss of performance. Refer to your engine specific Operation and Maintenance Manual, and refer to your aftertreatment device documentation for additional guidance.

Warning: Use of Oil Renewal System (ORS) is strictly forbidden. Any ORS that extends the oil life through the combustion process and topping off the oil reservoir with new oil will damage the aftertreatment device. Failures that result from the use of any oil are not Caterpillar factory defects. Therefore, the cost of repair would NOT be considered by the Caterpillar warranty for materials and/or the warranty for workmanship.

It is recommended that the Cat DPF operate in conjunction with ultra-low sulfur diesel fuel (ULSD-S15), less than 15 ppm sulfur by weight. ULSD fuel must meet the S-15 fuels designation in the latest edition of ASTM D975 and/or conform to Caterpillar Fuel Specification. Using ULSD, regeneration for engines meeting U.S. EPA Tier 2 and lower equivalent emission standards will occur when the duty cycle is above 300°C (572°F) for at least 30% of the operating time. For engines meeting Tier 3 equivalent emission standards and higher, consult Caterpillar for operating requirements.

Operating the Cat DPF on diesel engines using fuel with sulfur content greater than 50 ppm will increase the regeneration temperature requirements, typically 50-75°C (90-135°F). If the exhaust temperature meets these requirements, continuous regeneration still can take place. The regeneration temperature requirements will increase with high sulfur fuel. With added sulfur, the normal duty cycle of the engine will cause the filter to plug with PM, causing the backpressure to increase beyond the engine manufacturers' limits. Damage to the filter and/or the engine may occur.

When the fuel sulfur level is once again below 50 ppm, ULSD operating conditions will return. High sulfur fuel will not damage the catalyst coating or the ceramic filter. It does change the regeneration requirements as stated above.

Biodiesel fuel may be used up to the B20 blend level (20% biodiesel and 80% appropriate ULSD fuel) if the final B20 blend conforms to ASTM D7467 and API gravity 30-45. The neat biodiesel blend stock should conform to ASTM 6751. Refer to SEBU 6250 – Caterpillar Machine Fluids Recommendations for diesel engines and SEBU 6400 for natural gas engines.

Cat Diesel Engine Oils (Cat DEO) have been developed and tested to provide the full performance and service life that has been designed and built into Cat engines. Cat oils are currently used to fill Cat diesel engines at the factory. These oils are offered by Cat dealers for continued use when the engine oil is changed. Consult your Cat dealer for more information on these oils.

Cat DEO-ULS (Ultra Low Sulfur) oil exceeds the performance requirements of API category CJ-4 oil and is recommended due to a low ash specification. Engine oil that meets or exceeds the specifications in the Cat ECF-3 or API CJ4 categories may be used in these applications. Oil burned during the combustion process accounts for almost all of the DPF ash accumulation (because of oil additives). The use of recommended low ash oil results in lower ash accumulation in the filter. Failure to use the recommended grade of oil may result in more frequent ash removal service intervals.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

Cat Lubricants		Viscosity Grade
Diesel Engine Oil – Ultra Low Sulfur	Cat DEO – ULS	SAE 15W-40
		SAE 10W-30
	Cat DEO – ULS SYN	SAE 5W-40
	Cat Cold Weather DEO – ULS	SAE 0W-40
Diesel Engine Oil	Cat DEO	SAE 15W-40
		SAE 10W-30
	Cat DEO SYN	SAE 5W-40

Note: Cat DEO and Cat DEO-ULS multi-grade oils are the preferred oils for use in this Cat diesel engine.

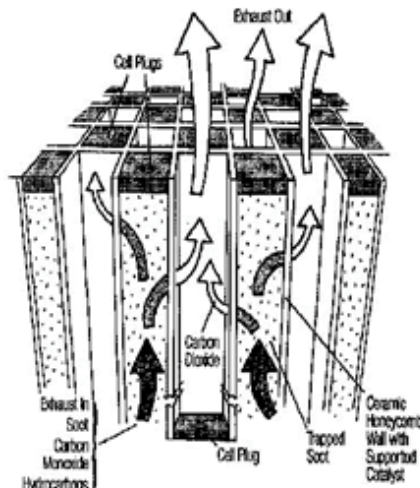
Note: Commercial oils that are not Cat oils are second choice oils for your engine.

Notice: Caterpillar does not warrant the quality or performance of fluids that are not Cat fluids. For more information, refer to Special Publication, SEBU6251, Cat Commercial Engine Fluids Recommendations.

2.0 Diesel Particulate Filter (DPF) Operation

Introduction of the Cat Diesel Particulate Filter

The Cat DPF is a catalyzed diesel particulate filter that is designed to reduce emissions of particulate (smoke), carbon monoxide (CO) and hydrocarbons (HC), from diesel engines. Carbon monoxide and hydrocarbon reductions are achieved when the exhaust gases interact with the catalyst on the ceramic filter. The catalyst is impregnated on the walls of the ceramic substrate. As the exhaust gases come in contact with the catalyst, a chemical reaction takes place that oxidizes the gases. The oxidation process turns carbon monoxide into carbon dioxide (CO₂) and hydrocarbons into water and carbon dioxide.



Reduction of Emissions

The Cat DPF is a complete product for reducing carbon monoxide, hydrocarbons and PM. The filter is catalyzed with a precious-metal catalyst. For CO and HC, the catalyst reduces the activation temperature needed in order to react with both types of compounds with oxygen (O₂). A simple version of the reactions is given below:

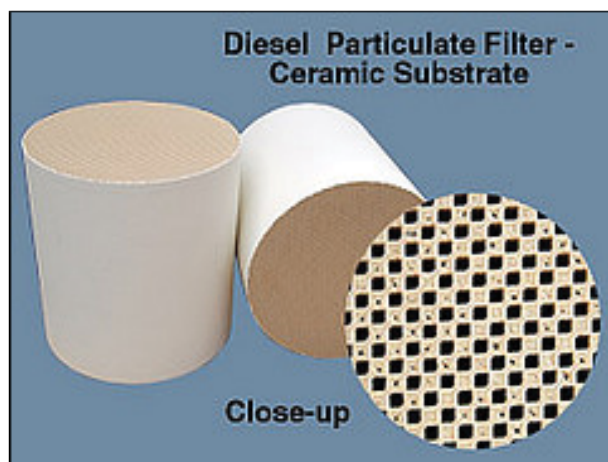
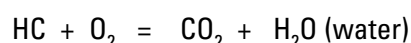
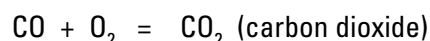


Figure 2.2

For the Cat DPF, these reactions can start to take place at temperatures as low as 180°C (356°F). By 230°C, the reductions are >90%.

Particulate matter, PM, is a more complex emission to reduce. PM is comprised of three basic fractions: carbon, volatile organics, and inorganics. These fractions change with engine combustion and are functions of ambient temperature, fuel composition, barometric pressure, lubrication oil, and exhaust composition.

Solid carbon and liquid volatile organics can be oxidized over the precious metal catalyst much the same as gaseous CO and HC are oxidized. Inorganics, such as calcium and magnesium compounds of lubricating oil, cannot be eliminated through oxidation. They are, however, trapped by the filter and comprise what is referred to as “ash.” Cleaning ash out of the filter is addressed in more detail in the “Maintenance” section.

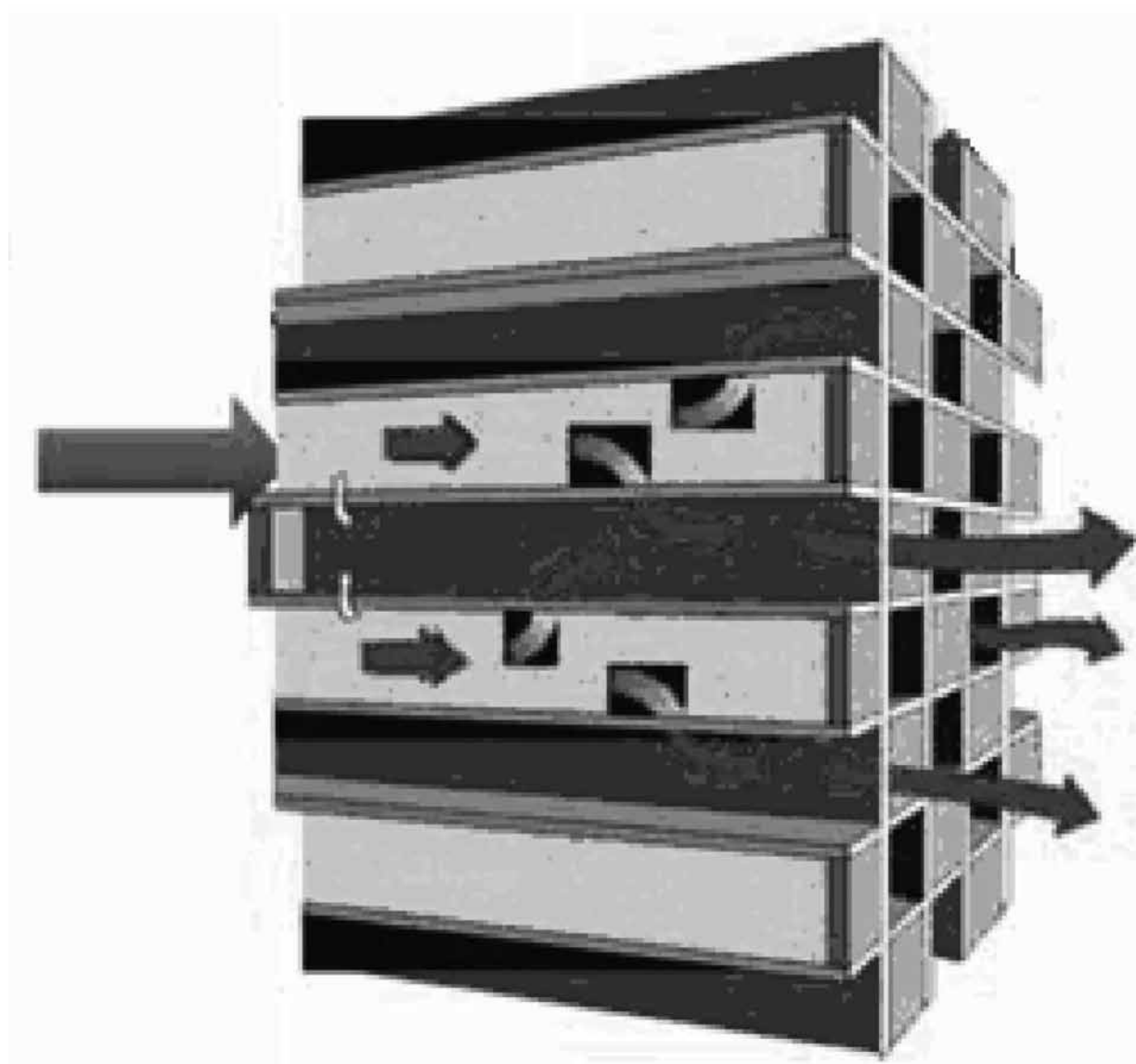


Figure 2.3

The DPF is used to reduce greater than 85 percent of the emissions of particulate matter. These emissions are reduced by filtration as the exhaust passes through the DPF wall. Carbon monoxide (CO), and Hydrocarbons (HC) are also reduced as the engine exhaust passes through the catalytic oxidation and filtration units. The DPF filter substrate uses a series of alternately blocked channels which forces exhaust gasses to flow through the channel walls. Particulates are physically captured and chemical reactions take place (see Illustration 5). Carbon monoxide and hydrocarbons are converted into carbon dioxide and water vapor. These filters are self-regenerating. Self-regenerating filters are not disposable, but, instead, will “burn off” the accumulated soot continuously if the proper exhaust temperature profile is met.

Regeneration

The process of particulate collection begins as soon as the engine is started and continues while the engine is operating. At low loads and low exhaust temperatures, PM accumulates in the filter, and pressure drop across the filter increases. When exhaust conditions are optimal, the catalyst promotes oxidation between the particulate matter and either oxygen or nitrogen dioxide in the exhaust. This process is called regeneration, whereby PM is burned off of the substrate walls, resulting in a cleaner filter. The regeneration process is dependent upon exhaust temperature, engine load, exhaust composition, and fuel sulfur content. At a certain exhaust condition, the rate of oxidation eclipses the rate at which PM is being trapped by the filter. The temperature at this exhaust condition is commonly referred to as the regeneration temperature. While the exhaust temperature does not have to be above its regeneration temperature all of the time, the more time above this temperature the cleaner the filter will be and the lower the backpressure. Operating above the regeneration temperature means that the filter will continuously regenerate and clean itself out.

Proper DPF regeneration **REQUIRES** the following conditions:

- Ultra Low Sulfur Diesel (ULSD) fuel must be used. ULSD fuel must have an average sulfur content of 15 parts per million (ppm) or less.
- The sulfur content in the diesel fuel is not to exceed 0.0015 percent by weight. ULSD fuel must meet the S-15 fuels designation in the latest edition of ASTM D975 and/or conform to Caterpillar fuel specification.
- Biodiesel fuel may be used up to the B20 blend level (20 percent biodiesel and 80 percent appropriate ULSD fuel). If the final B20 blend conforms to ASTM D7467 and API gravity 30-45. The neat biodiesel blend stock should conform to ASTM 6751.
- The engine exhaust temperature at the DPF inlet must be 300°C (572°F) or greater for at least 30 percent of the time or 2 hours whichever is longer.
- The ratio of nitrogen oxides (NOx) to particulate matter (PM) must be a minimum of 25:1. This ratio is the NOx level, in grams/brake horsepower hour, divided by the PM level). This technology is currently applicable to 1996 or newer Tier 1 or Tier 2 equivalent engines. Current Caterpillar retrofit passive DPF product is not applicable to Tier 3 equivalent engines.

- Consult with State and Federal agencies for verification requirements.
- The engine should be maintained and must not consume oil at a rate greater than the rate specified by the engine manufacturer.
- Caterpillar DEO-ULS (Ultra Low Sulfur) 319-2260 oil exceeds the performance requirements of API category CJ-4 oil and is recommended due to a low ash specification. Engine oil that meets or exceeds the specifications in the Caterpillar ECF-3 or API CJ4 categories may be used in these applications. Oil burned during the combustion process accounts for almost all of the DPF ash accumulation (because of oil additives). The use of the recommended low ash oil results in lower ash accumulation in the filter. Failure to use the recommended grade of oil may result in more frequent ash removal service intervals.

Illustration of the Cat Retrofit DPF Reactor

3.0 Illustration of the Cat Retrofit DPF Reactor

Applications of the Cat DPF reactor are extremely diverse. Some examples of Cat DPF reactor are shown in the pictures below:



Figure 3.1 – Stationary Installation of a Cat DPF Reactor on a Generator Set



Filter/muffler design
for stationary



4-filter combination with
industrial grade silencing
for stationary



6-filter silencer with critical
grade sound attenuation
for stationary

Throughout the remainder of this document, the terms filter, filter/muffler, and filter/silencer will be used. A Cat DPF is a single or multiple filter element reactor with inlet and outlet connections to attach to exhaust piping. These systems can be manufactured in industrial, critical, and super-critical grade silencing packages.

If lifting eyes are attached to the unit, use all eyes provided when lifting the unit. Always use all mounting feet and beams. Mounts are designed to distribute load evenly throughout the frame; each mount should be in contact with the support structure.

**Figure 3.2**

The Cat DPF reactor requires a Cat Data Logging and Alarm System (DLAS). The Cat DLAS measures and records exhaust temperature and backpressure. These parameters are essential in determining whether or not the application's duty cycle is acceptable for the filter.

Refer to DLAS Special Instructions UENR4923 for installation and maintenance guidelines.

General Comments

Installation of the Cat DPF reactor requires that the user ensure the entire exhaust system is properly designed before installing parts. Exhaust components such as expansion joints, rain caps, elbows, supports, etc. are critical installation pieces which, if they fail, may compromise emissions reductions as well as damage other components and even the engine. Refer to Application and Installation Guide, LEBW4970 "Exhaust Systems."

READ THROUGH THE ENTIRE MANUAL BEFORE PROCEEDING WITH ACTUAL INSTALLATION.

General Guidelines for Installation:

- If supplied, use all lifting eyes when lifting the filter/muffler or filter/silencer into place.
- If supplied, use all mounting feet when securing the Cat DPF into its operating position.
- Make sure all ports, openings and connections are clear from obstruction.
- Mount unit as close to the engine as possible. Make sure the unit is isolated from engine vibration using an expansion joint or flex connector.
- Use anti-seize on all threaded parts on the exhaust system.
- Use an expansion joint on the outlet of the Cat DPF reactor if piping is constrained downstream of the unit.
- Locate the Cat DLAS controller within 20 feet of the reactor if possible. Extra lengths for control wires can be supplied but are not standard and part of the originally supplied system.
- Ground the Cat DLAS control box. See Cat DLAS manual for complete instructions.
- When tightening fittings, torque to specifications listed in Cat 1E0279 or Caterpillar publication SENR3130 available on SISWEB <https://sis.cat.com/sisweb/sisweb/homepage>. Note: applying more than specified torque to the Cat DPF reactor may damage the filter assembly and affect the warranty.

Stationary Installation

4.0 Stationary Installation

Lifting of a Filter/Silencer Using Lifting Eyes



Lift using
all available
lifting eyes.

Figure 4.1

All Cat DPF silencers come with lifting eyes. Use all eyes when lifting unit into place.

The DPF silencer comes mounted on temporary shipping brackets and is equipped with lifting eyes. The lifting eyes can be used to remove the unit from the bed of the shipping truck and to install on the support system. When using the lifting eyes to lift the system, use all the provided eyes. The lifting eyes are arranged around the center of gravity and all must be used to lift the unit squarely. Failure to do so could result in accidents, potential injury, and equipment damage. Spreader bars are recommended where applicable.

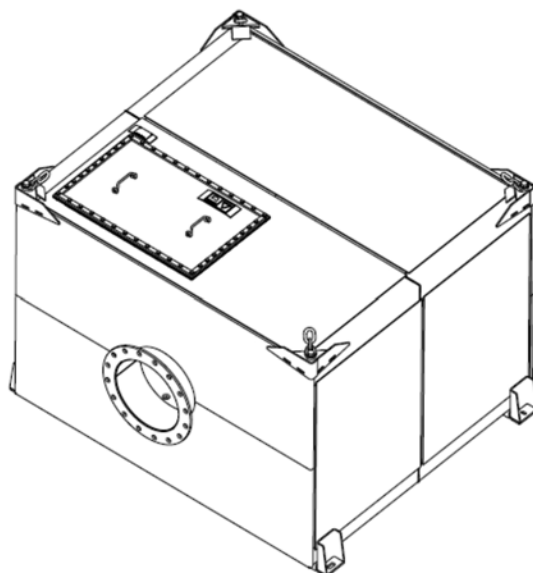


Figure 4.2

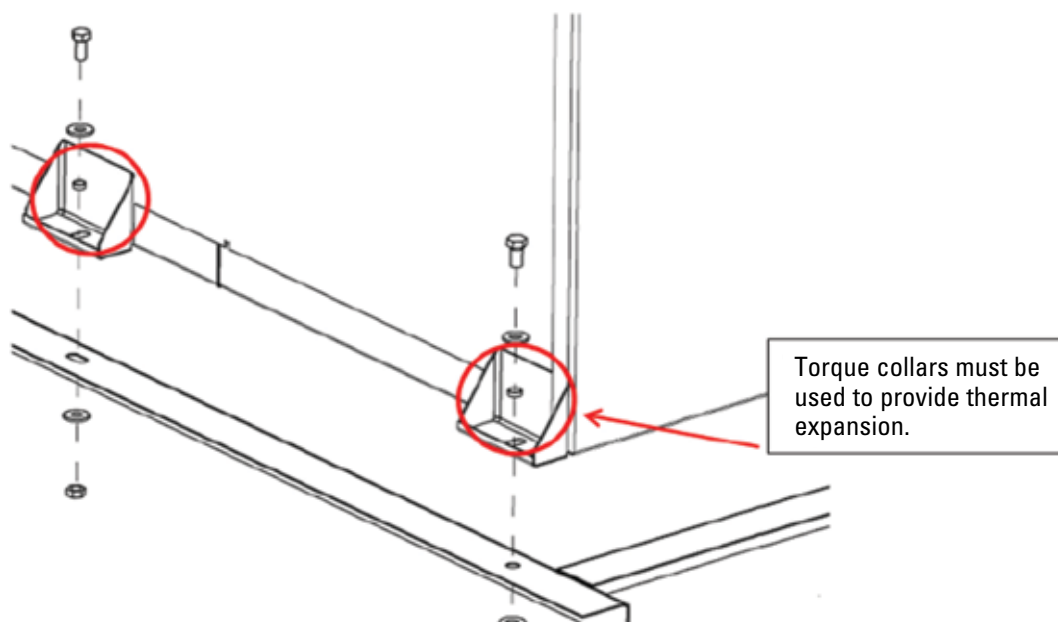
Lifting of a Filter/Silencer Using Forklift**Figure 4.3**

All Cat DPF reactors >75 lbs. will be palletized. Make sure lifting forks are positioned correctly underneath the designed lifting beams in the skids. For long units, side loading may be required. Check with your local Cat dealer for the weight of the DPF silencer. Smaller Cat DPF reactors (<75 lbs.) may be boxed instead of palletized.

Mounting of Filter/Silencers for Stationary Applications**Mounting the DPF Reactor Instructions**

The mounting feet on the DPF reactor unit are slotted with a 7/8" slot running parallel to the short axis of the unit. The mounting that the unit rests on should have (2) drilled (round) holes on the DPF exhaust inlet end only (see below). All other holes on the mounting (frame, posts, etc.) shall be slotted with 7/8" slots running parallel to the long axis of the unit. When the mounting feet are set on the mounting frame, the slots will form a cross. Use of torque collars allows the unit to thermally expand length and width ways.

It is mandatory that all feet are contacting the mounting surface to distribute the load over their entire surface.

**Figure 4.4 – DPF Reactor Mounting Technique**

Bolting the DPF to the pedestal using the mounting feet provided, include 7/8" slotted holes running parallel to the short axis of the unit. The customer-installed mounting platform that the unit rests on should have pre-fabricated 7/8" slotted holes running parallel to the long axis of the unit. When the mounting feet are set on the mounting frame the slots will form a cross. This allows the unit to thermally expand sideways and long ways. Flat washers should be used on both the bottom and top when tightening down the unit. A torque collar or spacer installed between the two flat plains enables the unit to move thermally back and forth or left and right discouraging structural impact on the housing of the SCR system. Both top and bottom must be secured. Secure the top once the bottom has been bolted in place.

For units with 7/8" slots an SAE grade five (5) 5/8" bolt is recommended and torque to $115 \pm 20 \text{ N}\cdot\text{m}$.

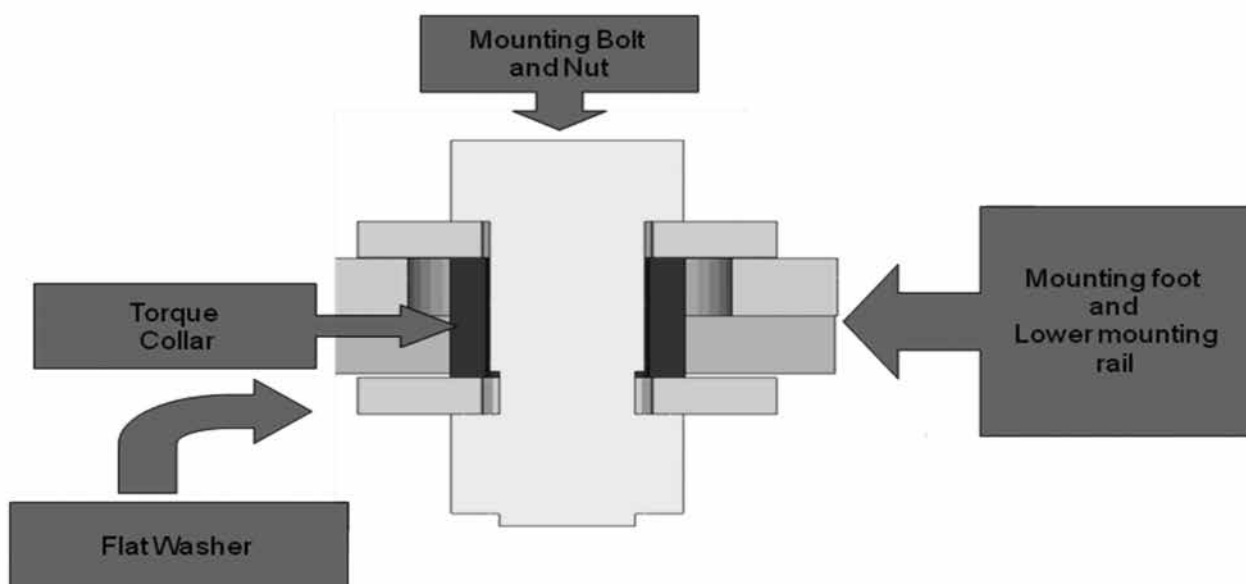


Figure 4.5 – Torque Collar Design

Thermal Expansion

From its cold state, 304L stainless steel will expand 0.3 mm (.0119 in) per 305 mm (1 ft) of DPF reactor length per 50°C (122°F) temperature rise. If not accounted for, the thermal growth can exert undue stress on the engine and SCR connections, as well as the pipe supports.

Note: If DPF is mounted rigid without thermal expansion allowance, weld failures and metal fatigue in the mounting feet and outer shell of the DPF could result in damage to the DPF structure.

Do not weld the DPF mounting brackets to the supporting frame.

										0.82%
										0.75%
										0.69%
										0.59%
										0.49%
										0.39%
										0.30%
										0.20%
										0.10%
27C	77C	127C	177C	227C	277C	327C	377C	427C	477C	

Figure 4.6 – Temperature Rise

Linear Thermal Expansion = for every 50°C temperature rise multiply
SCR system dimension by expansion percentage.

The following table lists the various fasteners required to install and/or service a DPF silencer. The exhaust flanges vary per engine bore size so the required size will depend on the flange used. It is a requirement that high temperature (>600°C) anti-seize compound be used on all exhaust bolts.

DPF Fastener Guide		
Mounting Point	Description	Fastener type/size
A	Lifting Eyes	NA
B	Elongated Base Mounting Brackets	5/8" bolt torque 115 ± 20 N•m
C	Exhaust In Flange	As required by flange bolt size
D	Exhaust Out Flange	As required by flange bolt size
E	Inspection Cover	3/8 x 16 bolt torque 25 N•m ± 4 N•m

Connections to the Exhaust System

The Cat DPF reactor must be isolated from engine vibration. The Cat DPF reactor exhaust inlet and outlet flanges are not designed to handle the significant loads that can come from thermal expansion of piping. Consequently, bellows are required on the inlet connection and are recommended on the outlet connection, especially if a long run of stack piping is required to convey the exhaust out of the building. Install bellows within two stack diameters of the DPF reactor outlet and in the same direction of flow from the outlet. If stack plenum has multiple directional changes, use bellows along each straight section to accommodate thermal expansion.



**Figure 4.7 –
Exhaust Bellows Connection**

Exhaust Stack Out Requirements

Not to exceed 300 lbs axial load on top of the exhaust flange. If more weight than this is placed on the top of the reactor, a support must be used on the stack with a bellows installed after the outlet flange. If made of 16 gauge metal, a 24" diameter 19' stack alone will weigh 300 lbs.

For Top-mounted Stacks

Wires must not be used to secure the stack to eliminate a moment on the exhaust flange. Stacks should be supported by a sleeve or roller supports, which will allow the stack to grow under thermal expansion but still prevent any moment being placed on the exhaust flange and outlet wall.

For Side- and End-mounted Stacks

The stack should be supported by a sleeve or roller supports which will allow the stack to grow under thermal expansion while still preventing any moment being generated on the exhaust flange and outlet wall.

Thickness for stacks should be 16 gauge or greater. Height limitation would only be necessary for a backpressure measurement if the stack is supported.

Water Ingress Prevention

The presence of water in the DPF can cause failures such as cracking of the catalyst from freeze/thaw cycles, cracking of catalyst by water causing thermal gradients across the catalyst substrate, and potential for loss of mat retention. Exhaust system outlets must be provided with an appropriate means of preventing snow, rainwater, or sea spray from entering the DPF through the exhaust piping. This can be accomplished by several methods, but must be given careful consideration. The selected method can impose significant restrictions that must be taken into account when calculating system backpressure. One simple method, used primarily with horizontal exhaust pipes, is to angle cut the end of the exhaust pipe with the point at the top.

A common method used with vertical exhaust pipes is to angle the pipe at 45° or 90° from vertical using an appropriate elbow, then angle cutting the pipe end as previously described.

For applications where none of the previous methods are possible, it may be necessary to fit some form of rain cap to the end of the vertical pipe section. This method can provide a positive means of water ingress prevention, but not without imposing a significant backpressure restriction.

Additional information related to exhaust system installation can be found in the Caterpillar publication LEBW4970.

General Requirements Summary

Attention should be given to exhaust gas flow restriction with the following recommendations:

- The exhaust backpressure must not exceed the limits given for each engine family and the Cat DPF installation. Reference TMI System Data or Engine Sales Manual for commercial applications and engine technical specifications.
- The exhaust piping must allow for movement and thermal expansion so that undue stresses are not imposed on the turbocharger structure or exhaust manifold.
- Never allow the turbocharger to support more than allowable loads. Reference TMI System Data or Engine Sales Manual for commercial applications and engine technical specifications.

Backpressure Verification

Excessive backpressure drop in the exhaust system will adversely affect the performance of the engine and the Cat DPF reactor. It is required that the systems meet these criteria for optimal performance. Excessive pressure drops can yield higher than expected exhaust temperatures, lower fuel economy, reduced altitude capability, and less than rated power.

For retrofit DPF reactors it is recommended that exhaust backpressure be measured and recorded prior to installation. Once installed the exhaust backpressure should be measured and recorded for future comparison as an indicator of catalyst performance.

Measuring Backpressure

Exhaust backpressure is measured as the engine is operating under full rated load and speed conditions (high idle for naturally aspirated engines). Either a water manometer or a gauge measuring inches of water may be used.

It is a requirement that high temperature (>600°C) anti-seize compound be used on all exhaust bolts.

Insulation Requirements

It is very important to retain as much heat in the DPF reactor exhaust as possible. The regeneration process of the DPF is more efficient at high exhaust temperatures. Insulate all piping prior to the Cat DPF reactor, as shown below. Check with your local Cat dealer regarding insulation practices related to exhaust system components.

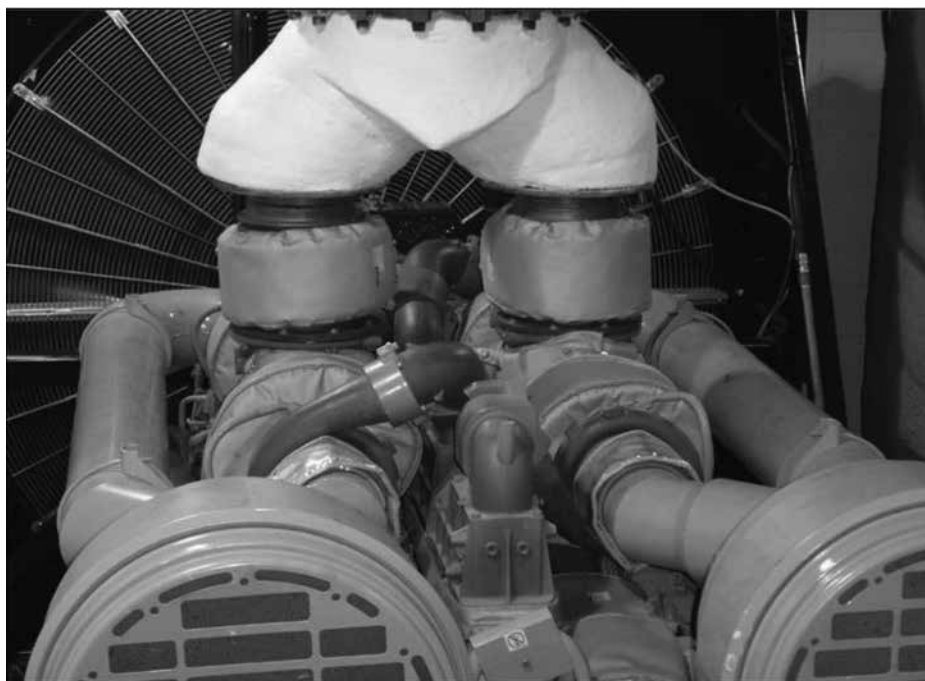


Figure 4.8 – Exhaust Piping Insulation

The DPF reactor skin temperature and/or exhaust gas temperatures are difficult to measure or simulate and are dependent upon many factors including the following: the design and packaging of the DPF reactor, the engine speed/load conditions, the condition of the DPF reactor, and the ambient conditions. Therefore, the potential temperatures are provided as a guideline for safe design of the installation.

Insulation results in an approximate surface temperature of 94°C (200°F) and a non-insulated unit has an approximate skin temperature of 120°C (280°F). The potential temperatures are provided as a guideline for safe design of the installation and proper precautions should be taken to ensure the aftertreatment device is properly shielded and not mounted in close proximity to surrounding components that may be damaged by heat.



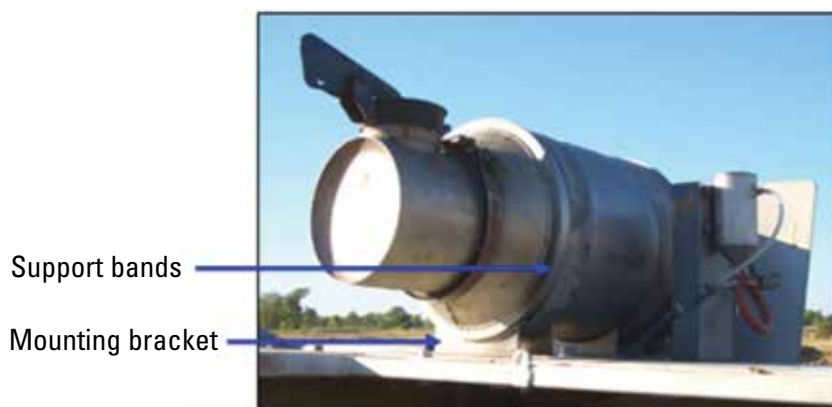
Figure 4.9 – Custom Thermal Blanket

If requirements of the installation require a lower surface temperature, optional blankets can be designed that conform to the shape of the DPF reactor and any piping connecting to the reactor. See the example of a custom made insulation blanket.

Mounting of Filters and Filter/Mufflers for Stationary Applications

Filters and filter/mufflers have substantial weight and need to be properly supported. Illustrations of some installations are shown below:





Single filter on a generator set system is properly supported by brackets and secured with support bands.

Weight information for Cat DPF reactors is supplied with the units. Design support brackets to handle the weight and vibration loads of the application.

When connecting to the current exhaust system, locate the filter as close to the engine exhaust manifold as possible to retain heat from the engine. In addition, isolate the unit with a flex connector or expansion joint. **CAUTION – DO NOT OVER TIGHTEN SUPPORT BANDS. DEFORMING THE METAL AROUND THE CENTER OF THE FILTER WILL VOID THE WARRANTY.**

For installations where sections of exhaust piping are to be removed to accommodate a Cat DPF reactor, remove the necessary length of pipe accounting for your chosen flex joint on the inlet and outlet. If an existing muffler is going to be kept in the exhaust, then you **MUST** mount the Cat DPF upstream of the muffler. Consult Caterpillar with regard to the designed pressure drop across the filter as you may exceed the engine manufacturer's specification for maximum backpressure. Caterpillar is **NOT** responsible for backpressure resulting from all other components in the exhaust system.

For installations using slip-on connectors, slip the filter inlet over the exhaust pipe until about 2 inches are inside the inlet cone. Secure the filter to your mounting brackets. Insert the exhaust pipe approximately 2 inches into the outlet cone. Once the Cat DPF is in position, tighten all clamps. Check the V-band clamps on the filter for tightness.

Warning: If you are installing the filter vertically, you must contact Caterpillar first to confirm that a vertical installation is acceptable. Take extra care to prevent the filter from slipping down on the exhaust pipe causing contact before the exhaust and the ceramic substrate. Contact will damage the ceramic and void the warranty.

5.0 Appendices

Appendix A

General Operation Guidelines

For Generator Set Installations of the DPF Reactors

1. Ensure the engine operation will adhere to the following guidelines:
 - At least 30% of the operating time the exhaust temperature is above 300°C and the engine load is above 40% or an exhaust gas heater is required.
 - Fuel sulfur content <15 ppm, ULSD
 - Engine PM output of < 0.2 g/bhp-hr
2. Insulate all exhaust components between the turbocharger and DPF inlet. This includes piping, expansion joints, and bellows.
3. Install the monitor/alarm system as it is the key component to ensuring the DPF unit is working as intended and that the filter media is not plugging with particulate matter. This unit records date, time, temperature, and backpressure data, allowing the user a comprehensive understanding of engine duty cycle and DPF performance. Follow the installation instructions carefully. Check the integrity of all plumbing and wiring connections. Once installed, download data, using the optional software, and check that the temperature and backpressure data correspond to engine load output.
4. Heed all warnings that the DLAS kit generates. Solid yellow or red alarms indicate an increase in backpressure and must be investigated. Blinking yellow or red lights indicate a problem with temperature or pressure measurements and require physical checks of the sensors and connections. Data must be collected when an error is generated.
5. The optional software package is required to see real-time data and to retrieve stored data, which can then be transferred into spreadsheet for viewing and graphing. The data includes a history of all errors generated plus 26,000 lines of temperature, backpressure, time, and date values, which equates to approximately 100 hours of operation when the logging interval is set at 15 seconds.
6. Create a schedule for downloading DLAS data and graphing the performance. Backpressure may go up and down but over time should be flat, meaning that particulate is not accumulating on the DPF. If particulates are not accumulating, the DPF is regenerating, or cleaning itself. This is the intended operating state.
7. DO NOT operate the generator after a red alarm is triggered. If the generator must be operated, limit the operating time to as short a duration as possible. Monitor the backpressure during operation using the DLAS software or a pressure gauge. If the backpressure continues to increase, stop the engine as soon as possible, allow the exhaust to cool, and then remove the DPF for cleaning. If the backpressure decreases the engine may continue operation until the backpressure has stabilized.

8. If you must operate at low loads, limit continuous operation at <40% load for under two hours. After two hours but less than four hours, and if no alarms have been triggered, you can regenerate the DPF by operating the engine at 80% to 100% load for 45 minutes or you can remove the DPF and have it cleaned.
9. If you have exceeded four hours of continuous operation at low load, <40% load, the DPF must be removed and cleaned.
10. You may perform a forced regeneration by operating the engine at high load. Make sure that you monitor the Cat data logging system and use the software or use a pressure gauge to keep track of the backpressure. It is possible that once high load is applied to the system, a yellow or even red alarm may trigger. If a red light triggers during a forced regeneration, do not stop the regeneration cycle (this is an exception to #7. We need to set a max allowable pressure, if it is too high, it damages the housing.) Allow the cycle to complete, meaning that backpressure drops to 15 to 20 inches of water and levels off. If after 20 minutes the backpressure does not decrease but instead continually increases even though temperature has leveled, then cease the forced regeneration, allow the exhaust to cool, remove and clean the DPF.
11. If cold starts are required, perform up to twelve 10-minute cold starts. After 12 and up to 24 cold starts with no alarms triggered, you can force regeneration by operating the engine at 80% to 100% load for 45 minutes or you can remove the DPFs and have them cleaned. If choosing to perform a forced regeneration, follow guideline 10.
12. If DPFs accumulate too much particulate and are not cleaned either on-line or off-line, an uncontrolled regeneration may occur, which can melt the filter media. If this occurs, there will be no structural damage to the filter package or to the silencer. However, the DPFs will become compromised and PM will now be visible in the exhaust. If this occurs, the DPFs must be replaced.
13. Non-regeneration does not constitute failure of the DPF. Regeneration is based upon engine operating conditions. Non-regeneration is not a warranty issue.
14. If a DPF should fail and the DLAS kit shows operation during an alarm or error condition, the warranty may be void.
15. If a DPF should fail and the DLAS kit shows no data, the warranty is void.
16. Over time, non-combustible ash may accumulate in the DPF media. Ash is composed mainly of minerals such as calcium, magnesium, and iron that occur in small amounts in lubrication oil. When lube oil is consumed in the combustion process, ash particles are airborne and then trapped in the DPF. Ash will manifest as increased backpressure and cannot be burned off. The DPF must be removed and cleaned. Depending upon the amount of lube oil consumed and the ash content of the oil, ash cleaning will need to be performed between 2500 and 5000 hours of operation. Use historical data to determine, at a 50% load condition, if ash accumulation has added five or more inches of water to clean DPF backpressure. If so, ash has accumulated and the DPF needs to be removed and cleaned.

Appendix B

Standard Caterpillar Inch Torque Specifications

For all torque specifications in this manual consult Caterpillar publication SENR3130 available on SIS Web at: <https://sis.cat.com/sisweb/sisweb/homepage>

Torque table excerpts from 1E0279 follow:

Note: All torque values should be the standard values except for specialty applications.

INCH THREAD SIZE	1E0279A STANDARD			1E0279G HIGH			1E0279E LOW			1E0279C SPECIAL			TENSILE STRESS AREA mm ²
	TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		
		DES	MIN		DES	MIN		DES	MIN		DES	MIN	
1/4 - 20	12±3	12	10	13±3	13	10	6±1	6	5	14±3	14	11	20.6
5/16 - 18	25±6	20	16	28±7	22	18	13±3	10	8	30±7	24	19	33.6
3/8 - 16	47±9	31	25	50±10	33	27	25±6	16	13	55±10	36	30	50.3
7/16 - 14	70±15	39	32	80±15	45	37	40±8	23	18	85±15	48	39	68.4
1/2 - 13	105±20	52	42	120±20	59	48	60±12	30	24	135±20	66	55	91.6
(9/16 - 12)	160±30	70	57	175±30	77	63	85±15	37	31	190±30	83	68	117
5/8 - 11	215±40	85	69	240±40	94	78	115±20	45	37	270±40	106	87	146
3/4 - 10	370±50	121	100	430±60	141	116	200±40	66	54	475±60	156	128	215
7/8 - 9	620±80	174	143	700±90	197	162	325±40	91	75	750±90	211	173	298
1 - 8	900±100	221	182	1050±150	258	212	500±65	123	101	1150±150	283	232	391
1-1/8 - 7	1300±150	284	233	1450±150	317	260	700±90	153	126	1600±200	350	287	492
1-1/4 - 7	1800±200	354	291	2100±250	413	339	1000±125	197	162	2300±300	453	371	625
1-3/8 - 6	2400±300	430	352	2700±300	483	397	1000±150	233	191	3000±350	537	441	745
1-1/2 - 6	3100±350	509	417	3600±400	591	485	1700±200	279	229	4000±500	656	538	906
() INCLUDED FOR INFORMATION, NOT PREFERRED FOR USE													
*W = T/DK													
WHERE T = TORQUE IN NEWTON METERS													
K = TORQUE COEFFICIENT													
DESIGN CLAMP LOAD, K = 0.16													
MIN CLAMP LOAD, K = 0.195													
*SEE PARAGRAPH 2.5.2 FOR SCATTER OF K.													
D = NOMINAL THREAD DIAMETER IN MILLIMETERS													
W = CLAMP LOAD IN KILONEWTONS													
TENSILE STRESS AREA = 0.7854 (D - 0.9743P) ²													
(PER ASTM A449, P = 25.4/THREADS PER INCH)													

Design and Expected Minimum Clamp Loads For Inch Fasteners

Standard Caterpillar Metric Torque Specifications

METRIC THREAD SIZE	1E0279B STANDARD			1E0279H HIGH			1E0279F LOW			1E0279D SPECIAL			TENSILE STRESS AREA** mm ²
	TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		
		DES	MIN		DES	MIN		DES	MIN		DES	MIN	
M6 X1	12±3	13	10	13±3	14	11	6±1	6	5	14±3	15	12	20.1
M8 X1.25	28±7	22	18	30±7	23	19	15±3	12	10	35±8	27	22	36.6
M10 X1.5	55±10	34	28	60±12	38	31	30±7	19	15	70±15	44	36	58.0
M12 X1.75	100±20	52	43	105±20	55	45	50±10	26	21	120±20	63	51	84.3
M14 X2	160±30	71	59	175±30	78	64	80±15	36	29	190±30	85	70	115
M16 X2	240±40	94	77	270±40	105	87	125±20	49	40	300±40	117	96	157
M20 X2.5	460±60	144	118	530±70	166	136	250±40	78	64	570±80	178	146	245
M24 X3	800±100	208	171	900±100	234	192	425±50	111	91	1000±125	260	214	353
M30 X3.5	1600±200	333	274	1800±200	375	308	850±100	177	145	2000±250	417	342	561
M36 X4	2700±300	469	385	3100±350	538	442	1500±200	260	214	3400±400	590	484	817
() INCLUDED FOR INFORMATION, NOT PREFERRED FOR USE													
*W=T/DK													
WHERE T= TORQUE IN NEWTON METERS													
K= TORQUE COEFFICIENT													
DESIGN CLAMP LOAD K = 0.16													
MIN CLAMP LOAD K = 0.195													
*SEE PARAGRAPH 2.5.2 FOR SCATTER OF K.													
D = NOMINAL THREAD DIAMETER IN MILLIMETERS													
W = CLAMP LOAD IN KILONEWTONS													
**TENSILE STRESS AREA = 0.7854 (D - .9382P) ²													
(PER ASTM F468M, P = THREAD PITCH)													

Design and Expected Minimum Clamp Loads For Metric Fasteners

Appendix C

DPF Cleaning Records Form

Note: This information must be maintained for warranty purpose.

Record of DPF Cleaning								
Customer Name _____ Initial Install Date _____ Machine Model _____ Machine S/N _____ Machine Fleet Number _____ EIN _____ Filter S/N _____ Filter Part Number _____ Catalyst Module S/N _____ Catalyst Part Number _____ Initial Engine Hours _____ Initial Back Pressure (Specify Units) _____ at FULL Throttle, NO-LOAD Condition.								
Cleaning Date:								
Engine Hours:								
Pre-Bake Weight (kg/lbs): Specify Units								
Post-Bake Weight (kg/lbs): Specify Units								
Weight After Pulsed Air (kg/lbs):								
Pre-Clean Back Pressure: Specify Units								
Post-Clean Back Pressure: Specify Units								
Cleaning Entity:								
Name/Initials of Technician:								

Cleaning the DPF

Because the sections of the DPF are replaceable, a small stock of filter sections can be maintained. Filter sections from a small on-hand stock can be used to replace filters in service at the next scheduled cleaning. The removed filters can be cleaned and returned for installation in the next vehicle. This process of maintaining a stock of filter sections can significantly reduce the amount of downtime that will occur.

Note: Check state and local air pollution regulations pertaining to record keeping of serviced filters. Some governmental entities may require filter tracking.

Wear goggles, gloves, protective clothing, and a National Institute for Occupational Safety and Health (NIOSH) approved P95 or N95 half-face respirator when handling a used DPF or catalytic converter muffler. Failure to do so could result in personal injury.

Note: Perform a backpressure test prior to cleaning the DPF and record the results. After cleaning the DPF, run the engine at high idle for 5 to 15 minutes to bring the engine and exhaust system to operating temperature. Perform another backpressure test and record the results on the DPF cleaning records form.

Recommended Cleaning Procedure

- Weigh and record the filter unit prior to baking
- Controlled baking of the filter unit (see following “Baking Procedure” section)
- Ash cleaning the filter unit using the 319-2189 Filter Cleaning Group
- Weigh and record the filter unit after controlled baking and pulsed air cleaning
- Reference the DPF cleaning records form for proper record keeping

Note: Cleaning DPF units without baking shortens the life of the HEPA filters within the cleaner. The result is a shortened ash service interval because of incomplete soot removal.

Baking Procedure

This procedure will burn off the remaining soot on the DPF leaving a smaller quantity of ash by baking the filter under controlled circumstances. Failure to observe this procedure can result in damage or cracking to the DPF substrate. A commercial programmable oven is required for this procedure. Careful adherence to this procedure is imperative. Deviation from this procedure may lead to thermal shock and cracking of the DPF substrate or melting at high temperatures.

1. Place filter into a programmable commercial oven designed for this purpose. Center the filter as much as possible on a rack with 2 inches of spacing below and above for best results.
2. Program the oven as follows:
 - a. Ramp oven temperature to 200°C (392°F) over 20 minutes.
 - b. Hold oven temperature at 200°C (392°F) for 120 minutes (2 hours).
 - c. Ramp oven temperature to 450°C (842°F) over 30 minutes (.5 hours).
 - d. Hold oven temperature at 450°C (842°F) for 120 minutes (2 hours).
 - e. Cool down to ambient temperature at natural rate within the oven with the doors closed. Do not use fans.
 - f. Place filter in cleaning machine and clean as per machine instructions.
 - g. Replace the filter in oven. Ramp temp to 650°C (1202°F) for 60 minutes (1 hour).
 - h. Hold oven temperature at 650°C (1202° F) for 240 minutes (4 hours).
 - i. Cool to ambient temperature at a natural rate. Do not use fans.

Note: Allow the filter to cool in the oven with the door closed until the filter can be handled with bare hands.

Cleaning Procedure

Ash and soot should be removed from the DPF using the Cat 319-2189 Diesel Particulate Filter Cleaner Gp. Using the cleaner without following baking procedure results in lower efficiency cleaning and will reduce the life of the HEPA filters in the machine. This tool uses pulsed air to flush the ash from the DPF and contains the filter ash through a HEPA filter and bag system. Other methods can release significant quantities of airborne ash and soot which may be considered a hazardous substance by some states. Adapters must be used to mount the DPF units in the machine. The 10.5-inch filter uses the 319-1839 adapter and the 319-1835 cone (medium). The 12-inch DPF uses the 319-1838 adapter with the 319-1836 cone (large).

Note: Other cleaning methods can release significant quantities of airborne ash and soot. Airborne ash and soot should not be inhaled and may be regulated as a hazardous substance by some states.

Cleaned Filter Specification

Note: The following steps determine a properly cleaned Cat filter.

Note: This specification applies to filters that were cleaned of ash only. This specification is only valid subsequent to the “Recommended Cleaning Procedure.” This specification should not be used to determine if soot-filled filters are properly cleaned. All filters must be baked appropriately using the “Recommended Cleaning Procedure” prior to application of this specification.

HEALTH AND SAFETY



WARNING

Wear goggles, gloves, protective clothing, and a National Institute for Occupational Safety and Health (NIOSH) approved P95 or N95 half-face respirator when handling a used DPF or catalytic converter muffler. Failure to do so could result in personal injury.

Adhere to all local health and safety rules and regulations. Use all the personal protective equipment listed below:

- Respirator
- Safety shoes
- Safety glasses
- Latex gloves
- Lab coat

RESOURCES

Necessary equipment:

- 38 cm (15 inch) long by 0.9 mm (0.04 inch) thick stainless steel probe for “200 cpsi” (cells/square inch) filters
- Tape measure

METHOD

Evaluation of a cleaned filter:

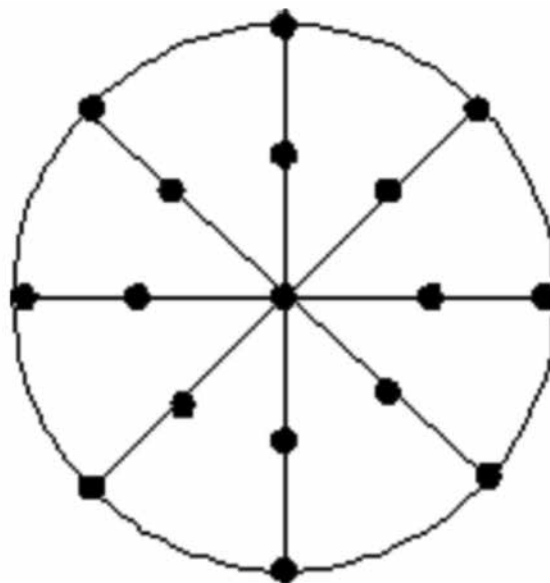
Note: A filter MUST meet all criteria in the section below to be considered clean.

1. Inspect both inlet and outlet surfaces for oil/fuel contamination, gouges and/or cracks. No cracks may be visible. Gouges may not exceed 4.0 mm (0.15 inch) deep.
2. There must be no filter movement within the filter’s banding. This movement is defined as the substrate moving past the bent-over flange. The filter must be even or below the bent-over flange.
3. There must not be any signs of the steel fiber ring coming loose or any mat material (cottony gauze) slipping past the filter.
4. The flanges are not damaged beyond repair.
5. There are no dents deeper than 6.4 mm (0.25 inch) in the outer can of the filter and the outer can is not cracked, torn or otherwise breached.

6. No more than 20 cells are allowed to be damaged (showing soot) on the outlet face of the filter.
7. Inspect the ash depth in the cells using the "Check Cell Depth" instructions below.

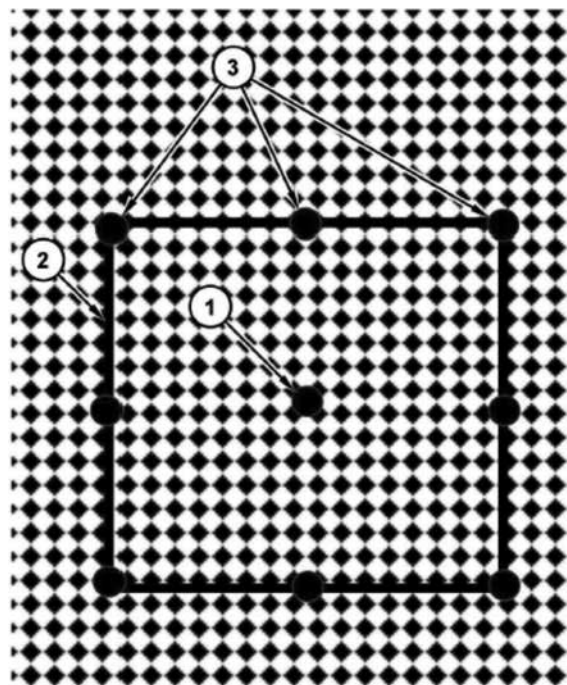
Check Cell Depth

1. Check cell depth by dropping the stainless steel probe into a cell location noted by a dot in the Illustration to the right.
2. Lightly tap the probe with a finger until the probe does not travel into the cell any further. Mark the probe to record the depth.
3. Measure the distance from the tip of the probe which entered the cell to the mark made on the probe. This distance is the cell depth. Repeat this step 17 times per the illustration to the right.
4. If the probe travels a minimum of 28.6 cm (11.25 inch) in all cells, the filter is considered clean.
5. If the probe encounters heavy resistance in one or two cells, proceed to Step 6.



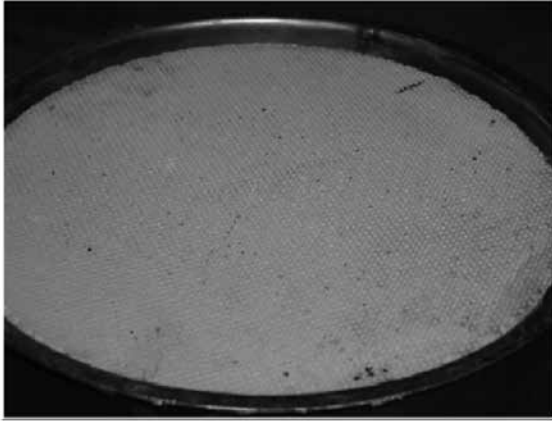
Evaluation of a Filter with Hardened Ash

6. Identify the one or two cells (1) where heavy resistance was noted during the cell depth check. Refer to illustration.
7. Draw a 50.8 mm (2 inch) square (2) around cell (1). Refer to illustration.
8. Check cell depth at the eight dot locations (3). Refer to illustration.
9. If the probe encounters heavy resistance in three or more cells, THE FILTER IS NOT CONSIDERED CLEAN. THE FILTER MUST NOT RETURN TO SERVICE UNTIL THE FILTER IS PROPERLY CLEANED.

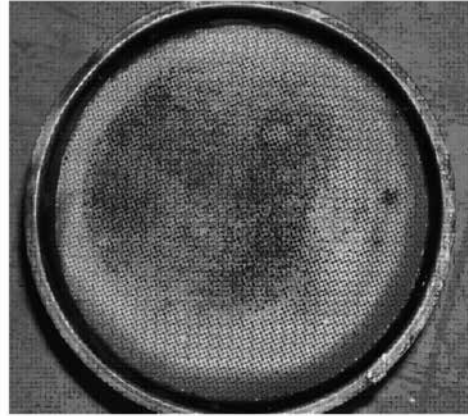


- (1) Cell
 (2) 50.8 mm (2.0 inch) square
 (3) Dot locations

Appendices



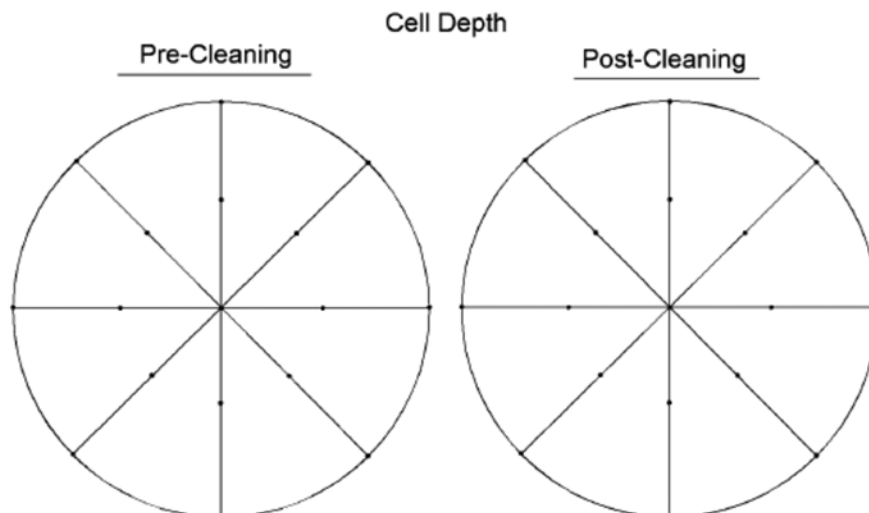
Acceptable filter with less than 20 damaged cells



Unacceptable filter with too many damaged cells

Filter Evaluation Form

Filter Evaluation			
Date Received:		Customer:	
Filter Serial Number:		Filter Model Number:	
Pre-Clean Weight (kg):		Post-Clean Weight (kg):	
Net Ash Removed (Pre-Clean/Post-Clean):		Photos Taken/Location:	
Notes:			



Appendix D

DLAS Installation



The Cat DLAS is a microprocessor based data logger and alarm system. The DLAS will record and monitor exhaust backpressure and temperature. Monitoring the engine exhaust provides information about engine performance as well as the performance of a Cat emissions control device. The Cat DLAS unit will warn the operator of a control device plugging and causing excessive backpressure on the engine. It will track the duty cycle of the engine and allow analysis of operation time, exhaust temperature, and backpressure profiles. Data collected by the Cat DLAS is downloadable.

Cat DLAS can be installed on SCR systems that have DPFs installed and where data logging and alarm are required.

Cat DLAS comes complete with the following components:

1. Control box with mounting bracket, 1/8" pressure nipple, reset button, 2-wire female thermocouple (TC) lead wire plug, Ethernet and USB ports and a 12-pin male harness plug.
2. K-type TC with a 1/4" NPT stainless steel nipple.
3. 20' TC lead wire (standard, longer leads available). 12-pin female wiring harness.
4. LED kit with one (1) yellow LED, one (1) red LED, one (1) green LED and six (6) push-on connectors.
5. Stainless steel flexible hose fitted to low temp PVC hose.
6. 20' long dual 1/8" ID low temperature PVC tubing.
7. Installation and Operation Manual UENR4924.

Read the Cat DLAS Installation and Operation Manual UENR4924 and the Cat DLAS Software Manual before installation. It is an important requirement to install the condensing can above the pressure port on the inlet of the filter.

DPF Installation References – Stationary Engines

- REHS9213 (fka PEXQ1001) – Caterpillar Pre-Installation Compatibility Assessment for Stationary Engines
- REHS9214 (fka PEXQ1002) – Caterpillar Post-Installation Compatibility Assessment for NEW Stationary Engines.
- REHS5606 DPF Special Instructions
- LEWB4970 – Exhaust System Application Design Guide
- UENR4923 DLAS Special Instructions
- UENR4924 DLAS Installation and Operation Manual

Criteria to Authorize a Person or Company to Install Cat DPF Reactor

1. Only specially trained personnel or your Cat dealer is authorized to install Cat DPF reactor.
2. Authorized person or company will have to be familiar with federal, state, and local regulations related to DPF reactor requirements, used DPF, and ash waste disposal.
3. Authorized person or company will have to follow the installation procedure described in this manual (lifting, mounting, flex joint connection, insulating blankets, torque specifications, etc.).
4. Authorized person or company will have to check that engine emissions (PM, HC, CO, NOx) meet engine manufacture specifications before installing Cat DPF reactor. Consult on-line TMI data for Cat engines.
5. Authorized person or company will have to check that engine fuel and oil meet Cat specifications referenced in this manual.
6. Authorized person or company will have to create a commissioning report.
7. Authorized person or company will have to create and maintain a record keeping system for DPF evaluation and cleaning.
8. Authorized person or company will have to adhere to using and retaining information gathered using the Pre/Post Installation Compliance Assessment Inspection checklists.

List of Authorized Installers

Cat dealers are the only authorized installers for the Cat DPF. This global network has the training, expertise, and materials to properly install and support owner's needs.

To locate the nearest dealer, please visit cat.com.

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Worldwide.**

Your Cat dealer is prepared to answer any questions you may have about Cat Power Systems, customer support, parts or service capability anywhere in the world. For the name and number of the Cat dealer nearest you, visit our website or contact Caterpillar Inc. World Headquarters in Peoria, Illinois, U.S.A.

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University of Alaska Fairbanks Comments on Proposed Rule – Air Plan Partial Approval and Partial Disapproval; AK, Fairbanks North Star Borough; 2006 24-Hour PM_{2.5} Serious Area and 189(d) Plan, Docket ID No. EPA-R10-OAR-2022-0115

A. DUAL FUEL-FIRED BOILER – EU ID 113

PM_{2.5}: Alaska’s BACT Determination is appropriate but MMR requirements are not provided

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations for Emissions Unit (EU) 113 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating proposed MRR requirements as proposed below for each PM_{2.5} BACT requirement for EU 113.
 - a. PM_{2.5} BACT Requirement: Operate and maintain fabric filters at all times the unit is in operation.
 - i. Condition 34.1 of Permit AQ0316TVP03 requires operation and maintenance of the baghouses. The MRR requirements are given in Conditions 34.2 through 34.6 and 35 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 34.2 through 34.6 and 35 of the Title V permit.
 - b. PM_{2.5} BACT Requirement: PM_{2.5} emissions from EU 113 shall not exceed 0.012 pounds per million British thermal unit (lb/MMBtu) over a 3-hour averaging period. Conduct an initial performance test to obtain an emission rate.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. No later than six months after approval of an Implementation Plan, conduct an initial source test on EU 113 to demonstrate compliance with the PM_{2.5} BACT emission limit of 0.012 lb/MMBtu over a 3-hour averaging period in accordance with procedures specified in 40 CFR 60, Appendix A-3, Method 5 and 40 CFR 51, Appendix M, Methods 201 or 201A and 202.
 2. Conduct annual source tests on EU 113 no more than 13 months after the previous source test.
 3. If two consecutive annual source tests demonstrate that PM_{2.5} emissions are less than the BACT emission limit, UAF may choose to conduct the PM_{2.5} source test every third year. Each source test must be conducted no more than 37 months after the previous source test. If a source test shows emissions exceeded the PM_{2.5} BACT emission limit, annual PM_{2.5} source testing must be resumed.
 4. For each source test, conduct the tests in accordance with the General Source Testing and Monitoring Requirements section, including the submittal of a test plan and test report, in the applicable operating permit issued for the stationary source under Alaska Statute (AS) 46.14.130(b) and 18 Alaska Administrative Code (AAC) 50.

5. Source tests shall be conducted downstream of all emission control devices.
- c. PM_{2.5} BACT Requirement: Maintain good combustion practices at all times of operation by following the manufacturer's operating and maintenance procedures.
- i. Condition 95 of Permit AQ0316TVP03 requires good air pollution control practices for minimizing emissions. The MRR requirements are given in Conditions 105.2, 105.3a, b, e, f, and 105.4 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 105.2, 105.3a, b, e, f, and 105.4 of the Title V permit.

SO₂: Alaska's BACT determination is not sufficient to meet BACT requirements

1. UAF has addressed sulfur dioxide (SO₂) BACT requirements for Emissions Unit (EU) 113 in a separate comment submittal on Feb 20, 2023 under this proposed rulemaking action. The conclusion of the BACT analysis, which included wet flue gas desulfurization (WFGD), circulation dry scrubber (CDS), and dry sorbent injection (DSI), demonstrated that the cost effectiveness in dollars tons per ton of sulfur dioxide avoided was not economically feasible.

Control Technology	Total Capital Investment (\$)	Total Annual Cost (\$/year)	Emissions Reduction (tpy) ¹	Cost-Effectiveness (\$/ton SO ₂ avoided)
WFGD	\$52,968,345	\$7,589,888	246.0	\$30,859
CDS	\$32,505,815	\$5,757,437	233.0	\$24,709
DSI - Tri-Mer system	\$5,794,396	\$5,193,086	233.0	\$22,287
DSI - BACT, Inc system	\$11,565,826	\$3,121,966	220.1	\$14,187
FBLI - Base Case	~	~	0.0	~

UAF specifically eliminated as BACT DSI control technology as several items were not included in the cost estimate which would increase as the estimate does not address all of the capital costs needed to install DSI on EU 113 at UAF. The following items are not captured in the cost estimate:

- Soil improvement and compaction;
- Site preparation and grading;
- Remediation of any soil contamination;
- Increases in capacity for existing auxiliary plant systems such as compressed air, electrical power, water, and ash handling; and
- Full extent of impacts due to the current economic environment including steadily increasing inflation and supply chain constraints and delays.

UAF also calculated the cost effectiveness numbers based on actual emissions for EU ID 113 which further increases the cost per ton of SO₂ removed/avoided. See the table below.

Control Technology	Control Efficiency (pct.)	SO ₂ Emissions (tpy) ¹	Emissions Reduction (tpy)	Total Annual Cost (\$/year)	Cost-Effectiveness (\$/ton SO ₂ avoided)
WFGD	95	0.5	9.9	\$7,589,888	\$768,207
CDS	90	1.0	9.4	\$5,757,437	\$615,111
DSI - Tri-Mer system	90	1.0	9.4	\$5,193,086	\$554,817
DSI - BACT, Inc system	85	1.6	8.8	\$3,121,966	\$353,164
FBLI - Base Case	0	10.4	0	~	~

B. MID-SIZED DIESEL-FIRED OIL BOILERS – EU IDS 3 AND 4

PM_{2.5}: Alaska's BACT Determination is appropriate but MMR requirements are not provided

EU ID 3

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations for EU 3 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating MRR requirements as proposed below for each PM_{2.5} BACT requirement for EU 3. Some of the PM_{2.5} BACT requirements are also SO₂ BACT requirements, as noted.
 - a. PM_{2.5} BACT Requirement: PM_{2.5} emissions shall not exceed 0.012 lb/MMBtu averaged over a 3-hour period.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. Combust only ULSD in EU 3 in accordance with Condition 44.1 of Permit AQ0316TVP03. UAF has permanently switched to the use of ULSD in EU 3, so this requirement could be modified so that the limit applies at all times. Comply with the federally enforceable MRR requirements in Condition 30.1 of Permit AQ0316TVP03.
 2. Comply with the federally enforceable visible emissions standard in Condition 1 of Permit AQ0316TVP03 and the federally enforceable MRR requirements in either Condition 1.2 or Condition 1.3 of Permit AQ0316TVP03.
 - b. PM_{2.5} and SO₂ BACT Requirement: Maintain good combustion practices at all times of operation by following the manufacturer's operating and maintenance procedures.
 - ii. Condition 95 of Permit AQ0316TVP03 requires good air pollution control practices for minimizing emissions. The MRR requirements are given in Conditions 105.2 through 105.4 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 105.2 through 105.4 of the Title V permit.

EU ID 4

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations for EU 4 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating MRR requirements as proposed below for each PM_{2.5} BACT requirement for EU 4. Some of the PM_{2.5} BACT requirements are also SO₂ BACT requirements, as noted.
 - a. PM_{2.5} BACT Requirement: PM_{2.5} emissions shall not exceed 0.012 lb/MMBtu averaged over a 3-hour period while firing diesel fuel.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. When firing diesel fuel, combust only ULSD in EU 4 in accordance with Condition 44.1 of Permit AQ0316TVP03. UAF has permanently switched to the use of ULSD in EU 4, so this requirement could be modified so that the limit applies at all times. Comply with the federally enforceable MRR requirements in Condition 30.1 of Permit AQ0316TVP03.
 2. Comply with the federally enforceable visible emissions standard in Condition 1 of Permit AQ0316TVP03 and the federally enforceable MRR requirements in Condition 1.2 of Permit AQ0316TVP03.
 - b. PM_{2.5} BACT Requirement: PM_{2.5} emissions shall not exceed 0.0075 lb/MMBtu averaged over a 3-hour period while firing natural gas.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. When firing natural gas, combust only pipeline-quality natural gas.
 2. Keep records that document that only pipeline-quality natural gas was combusted.
 3. Certify compliance with this requirement under Condition 144 of Permit AQ0316TVP03.
 - c. PM_{2.5} and SO₂ BACT Requirement: Maintain good combustion practices at all times of operation by following the manufacturer's operating and maintenance procedures.
 - i. Condition 95 of Permit AQ0316TVP03 requires good air pollution control practices for minimizing emissions. The MRR requirements are given in Conditions 105.2 through 105.4 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 105.2 through 105.4 of the Title V permit.
 - d. PM_{2.5} BACT Requirement: Limit NO_x emissions from EUs 4 and 8 to no more than 40 tons per year, combined.
 - iii. Condition 32 of Permit AQ0316TVP03 limits combined NO_x emissions from EUs 4 and 8 to no more than 40 tons per year, combined. The MRR requirements are given in Condition 32.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 32.1 of the Title V permit.

SO₂: Alaska's BACT determination is not sufficient to meet BACT requirements**EU ID 3**

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the SO₂ BACT determination for EU 3 requiring the use of ultra-low sulfur diesel (ULSD) fuel is appropriate but the delayed implementation and interim requirement are not supported as BACT. UAF has permanently switched to ULSD fuel for EU 3 and believes this deficiency can be addressed by incorporating a requirement to combust only ULSD in EU 3.
 - a. Demonstrating compliance with the requirement to combust only ULSD in EU 3 can be ensured by the federally enforceable MRR requirements in Conditions 44.1 and 30.1 of Permit AQ0316TVP03.

EU ID 4

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the SO₂ BACT determination for EU 4 requiring the use of ultra-low sulfur diesel (ULSD) fuel is appropriate but the delayed implementation and interim requirement are not supported as BACT. UAF has permanently switched to ULSD fuel when firing diesel fuel in EU 4 and believes this deficiency can be addressed by incorporating a requirement to combust only ULSD when firing diesel fuel in EU 4.
 - a. Demonstrating compliance with the requirement to combust only ULSD when firing diesel fuel in EU 4 can be ensured by the federally enforceable MRR requirements in Conditions 44.1 and 30.1 of Permit AQ0316TVP03.
 - b. SO₂ BACT Requirement: SO₂ emissions from EU 4 will be limited by complying with the combined annual SO₂ emission limit of 40 tons per 12 month rolling period for EUs 4 and 8.
 - i. Condition 31 of Permit AQ0316TVP03 limits combined SO₂ emissions from EUs 4 and 8 to less than 40 tons per year. The MRR requirements are given in Condition 31.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 31.1 of the Title V permit.
 - c. SO₂ BACT Requirement: SO₂ emissions from EU 4 while firing natural gas shall not exceed 0.60 pounds per million standard cubic feet (lb/MMscf).
 - i. Condition 42.2 of Permit AQ0316TVP03 limits SO₂ emissions to 0.60 lb/MMscf between October 1 and March 31 and provides an equivalent hydrogen sulfide (H₂S) content of natural gas fuel. Because EU 4 combusts only pipeline-quality natural gas when firing natural gas, this requirement could be modified so that the limit applies at all times. The MRR requirements are given in Condition 46 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 46 of the Title V permit.

C. SMALL- SIZED DIESEL-FIRED BOILERS – EU IDS 19-21***PM_{2.5}: Alaska's BACT Determination is appropriate but MMR requirements are not provided***

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations for EUs 19 through 21 are appropriate but EPA is proposing to disapprove those

determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating MRR requirements as proposed below for each PM_{2.5} BACT requirement for EUs 19 through 21. Some of the PM_{2.5} BACT requirements are also SO₂ BACT requirements, as noted.

- a. PM_{2.5} and SO₂ BACT Requirement: Combined operating limit of no more than 19,650 hours per year.
 - i. EUs 19 through 22 are subject to a more stringent federally enforceable operating hour limit of 18,739 hours per rolling 12-month period in Condition 41.1 of Permit AQ0316TVP03. This operating hour limit will inherently result in compliance with the BACT operating limit of 19,650 hours per year. The MRR requirements are given in Condition 41.2 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 41.2 of the Title V permit.
- b. PM_{2.5} BACT Requirement: PM_{2.5} emissions shall not exceed 0.012 lb/MMBtu averaged over a 3-hour period while firing diesel fuel.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. Combust only ULSD in EUs 19 through 21 in accordance with Condition 30 of Permit AQ0316TVP03. Comply with the federally enforceable MRR requirements in Condition 30.1 of Permit AQ0316TVP03.
 2. Comply with the federally enforceable visible emissions standard in Condition 1 of Permit AQ0316TVP03 and the federally enforceable MRR requirements in Condition 1.3 of Permit AQ0316TVP03.
- c. PM_{2.5} and SO₂ BACT Requirement: Maintain good combustion practices at all times of operation by following the manufacturer's operating and maintenance procedures.
 - i. Condition 95 of Permit AQ0316TVP03 requires good air pollution control practices for minimizing emissions. The MRR requirements are given in Conditions 105.2 through 105.4 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 105.2 through 105.4 of the Title V permit.

SO₂: Alaska's BACT determination is not sufficient to meet BACT requirements

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the SO₂ BACT determination for EUs 19 through 21 requiring the use of ultra-low sulfur diesel (ULSD) fuel is appropriate but the delayed implementation and interim requirement are not supported as BACT. Because EUs 19 through 21 are already subject to a federally enforceable requirement to combust only ULSD, UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements for the SO₂ BACT requirement to use ULSD for EUs 19 through 21.
 - a. EUs 19 through 21 are subject to a federally enforceable requirement to combust only ULSD in Condition 30 of Permit AQ0316TVP03. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.

D. LARGE DIESEL-FIRED ENGINES – EU ID 8***PM_{2.5}: Alaska's BACT Determination is appropriate but MMR requirements are not provided***

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} and SO₂ BACT determinations for EU 8 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating proposed MRR requirements as proposed below for each BACT requirement for EU 8.
 - a. PM_{2.5} BACT Requirement: PM_{2.5} emissions from EU 8 shall be controlled by operating positive crankcase ventilation and combusting only low ash diesel at all times of operation.
 - i. Positive crankcase ventilation is inherent to the design of this engine. The engine cannot be operated without positive crankcase ventilation. This information is provided in the UAF January 2017 Voluntary BACT Analysis report (page Appendix III.D.7.7-1126 in the Alaska Serious SIP).
 - ii. EU 8 is required to combust only ULSD. This federally enforceable requirement is in Condition 43.2 of Permit AQ0316TVP03. Demonstrating compliance with the requirement to combust only ULSD in EU 8 can be ensured by the federally enforceable MRR requirements in Condition 30.1 of Permit AQ0316TVP03.
 - b. PM_{2.5} BACT Requirement: Limit NO_x emissions from EUs 4 and 8 to no more than 40 tons per year, combined.
 - i. Condition 32 of Permit AQ0316TVP03 limits combined NO_x emissions from EUs 4 and 8 to no more than 40 tons per year. The MRR requirements are given in Condition 32.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 32.1 of the Title V permit.
 - c. PM_{2.5} and SO₂ BACT Requirement: Limit non-emergency operation of EU 8 to no more than 100 hours per year.
 - i. Condition 88.2 of Permit AQ0316TVP03 limits non-emergency operation to no more than 100 hours per year. The MRR requirements are given in Conditions 88.4 and 88.5 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 88.4 and 88.5 of the Title V permit.
 - d. PM_{2.5} BACT Requirement: PM_{2.5} emissions from EU 8 shall not exceed 0.32 g/hp-hr averaged over a 3-hour period.
 - i. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 1. After the closure of Compliance Order by Consent (COBC) No. 12-1016-50-0002, conduct an initial source test on EU 8 no later than either six months after approval of an Implementation Plan or within 180 days after the next planned operation, whichever comes first, conduct an initial source test on EU 8 to demonstrate compliance with the PM_{2.5} BACT emission limit of 0.32 g/hp-hr

averaged over a 3-hour period in accordance with procedures specified in 40 CFR 60, Appendix A-3, Method 5 and 40 CFR 51, Appendix M, Methods 201 or 201A and 202.

2. If EU 8 operates 400 hours or more in a 12-month period, conduct annual source tests no more than 13 months after the previous source test.
3. For EU 8, if two consecutive annual source tests demonstrate that PM_{2.5} emissions are less than the BACT emission limit or the unit operates less than 400 hours per 12-month period, UAF may choose to conduct the PM_{2.5} source test every fifth year. Each source test must be conducted no more than 61 months after the previous source test. If a source test shows emissions exceeded the PM_{2.5} BACT emission limit, annual PM_{2.5} source testing must be resumed.
4. For each source test, conduct the tests in accordance with the General Source Testing and Monitoring Requirements section, including the submittal of a test plan and test report, in the applicable operating permit issued for the stationary source under AS 46.14.130(b) and 18 AAC 50.
5. Source tests shall be conducted downstream of all emission control devices.
6. Report in accordance with the Excess Emissions and Permit Deviation condition in the applicable operating permit issued for the stationary source under AS 46.14.130(b) and 18 AAC 50 if the PM_{2.5} emission rate exceeds the PM_{2.5} BACT emission limit.

SO₂: Alaska's BACT determination is not sufficient to meet BACT requirements

1. Combust only ULSD beginning no later than June 9, 2021. Compliance with the proposed SO₂ emission limit will be demonstrated through fuel shipment receipts and/or fuel testing for sulfur content.
 - a. Condition 43.2 of Permit AQ0316TVP03 requires the combustion of ULSD. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.
2. Limit SO₂ emissions from EUs 4 and 8 to no more than 40 tons per year, combined.
 - b. Condition 31 of Permit AQ0316TVP03 limits combined SO₂ emissions from EUs 4 and 8 to less than 40 tons per year. The MRR requirements are given in Condition 31.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 31.1 of the Title V permit.
3. SO₂ BACT Requirement: Maintain good combustion practices by following the manufacturer's maintenance procedures at all times of operation.
 - c. UAF proposes the following MRR requirements to demonstrate compliance with this BACT requirement:
 - i. Keep records of manufacturer required maintenance conducted on EU 8.
 - ii. Provide maintenance records to ADEC upon request in accordance with Condition 141 of Permit AQ0316TVP03.
 - iii. Certify compliance annually in the Annual Compliance Certification in accordance with Condition 144 of Permit AQ0316TVP03.

E. SMALL- SIZED DIESEL-FIRED ENGINES – EU IDs 23, 24, 26, 27, 28, 29

PM_{2.5}: Alaska's BACT Determination is appropriate but MMR requirements are not provided

EU ID 23, 26, and 28

1. Section 7.7.8.6 of the Alaska State Air Quality Control Plan, Vol II, Chapter III.D.7.7 (herein referred to as the Alaska Serious SIP) includes BACT requirements for Emissions Units (EUs) 23 and 26. These units are no longer permitted EUs at the UAF Campus Stationary Source, as shown in Section 2, Table A of Permit AQ0316TVP03. EUs 23 and 26 have been permanently removed from service. Section 9.1 of the EPA technical support memorandumⁱ stated that these engines may either need operating hour limits or more stringent BACT requirements, and Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the BACT determination for these engines is not sufficient in part, and otherwise appropriate but monitoring, recordkeeping, and reporting (MRR) requirements are not provided. Because EUs 23 and 26 have been permanently removed from service, BACT requirements for these emissions units are not needed and should be removed from the SIP.
2. The Alaska Serious SIP includes BACT requirements for EU 28, which has been converted from a stationary engine to a nonroad engine. This engine is brought from a storage area to be used as needed as a nonroad engine. This engine is no longer a permitted EU at the UAF Campus Stationary source, as shown in Section 2, Table A of Permit AQ0316TVP03. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the BACT determination for this engine is appropriate but monitoring, recordkeeping, and reporting (MRR) requirements are not provided. As agreed between UAF, ADEC, and EPA, BACT analyses (and ultimately, BACT determinations) are only required for permitted emissions units.ⁱⁱ The Alaska Serious SIP should no longer include BACT requirements for EU 28.

EU ID 24

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} and SO₂ BACT determinations for EU 29 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements for each BACT requirement for EU 29.
 - a. PM_{2.5} and SO₂ BACT Requirement: Limit non-emergency operation to no more than 100 hours per year. Compliance with the operating hours limit will be demonstrated by monitoring and recording the number of hours operated on a monthly basis.
 - i. Condition 82.4b of Permit AQ0316TVP03 limits non-emergency operation to 100 hours per year. The MRR requirements are given in Condition 83 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 83 of the Title V permit.

- b. PM_{2.5} and SO₂ BACT Requirement: Maintain good combustion practices by following the manufacturer's maintenance procedures at all times of operation.
 - i. Condition 79 of Permit AQ0316TVP03 requires operating and maintaining EU 29 in accordance with manufacturer instructions over the life of the engine. The MRR requirements are given in Conditions 82.2, 82.3, and 83 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 82.2, 82.3 and 83 of the Title V permit.
- c. PM_{2.5} BACT Requirement: Demonstrate compliance with the numerical BACT emission limit of 0.015 g/hp-hr (3-hour average) by maintaining records of maintenance procedures conducted in accordance with the emissions unit operating manual.
 - i. This emission limit does not include the "not-to-exceed" (NTE) multiplier of 1.25 per 40 CFR 60.4212(c), 40 CFR 1039.102(g)(1), 40 CFR 1039.101(e) and ADEC policy. Exhaust emissions from stationary CI ICE subject to Tier 4 interim emission standards must not exceed the NTE numerical requirements. The PM_{2.5} BACT emission limit of 0.015 g/hp-hr is incorrect. The PM_{2.5} BACT emission limit for EU 29 should be 0.019 g/hp-hr.
 - ii. Condition 79 of Permit AQ0316TVP03 requires operating and maintaining EU 29 in accordance with manufacturer instructions over the life of the engine. The MRR requirements are given in Conditions 82.2, 82.3, and 83 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 82.2, 82.3 and 83 of the Title V permit.

EU ID 27

Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations in the Alaska Serious SIP are not sufficient for EU 27 because an emission control device is cost effective. Section 9.1 of the EPA technical support memorandumⁱⁱⁱ states that a diesel particulate filter (DPF) is recommended as a cost-effective control technology.

UAF believes that the Alaska Serious SIP PM_{2.5} BACT determinations for EU 27 are appropriate. EU 27 is a Tier 3 certified engine, combusts only ULSD, and per vendor-provided data, has potential PM_{2.5} emissions of 0.26 tpy. (UAF agrees that the correct basis for the cost-effectiveness calculation in the BACT analysis is the numerical BACT emission limit of 0.15 g/hp-hr in the Alaska Serious SIP.) Installation of a DPF on EU 27 is likely to result in only a nominal reduction in PM_{2.5} emissions.

Instead of a BACT requirement to install DPF, UAF will accept an operating limit of 2,500 hours per rolling 12-month period for EU 27. UAF will submit an air quality permit application to ADEC to obtain this owner-requested limit (ORL). An operating limit of 2,500 hours per rolling 12-month period will result in the following cost-effectiveness calculation for DPF.

Total Capital Investment (TCI)	\$30,751
Capital Recovery Factor (CRF)	0.1000
CRF Basis - Annual Interest Rate ^{iv} (%)	7.75
CRF Basis - Project life (years)	20
Total Annualized Cost = CRF x TCI	\$3,074
EU 27 operating hour limit (hr/yr)	2,500
EU 27 PM _{2.5} PTE (ton/yr)	0.21
DPF - Tons PM _{2.5} avoided per year (ton/yr)	0.18
DPF Cost-Effectiveness (\$ per ton avoided)	\$17,498

These calculations update the EPA cost analysis^v and demonstrate that a 2,500 hr/yr ORL would alter the analysis such that a DPF would not be an economically feasible PM_{2.5} emission control technology.

EU ID 29

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} and SO₂ BACT determinations for EU 29 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements for each BACT requirement for EU 29.
 - a. PM_{2.5} BACT Requirement: Limit non-emergency operation to no more than 100 hours per year. Compliance with the operating hours limit will be demonstrated by monitoring and recording the number of hours operated on a monthly basis.
 - i. Condition 82.4b of Permit AQ0316TVP03 limits non-emergency operation to 100 hours per year. The MRR requirements are given in Condition 83 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 83 of the Title V permit.
 - b. PM_{2.5} BACT Requirement: Maintain good combustion practices by following the manufacturer's maintenance procedures at all times of operation.
 - i. Condition 79 of Permit AQ0316TVP03 requires operating and maintaining EU 29 in accordance with manufacturer instructions over the life of the engine. The MRR requirements are given in Conditions 82.2, 82.3, and 83 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 82.2, 82.3 and 83 of the Title V permit.
 - c. PM_{2.5} BACT Requirement: Demonstrate compliance with the numerical BACT emission limit of 0.015 g/hp-hr (3-hour average) by maintaining records of maintenance procedures conducted in accordance with the emissions unit operating manual.
 - i. This emission limit does not include the "not-to-exceed" (NTE) multiplier of 1.25 per 40 CFR 60.4212(c), 40 CFR 1039.102(g)(1), 40 CFR 1039.101(e) and ADEC policy. Exhaust emissions from stationary CI ICE subject to Tier 4 interim emission standards must not exceed the NTE numerical requirements. The PM_{2.5} BACT emission limit of 0.015 g/hp-hr is incorrect. The PM_{2.5} BACT emission limit for EU 29 should be 0.019 g/hp-hr.

- ii. Condition 79 of Permit AQ0316TVP03 requires operating and maintaining EU 29 in accordance with manufacturer instructions over the life of the engine. The MRR requirements are given in Conditions 82.2, 82.3, and 83 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 82.2, 82.3 and 83 of the Title V permit.

SO₂: Alaska's BACT determination is not sufficient to meet BACT requirements

EU ID 24

1. SO₂ BACT Requirement: Combust only ULSD beginning no later than June 9, 2021. Compliance with the proposed SO₂ emission limit will be demonstrated through fuel shipment receipts and/or fuel testing for sulfur content.
 - a. Condition 43.2 of Permit AQ0316TVP03 requires the combustion of ULSD. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.

EU ID 27

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the SO₂ BACT determinations for EU 27 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements for each BACT requirement for EU 27.
 - a. SO₂ BACT Requirement: Limit operation of EU 27 to no more than 4,380 hours per year.
 - i. Condition 28.1 of Permit AQ0316TVP03 limits EU 27 to 4,380 hours of operation in a rolling 12-month period. The MRR requirements are given in Condition 28.2 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 28.2 of the Title V permit.
 - b. SO₂ BACT Requirement: Combust only ULSD beginning no later than June 9, 2021. Compliance with the proposed SO₂ emission limit will be demonstrated through fuel shipment receipts and/or fuel testing for sulfur content.
 - i. Condition 43.2 of Permit AQ0316TVP03 requires the combustion of ULSD. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.

EU ID 29

1. SO₂ BACT Requirement: Combust only ULSD beginning no later than June 9, 2021. Compliance with the proposed SO₂ emission limit will be demonstrated through fuel shipment receipts and/or fuel testing for sulfur content.
 - a. Condition 43.2 of Permit AQ0316TVP03 requires the combustion of ULSD. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating

compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.

F. PATHOGENIC WASTE INCINERATOR – EU ID 9A

PM_{2.5}: Alaska's BACT Determination is appropriate but MMR requirements are not provided

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} and SO₂ BACT determinations for EU 9A are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating proposed MRR requirements as proposed below for each BACT requirement for EU 9A.
 - a. PM_{2.5} BACT Requirement: PM_{2.5} emissions shall be controlled with a multiple chamber design.
 - i. Condition 48.1 of Permit AQ0316TVP03 requires the use of a multiple chamber designed incinerator. The MRR requirements are given in Conditions 48.3b and 48.3c of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 48.3 b and 48.3c of the Title V permit.
 - b. Limit the operation to no more than 109 tons of waste combusted per year. Compliance with the proposed operational limit will be demonstrated by recording pounds of waste combusted for the pathogenic waste incinerator.
 - i. Condition 48 of Permit AQ0316TVP03 limits the amount of waste combusted to 109 tons per rolling 12-month period. The MRR requirements are given in Conditions 29.1 and 48.3 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 29.1 and 48.3 of the Title V permit.
 - c. PM_{2.5} BACT Requirement: PM_{2.5} emissions from EU 9A shall not exceed 4.67 lb/ton of waste combusted.
 - i. The EPA technical memorandum recommends emission testing to demonstrate compliance with this emission limit. Because this emissions unit is small in size and has potential PM_{2.5} emissions of 0.25 tons per year, UAF proposes that the compliance demonstration requirements be periodic Method 9 observations and associated MRR requirements in accordance with Conditions 2 through 5 in Permit AQ0316TVP03. If the 18-minute average opacity result of any Method 9 observation conducted under Condition 3.3 of Permit AQ0316TVP03 is greater than 20 percent, UAF proposes a requirement to conduct a PM_{2.5} source test.
 1. Conduct Method 9 Visible Emission Observations as required by Condition 2.1 of Permit AQ0316TVP03, a federally enforceable requirement. Condition 2.1 requires complying with MRR requirements in Conditions 3 through 5 of Permit AQ0316TVP03.
 2. If the result of any Method 9 observation conducted under Condition 1 for EU 9A results in an 18-minute average opacity of greater than 20 percent, conduct a source

test on EU 9A within six months after that Method 9 observation to demonstrate compliance with the PM_{2.5} emission limit of 0.25 tons per year in accordance with procedures specified in 40 CFR 60, Appendix A-3, Method 5 and 40 CFR 51, Appendix M, Methods 201 or 201A and 202.

3. For each PM_{2.5} source test, conduct the tests in accordance with the General Source Testing and Monitoring Requirements section, including the submittal of a test plan and test report, in the applicable operating permit issued for the stationary source under AS 46.14.130(b) and 18 AAC 50.
4. PM_{2.5} source tests shall be conducted downstream of all emission control devices.
5. Report in accordance with the Excess Emissions and Permit Deviation condition in the applicable operating permit issued for the stationary source under AS 46.14.130(b) and 18 AAC 50 if the PM_{2.5} emission rate exceeds the PM_{2.5} BACT emission limit.
- d. Maintain good combustion practices at all times of operation by following the manufacturer's operating and maintenance procedures.
 - i. Condition 48.2 of Permit AQ0316TVP03 requires maintaining good combustion practices. The MRR requirements are given in Condition 48.3 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 48.3 of the Title V permit.

SO₂: Alaska's BACT determination is not sufficient to meet BACT requirements

1. SO₂ BACT Requirement: SO₂ emissions from the operation of EU 9A shall be controlled by combusting ULSD at all times of operation. Compliance shall be demonstrated by obtaining fuel shipment receipts and/or fuel tests for sulfur content.
 - i. Condition 43.2 of Permit AQ0316TVP03 requires the combustion of ULSD. The MRR requirements are given in Condition 30.1 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Condition 30.1 of the Title V permit.

G. MATERIAL HANDLING SOURCES – EU ID'S 105, 107, 109 – 111, 114, 128-130

PM_{2.5}: Alaska's BACT Determination is appropriate but MMR requirements are not provided

EU ID's 105, 107, 109, 110, 114, and 128 - 130

1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations for EUs 105, 107, 109, 110, 114, and 128 through 130 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements for each PM_{2.5} BACT requirement for EUs 105, 107, 109, 110, 114, and 128 through 130.
 - a. PM_{2.5} BACT Requirement: PM_{2.5} emissions from EUs 105, 107, 109, 110, 114, and 128 through 130 will be controlled by enclosing each EU.
 - i. Condition 49.3b of Permit AQ0316TVP03 requires operation in an enclosure. The MRR requirements are given in Conditions 49.3c and 49.5 of Permit AQ0316TVP03.

- Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 49.3c and 49.5 of the Title V permit.
- b. PM_{2.5} emissions from the operation of the material handling units will be controlled by installing, operating, and maintaining fabric filters and vents.
 - i. Condition 49.3a of Permit AQ0316TVP03 requires installing, operating, and maintaining fabric filters and vents. The MRR requirements are given in Conditions 49.3c and 49.5 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 49.3c and 49.5 of the Title V permit.
 - c. Comply with the numerical emission limits of 0.003 grains per dry standard cubic foot (gr/dscf) for EUs 105, 107, 109, 110, and 128 through 130 and 0.050 gr/dscf for EU 114. (These emission limits are given in State Air Quality Control Plan, Vol II, Chapter III.D.7.7, Table 7.7-18 on page III.D.7.7-92. Note that a table on page III.D.7.7-90 is also identified as Table 7.7-18.) Initial compliance with the emission rates for the material handling units will be demonstrated with a performance test to obtain an emission rate.
 - i. Condition 49.3d (which allows for either performance testing or providing vendor data documenting that an EU meets the emission limit) and Condition 49.3e (which requires PM_{2.5} testing on certain occasions) are requirements of Permit AQ0316TVP03. The associated MRR requirements are given in Conditions 49.3f, 49.4, and 49.5 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 49.3d through 49.3f, 49.4, and 49.5 of the Title V permit.

EU ID 114

- 1. Table 14 of the proposed rulemaking action (88 FR No. 6, pg 1484) states that the PM_{2.5} BACT determinations for EU 111 are appropriate but EPA is proposing to disapprove those determinations because the Alaska Serious SIP does not include the MRR requirements necessary to make the BACT requirements enforceable as a practical matter. UAF believes this deficiency can be addressed by incorporating existing federally enforceable MRR requirements, or by incorporating proposed MRR requirements as proposed below for each PM_{2.5} BACT requirement for EU 111.
 - a. PM_{2.5} BACT Requirement: PM_{2.5} emissions from EU 111 will be controlled by enclosing the EU.
 - i. Condition 50.1 of Permit AQ0316TVP03 requires operations in an enclosure. The MRR requirements are given in Conditions 50.2 and 50.3 of Permit AQ0316TVP03. Demonstrating compliance with this BACT requirement is ensured by the federally enforceable MRR requirements in Conditions 50.2 and 50.3 of the Title V permit.
 - b. PM_{2.5} BACT Requirement: Comply with the numerical emission limit of 5.50E-05 pounds per ton (lb/ton). (This emission limit is given in State Air Quality Control Plan, Vol II, Chapter III.D.7.7, Table 7.7-18 on page III.D.7.7-92. Note that a table on page III.D.7.7-90 is also identified as Table 7.7-18.)
 - i. The EPA technical memo section 9.4 states that EU 111 should be subject to an operational requirement that the building doors remain closed at all times that ash loading is occurring. UAF proposes that the requirement in Condition 50.1 of Permit AQ0316TVP03 be expanded to include a sentence stating, "Building doors must remain

- closed at all times that ash loading is occurring.” Demonstrating compliance with the requirement to keep the doors closed can be ensured by the federally enforceable MRR requirements in Conditions 50.2 and 50.3 of Permit AQ0316TVP03.
- ii. The EPA technical memo section 9.4 states that appropriate MRR conditions should be included to ensure no visible emissions escape the building. UAF proposes the following MRR requirements:
1. No later than six months after approval of an Implementation Plan, conduct a Method 22 Fugitive Emissions Observation on EU 111 during an ash loading event in accordance with procedures specified in 40 CFR 60, Appendix A-7, Method 22. The duration of the Fugitive Emissions Observation shall be for the duration of the ash loading event.
 2. Conduct a Method 22 Fugitive Emissions Observation on EU 111 during an ash loading event once each calendar year.
 3. Keep records as specified in Section 11 of 40 CFR 60, Appendix A-7, Method 22.
 4. Report in accordance with the Excess Emissions and Permit Deviation condition in the applicable operating permit issued for the stationary source under AS 46.14.130(b) and 18 AAC 50 if visible emissions are observed during the VE observation.

H. GENERAL COMMENTS

1. Section III.C.3.c.iii of the proposed rulemaking action (88 FR No. 6, pg 1483) states that “Alaska did not submit as part of the Fairbanks Serious Plan the emission limits corresponding to Alaska’s SO₂ or PM_{2.5} BACT findings for some emissions units.” The statement references footnote 168, which reads “Fuel oil-fired simple cycle gas turbine (EUs 1 and 2); Fuel oil-fired combined cycle gas turbine (EUs 5 and 6).” The UAF Campus stationary source does not have any fuel oil-fired simple cycle or combined cycle gas turbines. EUs 1, 2, 5, and 6 are not included in the UAF Campus emissions unit inventory, per the Emissions Unit Inventory in Section 2, Table A of Permit AQ0316TVP03. Please remove reference to any reference to fuel oil-fired simple cycle or combined cycle gas turbines from the UAF BACT determination discussion.

ⁱ Hedgpeth, Z. (August 24, 2022). Review of Best Available Control Technology analyses submitted for the University of Alaska, Fairbanks as part of the Fairbanks PM_{2.5} Nonattainment SIP. U.S. Environmental Protection Agency, Region 10 Laboratory Services and Applied Science Division. Docket Document ID EPA-R10-OAR-2022-0115-0215, 000008_EPA Technical Support Document - UAF BACT TSD v20220824.

ⁱⁱ “UAF PM_{2.5} Serious Nonattainment BACT Protocol Response” Letter from Denise Koch, Director, ADEC Division of Air Quality to Frances Isgrigg, Director, UAF Environmental Health, Safety & Risk Management, August 14, 2015. Alaska State Air Quality Control Plan, Vol II, Appendix III.D.7.7 at pages Appendix III.D.7.7-1038 through Appendix III.D.7.7-1040.

ⁱⁱⁱ Hedgpeth, Z. (August 24, 2022). Review of Best Available Control Technology analyses submitted for the University of Alaska, Fairbanks as part of the Fairbanks PM_{2.5} Nonattainment SIP. U.S. Environmental Protection Agency, Region 10 Laboratory Services and Applied Science Division. Docket Document ID EPA-R10-OAR-2022-0115-0215, 000008_EPA Technical Support Document - UAF BACT TSD v20220824.

^{iv} Current bank prime rate. <https://www.federalreserve.gov/releases/h15/> accessed on March 20, 2023.

^v “EU 27 DPF CE EPA Edits” tab. Docket Document ID EPA-R10-OAR-2022-0115-0216, 000008a_UAF calcs EPA-TSD.

From: [Germain, Grace \(DEC\)](#)
To: [Jones, Dave F \(DEC\)](#)
Subject: FW: 2023 BACT Analysis
Date: Monday, June 12, 2023 10:28:44 AM

FYI

Grace M. Germain

Air Permits Program, Juneau Supervisor
ADEC, Air Quality Division
Office: 907.269.3065 Mobile: 907.355.6347
Email: grace.germain@alaska.gov

From: Frances Isgrigg <fisgrigg@alaska.edu>
Sent: Monday, June 12, 2023 9:10 AM
To: Czarnecki, Nick P (DEC) <nick.czarnecki@alaska.gov>
Cc: Plosay, James R (DEC) <jim.plosay@alaska.gov>; Germain, Grace (DEC) <grace.germain@alaska.gov>
Subject: 2023 BACT Analysis

You don't often get email from fisgrigg@alaska.edu. [Learn why this is important](#)

CAUTION: This email originated from outside the State of Alaska mail system. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Nick,

Please use the link in this email to download a copy of UAF's most recent BACT. [UAF_SO2_BACT_EU113-Jan2023.pdf](#)

We are also updating the BACT analysis for EU ID 27, ACEP engine. Below is a table that we have provided to EPA on EU 27.

	Values presented in March 2023 UAF comments to EPA	Values based on April 2023 NC Power quote
Total Capital Investment (TCI)	\$30,751	\$78,210
Capital Recovery Factor (CRF)	0.1000	0.1000
CRF Basis - Annual Interest Rate (%)	7.75	7.75
CRF Basis - Project life (years)	20	20
Total Annualized Cost = CRF x TCI	\$3,074	\$7,818
EU 27 operating hour limit (hr/yr)	2,500	4,380
EU 27 PM _{2.5} PTE (ton/yr)	0.21	0.36
DPF Control Efficiency	85%	85%

DPF - Tons PM _{2.5} avoided per year (ton/yr)	0.18	<u>0.31</u>
DPF Cost Effectiveness (\$ per ton avoided)	\$17,498	<u>\$25,401</u>

Please let me know if you need anything else or the link does not work,

Frances

--

Frances M. Isgrigg, PE
Division of Design and Construction
907-590-5809

Public Review Draft



August 19, 2024

Kellie Fritze, Associate Vice Chancellor

907-474-6005

907-474-5656 fax

kfritze@alaska.edu

www.uaf.edu/fs

Office of the Associate Vice Chancellor

University of Alaska Fairbanks, P.O. Box 757380, Fairbanks, Alaska 99775-7380

August 16, 2023

DELIVERY: Electronically

Nick Czarnecki, Air Non-Point and Mobile Sources Program Manager
Alaska Department of Environmental Conservation
Division of Air Quality
610 University Avenue
Fairbanks, AK 99709

Subject: University of Alaska Fairbanks Supplemental Best Available Control Technology Analysis for Emissions Unit 27

Mr. Czarnecki,

The University of Alaska Fairbanks (UAF) submits the enclosed supplemental Best Available Control Technology (BACT) analysis report for Emissions Unit (EU) 27. The BACT analysis addresses fine particulate matter (PM_{2.5}) emissions from EU 27, a 500-horsepower diesel-fired generator engine located on UAF campus at the UAF Alaska Center for Energy and Power (ACEP).

On January 10, 2023, the U.S. Environmental Protection Agency (EPA) published a proposed rulemaking action to partially approve and partially disapprove the Alaska Department of Environmental Conservation (ADEC) Serious PM_{2.5} Nonattainment State Implementation Plan (SIP). In this proposed rulemaking action, EPA states that the Alaska Serious SIP PM_{2.5} BACT determinations for EU 27 are not correct¹ because installing a PM_{2.5} emission control device would be cost effective and recommends a diesel particulate filter (DPF) as such a technology.

UAF believes that the Alaska Serious SIP PM_{2.5} BACT determinations for EU 27 are appropriate. The enclosed report is a supplemental BACT analysis to formalize the DPF cost analysis and provide ADEC with updated information to support the existing PM_{2.5} BACT determination for EU 27 in the Serious PM_{2.5} SIP. The BACT analysis follows the five-step "top-down" methodology in accordance with EPA guidance. The analysis focuses on the economic impact of the DPF emission control technology. The cost-effectiveness of the technically feasible control options is presented in Section 6.3 of the report. The analysis concludes that the federal standard, limited operation, and good combustion practices, the base case PM_{2.5} emission control technology in operation on EU 27, is BACT with a PM_{2.5} emission rate of 0.20 grams per kilowatt-hour (g/kW-hr).

¹ ADEC's BACT determination for EU 27: Federal Limit (NSPS Subpart IIII, Tier 3) + Limited Operation

Public Review Draft

August 19, 2024

Please contact Frances Isgrigg at (907)-590-5809 or at fisgrigg@alaska.edu if you have any questions or concerns

Sincerely,

DocuSigned by:


064509AEEF3C4D0...

Kellie Fritze

Associate Vice Chancellor for Facilities Services

Enclosure: Supplemental Fine Particulate Matter Best Available Control Technology Analysis for Emissions Unit 27

cc:

Matthew Jentgen, EPA

Zach Hedgpeth, EPA

Larry Sorrels, EPA

Jason Brune, Commissioner, ADEC

Jason Olds, Acting Director, Air Quality Division, ADEC

James Plosay, Air Permit Program Manager, ADEC

Julie Queen, UAF Vice Chancellor for Administrative Services

Cameron Wohlford, Director, UAF Design and Construction

Frances Isgrigg, UAF Design and Construction

Tracey Martinson, Director, UAF Environmental, Health, Safety, and Risk Management

Russ Steiger, UAF Environmental, Health, Safety, and Risk Management

Courtney Kimball, Boreal Environmental Services



Supplemental Fine Particulate Matter Best Available Control Technology Analysis for Emissions Unit 27

Prepared for:
University of Alaska Fairbanks

July 2023



Supplemental Fine Particulate Matter Best Available Control Technology Analysis for Emissions Unit 27

Prepared for:

University of Alaska Fairbanks

Facilities Services, Division of Design and Construction

PO Box 757380

Fairbanks, AK 99775

Prepared by:

Boreal Environmental Services

4300 B Street, Suite 510

Anchorage, AK 99503





1.0 INTRODUCTION

A portion of the Fairbanks North Star Borough (FNSB) that includes the University of Alaska Fairbanks (UAF) Campus stationary source has been classified as a Serious Nonattainment Area for fine particulate matter (PM_{2.5}). The Alaska Department of Environmental Conservation (ADEC) prepared a Serious PM_{2.5} Nonattainment State Implementation Plan (SIP). ADEC adopted the Serious PM_{2.5} SIP on November 19, 2019. Amendments to the SIP were adopted on November 18, 2020. The Serious PM_{2.5} SIP addresses direct PM_{2.5} emissions and precursor emissions of oxides of nitrogen (NO_x) and sulfur dioxide (SO₂). The Serious PM_{2.5} SIP includes Best Available Control Technology (BACT) determinations for the UAF Campus emissions units. ADEC submitted the Serious PM_{2.5} SIP and the amendments to the U.S. Environmental Protection Agency (EPA).

On January 10, 2023, the EPA published a proposed rulemaking action¹ to partially approve and partially disapprove the Serious PM_{2.5} SIP. In Table 14 of the proposed rulemaking action, EPA states that the PM_{2.5} BACT determinations in the Alaska Serious SIP are not sufficient for EU 27 because installing a PM_{2.5} emission control device would be cost effective. Section 9.1 of the EPA technical support memorandum² states that a diesel particulate filter (DPF) is recommended as a cost-effective emission control technology.

EU 27 is a Caterpillar (CAT) model C-15, Tier 3 certified engine. EU 27 combusts only ultra-low sulfur diesel (ULSD) and has potential PM_{2.5} emissions of 0.36 tons per year (tpy). Detailed emissions calculations are provided in Appendix A. The PM_{2.5} potential emissions are based on the Tier 3 particulate matter (PM) emission standard of 0.2 grams per kilowatt-hour (g/kW-hr) located in Appendix I to 40 Code of Federal Regulations (CFR) 1039 – Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines. EU 27 is subject to a federally enforceable owner-requested limit not to exceed 4,380 operating hours in a rolling 12-month period, per Condition 28.1 of Air Quality Operating Permit AQ0316TVP03.

UAF believes that the Alaska Serious SIP PM_{2.5} BACT determinations for EU 27 are appropriate. UAF submitted comments to EPA during the comment period for the proposed rulemaking action¹. UAF received an updated vendor quote for installing DPF on EU 27 following the closure of the public comment period and submitted supplemental comments to EPA on May 26, 2023, to provide the current cost data and cost-effectiveness value for implementing DPF on EU 27.

This report is a supplemental BACT analysis to formalize the DPF cost analysis and provide ADEC with updated information to support the existing PM_{2.5} BACT determination for EU 27 in the Serious PM_{2.5} SIP.

¹ Federal Register Vol. 88, No. 6, January 10, 2023.

² Hedgpeth, Z. (August 24, 2022). Review of Best Available Control Technology analyses submitted for the University of Alaska, Fairbanks as part of the Fairbanks PM_{2.5} Nonattainment SIP. U.S. Environmental Protection Agency, Region 10 Laboratory Services and Applied Science Division. Docket Document ID EPA-R10-OAR-2022-0115-0215, 000008_EPA Technical Support Document - UAF BACT TSD v20220824.



2.0 BACT METHODOLOGY

This supplemental BACT analysis for EU 27 was prepared consistent with the five-step “top-down” methodology provided in the EPA New Source Review (NSR) Rule Revisions (proposed)³, which references the 1990 Draft NSR Workshop Manual. The five steps of the BACT analysis process are:

1. Identify all available control options.
2. Eliminate technically infeasible options.
3. Rank the remaining options by control effectiveness.
4. Evaluate the most effective controls.
5. Select BACT.

3.0 STEP 1 – AVAILABLE PM_{2.5} CONTROL TECHNOLOGIES

In January 2017, UAF submitted a BACT Analysis to ADEC which addressed emissions units at the UAF Campus stationary source. The analysis was prepared in anticipation of the Serious Nonattainment Area classification for the Fairbanks area. In that analysis, UAF identified the available PM_{2.5} control technologies for EU 27 as presented in Table 1. UAF is not identifying any changes to this list of available control technologies in this supplemental analysis.

Table 1. Available PM_{2.5} Emission Control Technologies for EU 27

Available PM _{2.5} Emission Control Technologies
DPF
Federal Standard
Limited Operation
Good Combustion Practices

4.0 STEP 2 – TECHNICAL FEASIBILITY OF AVAILABLE PM_{2.5} CONTROL TECHNOLOGIES

The 2017 UAF Campus BACT Analysis identified the technically feasible PM_{2.5} control technologies for EU 27 as presented in Table 2.

Table 2. Technically Feasible PM_{2.5} Emission Control Technologies for EU 27

Technically Feasible PM _{2.5} Emission Control Technologies
DPF
Federal Standard
Limited Operation
Good Combustion Practices

³ Federal Register Vol. 61, No. 142, July 23, 1996.



EU 27 is subject to the Tier 3 federal emission standards and is a certified Tier 3 engine. EU 27 is subject to an annual operating limit per Condition 28.1 of Permit AQ0316TVP03. The original UAF BACT analysis did not carry good combustion practices forward in the analysis because that option would not reduce PM_{2.5} emissions below the existing levels based on the federal standard and operating limit. The use of good combustion practices for EU 27 is a BACT requirement in the Serious PM_{2.5} SIP. UAF is not identifying any changes to this list of technically feasible control technologies in this supplemental analysis.

5.0 STEP 3 – RANK TECHNICALLY FEASIBLE PM_{2.5} CONTROL TECHNOLOGIES

The technically feasible control technologies are DPF, federal standard, limited operation, and good combustion practices. The federal standard, limited operation, and good combustion practices are included in the base case for these rankings. The base case PM_{2.5} potential to emit (PTE) of EU 27 is 0.36 tpy. The DPF vendor-provided PM emission reduction capability is 85 percent, which results in a controlled PTE of 0.05 tpy. Table 3 presents the removal efficiency, potential PM_{2.5} emissions, and the amount of PM_{2.5} emission reduction for each control option.

Table 3. Ranking of Technically Feasible PM_{2.5} Emission Control Technologies

Control Technology	Control Efficiency (pct.)	PM _{2.5} Emission Rate (g/hp-hr)	PM _{2.5} Emissions (tpy)	PM _{2.5} Emissions Reduction (tpy)
DPF	85	0.02	0.05	0.31
Base Case: Federal Standard, Limited Operation, and Good Combustion Practices	0	0.15	0.36	0.00

6.0 STEP 4 – EVALUATE MOST EFFECTIVE CONTROL OPTIONS

This section presents an evaluation of the economic impacts of the technically feasible PM_{2.5} control options – DPF and the base case.

6.1 Highest PM_{2.5} Removal Efficiency – DPF

The DPF emission control system is 85 percent efficient in reducing PM_{2.5} emissions. This section evaluates the economic impacts that would result from installing DPF on EU 27. Vendor-provided information on the DPF system is presented in Appendix B. To evaluate the economic impact, UAF prepared a cost estimate to retrofit EU 27 with a DPF. The cost estimate incorporates the vendor quote, EPA guidance, and other information, as appropriate. The DPF cost estimate is presented in Appendix C.

NC Power Systems, a certified Caterpillar (CAT) dealership, provided a quotation for the DPF assembly, system monitor, and insulation blanket. The quote is \$78,210, including freight on board (FOB) Fairbanks.



EU 27 is a CAT Tier 3 engine. NC Power is the certified CAT dealer in Alaska. Section 2 of the CAT DPF Application and Installation Guide (included in Appendix B) provides a detailed description of methodology the CAT DPF uses to reduce emissions of particulate matter, as well as carbon monoxide and hydrocarbons. Page 10 of the Application and Installation Guide indicates that several conditions are required for proper DPF regeneration, including use of ULSD, a minimum engine exhaust temperature for certain time periods, a minimum ratio of NO_x to PM, specific engine oil use, and a maximum engine oil consumption rate. The Application and Installation Guide states that the DPF regeneration technology is applicable to Tier 1 and Tier 2 engines. As noted in an email dated March 9, 2023, from Thomas LaMont at NC Power Systems, ensuring that the DPF was technically feasible for EU 27, a Tier 3 engine, required additional investigation and coordination with CAT technical advisors. UAF believes that the quote from NC Power is an accurate reflection of equipment costs.

As indicated on pages 19 and 20 of the CAT DPF Application and Installation Guide, heat retention in the DPF reactor is very important. Because EU 27 is located in Fairbanks, Alaska, NC Power included the insulating blanket for the DPF in the quote.

The DPF cost estimate includes the basic scope for the emissions control equipment. Examples of costs that were not evaluated and are not included are:

- Freight offloading and transport to UAF project site;
- Direct installation costs;
- Engineering and construction support services;
- Performance testing;
- Management and contingency costs;
- Insulation installation on additional piping or other components, if needed;

In addition to the costs not included as described above, the cost estimate does not consider project delays or increased costs due to supply chain issues or delivery delays, both issues common in today's business environment. NC Power noted in an email dated March 23, 2023, that supply chain issues are currently affecting CAT. Direct annual costs, including operating labor, maintenance labor, and maintenance materials, were not estimated for the purposes of this analysis. Indirect annual costs including overhead, administrative charges, and insurance were not estimated for the purposes of this analysis. As a result, the cost estimate is conservatively low.

As shown in Table C-1 of Appendix C, the Total Capital Investment (TCI) for retrofitting EU 27 with DPF is estimated at \$78,210. The Total Annual Cost (TAC) is estimated at \$8,115.

Energy and environmental impacts beyond any addressed as part of the cost estimate process have not been identified for the DPF system during this analysis.

6.2 Second-Highest PM_{2.5} Removal Efficiency Option – Base Case

The base case includes the federal NSPS standard, limited operation, and good combustion practices, which are already in use on EU 27.



6.3 Cost-Effectiveness Evaluation

In this analysis, evaluating the impact of the PM_{2.5} emission control option hinges on the economic feasibility of the DPF system. For any given emission control technology, the cost-effectiveness value is expressed in terms of the cost in dollars per ton of pollutant reduction. Cost-effectiveness is calculated as the annualized cost of the control technology divided by the annual reduction in emissions compared to the baseline emission rate. The annualized cost of the DPF system is calculated using the Equivalent Uniform Annual Cost (EUAC) approach consistent with EPA methodology. Table 4 presents the cost-effectiveness for DPF as evaluated in Step 4 of this BACT analysis.

Table 4. PM_{2.5} Cost-Effectiveness Summary

Control Technology	Total Capital Investment (\$)¹	Total Annual Cost (\$/year)²	Emissions Reduction (tpy)³	Cost-Effectiveness (\$/ton PM _{2.5} Emissions Avoided)
DPF	\$78,210	\$8,115	0.31	\$26,539
Base Case: Federal Standard, Limited Operation, and Good Combustion Practices	~	~	0.00	~

Notes:

¹Total Capital Investment is calculated in Table C-1 of Appendix C.

²Total Annual Cost is calculated in Table C-2 of Appendix C.

³Emissions reductions are calculated in Table 3 above.

The cost-effectiveness of DPF, with a PM_{2.5} removal efficiency of 85 percent, is \$26,539 per ton of PM_{2.5} emission reductions.

7.0 STEP 5 – SELECT BACT

The final step in the top-down BACT analysis approach is to select the most effective control option that is not eliminated in Step 4. As shown in Table 4, the add-on PM_{2.5} emission control option DPF is not cost-effective. The cost-effectiveness value of DPF is greater than \$25,000 per ton of PM_{2.5} removed. Consistent with past EPA and ADEC BACT determinations, this cost-effectiveness value is not economically feasible. Control options which are not economically feasible are by definition eliminated from consideration as BACT.

The existing, base case PM_{2.5} emission control technology, including the federal NSPS standard, limited operation, and good combustion practices, is the best available control technology for EU 27. As a result, the BACT emission limit is 0.20 g/kW-hr. UAF is currently in compliance with this emission limit as required in Condition 81.1 of Permit AQ0316TVP03.



Appendix A

EU 27 PM_{2.5} Emission Calculations

Table A-1. Potential to Emit Calculations for EU 27 Supplemental BACT Analysis - PM_{2.5} Emissions
University of Alaska Fairbanks Campus

Emissions Unit		Fuel Type	PM _{2.5} Emission Factor		Maximum Rating/Capacity	Allowable Annual Operation	Control Technology	Short Term PM _{2.5} Emissions	Potential PM _{2.5} Emissions
ID	Description		Reference	Factor					
27	Alaska Center for Energy and Power Generator Engine, Caterpillar C-15	ULSD	Table 3 to Appendix I, 40 CFR 1039	0.2 g/kW-hr	500 hp	4,380 hr/yr	Tier 3	0.15 g/hp-hr	0.36 tpy

Notes:

¹ Conversion factors:

Power Conversion 1.341 hp/kW
Mass Conversion 454.0 g/lb
Mass Conversion 2,000 lb/ton

² EU ID 27 limited to operating no more than 4,380 hr/yr per Condition 28.1 of Permit No. AQ0316TVP03.



Appendix B

Diesel Particulate Filter Vendor Data

- B-1 NC Power Systems DPF Quote Email and Correspondence
- B-2 CAT DPF Datasheet
- B-3 CAT DPF Application and Installation Guide
- B-4 CAT DPF Drawings



B-1 NC Power Systems DPF Quote Email and Correspondence

From: [Erick Pomrenke](#)
To: [Ryan Coursey-Willis](#)
Cc: [Courtney Kimball](#)
Subject: RE: DPF Quote
Date: Friday, April 14, 2023 14:16:48
Attachments: [image002.png](#)
[Datasheet - DPF.pdf](#)
[A & I Guide for DPF installation.pdf](#)
[6275669DWF.ZIP](#)

Ryan,

Sorry for the delay.

Here's what we can provide.

- Critical grade DPF assembly.
- Monitor with 25 foot harness included.
- Insulated blanket included.

Attached is the spec sheet, drawing and installation guide.

Lead time is 20-24 weeks.

Sale price FOB Fairbanks Alaska – offloaded by others. \$78,210.00

Let me know if you need anything else.

Thank you

Erick Pomrenke
NC POWER SYSTEMS
GENERATOR / COMPRESSOR
RENTALS AND SALES
1-907-786-7565 OFFICE
1-907-632-6700 CELL
1-907-786-7567 FAX



From: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Sent: Tuesday, March 28, 2023 2:33 PM
To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Yes, this will be FOB Fairbanks.

From: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Sent: Tuesday, March 28, 2023 2:29 PM

To: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Sure.

I'll work on the different freight quotes.

Is this FOB Fairbanks?

From: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Sent: Tuesday, March 28, 2023 2:27 PM

To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Can we quote both options?

Thanks

From: Erick Pomrenke <EPomrenke@NCPowerSystems.com>

Sent: Tuesday, March 28, 2023 11:15 AM

To: Ryan Coursey-Willis <rcwillis@boreal-services.com>

Cc: Courtney Kimball <ckimball@boreal-services.com>

Subject: RE: DPF Quote

Ryan,

I've got movement. Do you want silenced or non silenced?

Thank you

Erick Pomrenke

**NC POWER SYSTEMS
GENERATOR / COMPRESSOR
RENTALS AND SALES
1-907-786-7565 OFFICE
1-907-632-6700 CELL**

1-907-786-7567 FAX



From: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Sent: Thursday, March 23, 2023 5:36 PM
To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>
Cc: Courtney Kimball <ckimball@boreal-services.com>
Subject: Re: DPF Quote

Hi Erick,

Appreciate the heads up on this. That's good to know supply chain issues are a factor that needs to be taken into account on our end. Any major delays in procurement of equipment would be good to know about in the final quote as well.

Thank you for your time on this,
Ryan

From: Erick Pomrenke <EPomrenke@NCPowerSystems.com>
Sent: Thursday, March 23, 2023 2:38:20 PM
To: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Subject: RE: DPF Quote

Ryan,

I spoke with the folks at CAT earlier today.

They are working on it. They have some supply chain issues.

Just wanted to give you a heads up.

Thank you

Erick Pomrenke
**NC POWER SYSTEMS
GENERATOR / COMPRESSOR
RENTALS AND SALES
1-907-786-7565 OFFICE
1-907-632-6700 CELL
1-907-786-7567 FAX**



From: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Sent: Thursday, March 16, 2023 9:58 AM
To: Erick Pomrenke <EPomrenke@NCPowerSystems.com>
Subject: DPF Quote

Hello Erick,

I wanted to touch base and see where you were at with the DPF quote for the C15 engine at UAF.
Would we be able to get this today or tomorrow?

Thanks!
Ryan



Ryan Coursey-Willis

Project Engineer

Mobile: (907) 687-8446

Email: rcwillis@boreal-services.com

Address: 4300 B Street, Suite 510, Anchorage, AK 99503

From: [Ryan Coursey-Willis](#)
To: [Courtney Kimball](#)
Subject: FW: Diesel Particulate filter for C15 Engine
Date: Thursday, March 9, 2023 09:19:02
Attachments: [REHS3672.docx](#)
[DPF installation.docx](#)

NC is slowly working on this. Some interesting info came in this morning. It appears that adding a DPF is going to turn into a major overhaul.

From: Brian Swierk <BSwierk@NCMachinery.com>
Sent: Thursday, March 9, 2023 8:41 AM
To: Ryan Coursey-Willis <rcwillis@boreal-services.com>
Subject: FW: Diesel Particulate filter for C15 Engine

Ryan,

See below and the attached

From: Thomas LaMont <TLaMont@ncpowersystems.com>
Sent: Thursday, March 9, 2023 8:38 AM
To: Brian Swierk <BSwierk@NCMachinery.com>
Subject: RE: Diesel Particulate filter for C15 Engine

Brian,

I will need to do some more investigating and probably need to pull in information from Steve our TC but before I do wanted to make sure we were all on the same page. The installing a DPF is not just adding it to the system. This being a tier 3 engine already it is going to take major changes, see attached to be honest not 100% sure the extent of those changes but will work on that, just want to make sure they understand it first.

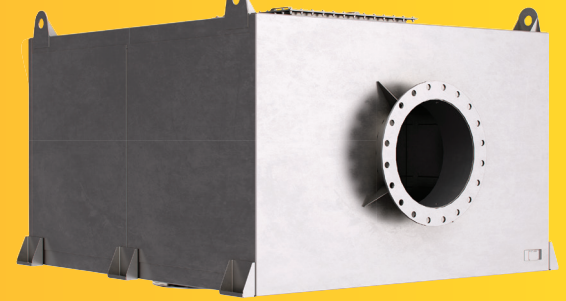
Thomas LaMont
NC Power Systems
AD07 Cert:AD LAMONTE864RH
Wa. State CEU Instructor ID: 1657
Service Supervisor/ Electric Power Generation
Cell: 206 510-0535
Office: 425 251-5866
Toll free: 800-562-4735
TLaMont@ncpowersystems.com



B-2 CAT DPF Datasheet

CAT[®] RETROFIT DIESEL PARTICULATE FILTER (DPF)

For New and Existing Installations



Serviceability

- Cat[®] DPFs feature serviceable, fully removable catalysts with clamped catalyst filter modules for ease of service during maintenance checks.
- Large box design models feature access hatches that can be lifted by one technician without the need for cranes or other lifting devices.
- For models equipped with hatches, nut strips provide ease in securing of hatches after service.

Performance

- Optimized housing design maximizes emissions reduction while minimizing backpressure for increased efficiency.
- Integral silencer design provides high levels of sound reduction (most models).
- Insulation blanket increases heat retention for increased emissions reductions in demanding applications (optional).

Flexibility

- Slip-fit connectors on small models and flange connectors on medium to large models provide flexible and convenient connection options with existing exhaust piping.

Support

- Worldwide Cat dealer coverage – one source for you to trust.

Durability

- Housing is constructed of stainless steel for superior life in indoor and outdoor installations.
- Ceramic catalyzed substrate is resistant to high heat conditions.
- Specialized mounting feet allow natural thermal expansion during operation, reducing the potential for stress cracking (large box design models).

Ease of Installation

- Cat DPFs require minimal installation time and expertise to place into service.
- Medium and large models feature integral lifting eyes for easy lifting and placement.
- Cat Datalogging and Alarm System (DLAS) is pre-configured and easy to install for complete system monitoring (optional).

Safety

- Optional insulation blanket reduces surface temperature for additional safety.

CAT[®] Public Review Draft

CAT[®] RETROFIT DIESEL PARTICULATE FILTER (DPF)

For New and Existing Installations

August 19, 2024

Housing		
Construction	Stainless Steel	
Catalyst		
Construction	Catalyzed Ceramic Substrate	
Sulfur Tolerance (Diesel)	ULSD (<15 PPM)	
Biodiesel	Up to B20	
Emissions Reduction Capability		
Carbon Monoxide (CO)	Up to 95%	
Hydrocarbons (HC)	Up to 90%	
Particulate Matter (PM)	Over 85%	
Engine Applications		
Non-silenced	55-560 kW	80-750 hp
Industrial Grade Silencing	55-225 kW	80-300 hp
Critical Grade Silencing	225-4325 kW	300-5800 hp

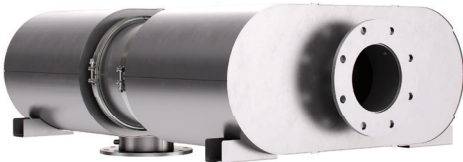
Datalogging and Alarm System (DLAS) (Optional)	
Monitoring Functions	Exhaust Temperature
	Exhaust Backpressure
	Date and Time
Cable Length	7.6 m / 25 ft.
Cable Length (Optional)	15.2 m / 50 ft.
Data Download	Ethernet Port

Housing Types

Non-silenced, 55 kW / 80 hp to 225 kW / 300 hp



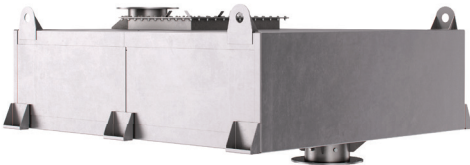
Non-silenced, 225 kW / 300 hp to 560 kW / 750 hp



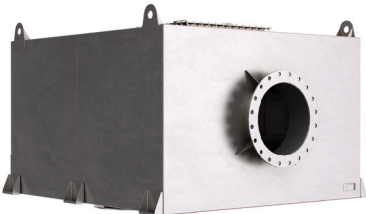
Industrial Grade Silencing, 55 kW / 80 hp to 225 kW / 300 hp



Critical Grade Silencing, 225 kW / 300 hp to 1045 kW / 1400 hp



Critical Grade Silencing, 930 kW / 1250 hp to 4325 kW / 5800 hp



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Appendix III.D.7.7-2339





B-3 CAT DPF Application and Installation Guide

**Retrofit
Diesel Particulate
Filter (DPF) Reactor
CARB Verified Level 3+
application &
installation guide
ES5 1-Up**

The information contained in this supplement is confidential and proprietary to Caterpillar. Distribution of this material must be limited to personnel whose duties require knowledge of such material and is intended exclusively for their information and training. Distribution of this material for other purposes is strictly prohibited.

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1.0 Introduction

Purpose

This document is intended as a reference and guide for the correct installation of the retrofit Diesel Particulate Filter (DPF) reactor. The primary purpose is to assist engineers and designers specializing in engine installations. The Engine Application and Installation Guide and Engine Data Sheets complement this booklet.

Note: The information in this document is subject to change as engine exhaust aftertreatments are revised, improved, and required for emission reduction standards.

Cat engines are designed and built to provide superior value; however, achieving the end user's value expectations depends greatly on the performance of the complete installation to assure proper function over the design life of the installation. This detail will allow the engine to produce its published rated power and fuel consumption and meet applicable emission standards.

Caterpillar exercises all reasonable effort to assure engine and Cat DPF perform properly. However, it is the responsibility of the OEM/installer to properly install the engine and Cat DPF reactor. Caterpillar assumes no responsibility for deficiencies in the installation. It is the responsibility of the OEM/installer to meet all Caterpillar requirements as provided in this Application and Installation Guide.

Caterpillar does not guarantee or approve the validity or correctness of any installation. Caterpillar's sole obligation with respect to any product is as set forth in the applicable Caterpillar warranty statement.

It is the installer's responsibility to consider and avoid possible hazardous conditions which could develop from the systems involved in the specific engine installation. The suggestions provided in this guide should be considered general examples only and are in no way intended to cover every possible hazard in every installation.

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Contact the appropriate application support group for the latest information on Cat DPF reactor guidelines and requirements.

Safety

Most accidents that involve product operation, maintenance, and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. An OEM installer must be alert to potential hazards. An OEM installer should also have the necessary training, skills, and tools to perform these functions properly.

The information in this publication was based upon current information at the time of publication. Check for the most current information before you start any job. Cat dealers will have the most current information.

Warning: Improper operation, maintenance, or repair of this product may be dangerous. Improper operation, maintenance, or repair of this product may result in injury or death. Do not operate or perform any maintenance or repair on this product until you have read and understood the operation, maintenance, and repair information. Burn and fire hazards are possible. Failure to properly connect the aftertreatment/regeneration device, if equipped, manage the regeneration gas temperature, or properly route the exhaust gases away from the module may result in personal injury or death.

Notice: Failure to properly connect the aftertreatment/regeneration device or manage the regeneration gas temperature may result in poor aftertreatment performance.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are not all inclusive. If a tool, a procedure, a work method, or an operating technique that is not specifically recommended by Caterpillar is used, you must be certain that it is safe for you and for other people. You must also be certain that the product will not be damaged. You must also be certain that the product will not be made unsafe by the procedures that are used.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury. Always wear a protective face shield, protective clothing, and protective shoes when cleaning components. The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded and used with effective chip guarding (if applicable) and personal protective equipment. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

High Pressure Wash

Notice: High pressure wash systems, including high pressure spray washers and water cannons, are now in frequent use by maintenance people. Connector seals will fail when hit directly with high pressure spray. Where direct exposure to high pressure wash systems cannot be avoided, protective shields will need to be designed and installed.

Welding

Warning Notice: Welding on DPF silencer frame/reactor body is prohibited.

Do not use electrical components (electronic controller or sensors) or electronic component grounding points for grounding a welder.

Painting

Painting of the Cat DPF is NOT recommended and strongly discouraged. Some components' skin temperatures on the DPF can get to as high as 650°F during operation and will cause charring or burning of the paint.

Replacement Parts



WARNING

When replacement parts are required for this product, Caterpillar recommends using Cat replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength, and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury, or death.

READ THROUGH THE ENTIRE MANUAL BEFORE PROCEEDING WITH ACTUAL INSTALLATION.

Emissions Requirements

This Installation Guide is intended for use for engines that must meet applicable emission standards. Proper fluids must be used to meet these requirements. Refer to the specific Operation and Maintenance Manual (OMM) for the engine model being installed for the proper fuel, lubricants, and coolants that are to be used. The proper fuels, lubricants, and coolants must be used to enable the engine to produce its published rated power and fuel consumption and meet applicable emission standards. JP8 fuel is not compatible with Cat DPF reactors.

Notice: Oils that have more than 1% total sulfated ash should not be used in aftertreatment device equipped engines. In order to achieve expected ash service intervals, performance, and life, aftertreatment device equipped diesel engines require the use of Cat DEO-ULS™ or oils meeting the Cat ECF-3 specification and the API CJ-4 oil category. Oils that meet the Cat ECF-2 specification and that have a maximum sulfated ash level of 1% are also acceptable for use in most aftertreatment equipped engines. Use of oils with more than 1% total sulfated ash in aftertreatment device equipped engines will cause the need for more frequent ash service intervals, and/or cause loss of performance. Refer to your engine specific Operation and Maintenance Manual, and refer to your aftertreatment device documentation for additional guidance.

Warning: Use of Oil Renewal System (ORS) is strictly forbidden. Any ORS that extends the oil life through the combustion process and topping off the oil reservoir with new oil will damage the aftertreatment device. Failures that result from the use of any oil are not Caterpillar factory defects. Therefore, the cost of repair would NOT be considered by the Caterpillar warranty for materials and/or the warranty for workmanship.

It is recommended that the Cat DPF operate in conjunction with ultra-low sulfur diesel fuel (ULSD-S15), less than 15 ppm sulfur by weight. ULSD fuel must meet the S-15 fuels designation in the latest edition of ASTM D975 and/or conform to Caterpillar Fuel Specification. Using ULSD, regeneration for engines meeting U.S. EPA Tier 2 and lower equivalent emission standards will occur when the duty cycle is above 300°C (572°F) for at least 30% of the operating time. For engines meeting Tier 3 equivalent emission standards and higher, consult Caterpillar for operating requirements.

Operating the Cat DPF on diesel engines using fuel with sulfur content greater than 50 ppm will increase the regeneration temperature requirements, typically 50-75°C (90-135°F). If the exhaust temperature meets these requirements, continuous regeneration still can take place. The regeneration temperature requirements will increase with high sulfur fuel. With added sulfur, the normal duty cycle of the engine will cause the filter to plug with PM, causing the backpressure to increase beyond the engine manufacturers' limits. Damage to the filter and/or the engine may occur.

When the fuel sulfur level is once again below 50 ppm, ULSD operating conditions will return. High sulfur fuel will not damage the catalyst coating or the ceramic filter. It does change the regeneration requirements as stated above.

Biodiesel fuel may be used up to the B20 blend level (20% biodiesel and 80% appropriate ULSD fuel) if the final B20 blend conforms to ASTM D7467 and API gravity 30-45. The neat biodiesel blend stock should conform to ASTM 6751. Refer to SEBU 6250 – Caterpillar Machine Fluids Recommendations for diesel engines and SEBU 6400 for natural gas engines.

Cat Diesel Engine Oils (Cat DEO) have been developed and tested to provide the full performance and service life that has been designed and built into Cat engines. Cat oils are currently used to fill Cat diesel engines at the factory. These oils are offered by Cat dealers for continued use when the engine oil is changed. Consult your Cat dealer for more information on these oils.

Cat DEO-ULS (Ultra Low Sulfur) oil exceeds the performance requirements of API category CJ-4 oil and is recommended due to a low ash specification. Engine oil that meets or exceeds the specifications in the Cat ECF-3 or API CJ4 categories may be used in these applications. Oil burned during the combustion process accounts for almost all of the DPF ash accumulation (because of oil additives). The use of recommended low ash oil results in lower ash accumulation in the filter. Failure to use the recommended grade of oil may result in more frequent ash removal service intervals.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

Cat Lubricants		Viscosity Grade
Diesel Engine Oil – Ultra Low Sulfur	Cat DEO – ULS	SAE 15W-40
		SAE 10W-30
	Cat DEO – ULS SYN	SAE 5W-40
	Cat Cold Weather DEO – ULS	SAE 0W-40
Diesel Engine Oil	Cat DEO	SAE 15W-40
		SAE 10W-30
	Cat DEO SYN	SAE 5W-40

Note: Cat DEO and Cat DEO-ULS multi-grade oils are the preferred oils for use in this Cat diesel engine.

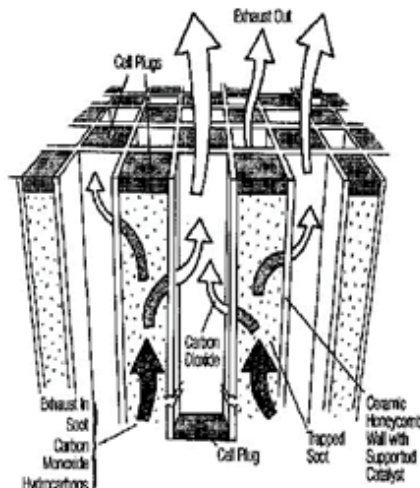
Note: Commercial oils that are not Cat oils are second choice oils for your engine.

Notice: Caterpillar does not warrant the quality or performance of fluids that are not Cat fluids. For more information, refer to Special Publication, SEBU6251, Cat Commercial Engine Fluids Recommendations.

2.0 Diesel Particulate Filter (DPF) Operation

Introduction of the Cat Diesel Particulate Filter

The Cat DPF is a catalyzed diesel particulate filter that is designed to reduce emissions of particulate (smoke), carbon monoxide (CO) and hydrocarbons (HC), from diesel engines. Carbon monoxide and hydrocarbon reductions are achieved when the exhaust gases interact with the catalyst on the ceramic filter. The catalyst is impregnated on the walls of the ceramic substrate. As the exhaust gases come in contact with the catalyst, a chemical reaction takes place that oxidizes the gases. The oxidation process turns carbon monoxide into carbon dioxide (CO₂) and hydrocarbons into water and carbon dioxide.



Reduction of Emissions

The Cat DPF is a complete product for reducing carbon monoxide, hydrocarbons and PM. The filter is catalyzed with a precious-metal catalyst. For CO and HC, the catalyst reduces the activation temperature needed in order to react with both types of compounds with oxygen (O₂). A simple version of the reactions is given below:

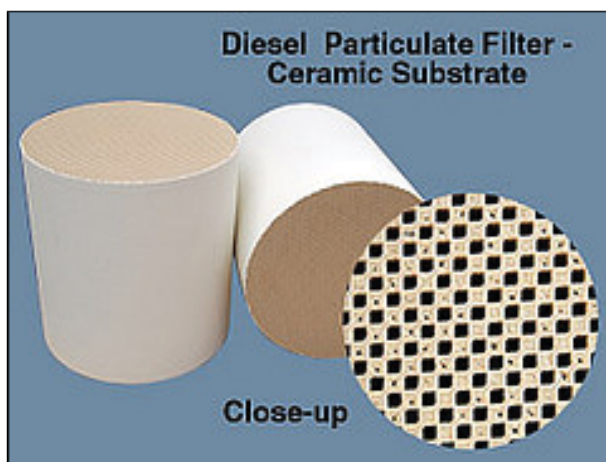
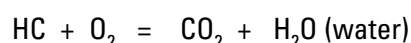
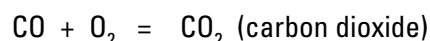


Figure 2.2

For the Cat DPF, these reactions can start to take place at temperatures as low as 180°C (356°F). By 230°C, the reductions are >90%.

Particulate matter, PM, is a more complex emission to reduce. PM is comprised of three basic fractions: carbon, volatile organics, and inorganics. These fractions change with engine combustion and are functions of ambient temperature, fuel composition, barometric pressure, lubrication oil, and exhaust composition.

Solid carbon and liquid volatile organics can be oxidized over the precious metal catalyst much the same as gaseous CO and HC are oxidized. Inorganics, such as calcium and magnesium compounds of lubricating oil, cannot be eliminated through oxidation. They are, however, trapped by the filter and comprise what is referred to as “ash.” Cleaning ash out of the filter is addressed in more detail in the “Maintenance” section.

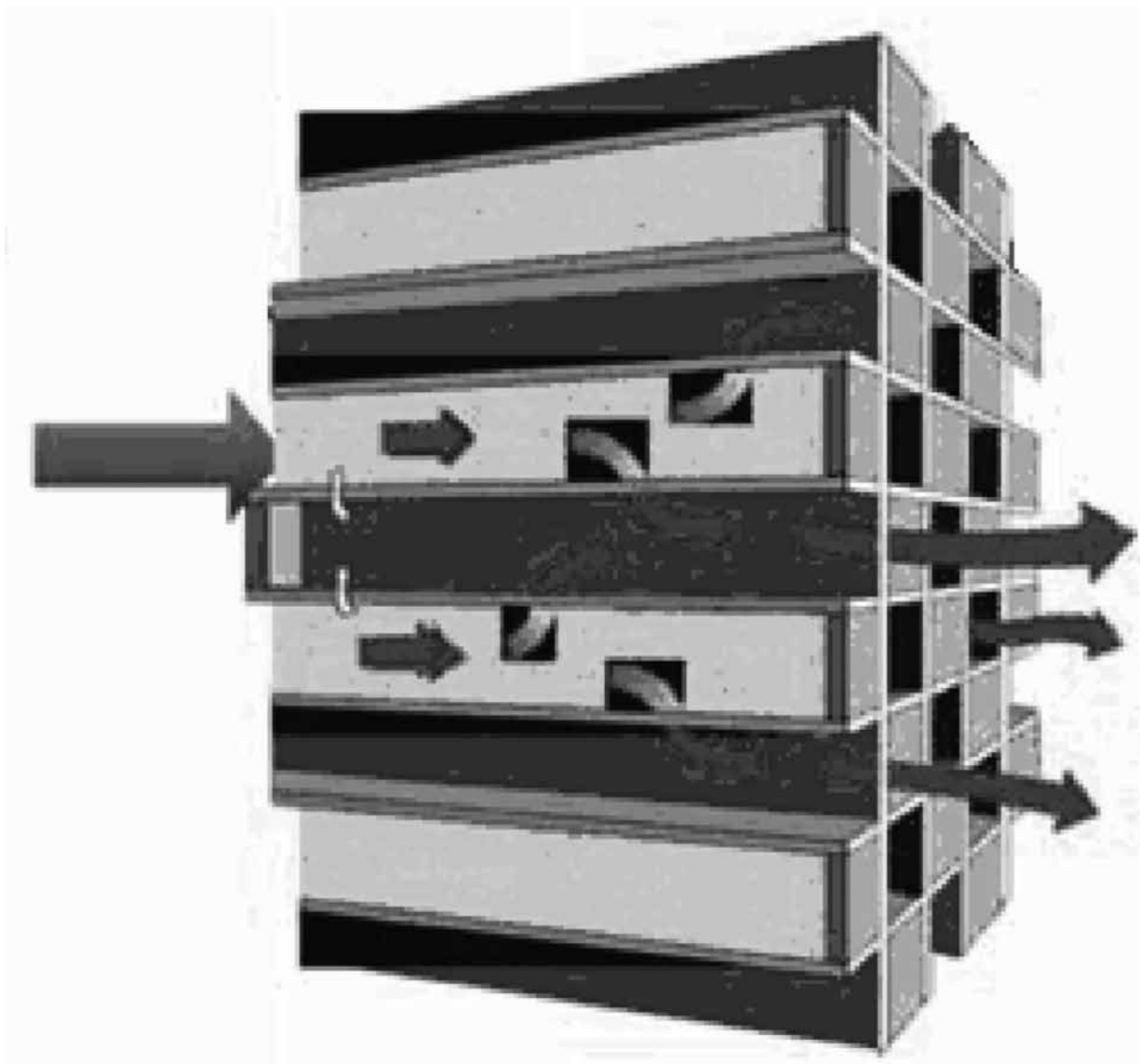


Figure 2.3

The DPF is used to reduce greater than 85 percent of the emissions of particulate matter. These emissions are reduced by filtration as the exhaust passes through the DPF wall. Carbon monoxide (CO), and Hydrocarbons (HC) are also reduced as the engine exhaust passes through the catalytic oxidation and filtration units. The DPF filter substrate uses a series of alternately blocked channels which forces exhaust gasses to flow through the channel walls. Particulates are physically captured and chemical reactions take place (see Illustration 5). Carbon monoxide and hydrocarbons are converted into carbon dioxide and water vapor. These filters are self-regenerating. Self-regenerating filters are not disposable, but, instead, will “burn off” the accumulated soot continuously if the proper exhaust temperature profile is met.

Regeneration

The process of particulate collection begins as soon as the engine is started and continues while the engine is operating. At low loads and low exhaust temperatures, PM accumulates in the filter, and pressure drop across the filter increases. When exhaust conditions are optimal, the catalyst promotes oxidation between the particulate matter and either oxygen or nitrogen dioxide in the exhaust. This process is called regeneration, whereby PM is burned off of the substrate walls, resulting in a cleaner filter. The regeneration process is dependent upon exhaust temperature, engine load, exhaust composition, and fuel sulfur content. At a certain exhaust condition, the rate of oxidation eclipses the rate at which PM is being trapped by the filter. The temperature at this exhaust condition is commonly referred to as the regeneration temperature. While the exhaust temperature does not have to be above its regeneration temperature all of the time, the more time above this temperature the cleaner the filter will be and the lower the backpressure. Operating above the regeneration temperature means that the filter will continuously regenerate and clean itself out.

Proper DPF regeneration **REQUIRES** the following conditions:

- Ultra Low Sulfur Diesel (ULSD) fuel must be used. ULSD fuel must have an average sulfur content of 15 parts per million (ppm) or less.
- The sulfur content in the diesel fuel is not to exceed 0.0015 percent by weight. ULSD fuel must meet the S-15 fuels designation in the latest edition of ASTM D975 and/or conform to Caterpillar fuel specification.
- Biodiesel fuel may be used up to the B20 blend level (20 percent biodiesel and 80 percent appropriate ULSD fuel). If the final B20 blend conforms to ASTM D7467 and API gravity 30-45. The neat biodiesel blend stock should conform to ASTM 6751.
- The engine exhaust temperature at the DPF inlet must be 300°C (572°F) or greater for at least 30 percent of the time or 2 hours whichever is longer.
- The ratio of nitrogen oxides (NOx) to particulate matter (PM) must be a minimum of 25:1. This ratio is the NOx level, in grams/brake horsepower hour, divided by the PM level). This technology is currently applicable to 1996 or newer Tier 1 or Tier 2 equivalent engines. Current Caterpillar retrofit passive DPF product is not applicable to Tier 3 equivalent engines.

- Consult with State and Federal agencies for verification requirements.
- The engine should be maintained and must not consume oil at a rate greater than the rate specified by the engine manufacturer.
- Caterpillar DEO-ULS (Ultra Low Sulfur) 319-2260 oil exceeds the performance requirements of API category CJ-4 oil and is recommended due to a low ash specification. Engine oil that meets or exceeds the specifications in the Caterpillar ECF-3 or API CJ4 categories may be used in these applications. Oil burned during the combustion process accounts for almost all of the DPF ash accumulation (because of oil additives). The use of the recommended low ash oil results in lower ash accumulation in the filter. Failure to use the recommended grade of oil may result in more frequent ash removal service intervals.

3.0 Illustration of the Cat Retrofit DPF Reactor

Applications of the Cat DPF reactor are extremely diverse. Some examples of Cat DPF reactor are shown in the pictures below:



Figure 3.1 – Stationary Installation of a Cat DPF Reactor on a Generator Set



Filter/muffler design
for stationary



4-filter combination with
industrial grade silencing
for stationary



6-filter silencer with critical
grade sound attenuation
for stationary

Throughout the remainder of this document, the terms filter, filter/muffler, and filter/silencer will be used. A Cat DPF is a single or multiple filter element reactor with inlet and outlet connections to attach to exhaust piping. These systems can be manufactured in industrial, critical, and super-critical grade silencing packages.

If lifting eyes are attached to the unit, use all eyes provided when lifting the unit. Always use all mounting feet and beams. Mounts are designed to distribute load evenly throughout the frame; each mount should be in contact with the support structure.



Figure 3.2

The Cat DPF reactor requires a Cat Data Logging and Alarm System (DLAS). The Cat DLAS measures and records exhaust temperature and backpressure. These parameters are essential in determining whether or not the application's duty cycle is acceptable for the filter.

Refer to DLAS Special Instructions UENR4923 for installation and maintenance guidelines.

General Comments

Installation of the Cat DPF reactor requires that the user ensure the entire exhaust system is properly designed before installing parts. Exhaust components such as expansion joints, rain caps, elbows, supports, etc. are critical installation pieces which, if they fail, may compromise emissions reductions as well as damage other components and even the engine. Refer to Application and Installation Guide, LEBW4970 "Exhaust Systems."

READ THROUGH THE ENTIRE MANUAL BEFORE PROCEEDING WITH ACTUAL INSTALLATION.

General Guidelines for Installation:

- If supplied, use all lifting eyes when lifting the filter/muffler or filter/silencer into place.
- If supplied, use all mounting feet when securing the Cat DPF into its operating position.
- Make sure all ports, openings and connections are clear from obstruction.
- Mount unit as close to the engine as possible. Make sure the unit is isolated from engine vibration using an expansion joint or flex connector.
- Use anti-seize on all threaded parts on the exhaust system.
- Use an expansion joint on the outlet of the Cat DPF reactor if piping is constrained downstream of the unit.
- Locate the Cat DLAS controller within 20 feet of the reactor if possible. Extra lengths for control wires can be supplied but are not standard and part of the originally supplied system.
- Ground the Cat DLAS control box. See Cat DLAS manual for complete instructions.
- When tightening fittings, torque to specifications listed in Cat 1E0279 or Caterpillar publication SENR3130 available on SISWEB <https://sis.cat.com/sisweb/sisweb/homepage>. Note: applying more than specified torque to the Cat DPF reactor may damage the filter assembly and affect the warranty.

4.0 Stationary Installation

Lifting of a Filter/Silencer Using Lifting Eyes



Lift using
all available
lifting eyes.

Figure 4.1

All Cat DPF silencers come with lifting eyes. Use all eyes when lifting unit into place.

The DPF silencer comes mounted on temporary shipping brackets and is equipped with lifting eyes. The lifting eyes can be used to remove the unit from the bed of the shipping truck and to install on the support system. When using the lifting eyes to lift the system, use all the provided eyes. The lifting eyes are arranged around the center of gravity and all must be used to lift the unit squarely. Failure to do so could result in accidents, potential injury, and equipment damage. Spreader bars are recommended where applicable.

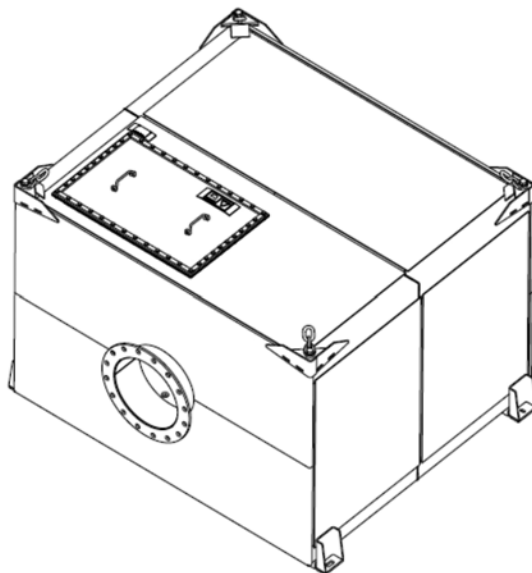


Figure 4.2

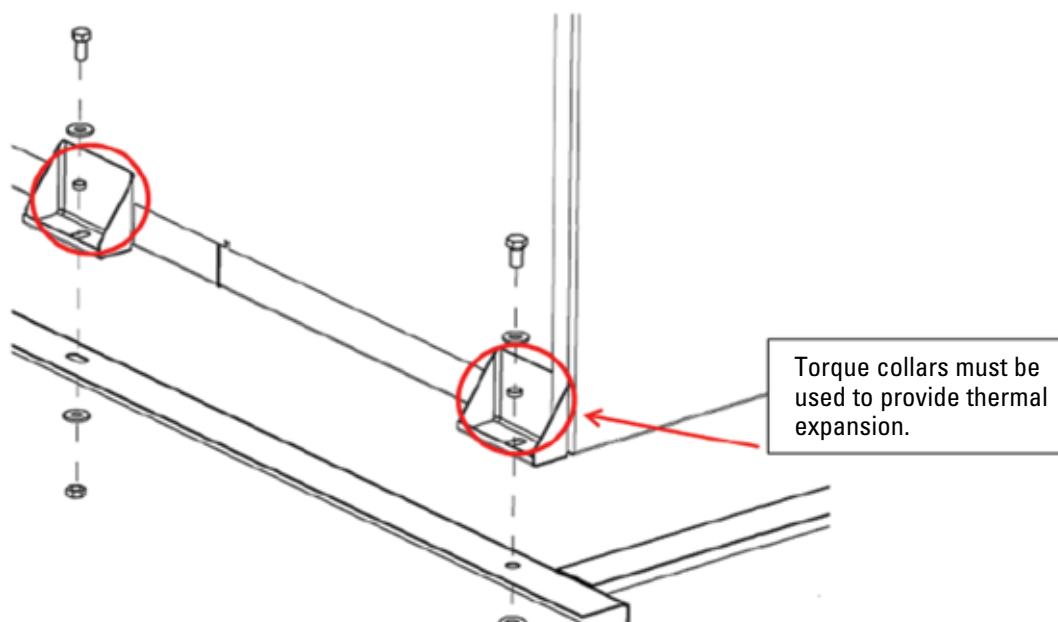
Lifting of a Filter/Silencer Using Forklift**Figure 4.3**

All Cat DPF reactors >75 lbs. will be palletized. Make sure lifting forks are positioned correctly underneath the designed lifting beams in the skids. For long units, side loading may be required. Check with your local Cat dealer for the weight of the DPF silencer. Smaller Cat DPF reactors (<75 lbs.) may be boxed instead of palletized.

Mounting of Filter/Silencers for Stationary Applications**Mounting the DPF Reactor Instructions**

The mounting feet on the DPF reactor unit are slotted with a 7/8" slot running parallel to the short axis of the unit. The mounting that the unit rests on should have (2) drilled (round) holes on the DPF exhaust inlet end only (see below). All other holes on the mounting (frame, posts, etc.) shall be slotted with 7/8" slots running parallel to the long axis of the unit. When the mounting feet are set on the mounting frame, the slots will form a cross. Use of torque collars allows the unit to thermally expand length and width ways.

It is mandatory that all feet are contacting the mounting surface to distribute the load over their entire surface.

**Figure 4.4 – DPF Reactor Mounting Technique**

Bolting the DPF to the pedestal using the mounting feet provided, include 7/8" slotted holes running parallel to the short axis of the unit. The customer-installed mounting platform that the unit rests on should have pre-fabricated 7/8" slotted holes running parallel to the long axis of the unit. When the mounting feet are set on the mounting frame the slots will form a cross. This allows the unit to thermally expand sideways and long ways. Flat washers should be used on both the bottom and top when tightening down the unit. A torque collar or spacer installed between the two flat plains enables the unit to move thermally back and forth or left and right discouraging structural impact on the housing of the SCR system. Both top and bottom must be secured. Secure the top once the bottom has been bolted in place.

For units with 7/8" slots an SAE grade five (5) 5/8" bolt is recommended and torque to $115 \pm 20 \text{ N}\cdot\text{m}$.

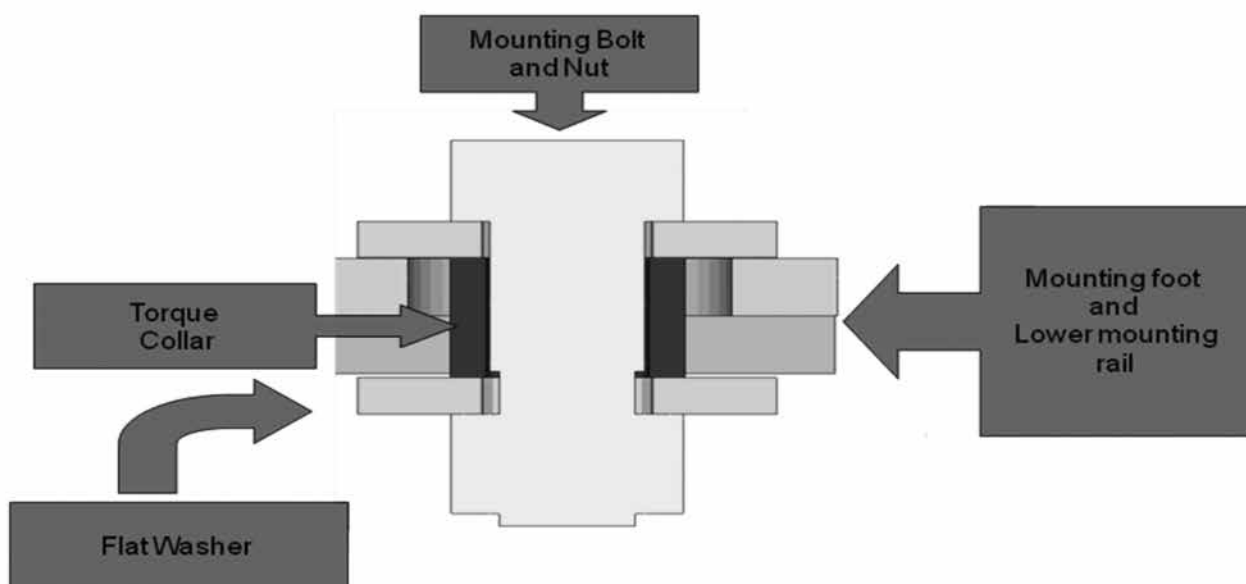


Figure 4.5 – Torque Collar Design

Thermal Expansion

From its cold state, 304L stainless steel will expand 0.3 mm (.0119 in) per 305 mm (1 ft) of DPF reactor length per 50°C (122°F) temperature rise. If not accounted for, the thermal growth can exert undue stress on the engine and SCR connections, as well as the pipe supports.

Note: If DPF is mounted rigid without thermal expansion allowance, weld failures and metal fatigue in the mounting feet and outer shell of the DPF could result in damage to the DPF structure.

Do not weld the DPF mounting brackets to the supporting frame.

										0.82%
										0.75%
										0.69%
										0.59%
										0.49%
										0.39%
										0.30%
										0.20%
										0.10%
27C	77C	127C	177C	227C	277C	327C	377C	427C	477C	

Figure 4.6 – Temperature Rise

Linear Thermal Expansion = for every 50°C temperature rise multiply
SCR system dimension by expansion percentage.

The following table lists the various fasteners required to install and/or service a DPF silencer. The exhaust flanges vary per engine bore size so the required size will depend on the flange used. It is a requirement that high temperature (>600°C) anti-seize compound be used on all exhaust bolts.

DPF Fastener Guide		
Mounting Point	Description	Fastener type/size
A	Lifting Eyes	NA
B	Elongated Base Mounting Brackets	5/8" bolt torque 115 ± 20 N•m
C	Exhaust In Flange	As required by flange bolt size
D	Exhaust Out Flange	As required by flange bolt size
E	Inspection Cover	3/8 x 16 bolt torque 25 N•m ± 4 N•m

Connections to the Exhaust System

The Cat DPF reactor must be isolated from engine vibration. The Cat DPF reactor exhaust inlet and outlet flanges are not designed to handle the significant loads that can come from thermal expansion of piping. Consequently, bellows are required on the inlet connection and are recommended on the outlet connection, especially if a long run of stack piping is required to convey the exhaust out of the building. Install bellows within two stack diameters of the DPF reactor outlet and in the same direction of flow from the outlet. If stack plenum has multiple directional changes, use bellows along each straight section to accommodate thermal expansion.

**Figure 4.7 – Exhaust Bellows Connection**

Exhaust Stack Out Requirements

Not to exceed 300 lbs axial load on top of the exhaust flange. If more weight than this is placed on the top of the reactor, a support must be used on the stack with a bellows installed after the outlet flange. If made of 16 gauge metal, a 24" diameter 19' stack alone will weigh 300 lbs.

For Top-mounted Stacks

Wires must not be used to secure the stack to eliminate a moment on the exhaust flange. Stacks should be supported by a sleeve or roller supports, which will allow the stack to grow under thermal expansion but still prevent any moment being placed on the exhaust flange and outlet wall.

For Side- and End-mounted Stacks

The stack should be supported by a sleeve or roller supports which will allow the stack to grow under thermal expansion while still preventing any moment being generated on the exhaust flange and outlet wall.

Thickness for stacks should be 16 gauge or greater. Height limitation would only be necessary for a backpressure measurement if the stack is supported.

Water Ingress Prevention

The presence of water in the DPF can cause failures such as cracking of the catalyst from freeze/thaw cycles, cracking of catalyst by water causing thermal gradients across the catalyst substrate, and potential for loss of mat retention. Exhaust system outlets must be provided with an appropriate means of preventing snow, rainwater, or sea spray from entering the DPF through the exhaust piping. This can be accomplished by several methods, but must be given careful consideration. The selected method can impose significant restrictions that must be taken into account when calculating system backpressure. One simple method, used primarily with horizontal exhaust pipes, is to angle cut the end of the exhaust pipe with the point at the top.

A common method used with vertical exhaust pipes is to angle the pipe at 45° or 90° from vertical using an appropriate elbow, then angle cutting the pipe end as previously described.

For applications where none of the previous methods are possible, it may be necessary to fit some form of rain cap to the end of the vertical pipe section. This method can provide a positive means of water ingress prevention, but not without imposing a significant backpressure restriction.

Additional information related to exhaust system installation can be found in the Caterpillar publication LEBW4970.

General Requirements Summary

Attention should be given to exhaust gas flow restriction with the following recommendations:

- The exhaust backpressure must not exceed the limits given for each engine family and the Cat DPF installation. Reference TMI System Data or Engine Sales Manual for commercial applications and engine technical specifications.
- The exhaust piping must allow for movement and thermal expansion so that undue stresses are not imposed on the turbocharger structure or exhaust manifold.
- Never allow the turbocharger to support more than allowable loads. Reference TMI System Data or Engine Sales Manual for commercial applications and engine technical specifications.

Backpressure Verification

Excessive backpressure drop in the exhaust system will adversely affect the performance of the engine and the Cat DPF reactor. It is required that the systems meet these criteria for optimal performance. Excessive pressure drops can yield higher than expected exhaust temperatures, lower fuel economy, reduced altitude capability, and less than rated power.

For retrofit DPF reactors it is recommended that exhaust backpressure be measured and recorded prior to installation. Once installed the exhaust backpressure should be measured and recorded for future comparison as an indicator of catalyst performance.

Measuring Backpressure

Exhaust backpressure is measured as the engine is operating under full rated load and speed conditions (high idle for naturally aspirated engines). Either a water manometer or a gauge measuring inches of water may be used.

It is a requirement that high temperature (>600°C) anti-seize compound be used on all exhaust bolts.

Insulation Requirements

It is very important to retain as much heat in the DPF reactor exhaust as possible. The regeneration process of the DPF is more efficient at high exhaust temperatures. Insulate all piping prior to the Cat DPF reactor, as shown below. Check with your local Cat dealer regarding insulation practices related to exhaust system components.

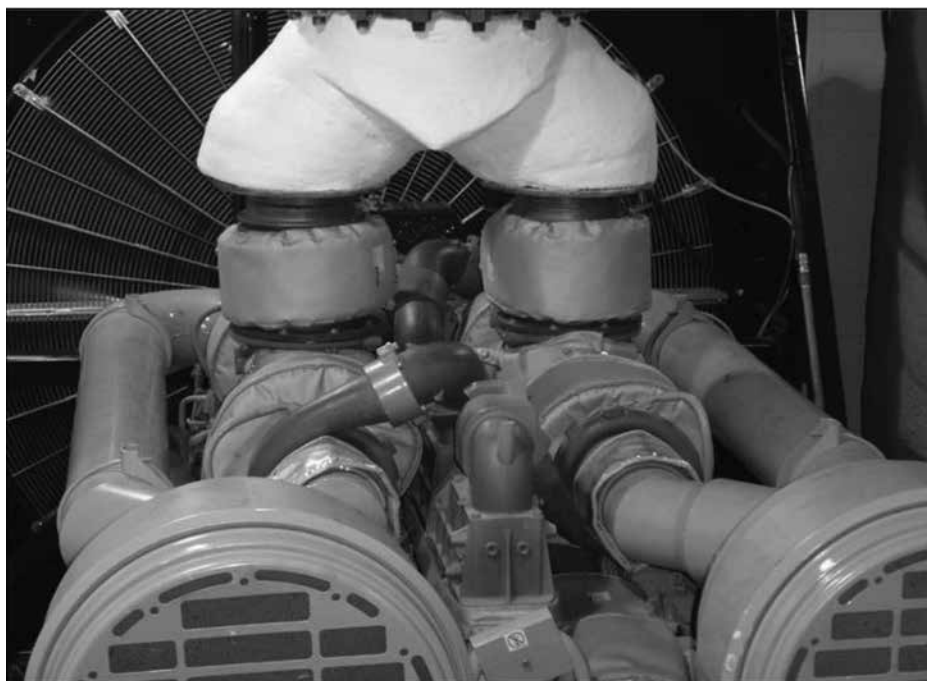


Figure 4.8 – Exhaust Piping Insulation

The DPF reactor skin temperature and/or exhaust gas temperatures are difficult to measure or simulate and are dependent upon many factors including the following: the design and packaging of the DPF reactor, the engine speed/load conditions, the condition of the DPF reactor, and the ambient conditions. Therefore, the potential temperatures are provided as a guideline for safe design of the installation.

Insulation results in an approximate surface temperature of 94°C (200°F) and a non-insulated unit has an approximate skin temperature of 120°C (280°F). The potential temperatures are provided as a guideline for safe design of the installation and proper precautions should be taken to ensure the aftertreatment device is properly shielded and not mounted in close proximity to surrounding components that may be damaged by heat.



Figure 4.9 – Custom Thermal Blanket

If requirements of the installation require a lower surface temperature, optional blankets can be designed that conform to the shape of the DPF reactor and any piping connecting to the reactor. See the example of a custom made insulation blanket.

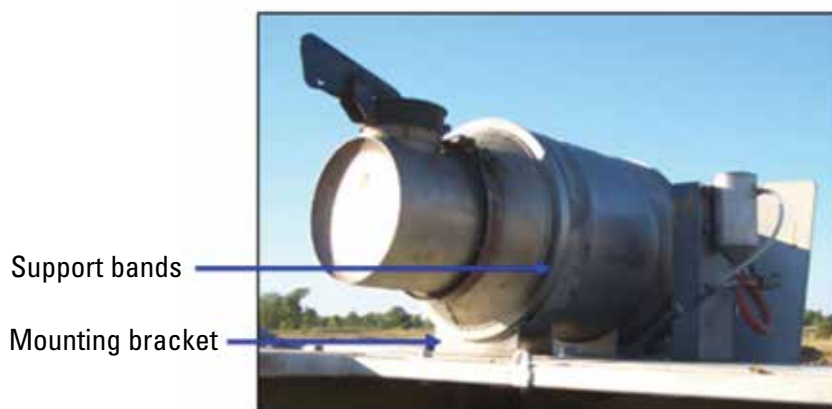
Mounting of Filters and Filter/Mufflers for Stationary Applications

Filters and filter/mufflers have substantial weight and need to be properly supported. Illustrations of some installations are shown below:



Dual filter/muffler on a generator set system is properly supported by the mounting feet.

Cat DLAS condensing can is properly mounted above the sampling port.



Single filter on a generator set system is properly supported by brackets and secured with support bands.

Weight information for Cat DPF reactors is supplied with the units. Design support brackets to handle the weight and vibration loads of the application.

When connecting to the current exhaust system, locate the filter as close to the engine exhaust manifold as possible to retain heat from the engine. In addition, isolate the unit with a flex connector or expansion joint. **CAUTION – DO NOT OVER TIGHTEN SUPPORT BANDS. DEFORMING THE METAL AROUND THE CENTER OF THE FILTER WILL VOID THE WARRANTY.**

For installations where sections of exhaust piping are to be removed to accommodate a Cat DPF reactor, remove the necessary length of pipe accounting for your chosen flex joint on the inlet and outlet. If an existing muffler is going to be kept in the exhaust, then you **MUST** mount the Cat DPF upstream of the muffler. Consult Caterpillar with regard to the designed pressure drop across the filter as you may exceed the engine manufacturer's specification for maximum backpressure. Caterpillar is **NOT** responsible for backpressure resulting from all other components in the exhaust system.

For installations using slip-on connectors, slip the filter inlet over the exhaust pipe until about 2 inches are inside the inlet cone. Secure the filter to your mounting brackets. Insert the exhaust pipe approximately 2 inches into the outlet cone. Once the Cat DPF is in position, tighten all clamps. Check the V-band clamps on the filter for tightness.

Warning: If you are installing the filter vertically, you must contact Caterpillar first to confirm that a vertical installation is acceptable. Take extra care to prevent the filter from slipping down on the exhaust pipe causing contact before the exhaust and the ceramic substrate. Contact will damage the ceramic and void the warranty.

5.0 Appendices

Appendix A

General Operation Guidelines

For Generator Set Installations of the DPF Reactors

1. Ensure the engine operation will adhere to the following guidelines:
 - At least 30% of the operating time the exhaust temperature is above 300°C and the engine load is above 40% or an exhaust gas heater is required.
 - Fuel sulfur content <15 ppm, ULSD
 - Engine PM output of < 0.2 g/bhp-hr
2. Insulate all exhaust components between the turbocharger and DPF inlet. This includes piping, expansion joints, and bellows.
3. Install the monitor/alarm system as it is the key component to ensuring the DPF unit is working as intended and that the filter media is not plugging with particulate matter. This unit records date, time, temperature, and backpressure data, allowing the user a comprehensive understanding of engine duty cycle and DPF performance. Follow the installation instructions carefully. Check the integrity of all plumbing and wiring connections. Once installed, download data, using the optional software, and check that the temperature and backpressure data correspond to engine load output.
4. Heed all warnings that the DLAS kit generates. Solid yellow or red alarms indicate an increase in backpressure and must be investigated. Blinking yellow or red lights indicate a problem with temperature or pressure measurements and require physical checks of the sensors and connections. Data must be collected when an error is generated.
5. The optional software package is required to see real-time data and to retrieve stored data, which can then be transferred into spreadsheet for viewing and graphing. The data includes a history of all errors generated plus 26,000 lines of temperature, backpressure, time, and date values, which equates to approximately 100 hours of operation when the logging interval is set at 15 seconds.
6. Create a schedule for downloading DLAS data and graphing the performance. Backpressure may go up and down but over time should be flat, meaning that particulate is not accumulating on the DPF. If particulates are not accumulating, the DPF is regenerating, or cleaning itself. This is the intended operating state.
7. DO NOT operate the generator after a red alarm is triggered. If the generator must be operated, limit the operating time to as short a duration as possible. Monitor the backpressure during operation using the DLAS software or a pressure gauge. If the backpressure continues to increase, stop the engine as soon as possible, allow the exhaust to cool, and then remove the DPF for cleaning. If the backpressure decreases the engine may continue operation until the backpressure has stabilized.

8. If you must operate at low loads, limit continuous operation at <40% load for under two hours. After two hours but less than four hours, and if no alarms have been triggered, you can regenerate the DPF by operating the engine at 80% to 100% load for 45 minutes or you can remove the DPF and have it cleaned.
9. If you have exceeded four hours of continuous operation at low load, <40% load, the DPF must be removed and cleaned.
10. You may perform a forced regeneration by operating the engine at high load. Make sure that you monitor the Cat data logging system and use the software or use a pressure gauge to keep track of the backpressure. It is possible that once high load is applied to the system, a yellow or even red alarm may trigger. If a red light triggers during a forced regeneration, do not stop the regeneration cycle (this is an exception to #7. We need to set a max allowable pressure, if it is too high, it damages the housing.) Allow the cycle to complete, meaning that backpressure drops to 15 to 20 inches of water and levels off. If after 20 minutes the backpressure does not decrease but instead continually increases even though temperature has leveled, then cease the forced regeneration, allow the exhaust to cool, remove and clean the DPF.
11. If cold starts are required, perform up to twelve 10-minute cold starts. After 12 and up to 24 cold starts with no alarms triggered, you can force regeneration by operating the engine at 80% to 100% load for 45 minutes or you can remove the DPFs and have them cleaned. If choosing to perform a forced regeneration, follow guideline 10.
12. If DPFs accumulate too much particulate and are not cleaned either on-line or off-line, an uncontrolled regeneration may occur, which can melt the filter media. If this occurs, there will be no structural damage to the filter package or to the silencer. However, the DPFs will become compromised and PM will now be visible in the exhaust. If this occurs, the DPFs must be replaced.
13. Non-regeneration does not constitute failure of the DPF. Regeneration is based upon engine operating conditions. Non-regeneration is not a warranty issue.
14. If a DPF should fail and the DLAS kit shows operation during an alarm or error condition, the warranty may be void.
15. If a DPF should fail and the DLAS kit shows no data, the warranty is void.
16. Over time, non-combustible ash may accumulate in the DPF media. Ash is composed mainly of minerals such as calcium, magnesium, and iron that occur in small amounts in lubrication oil. When lube oil is consumed in the combustion process, ash particles are airborne and then trapped in the DPF. Ash will manifest as increased backpressure and cannot be burned off. The DPF must be removed and cleaned. Depending upon the amount of lube oil consumed and the ash content of the oil, ash cleaning will need to be performed between 2500 and 5000 hours of operation. Use historical data to determine, at a 50% load condition, if ash accumulation has added five or more inches of water to clean DPF backpressure. If so, ash has accumulated and the DPF needs to be removed and cleaned.

Appendix B

Standard Caterpillar Inch Torque Specifications

For all torque specifications in this manual consult Caterpillar publication SENR3130 available on SIS Web at: <https://sis.cat.com/sisweb/sisweb/homepage>

Torque table excerpts from 1E0279 follow:

Note: All torque values should be the standard values except for specialty applications.

INCH THREAD SIZE	1E0279A STANDARD			1E0279G HIGH			1E0279E LOW			1E0279C SPECIAL			TENSILE STRESS AREA mm ²
	TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N-m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		
		DES	MIN		DES	MIN		DES	MIN		DES	MIN	
1/4 - 20	12±3	12	10	13±3	13	10	6±1	6	5	14±3	14	11	20.6
5/16 - 18	25±6	20	16	28±7	22	18	13±3	10	8	30±7	24	19	33.6
3/8 - 16	47±9	31	25	50±10	33	27	25±6	16	13	55±10	36	30	50.3
7/16 - 14	70±15	39	32	80±15	45	37	40±8	23	18	85±15	48	39	68.4
1/2 - 13	105±20	52	42	120±20	59	48	60±12	30	24	135±20	66	55	91.6
(9/16 - 12)	160±30	70	57	175±30	77	63	85±15	37	31	190±30	83	68	117
5/8 - 11	215±40	85	69	240±40	94	78	115±20	45	37	270±40	106	87	146
3/4 - 10	370±50	121	100	430±60	141	116	200±40	66	54	475±60	156	128	215
7/8 - 9	620±80	174	143	700±90	197	162	325±40	91	75	750±90	211	173	298
1 - 8	900±100	221	182	1050±150	258	212	500±65	123	101	1150±150	283	232	391
1-1/8 - 7	1300±150	284	233	1450±150	317	260	700±90	153	126	1600±200	350	287	492
1-1/4 - 7	1800±200	354	291	2100±250	413	339	1000±125	197	162	2300±300	453	371	625
1-3/8 - 6	2400±300	430	352	2700±300	483	397	1000±150	233	191	3000±350	537	441	745
1-1/2 - 6	3100±350	509	417	3600±400	591	485	1700±200	279	229	4000±500	656	538	906
() INCLUDED FOR INFORMATION, NOT PREFERRED FOR USE													
*W = T/DK													
WHERE T = TORQUE IN NEWTON METERS													
K = TORQUE COEFFICIENT													
DESIGN CLAMP LOAD, K = 0.16													
MIN CLAMP LOAD, K = 0.195													
*SEE PARAGRAPH 2.5.2 FOR SCATTER OF K.													
D = NOMINAL THREAD DIAMETER IN MILLIMETERS													
W = CLAMP LOAD IN KILONEWTONS													
TENSILE STRESS AREA = 0.7854 (D - 0.9743P) ²													
(PER ASTM A449, P = 25.4/THREADS PER INCH)													

Design and Expected Minimum Clamp Loads For Inch Fasteners

Standard Caterpillar Metric Torque Specifications

METRIC THREAD SIZE	1E0279B STANDARD			1E0279H HIGH			1E0279F LOW			1E0279D SPECIAL			TENSILE STRESS AREA** mm ²
	TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		TORQUE NEWTON METERS N·m	FASTENER CLAMP LOAD* KILO- NEW-TONS kN		
		DES	MIN		DES	MIN		DES	MIN		DES	MIN	
M6 X1	12±3	13	10	13±3	14	11	6±1	6	5	14±3	15	12	20.1
M8 X1.25	28±7	22	18	30±7	23	19	15±3	12	10	35±8	27	22	36.6
M10 X1.5	55±10	34	28	60±12	38	31	30±7	19	15	70±15	44	36	58.0
M12 X1.75	100±20	52	43	105±20	55	45	50±10	26	21	120±20	63	51	84.3
M14 X2	160±30	71	59	175±30	78	64	80±15	36	29	190±30	85	70	115
M16 X2	240±40	94	77	270±40	105	87	125±20	49	40	300±40	117	96	157
M20 X2.5	460±60	144	118	530±70	166	136	250±40	78	64	570±80	178	146	245
M24 X3	800±100	208	171	900±100	234	192	425±50	111	91	1000±125	260	214	353
M30 X3.5	1600±200	333	274	1800±200	375	308	850±100	177	145	2000±250	417	342	561
M36 X4	2700±300	469	385	3100±350	538	442	1500±200	260	214	3400±400	590	484	817
() INCLUDED FOR INFORMATION, NOT PREFERRED FOR USE													
*W=T/DK													
WHERE T= TORQUE IN NEWTON METERS													
K= TORQUE COEFFICIENT													
DESIGN CLAMP LOAD K = 0.16													
MIN CLAMP LOAD K = 0.195													
*SEE PARAGRAPH 2.5.2 FOR SCATTER OF K.													
D = NOMINAL THREAD DIAMETER IN MILLIMETERS													
W = CLAMP LOAD IN KILONEWTONS													
**TENSILE STRESS AREA = 0.7854 (D - .9382P) ²													
(PER ASTM F468M, P = THREAD PITCH)													

Design and Expected Minimum Clamp Loads For Metric Fasteners

Appendix C

DPF Cleaning Records Form

Note: This information must be maintained for warranty purpose.

Record of DPF Cleaning								
Customer Name _____ Initial Install Date _____ Machine Model _____ Machine S/N _____ Machine Fleet Number _____ EIN _____ Filter S/N _____ Filter Part Number _____ Catalyst Module S/N _____ Catalyst Part Number _____ Initial Engine Hours _____ Initial Back Pressure (Specify Units) _____ at FULL Throttle, NO-LOAD Condition.								
Cleaning Date:								
Engine Hours:								
Pre-Bake Weight (kg/lbs): Specify Units								
Post-Bake Weight (kg/lbs): Specify Units								
Weight After Pulsed Air (kg/lbs):								
Pre-Clean Back Pressure: Specify Units								
Post-Clean Back Pressure: Specify Units								
Cleaning Entity:								
Name/Initials of Technician:								

Cleaning the DPF

Because the sections of the DPF are replaceable, a small stock of filter sections can be maintained. Filter sections from a small on-hand stock can be used to replace filters in service at the next scheduled cleaning. The removed filters can be cleaned and returned for installation in the next vehicle. This process of maintaining a stock of filter sections can significantly reduce the amount of downtime that will occur.

Note: Check state and local air pollution regulations pertaining to record keeping of serviced filters. Some governmental entities may require filter tracking.

Wear goggles, gloves, protective clothing, and a National Institute for Occupational Safety and Health (NIOSH) approved P95 or N95 half-face respirator when handling a used DPF or catalytic converter muffler. Failure to do so could result in personal injury.

Note: Perform a backpressure test prior to cleaning the DPF and record the results. After cleaning the DPF, run the engine at high idle for 5 to 15 minutes to bring the engine and exhaust system to operating temperature. Perform another backpressure test and record the results on the DPF cleaning records form.

Recommended Cleaning Procedure

- Weigh and record the filter unit prior to baking
- Controlled baking of the filter unit (see following “Baking Procedure” section)
- Ash cleaning the filter unit using the 319-2189 Filter Cleaning Group
- Weigh and record the filter unit after controlled baking and pulsed air cleaning
- Reference the DPF cleaning records form for proper record keeping

Note: Cleaning DPF units without baking shortens the life of the HEPA filters within the cleaner. The result is a shortened ash service interval because of incomplete soot removal.

Baking Procedure

This procedure will burn off the remaining soot on the DPF leaving a smaller quantity of ash by baking the filter under controlled circumstances. Failure to observe this procedure can result in damage or cracking to the DPF substrate. A commercial programmable oven is required for this procedure. Careful adherence to this procedure is imperative. Deviation from this procedure may lead to thermal shock and cracking of the DPF substrate or melting at high temperatures.

1. Place filter into a programmable commercial oven designed for this purpose. Center the filter as much as possible on a rack with 2 inches of spacing below and above for best results.
2. Program the oven as follows:
 - a. Ramp oven temperature to 200°C (392°F) over 20 minutes.
 - b. Hold oven temperature at 200°C (392°F) for 120 minutes (2 hours).
 - c. Ramp oven temperature to 450°C (842°F) over 30 minutes (.5 hours).
 - d. Hold oven temperature at 450°C (842°F) for 120 minutes (2 hours).
 - e. Cool down to ambient temperature at natural rate within the oven with the doors closed. Do not use fans.
 - f. Place filter in cleaning machine and clean as per machine instructions.
 - g. Replace the filter in oven. Ramp temp to 650°C (1202°F) for 60 minutes (1 hour).
 - h. Hold oven temperature at 650°C (1202° F) for 240 minutes (4 hours).
 - i. Cool to ambient temperature at a natural rate. Do not use fans.

Note: Allow the filter to cool in the oven with the door closed until the filter can be handled with bare hands.

Cleaning Procedure

Ash and soot should be removed from the DPF using the Cat 319-2189 Diesel Particulate Filter Cleaner Gp. Using the cleaner without following baking procedure results in lower efficiency cleaning and will reduce the life of the HEPA filters in the machine. This tool uses pulsed air to flush the ash from the DPF and contains the filter ash through a HEPA filter and bag system. Other methods can release significant quantities of airborne ash and soot which may be considered a hazardous substance by some states. Adapters must be used to mount the DPF units in the machine. The 10.5-inch filter uses the 319-1839 adapter and the 319-1835 cone (medium). The 12-inch DPF uses the 319-1838 adapter with the 319-1836 cone (large).

Note: Other cleaning methods can release significant quantities of airborne ash and soot. Airborne ash and soot should not be inhaled and may be regulated as a hazardous substance by some states.

Cleaned Filter Specification

Note: The following steps determine a properly cleaned Cat filter.

Note: This specification applies to filters that were cleaned of ash only. This specification is only valid subsequent to the “Recommended Cleaning Procedure.” This specification should not be used to determine if soot-filled filters are properly cleaned. All filters must be baked appropriately using the “Recommended Cleaning Procedure” prior to application of this specification.

HEALTH AND SAFETY


WARNING

Wear goggles, gloves, protective clothing, and a National Institute for Occupational Safety and Health (NIOSH) approved P95 or N95 half-face respirator when handling a used DPF or catalytic converter muffler. Failure to do so could result in personal injury.

Adhere to all local health and safety rules and regulations. Use all the personal protective equipment listed below:

- Respirator
- Safety shoes
- Safety glasses
- Latex gloves
- Lab coat

RESOURCES

Necessary equipment:

- 38 cm (15 inch) long by 0.9 mm (0.04 inch) thick stainless steel probe for “200 cpsi” (cells/square inch) filters
- Tape measure

METHOD

Evaluation of a cleaned filter:

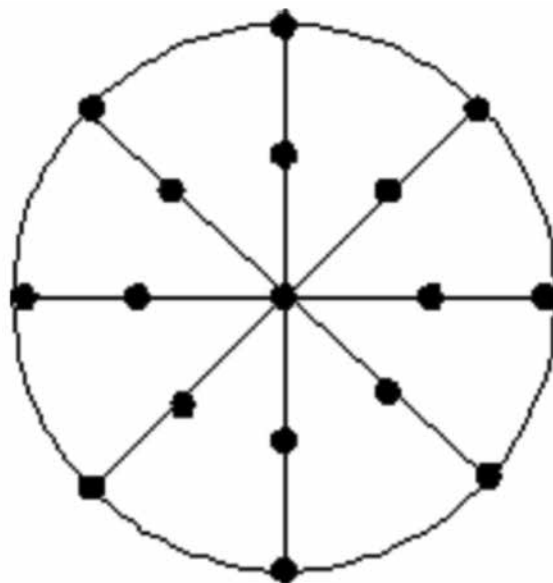
Note: A filter MUST meet all criteria in the section below to be considered clean.

1. Inspect both inlet and outlet surfaces for oil/fuel contamination, gouges and/or cracks. No cracks may be visible. Gouges may not exceed 4.0 mm (0.15 inch) deep.
2. There must be no filter movement within the filter’s banding. This movement is defined as the substrate moving past the bent-over flange. The filter must be even or below the bent-over flange.
3. There must not be any signs of the steel fiber ring coming loose or any mat material (cottony gauze) slipping past the filter.
4. The flanges are not damaged beyond repair.
5. There are no dents deeper than 6.4 mm (0.25 inch) in the outer can of the filter and the outer can is not cracked, torn or otherwise breached.

6. No more than 20 cells are allowed to be damaged (showing soot) on the outlet face of the filter.
7. Inspect the ash depth in the cells using the "Check Cell Depth" instructions below.

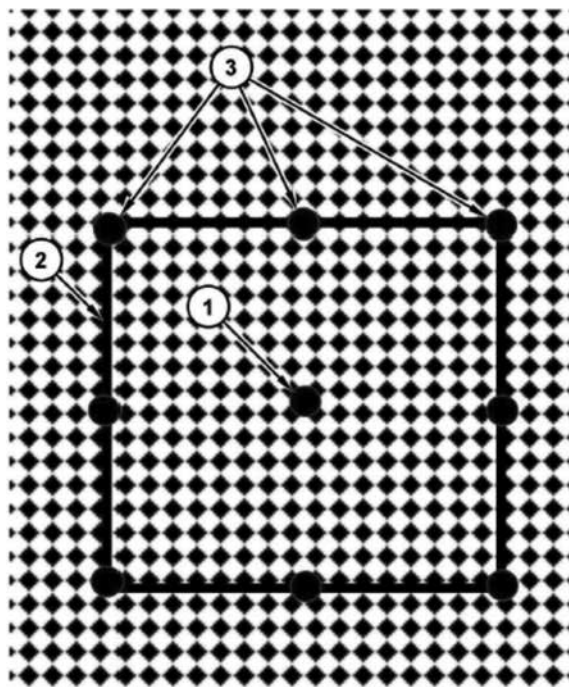
Check Cell Depth

1. Check cell depth by dropping the stainless steel probe into a cell location noted by a dot in the Illustration to the right.
2. Lightly tap the probe with a finger until the probe does not travel into the cell any further. Mark the probe to record the depth.
3. Measure the distance from the tip of the probe which entered the cell to the mark made on the probe. This distance is the cell depth. Repeat this step 17 times per the illustration to the right.
4. If the probe travels a minimum of 28.6 cm (11.25 inch) in all cells, the filter is considered clean.
5. If the probe encounters heavy resistance in one or two cells, proceed to Step 6.

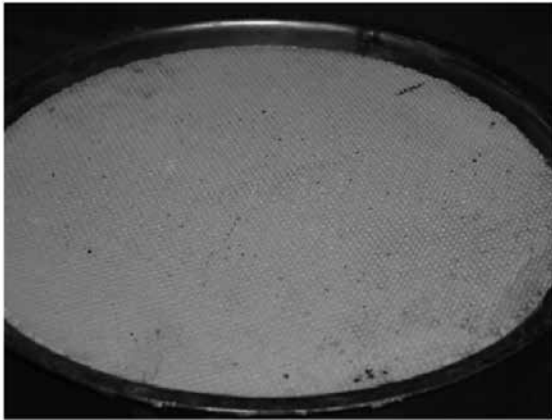


Evaluation of a Filter with Hardened Ash

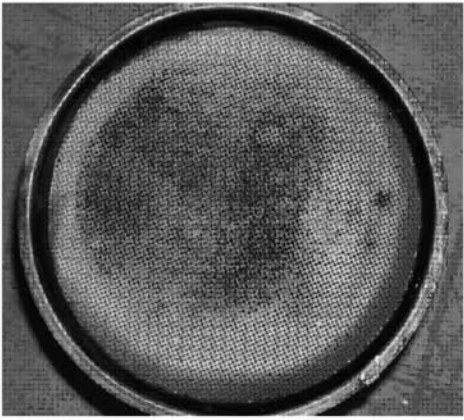
6. Identify the one or two cells (1) where heavy resistance was noted during the cell depth check. Refer to illustration.
7. Draw a 50.8 mm (2 inch) square (2) around cell (1). Refer to illustration.
8. Check cell depth at the eight dot locations (3). Refer to illustration.
9. If the probe encounters heavy resistance in three or more cells, THE FILTER IS NOT CONSIDERED CLEAN. THE FILTER MUST NOT RETURN TO SERVICE UNTIL THE FILTER IS PROPERLY CLEANED.



- (1) Cell
- (2) 50.8 mm (2.0 inch) square
- (3) Dot locations



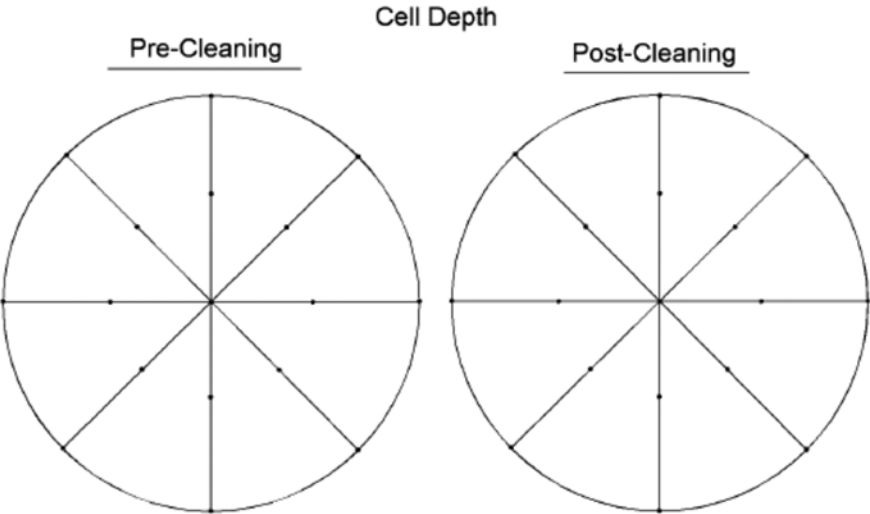
Acceptable filter with less than 20 damaged cells



Unacceptable filter with too many damaged cells

Filter Evaluation Form

Filter Evaluation			
Date Received:		Customer:	
Filter Serial Number:		Filter Model Number:	
Pre-Clean Weight (kg):		Post-Clean Weight (kg):	
Net Ash Removed (Pre-Clean/Post-Clean):		Photos Taken/Location:	
Notes:			



Appendix D

DLAS Installation



The Cat DLAS is a microprocessor based data logger and alarm system. The DLAS will record and monitor exhaust backpressure and temperature. Monitoring the engine exhaust provides information about engine performance as well as the performance of a Cat emissions control device. The Cat DLAS unit will warn the operator of a control device plugging and causing excessive backpressure on the engine. It will track the duty cycle of the engine and allow analysis of operation time, exhaust temperature, and backpressure profiles. Data collected by the Cat DLAS is downloadable.

Cat DLAS can be installed on SCR systems that have DPFs installed and where data logging and alarm are required.

Cat DLAS comes complete with the following components:

1. Control box with mounting bracket, 1/8" pressure nipple, reset button, 2-wire female thermocouple (TC) lead wire plug, Ethernet and USB ports and a 12-pin male harness plug.
2. K-type TC with a 1/4" NPT stainless steel nipple.
3. 20' TC lead wire (standard, longer leads available). 12-pin female wiring harness.
4. LED kit with one (1) yellow LED, one (1) red LED, one (1) green LED and six (6) push-on connectors.
5. Stainless steel flexible hose fitted to low temp PVC hose.
6. 20' long dual 1/8" ID low temperature PVC tubing.
7. Installation and Operation Manual UENR4924.

Read the Cat DLAS Installation and Operation Manual UENR4924 and the Cat DLAS Software Manual before installation. It is an important requirement to install the condensing can above the pressure port on the inlet of the filter.

DPF Installation References – Stationary Engines

- REHS9213 (fka PEXQ1001) – Caterpillar Pre-Installation Compatibility Assessment for Stationary Engines
- REHS9214 (fka PEXQ1002) – Caterpillar Post-Installation Compatibility Assessment for NEW Stationary Engines.
- REHS5606 DPF Special Instructions
- LEWB4970 – Exhaust System Application Design Guide
- UENR4923 DLAS Special Instructions
- UENR4924 DLAS Installation and Operation Manual

Criteria to Authorize a Person or Company to Install Cat DPF Reactor

1. Only specially trained personnel or your Cat dealer is authorized to install Cat DPF reactor.
2. Authorized person or company will have to be familiar with federal, state, and local regulations related to DPF reactor requirements, used DPF, and ash waste disposal.
3. Authorized person or company will have to follow the installation procedure described in this manual (lifting, mounting, flex joint connection, insulating blankets, torque specifications, etc.).
4. Authorized person or company will have to check that engine emissions (PM, HC, CO, NOx) meet engine manufacture specifications before installing Cat DPF reactor. Consult on-line TMI data for Cat engines.
5. Authorized person or company will have to check that engine fuel and oil meet Cat specifications referenced in this manual.
6. Authorized person or company will have to create a commissioning report.
7. Authorized person or company will have to create and maintain a record keeping system for DPF evaluation and cleaning.
8. Authorized person or company will have to adhere to using and retaining information gathered using the Pre/Post Installation Compliance Assessment Inspection checklists.

List of Authorized Installers

Cat dealers are the only authorized installers for the Cat DPF. This global network has the training, expertise, and materials to properly install and support owner's needs.

To locate the nearest dealer, please visit cat.com.

**Caterpillar.
Your Local Resource.
Worldwide.**

Your Cat dealer is prepared to answer any questions you may have about Cat Power Systems, customer support, parts or service capability anywhere in the world. For the name and number of the Cat dealer nearest you, visit our website or contact Caterpillar Inc. World Headquarters in Peoria, Illinois, U.S.A.

World Headquarters:

Caterpillar Inc.

Peoria, Illinois, U.S.A

Tel: (309) 578-6298

Fax: (309) 578-2559

Mailing Address:

Caterpillar Inc.

Industrial Power Systems

P.O. Box 610

Mossville, IL 61552

www.cat-industrial.com

E-mail: cat_power@cat.com

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B-4 CAT DPF Drawings

CATERPILLAR ENGINE DIVISION
TECHNICAL COMMUNICATIONS GROUP

Installation Drawing Index
AutoCAD 2015 Format

Installation Drawing No. 6275669 chg 00

DPF-BOX DESIGN

Attachment pricing arrangements found on drawing:

6168788 chg 00 6168789 chg 00 6233344 chg 00

6275669A.dwf = Top View, Left Side View, Front View, Right Side View, Bottom View of
6168788 CHG 00 Shown (sheet1)

Detail pf Exhaust Inlet/Outlet Flange

Attachments found on this sheet:

6168788 chg 00

6275669B.dwf = Top View, Left Side View, Front View, Right Side View, Bottom View of
6168789 CHG 00 Shown (sheet2)

Detail of Exhaust Inlet/Outlet Flange

Attachments found on this sheet:

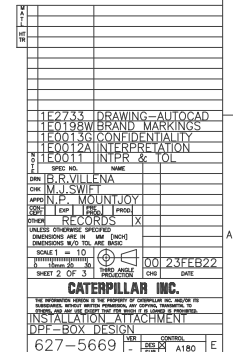
6168789 chg 00

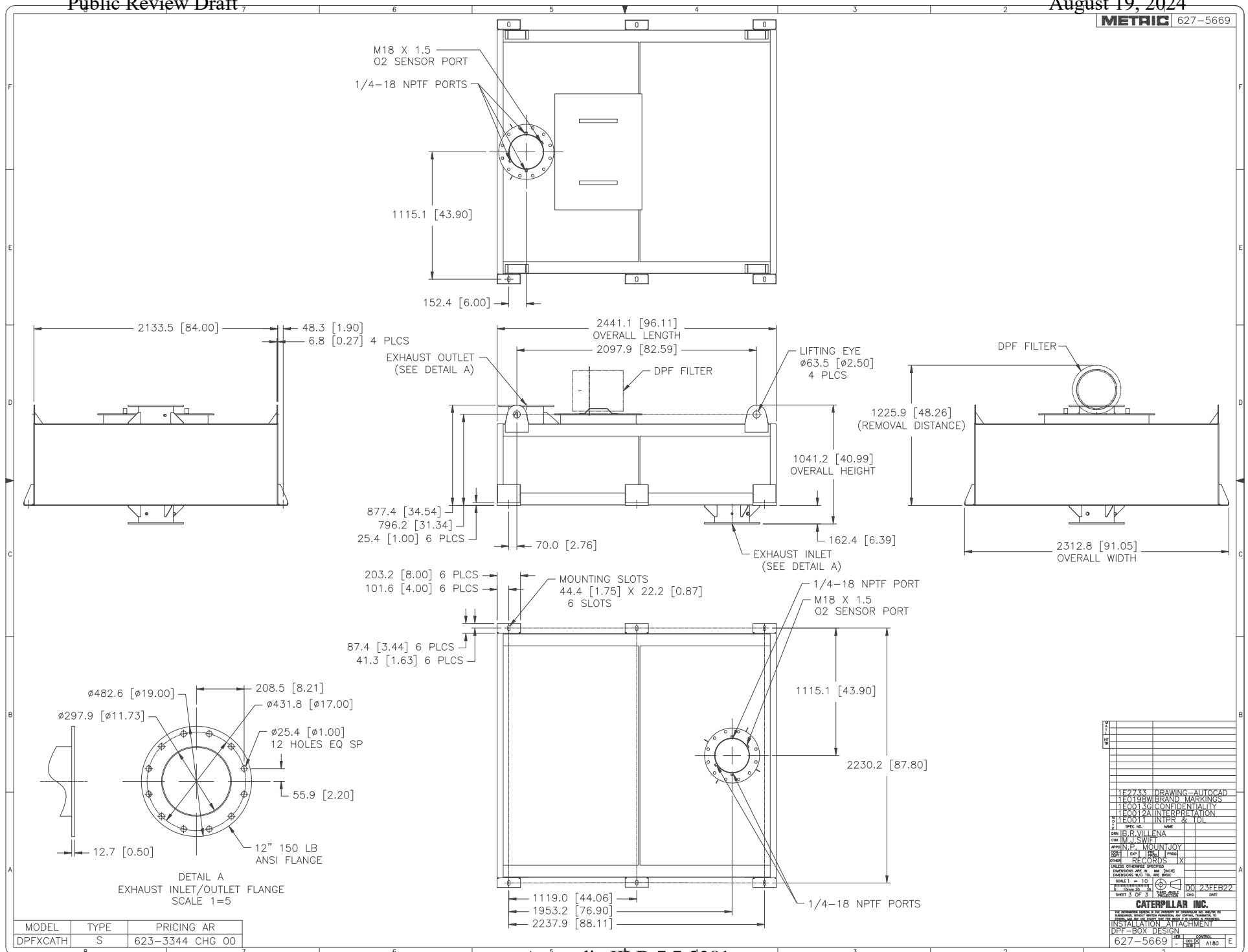
6275669C.dwf = Top View, Left Side View, Front View, Right Side View, Bottom View of
6233344 CHG 00 Shown (sheet3)

Detail of Exhaust Inlet/Outlet Flange

Attachments found on this sheet:

6233344 chg 00

Appendix III.D.7.7-2380





Appendix C

Diesel Particulate Filter Cost Estimate

**Table C-1. Total Capital Investment for DPF on EU 27
University of Alaska Fairbanks Campus**

Total Capital Investment Determination - DPF						Shaded cells indicate user inputs	
Project: UAF PM _{2.5} BACT Analysis - ACEP Engine (EU 27)						Date:	6/12/2023
						Prepared By:	C. Kimball
Capital Costs							
DIRECT COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST	
(1) Purchased equipment and material costs							
(a)	Basic equipment						
	Total DPF System	1	EA	78,210	\$ 78,210		
	(per NC Power Systems)						TOTAL = \$ 78,210
(b)	Instrumentation						
	Total Instrumentation		EA		\$ -	Included in above price	TOTAL = \$ -
(c)	Freight						
	DPF Freight		% MATL COST			FOB Fairbanks included in above price	TOTAL = \$ -
(d)	Labor						
	Labor - offsite fab	0	MH		None required	\$ -	
	Labor - onsite	0	MH		Excluded from estimate	\$ -	TOTAL = \$ -
(e)	Vendor representatives fees						
	Onsite Vendor Representatives fees (enter no. of days and daily rate)	0	Days		Excluded from estimate	\$ -	TOTAL = \$ -
Purchased Equipment and Material Cost (PEMC)						PEMC = \$ 78,210	
Direct Installation Costs (DIC)						DIC = \$ -	
						Excluded from estimate	
Total Direct Costs (TDC)						TDC = (PEMC) + (DIC) = \$ 78,210	
INDIRECT COSTS							
(2)	Engineering, Procurement & Construction Support Services		% TDC		\$ -	Excluded from estimate	
(3)	Performance tests		EA		\$ -	Excluded from estimate	
Total Indirect Costs (TIC)						TIC = \$ -	
MANAGEMENT AND CONTINGENCY COSTS							
(4)	Unit Operator Costs		% TDC		\$ -	Excluded from estimate	
(5)	Contingency		% TDC		\$ -	Excluded from estimate	
Total Management and Contingency Costs (TM&CC)						TM & CC = \$ -	
						Excluded from estimate	
TOTAL CAPITAL INVESTMENT (TCI)						TCI = (TDC)+(TIC)+(TM&CC) = \$ 78,210	

Table C-2. Total Annualized Cost for DPF on EU 27
University of Alaska Fairbanks Campus

Cost Effectiveness Determination - DPF							Shaded cells indicate user inputs
Project: UAF PM _{2.5} BACT Analysis - ACEP Engine (EU 27)							Date: 6/26/2023
							Prepared By: C. Kimball
Annualized Costs							
DIRECT ANNUAL COSTS		QTY	UNIT	UNIT COST	TOTAL MATERIALS COST	TOTAL LABOR COST	TOTAL
(1)	Operating Labor		MH			\$ -	\$ -
(2)	Supervisory Labor		MH			\$ -	\$ -
(3)	Maintenance Labor		MH			\$ -	\$ -
(4)	Maintenance Materials		LOT		\$ -		\$ -
Total Direct Annual Costs (TDAC)		Excluded in this estimate				TDAC =	\$ -
INDIRECT ANNUAL COSTS							
(5)	Overhead		MH		Excluded from estimate	\$ -	\$ -
(6)	Administrative Charges		MH		Excluded from estimate	\$ -	\$ -
(7)	Property tax				Not Applicable		
(8)	Insurance				Excluded from estimate		
(9)	Capital Recovery Factor [see inputs below]	0.1038					
	Capital Recovery					CRF * TCI =	\$ 8,115
Total Indirect Annual Costs (TIAC)						TIAC =	\$ 8,115
TOTAL ANNUALIZED COSTS (TAC)						TAC = (TDAC) + (TIAC) =	\$ 8,115

Data Inputs for Capital Recovery Factor:

Annual Interest Rate (22 June 2023 bank prime rate)	8.25	%
Project Life (EPA OAQPS Control Cost Manual)	20	years
Catalyst Life	N/A	years
Asset Utilization	N/A	%



Office of the Associate Vice Chancellor

University of Alaska Fairbanks, P.O. Box 757380, Fairbanks, Alaska 99775-7380

December 22, 2023

Transmitted Electronically

Mr. Dave Jones

Alaska Department of Environmental Conservation

P.O. Box 111800

Juneau, Alaska 99811

RE: SO₂ Limit Proposal for EU ID 113, Circulating Fluidized Bed Boiler

Mr. Jones:

The University of Alaska Fairbanks (UAF) has reviewed the state's requested to provide an SO₂ limit for EU ID 113 and is submitting a limit of 0.125 lb/MMBTUs. This limit will change the cost effectiveness calculation (\$/ton SO₂ avoided) of the January 2023 BACT analysis. The new calculations are shown in the table below.

Control Technology 0.125 lb/MMBTUs - Emission Rate	Total Capital Investment (\$)	Total Annual Cost (\$/year)	Emissions Reduction (tpy)¹	Cost-Effectiveness (\$/ton SO₂ avoided)
WFGD	\$52,968,345	\$7,589,888	153.7	\$49,365
CDS	\$32,505,815	\$5,757,437	142.4	\$40,426
DSI - Tri-Mer system	\$5,794,396	\$5,193,086	142.4	\$36,463
DSI - BACT, Inc system	\$11,565,826	\$3,121,966	132.7	\$23,525
FBLI - Base Case	~	~	97.1	~

EPA recently released Document EPA-R10-OAR-2022-0115-0380¹, Section 3, page 56, last paragraph which indicates that "EPA's position is that costs per ton in excess of \$14,000 per ton (in 2018 dollars) are feasible and appropriate for Serious nonattainment areas." Although UAF does not agree with EPA's analysis, we are willing to take the above SO₂ limit which almost doubles the cost effectiveness of the DSI – BACT, Inc system. The 0.125 limit will place the cost well beyond the \$14K for all other control technology and UAF believes costs are well above the threshold for implementation of BACT.

¹ <https://www.regulations.gov/document/EPA-R10-OAR-2022-0115-0380>

Operationally, the CFB boiler was designed for campus growth over 25 years (2018 to 2043) which will increase the need for additional heat and power distribution. UAF can safely maintain 0.125 lb/MMBTUs with the current limestone injection system without causing agglomeration problems in the combustor bed. Lower SO₂ emissions would increase limestone injection rates beyond 35 – 40 percent which can cause significant ash agglomeration in the bed and disrupt bed temperature control, and ash removal problems, as well as other potential issues.

UAF, along with the other heat and power facilities use Usibelli coal. Usibelli Coal Mine (UCM) provides, on their [website](#), a data sheet for their coal. The online sulfur average is 0.20 percent with a range of 0.08 - 0.28 percent. UCM also provides analysis for the coal delivered to UAF. Since January 2020, using the analytical reporting from UCM for each shipment of coal, the average sulfur content is 0.129 percent, with the highest SO₂ percent being 0.24 percent and the lowest at 0.07 percent. The average SO₂ emission since 2021 is 0.019 lb/MMBTUs. UAF has exceeded the 0.2 lb/MMBTU emission rate (on a daily average basis), with the highest daily average at 0.564 lb/MMBTUs. These numbers are part of the 30-day average for reporting and did not cause any reportable exceedances. Please note that UAF can accept a new limit of 0.125 lb/MMBTU but only on the basis of the current TVP03 permit requirement of a rolling 30-day average basis.

UAF is willing to accept a 0.125 lb/MMBTUs, but only if the Environmental Protection Agency does not approve the ADEC's SO₂ precursor demonstration. UAF understands that the precursor demonstration is expected to show that the major sources in the non-attainment area are not contributing to the SO₂ exceedances. If this demonstration shows that the major sources are not contributing, then there is no logical reason for UAF to take an SO₂ limit.

If you have questions regarding this letter, please contact Frances Isgrigg (fisgrigg@alaska.edu, 907-590-5809) or Cameron Wohlford (cmwohlford@alaska.edu, 907-474-2627). UAF will be closed from December 25, 2023 to January 3, 2024.

Sincerely,

DocuSigned by:



964509AEDE3C4D0...

Kellie Fritze

Associate Vice Chancellor for Facilities

cc:

Moses Coss, ADEC, Supervisor, Permitting Support

Julie Queen, UAF Vice Chancellor Administrative Services

Cameron Wohlford, UAF, Director of Design and Construction

Frances Isgrigg, UAF, Project Manager, Design and Construction

Russ Steiger, UAF, Environmental Compliance Officer, Environmental, Health, Safety & Risk Management

Kurt Knitter, UAF, Director of Utilities