# REINHOLD ENVIRONMENTAL ®

# 2025 Reinhold/PCUG Round Table Presentation

Hosted by AEP and Buckeye Power

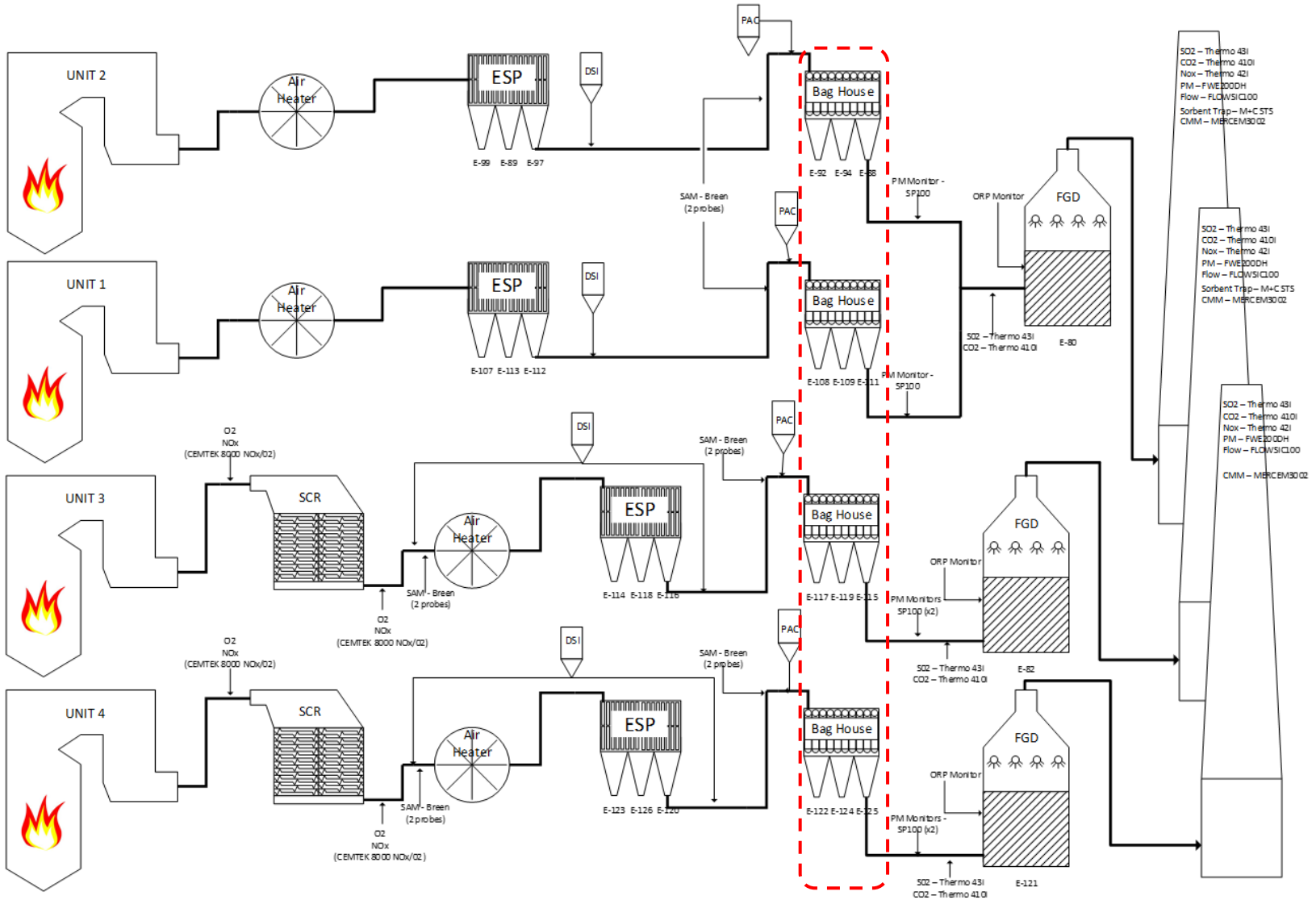
in The Hilton Columbus Polaris Hotel, Columbus, OH

on June 23-24, 2025

# PJFF Troubleshooting and Lessons Learned

Emily Yadon, LG&E Mill Creek Station

# Mill Creek Station

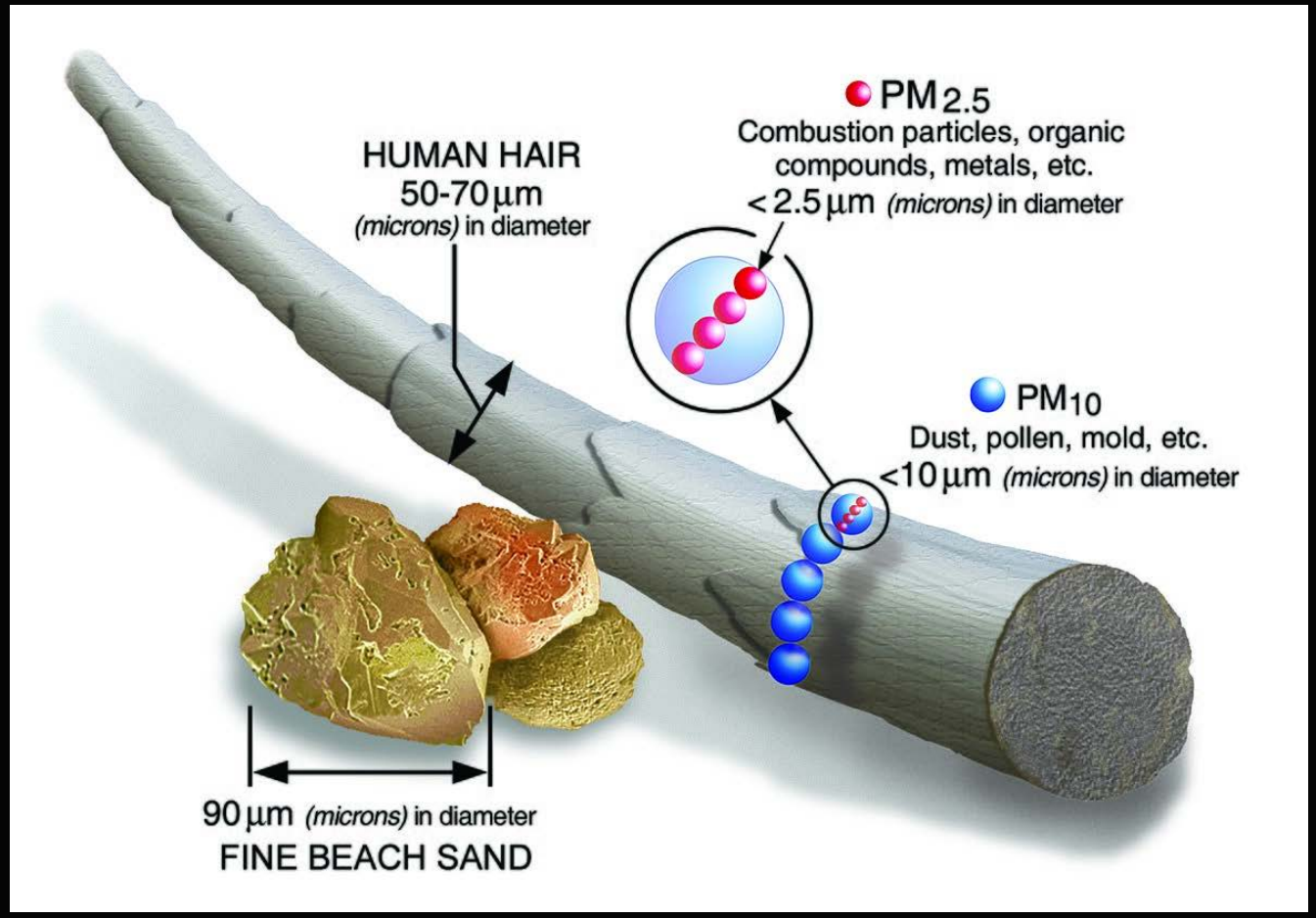


# PJFF Performance: Why It's Important

- EPA regulations
- High Differential Pressure System Impacts
- Air compressor strain

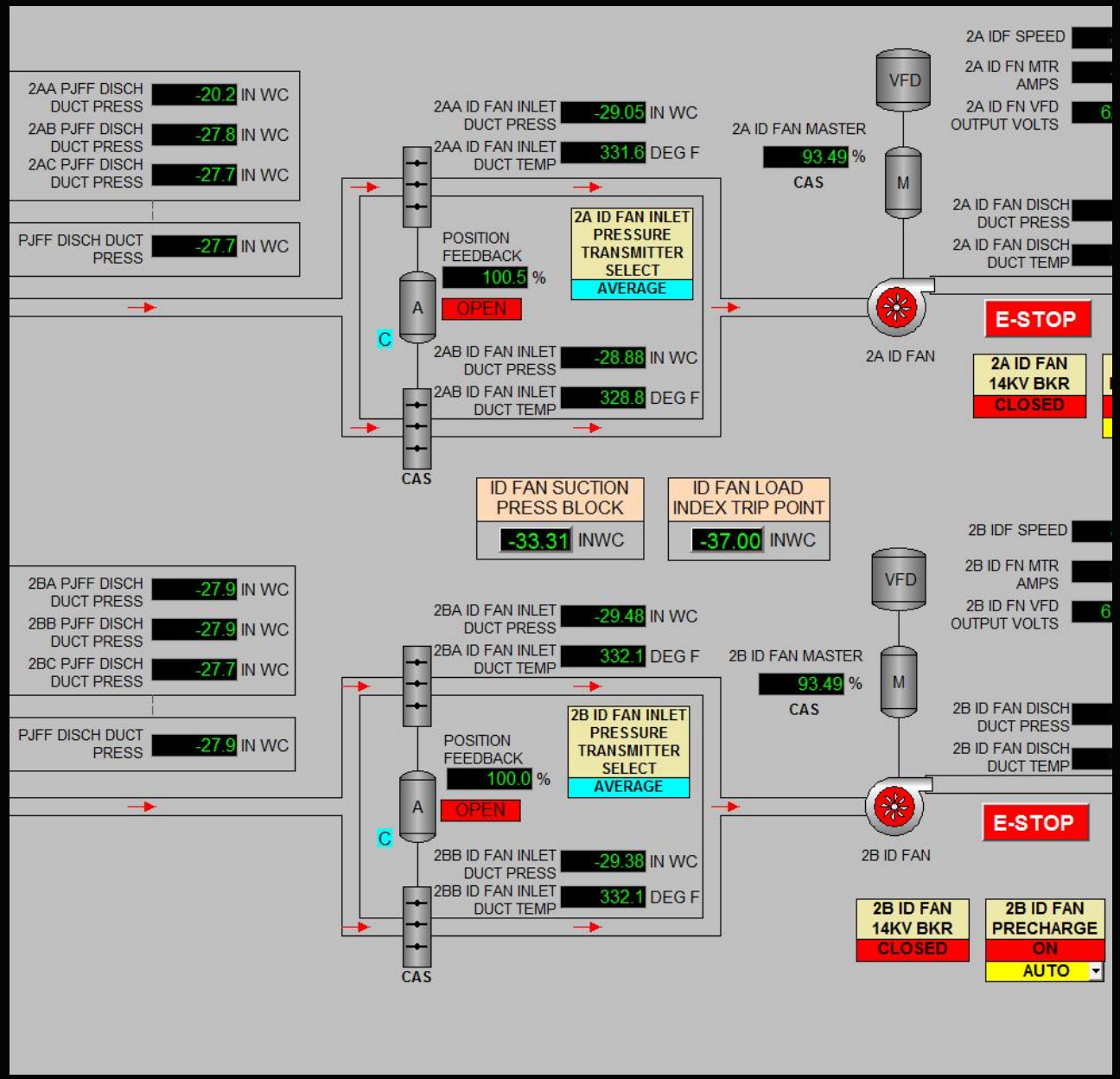
# Environmental Considerations

- Current PM compliance limit: 0.010 lb/MMBTU
- 93% of coal units not slated to retire are able to meet this limit
- PJFFs can help capture SAM and Hg emissions through HL and PAC coatings on bags



# High Differential Pressure Concerns

- ID fan load index trip potential
- Higher aux power usage
- Ash agglomeration causing plugging in ash removal systems
- Leak through causing high PM and/or impacts to FGD performance



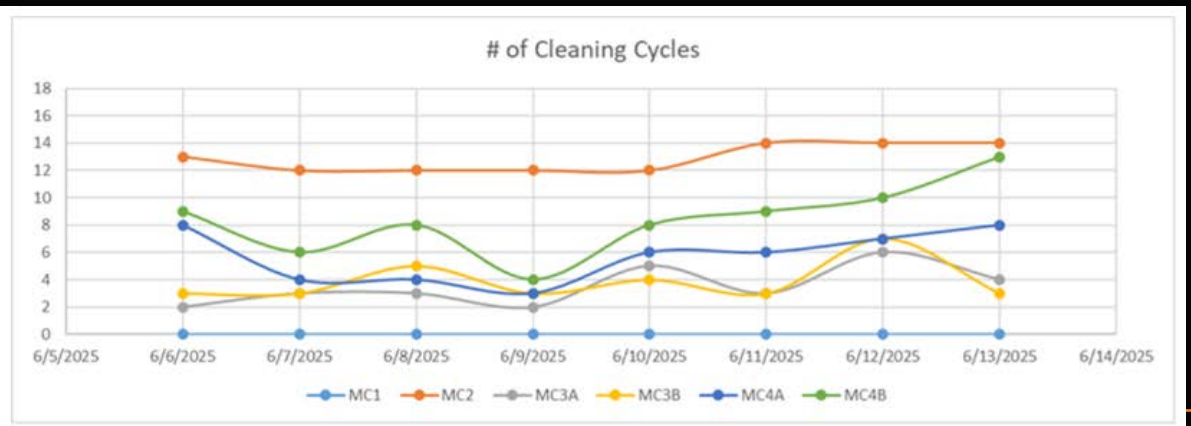
| PJFF Air Compressor Health | | | | |
|---|---|---|---|---|
| | | Hrs Loaded | Air Dewpoint (Deg F) | Dis. Press. |
| 1A | | 0.00 | 4.18 | 90.50 |
| 1B | | 4.24 | -33.60 | |
| 2A | | 7.77 | -19.70 | 90.39 |
| 2B | | 2.77 | -45.64 | |
| 3A | | 24.00 | -114.17 | 98.73 |
| 3B | | 23.74 | -56.72 | |
| 4A | | 24.00 | -102.55 | 99.41 |
| 4B | | 24.00 | -103.10 | |

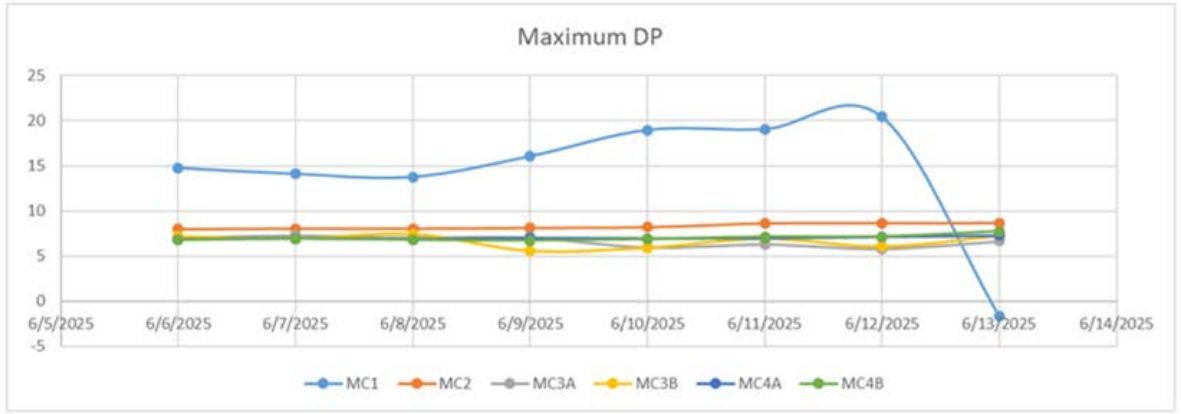
| AQCS Air Compressor Health | | |
|---|---|---|
| | Hrs Loaded | Dis. Press. |
| 1 | 23.90 | 90.59 |
| 2 | 24.00 | |
| 3A | 15.59 | 99.79 |
| 4B | 24.00 | |

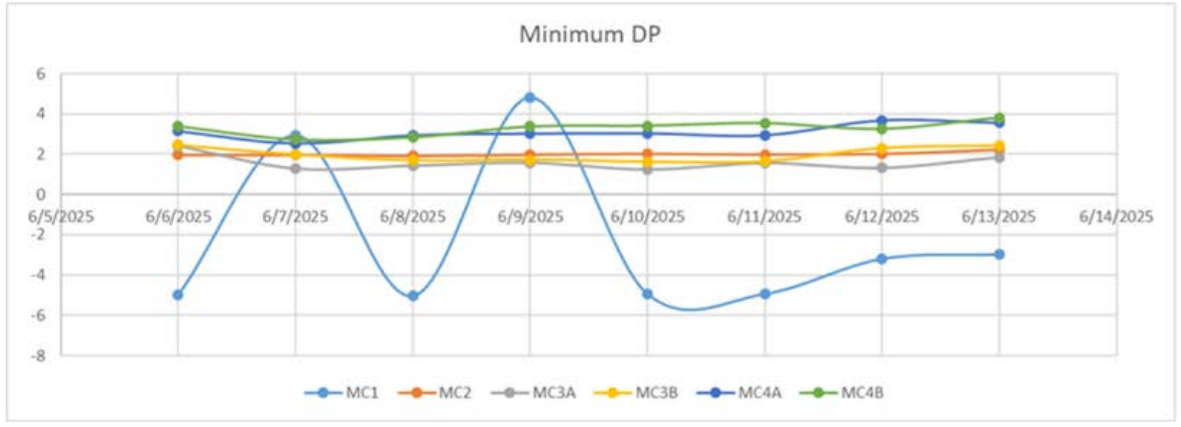
# Air Compressor Health

- Daily reports:
  - Hours loaded
  - Dewpoints
  - Discharge pressures
- Leaks in pulse air headers
- Keep dewpoints below -60 deg F

| Daily PJFF Report<br>6/13/2025 | | | | | |
|---|---|---|---|---|---|
| | Avg Load | Pulse Rate | Differential Pressure | | Clean Air Press |
| | (MW) | | Max. | Min. | (psi) |
| MC1 | -0.01 | 0 | -1.64 | -2.96 | 0.0 |
| MC2 | 259 | 14 | 8.65 | 2.23 | 50.2 |
| MC3A | 362 | 4 | 6.65 | 1.85 | 30.6 |
| MC3B | | 3 | 7.26 | 2.43 | 32.3 |
| MC4A | 442 | 8 | 7.28 | 3.57 | 35.9 |
| MC4B | | 13 | 7.74 | 3.81 | 33.1 |

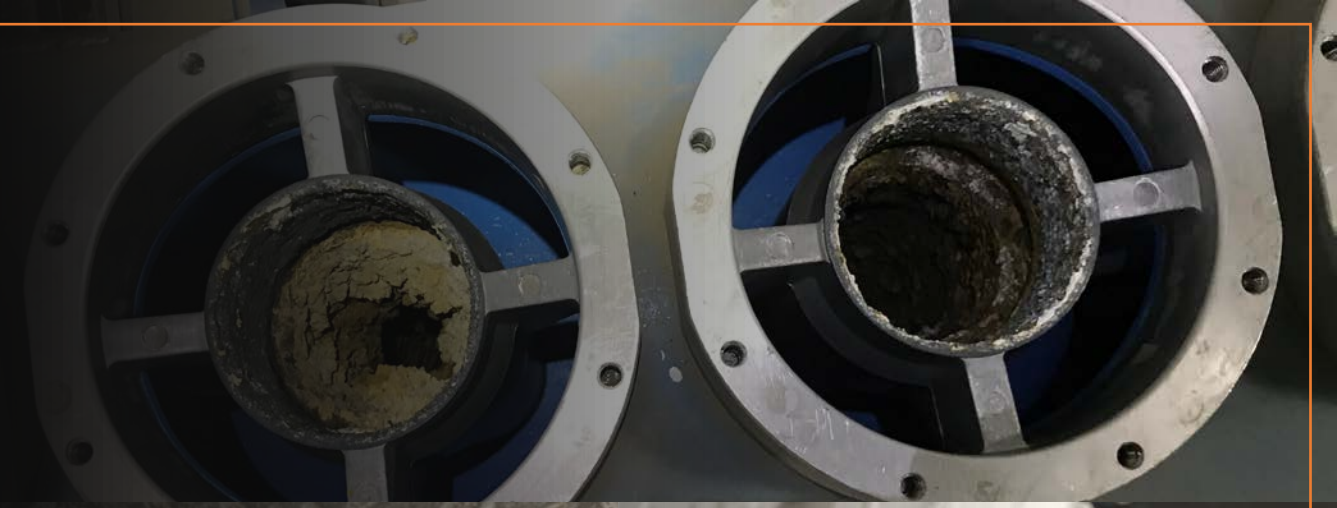


# Pulse Air Headers

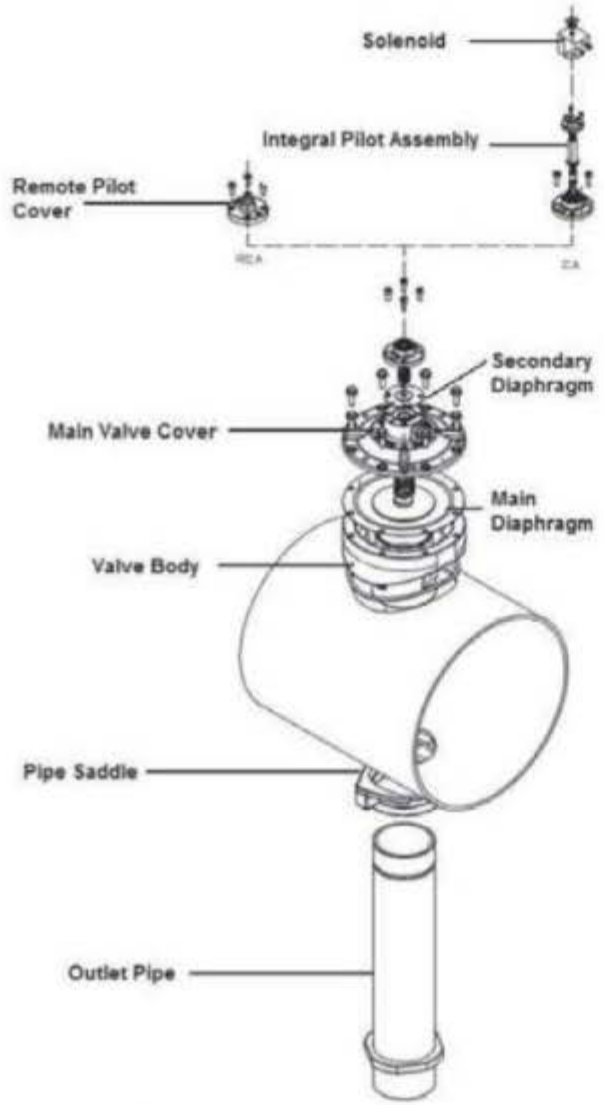
- Ineffective cleaning of bags through:
  - Pluggage from flue gas
  - Hose issues
  - Inadequate air pressure
  - Any moisture in air
  - Diaphragm condition

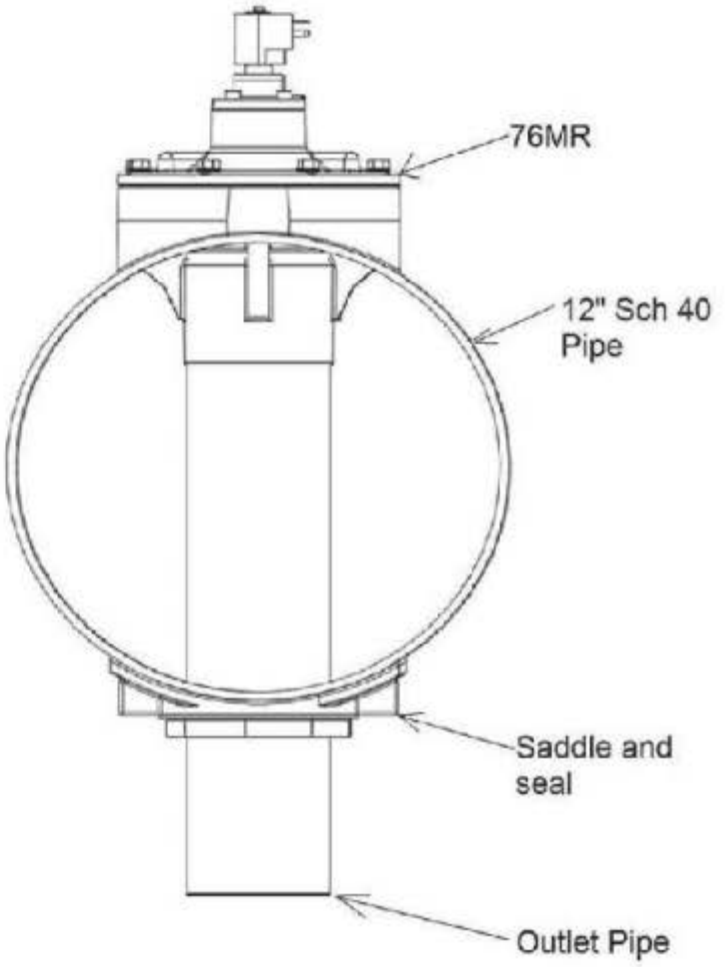


# Pulse Jet Valve 76MR
# Technical Drawing

GOYEN

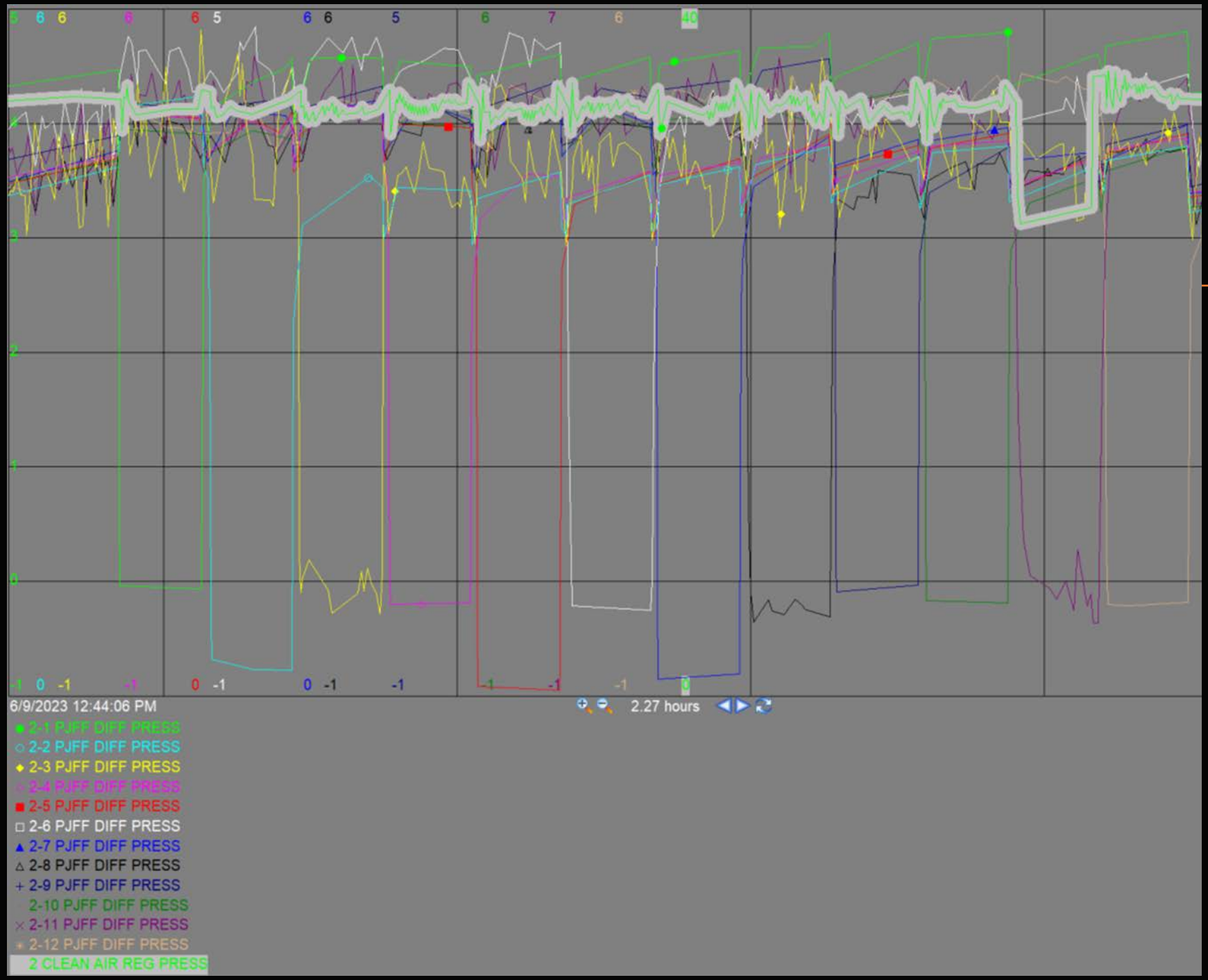
## 3.2 Arrangement Drawings



# Goyen Valve Top Components

- Valve Body
- Diaphragm
- Solenoid


6/9/2023 12:44:06 PM
2.27 hours
2-1 PJFF DIFF PRESS
2-2 PJFF DIFF PRESS
2-3 PJFF DIFF PRESS
2-4 PJFF DIFF PRESS
2-5 PJFF DIFF PRESS
2-6 PJFF DIFF PRESS
2-7 PJFF DIFF PRESS
2-8 PJFF DIFF PRESS
2-9 PJFF DIFF PRESS
2-10 PJFF DIFF PRESS
2-11 PJFF DIFF PRESS
2-12 PJFF DIFF PRESS
2 CLEAN AIR REG PRESS

# Pulse Air Headers

- Multiple actions taken:
  - Installing an insert- unsuccessful
  - Replacing valves one at a time
  - Added actuators to tanks
  - Replaced valve seats
  - Replaced check valves
  - Added insulation
- Entire header replacement from OEM is costly (new valves and header): $36k per header

Replaced check valves with 0.062”
pressure washer nozzle orifices


DISTANCE
1.8 ft
LeakQ Scale
2
06/07/2022 8:30 AM
Default
42 dB


SONIC INDUSTRIAL IMAGER
DISTANCE
2.3 ft
LeakQ Scale
3
LUKE
06/07/2022 8:32 AM
Default

# Pulse Air Headers

- Hoses have collapsed and failed due to vacuum

# Pulse Pipe Build-up

- Have had to clean due to buildup
- Checking during sampling or changeouts is essential

# Pulse Pipe Holes

- Ensure holes have not elongated
- Circular hole pattern

# Moisture Issues

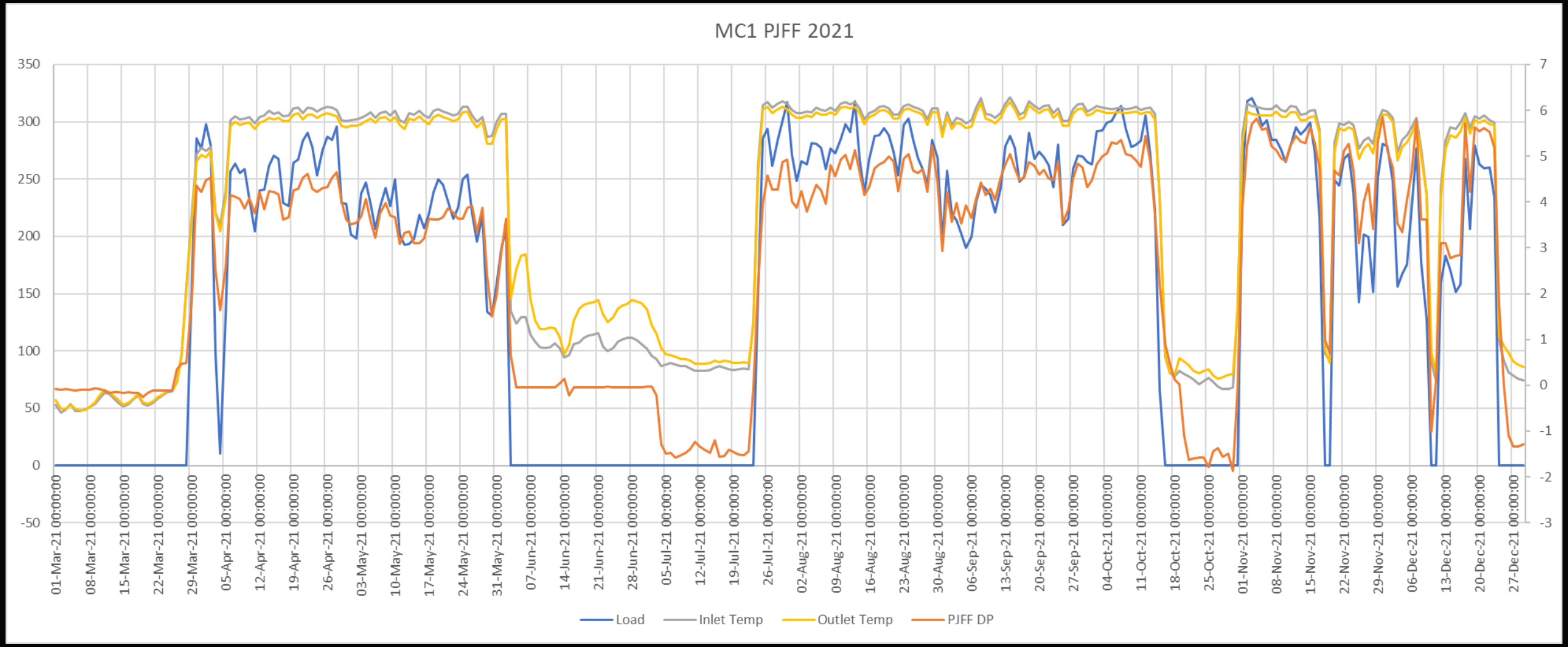
- Holes in ductwork or other process areas lead to moisture issues
  - Will also cause increased air flow to PJFF
- Process upsets can cause issues
- Operating temps above 300 deg F

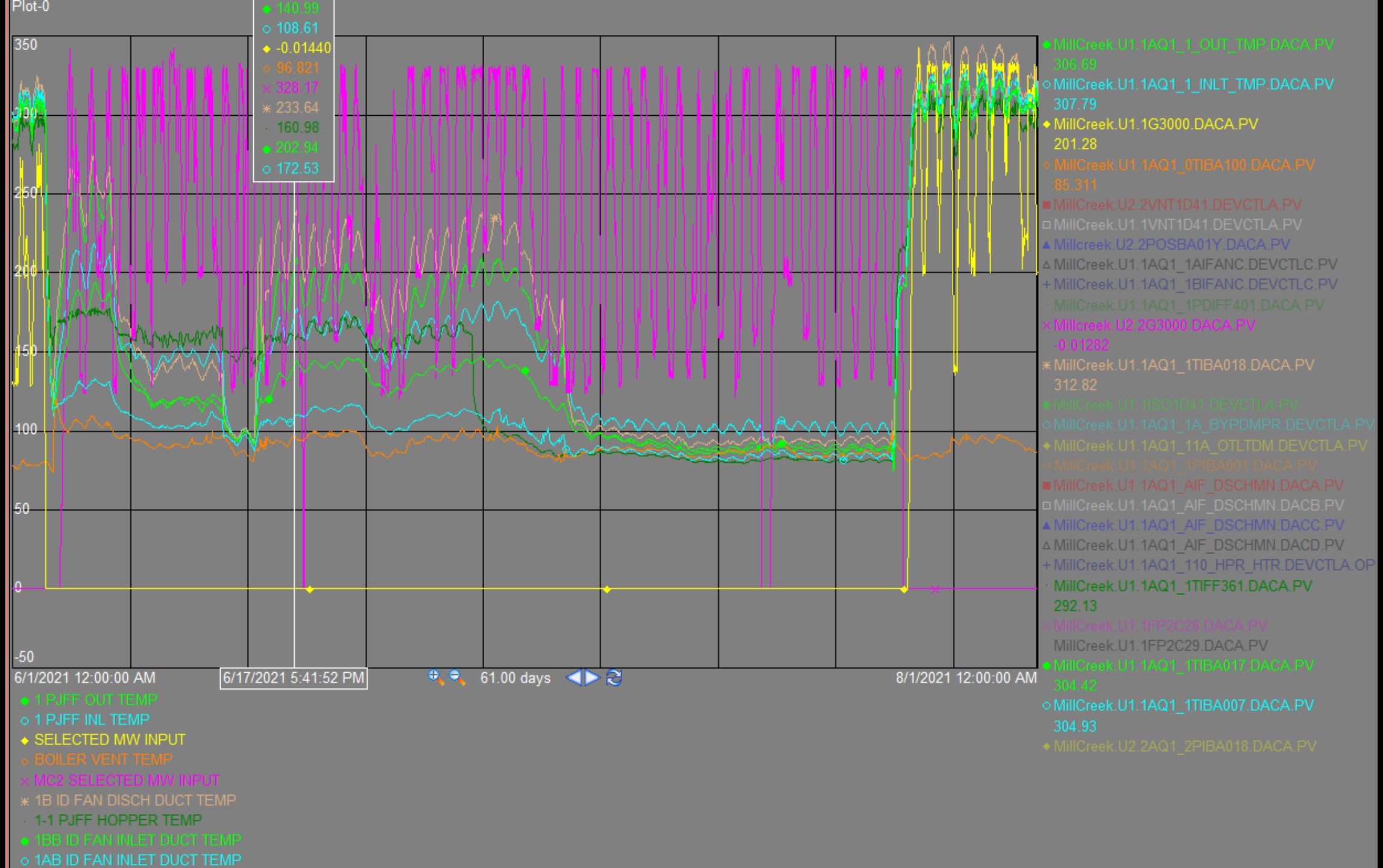
# Unit 1 High Differential Pressure Issues

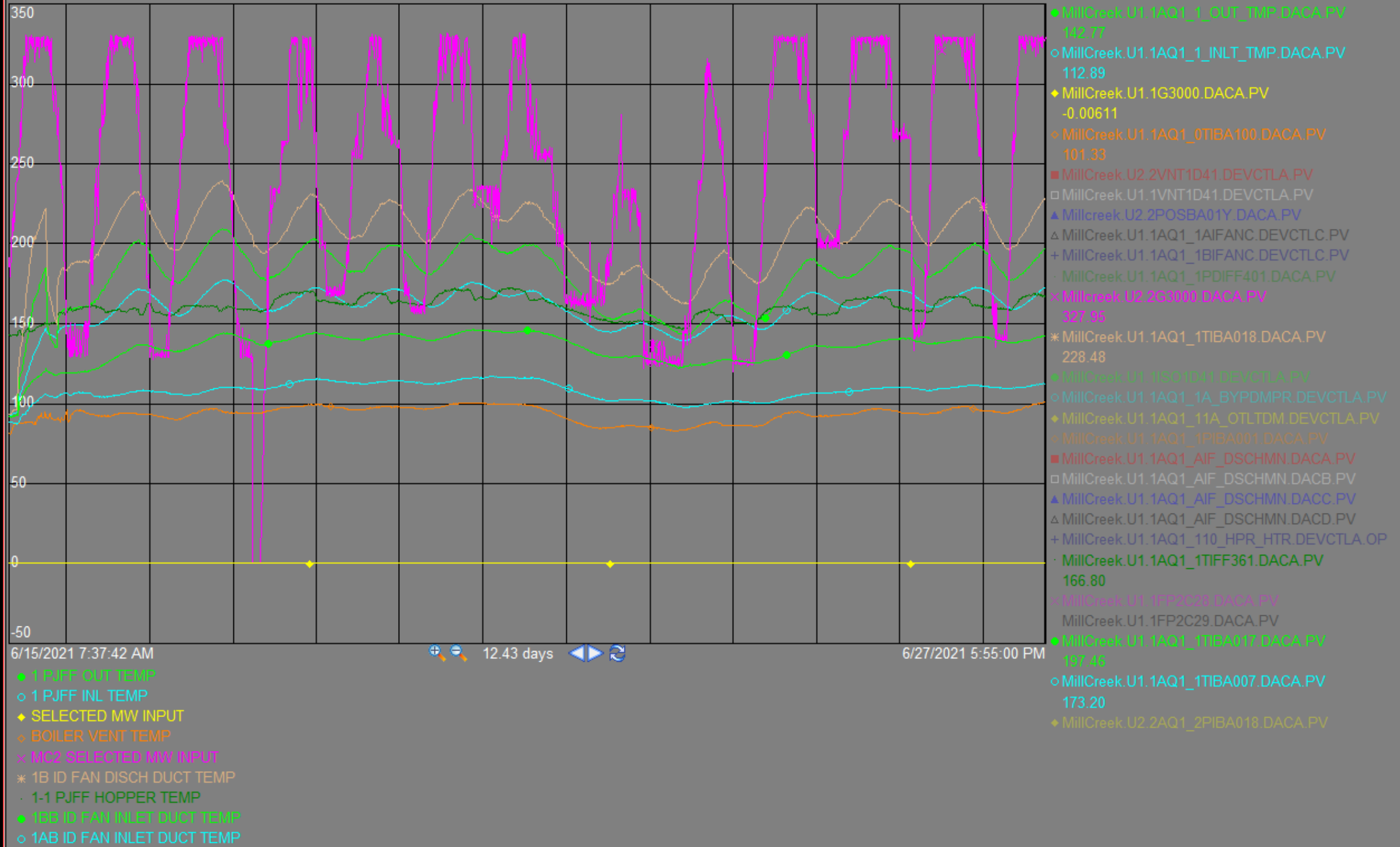
- Changed bags March 2021
- Unit 1 online (3/25/21 - 6/3/21)
- Unit 1 offline (6/3/21 - 7/24/21)
- DP started to creep up
- ID fan load index alarms by November 2021

# Unit 1 High Differential Pressure Issues

- Started Investigating:
  - Were bags introduced to moisture in any way?
  - Not precoated correctly?
  - Abnormal operating temps?
  - Was pulse air working correctly?
  - Air-in leakage/more gas flow?
    - Combustion/Air heater
  - Verified specs/quality of new bags with supplier and third-party testing


MC1 PJFF 2021
350
300
250
200
150
100
50
0
-50
7
6
5
4
3
2
1
0
-1
-2
-3
01-Mar-21 00:00:00
08-Mar-21 00:00:00
15-Mar-21 00:00:00
22-Mar-21 00:00:00
29-Mar-21 00:00:00
05-Apr-21 00:00:00
12-Apr-21 00:00:00
19-Apr-21 00:00:00
26-Apr-21 00:00:00
03-May-21 00:00:00
10-May-21 00:00:00
17-May-21 00:00:00
24-May-21 00:00:00
31-May-21 00:00:00
07-Jun-21 00:00:00
14-Jun-21 00:00:00
21-Jun-21 00:00:00
28-Jun-21 00:00:00
05-Jul-21 00:00:00
12-Jul-21 00:00:00
19-Jul-21 00:00:00
26-Jul-21 00:00:00
02-Aug-21 00:00:00
09-Aug-21 00:00:00
16-Aug-21 00:00:00
23-Aug-21 00:00:00
30-Aug-21 00:00:00
06-Sep-21 00:00:00
13-Sep-21 00:00:00
20-Sep-21 00:00:00
27-Sep-21 00:00:00
04-Oct-21 00:00:00
11-Oct-21 00:00:00
18-Oct-21 00:00:00
25-Oct-21 00:00:00
01-Nov-21 00:00:00
08-Nov-21 00:00:00
15-Nov-21 00:00:00
22-Nov-21 00:00:00
29-Nov-21 00:00:00
06-Dec-21 00:00:00
13-Dec-21 00:00:00
20-Dec-21 00:00:00
27-Dec-21 00:00:00
Load
Inlet Temp
Outlet Temp
PJFF DP


Plot-0
140.99
108.61
-0.01440
96.821
328.17
233.64
160.98
202.94
172.53
350
300
250
200
150
100
50
0
-50
6/1/2021 12:00:00 AM
6/17/2021 5:41:52 PM
61.00 days
8/1/2021 12:00:00 AM
MillCreek.U1.1AQ1_1_OUT_TMP.DACA.PV
306.69
MillCreek.U1.1AQ1_1_INLT_TMP.DACA.PV
307.79
MillCreek.U1.1G3000.DACA.PV
201.28
MillCreek.U1.1AQ1_0TIBA100.DACA.PV
85.311
MillCreek.U2.2VNT1D41.DEVCTLA.PV
MillCreek.U1.1VNT1D41.DEVCTLA.PV
Millcreek.U2.2POSBA01Y.DACA.PV
MillCreek.U1.1AQ1_1AIFANC.DEVCTLC.PV
MillCreek.U1.1AQ1_1BIFANC.DEVCTLC.PV
MillCreek.U1.1AQ1_1PDIFF401.DACA.PV
Millcreek.U2.2G3000.DACA.PV
-0.01282
MillCreek.U1.1AQ1_1TIBA018.DACA.PV
312.82
MillCreek.U1.1ISO1D41.DEVCTLA.PV
MillCreek.U1.1AQ1_1A_BYPDMPR.DEVCTLA.PV
MillCreek.U1.1AQ1_11A_OTLTDM.DEVCTLA.PV
MillCreek.U1.1AQ1_1PIBA001.DACA.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACA.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACB.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACC.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACD.PV
MillCreek.U1.1AQ1_110_HPR_HTR.DEVCTLA.OP
MillCreek.U1.1AQ1_1TIFF361.DACA.PV
292.13
MillCreek.U1.1FP2C28.DACA.PV
MillCreek.U1.1FP2C29.DACA.PV
MillCreek.U1.1AQ1_1TIBA017.DACA.PV
304.42
MillCreek.U1.1AQ1_1TIBA007.DACA.PV
304.93
MillCreek.U2.2AQ1_2PIBA018.DACA.PV
1 PJFF OUT TEMP
1 PJFF INL TEMP
SELECTED MW INPUT
BOILER VENT TEMP
MC2 SELECTED MW INPUT
1B ID FAN DISCH DUCT TEMP
1-1 PJFF HOPPER TEMP
1BB ID FAN INLET DUCT TEMP
1AB ID FAN INLET DUCT TEMP


350
300
250
200
150
100
50
0
-50
6/15/2021 7:37:42 AM
12.43 days
6/27/2021 5:55:00 PM
1 PJFF OUT TEMP
1 PJFF INL TEMP
SELECTED MW INPUT
BOILER VENT TEMP
MC2 SELECTED MW INPUT
1B ID FAN DISCH DUCT TEMP
1-1 PJFF HOPPER TEMP
1BB ID FAN INLET DUCT TEMP
1AB ID FAN INLET DUCT TEMP
MillCreek.U1.1AQ1_1_OUT_TMP.DACA.PV
142.77
MillCreek.U1.1AQ1_1_INLT_TMP.DACA.PV
112.89
MillCreek.U1.1G3000.DACA.PV
-0.00611
MillCreek.U1.1AQ1_0TIBA100.DACA.PV
101.33
MillCreek.U2.2VNT1D41.DEVCTLA.PV
MillCreek.U1.1VNT1D41.DEVCTLA.PV
Millcreek.U2.2POSBA01Y.DACA.PV
MillCreek.U1.1AQ1_1AIFANC.DEVCTLC.PV
MillCreek.U1.1AQ1_1BIFANC.DEVCTLC.PV
MillCreek.U1.1AQ1_1PDIFF401.DACA.PV
Millcreek.U2.2G3000.DACA.PV
327.95
MillCreek.U1.1AQ1_1TIBA018.DACA.PV
228.48
MillCreek.U1.1ISOND41.DEVCTLA.PV
MillCreek.U1.1AQ1_1A_BYPDMPR.DEVCTLA.PV
MillCreek.U1.1AQ1_11A_OTLTDM.DEVCTLA.PV
MillCreek.U1.1AQ1_1PIBA001.DACA.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACA.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACB.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACC.PV
MillCreek.U1.1AQ1_AIF_DSCHMN.DACD.PV
MillCreek.U1.1AQ1_110_HPR_HTR.DEVCTLA.OP
MillCreek.U1.1AQ1_1TIFF361.DACA.PV
166.80
MillCreek.U1.1FP2C28.DACA.PV
MillCreek.U1.1FP2C29.DACA.PV
MillCreek.U1.1AQ1_1TIBA017.DACA.PV
197.46
MillCreek.U1.1AQ1_1TIBA007.DACA.PV
173.20
MillCreek.U2.2AQ1_2PIBA018.DACA.PV

# Root cause: leaking FGD isolation damper

- Flue gas leakage
- Permeability and bag performance impacts


APPEARANCE OF THE NON-COLLECTION SIDE (BOTTOM DISC)

APPEARANCE OF RUST PARTICLES IN BAG BOTTOM (NON-COLLECTION SIDE)

# TABLE 1
## SUMMARY OF FABRIC TEST RESULTS

| ETS I.D. | BAG I.D. | PERMEABILITY – FPM AS REC'D | PERMEABILITY – FPM AFTER 10" VAC | PERMEABILITY – FPM AFTER 30" VAC | PERMEABILITY – FPM AFTER WASH | MULLEN BURST PSI | TENSILE LBS/INCH WARP | TENSILE LBS/INCH FILL | MIT FLEX # FLEXES WARP | MIT FLEX # FLEXES FILL | FABRIC WEIGHT OZ/YD² AS REC'D | FABRIC WEIGHT OZ/YD² AFTER 30" VAC | FABRIC WEIGHT OZ/YD² AFTER WASH | FABRIC/ DUST pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29529CB | New Bag #1 | 7.1 | - | - | - | 1200 | 356 | 502 | 10000 | 10000 | 23.4 | - | - | - |
| % Retention | | 113 | - | - | - | 100 | 62 | 82 | 100 | 100 | 102 | - | - | - |
| 29530CB | Brand New Bag #2 | 6.3 | - | - | - | 1200 | 492 | 581 | 10000 | 10000 | 22.1 | - | - | - |
| % Retention | | 101 | - | - | - | 100 | 85 | 95 | 100 | 100 | 96 | - | - | - |
| 29531DB | MC1-11-4-N16 | 3.8 | 4.4 | 5.5 | - | 983 | 441 | 523 | 10000 | 10000 | - | 23.3 | - | - |
| % Retention | | 61 | 70 | 88 | - | 82 | 76 | 86 | 100 | 100 | - | 102 | - | - |
| 29532DB | MC1-7-9-C10 | 3.8 | 4.0 | 5.0 | - | 1057 | 464 | 577 | 10000 | 10000 | - | 24.1 | - | - |
| % Retention | | 61 | 64 | 79 | - | 88 | 80 | 95 | 100 | 100 | - | 105 | - | - |
| 29533DB | MC1-12-2-L8 | 4.3 | 4.7 | 5.4 | - | 995 | 385 | 544 | 10000 | 10000 | - | 23.4 | - | - |
| % Retention | | 69 | 74 | 86 | - | 83 | 67 | 89 | 100 | 100 | - | 102 | - | - |
| 29534DB | MC1-6-15-D19 | 4.0 | 5.1 | 6.6 | - | 1050 | 407 | 620 | 10000 | 9277 | - | 23.8 | - | - |
| % Retention | | 64 | 81 | 105 | - | 88 | 71 | 102 | 100 | 93 | - | 104 | - | - |
| 29535DB | MC1-2-22-D6 | 2.8 | 4.0 | 4.1 | 5.9 | 815 | 311 | 462 | 7674 | 5446 | 37.8 | 25.4 | 23.6 | 2.65 |
| % Retention | | 45 | 63 | 66 | 93 | 68 | 54 | 76 | 77 | 54 | 165 | 111 | 103 | - |
| 29536DB | MC1-1-24-P22 | 3.8 | 4.8 | 4.9 | 6.1 | 955 | 405 | 547 | 9774 | 8964 | 29.7 | 24.3 | 23.8 | 2.81 |
| % Retention | | 61 | 76 | 77 | 97 | 80 | 70 | 90 | 98 | 90 | 130 | 106 | 104 | - |
| *New Fabric Values^* | *N/A* | *6.3* | - | - | | *1197* | *577* | *610* | *10000+* | *10000+* | | *22.9* | | |

%Retention = (Old Value/New Value)*100

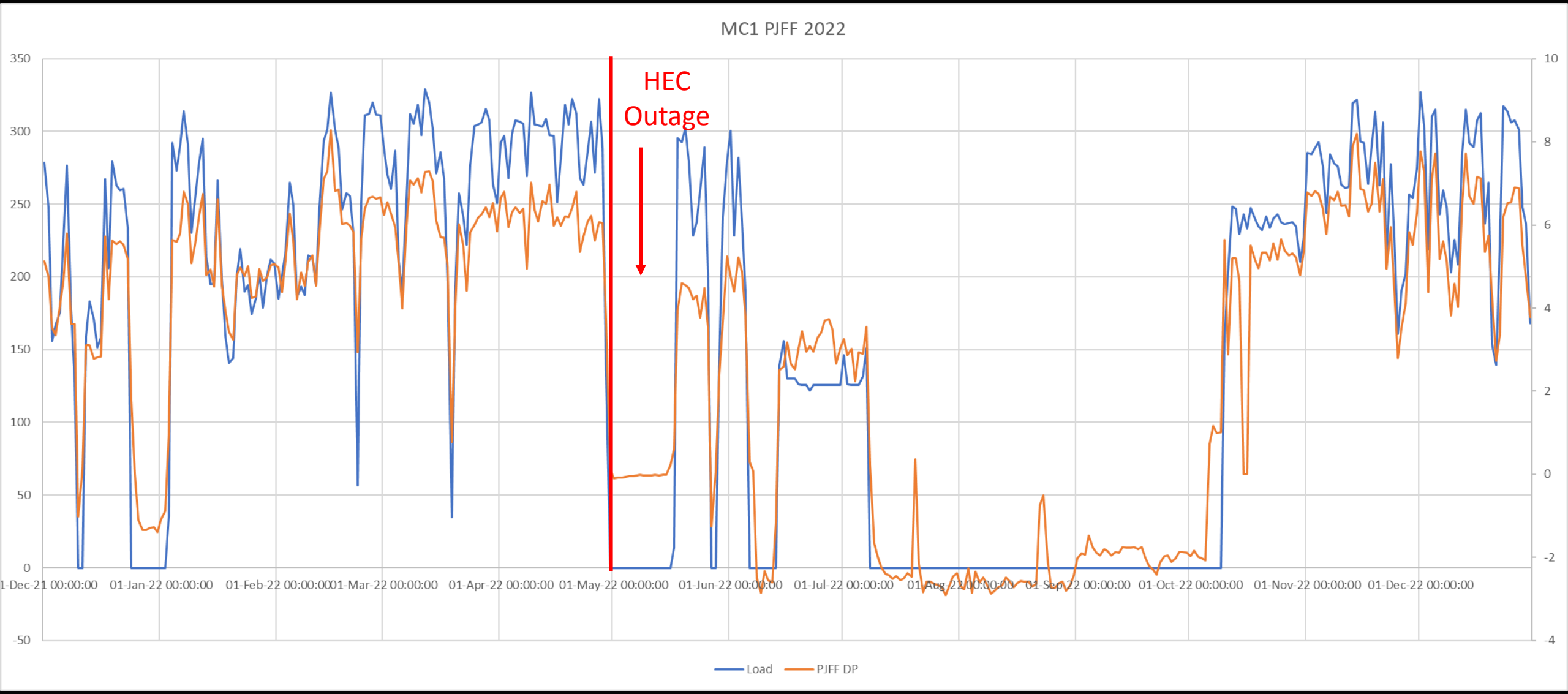
^Average new fabric values taken from the QA/QC Program under ETS Report 20-4128-L dated January 6, 2021, and are included for % retention calculations.

# Preventative Measures

- Ensure PJFF dampers were all shut on outages
- Monitor seal air system closely on FGD isolation damper
- Alarm if PJFF temperatures exceed 100 deg F while unit is offline

# Making Bags Last Until Retirement

- Have used high energy cleaning:
  - Not a permanent fix
  - Can lower DPs to limp until retirement or changeout
  - Could damage bag membrane
  - Can cost about $13-15/bag
  - Cheaper than a changeout


MC1 PJFF 2022
HEC
Outage
350
300
250
200
150
100
50
0
-50
10
8
6
4
2
0
-2
-4
1-Dec-21 00:00:00
01-Jan-22 00:00:00
01-Feb-22 00:00:00
01-Mar-22 00:00:00
01-Apr-22 00:00:00
01-May-22 00:00:00
01-Jun-22 00:00:00
01-Jul-22 00:00:00
01-Aug-22 00:00:00
01-Sep-22 00:00:00
01-Oct-22 00:00:00
01-Nov-22 00:00:00
01-Dec-22 00:00:00
Load
PJFF DP

# Compartment Lids

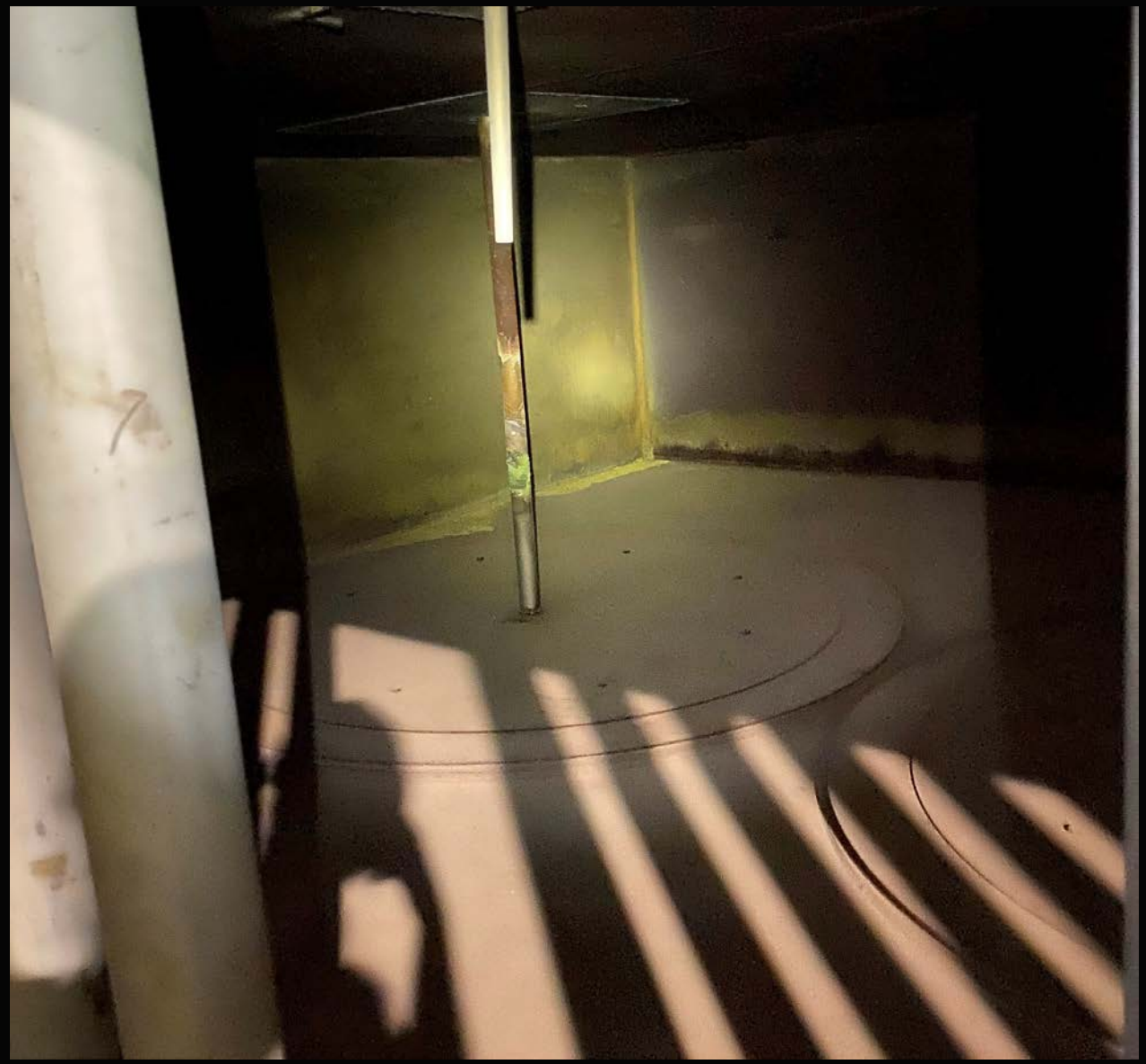
- Gasket:
  - Helps seal up doors
  - Prevents air-in leakage
  - Have swapped to square gasket
    - More costly up front, but holds up over time
- Bolts for doors
  - Heat causing them to loosen
  - Bolts have bent over time
  - Have replaced some of the bolts

# Bypass Dampers

- Poppet Inspections:
  - Open and check poppets are attached
  - Have had several bypass poppets fail:
    - Fixed in house with welders

# Outlet Poppets

- Ensure proper opening and closing of poppets from the compartments
  - Failures would result in higher DPs



# Leak Tests

- Important after changeouts
- Helps ensure PJFF will meet PM limits
- Identifies failed bags effectively

| ion | Weight Analysis (% Increase) | Permeability (4.0 cfm) | Mullen Burst Strength (800 psi) | Warp Tensile Strength (350 lbf) | Fill Tensile Strength (350 lbf) |
|---|---|---|---|---|---|
| -E10 | 7% | 3.95 | 1000 | 396 | 550 |
| 7-J6 | 8% | 5.06 | 1000 | 442 | 574 |
| 0-D6 | 4% | 4.1 | 1000 | 463 | 636 |
| -D19 | 8% | 4.06 | 1000 | 474 | 745 |
| K10 | 6% | 4.59 | 1000 | 459 | 692 |
| G18 | 7% | 4.15 | 1000 | 463 | 676 |
| -E10 | 8% | 5.42 | 1000 | 401 | 649 |
| 7-J6 | 7% | 4.24 | 1000 | 446 | 801 |
| 0-D6 | 14% | 5.33 | 1000 | 431 | 679 |
| -D19 | 6% | 5.16 | 1000 | 392 | 685 |
| K10 | 7% | 4.44 | 1000 | 426 | 674 |
| G18 | 8% | 4.84 | 1000 | 379 | 625 |
| -P16 | 3% | 5.28 | 1000 | 396 | 550 |
| 4-E7 | 5% | 5.19 | 1000 | 442 | 574 |
| -D3 | 5% | 5.35 | 1000 | 463 | 636 |
| D18 | 3% | 5.06 | 1000 | 474 | 745 |
| -E5 | 8% | 7.28 | 1000 | 459 | 692 |
| -M15 | 6% | 5.6 | 1000 | 463 | 676 |
| 6-A6 | 18% | 5.59 | 1000 | 396 | 550 |
| 4-E7 | 14% | 4.94 | 897 | 396 | 550 |
| -D3 | 14% | 4.73 | 867 | 463 | 636 |
| D18 | 12% | 4.98 | 1000 | 474 | 745 |
| E5 | 18% | 4.65 | 1000 | 459 | 692 |

# Bag Sampling

- Bag life predictability:
  - Prevents early or late changeouts
  - Trend over time
- Determines if there are issues:
  - Moisture
  - Flow inequities
  - Cage movement
  - Cage wear

# Maintaining ESPs for PJFF Performance

Less ash going to the PJFF → Less cleaning cycles

Improved bag life → Less changeouts

# Maintaining ESPs for Flyash Beneficial Reuse

- Flyash captured in the ESP contains lower SO3 concentrations
- Captured ESP ash at Mill Creek is sellable
  - Profits go towards benefitting LG&E customers
  - Beneficial reuse as concrete additive
    - Approx. 25k tons of Mill Creek flyash was used to construct the bridges in Louisville
- PJFF ash goes to the landfill
  - Costly to landfill
  - Reduces landfill lifespan

# Questions/Discussion