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Front Range Power Plant: Air Cooled Condenser

Tom Cook, PE
Colorado Springs Utilities, Operating Engineering Group

Air Cooled Condenser User Group: October 2018

Supply Reliability (1,149 MW Total)

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Martin Drake Power Plant
Coal
#6 - 77 MW
#7 - 131 MW

Front Range Power Plant
Natural Gas
Combined cycle
480 MW

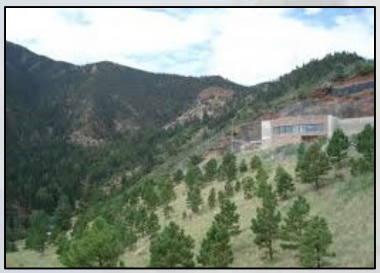
Nixon Power Plant
Coal
#1 - 208 MW

Natural Gas
#2 & #3 - CT's, 60 MW

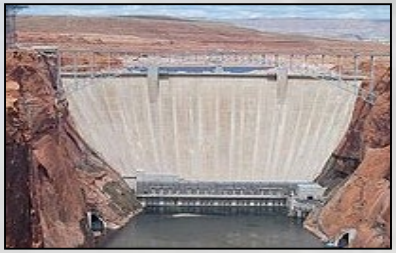
Birdsall Power Plant
Natural Gas
55 MW

Contracted Solar Facilities

AFA	5.4 MW
Solar Gardens	4 MW
CSR	10 MW



CSU Hydro Electric
35.2 MW (6 units)



Contracted WAPA
Hydro ~ 83MW

Agenda

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- Description
- Performance Monitoring
- Maintenance / Inspections
- Operating Practices

ACC Description

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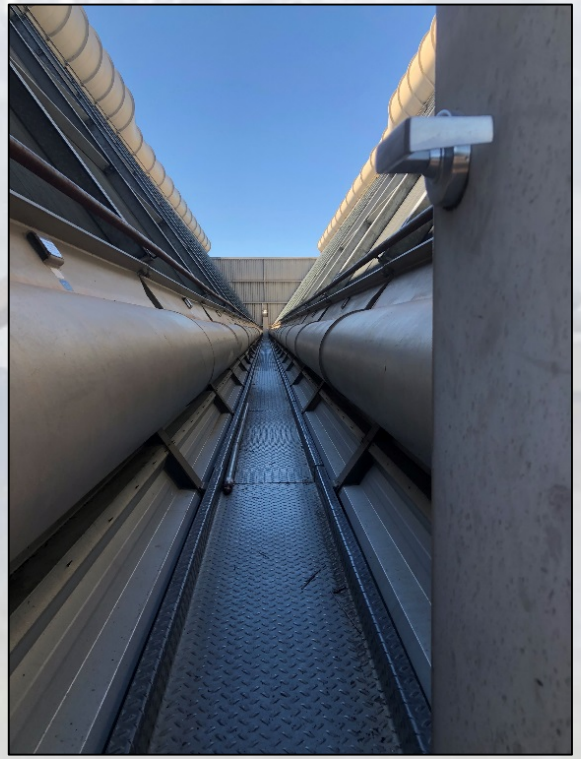
Plant Design Parameters

480 MW
100 gpm max water use

ACC Design Conditions	
1,266,468	pph
1081	Btu / lb
3.57	in HgA
80	°F air temp
12.01	psia barometer

40 two-speed fans
8 rows



ACC Description

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Row 8 - 5

ACC Description

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Permanent Ladders / Platforms

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Permanent Ladders / Platforms

ACC Performance Monitoring

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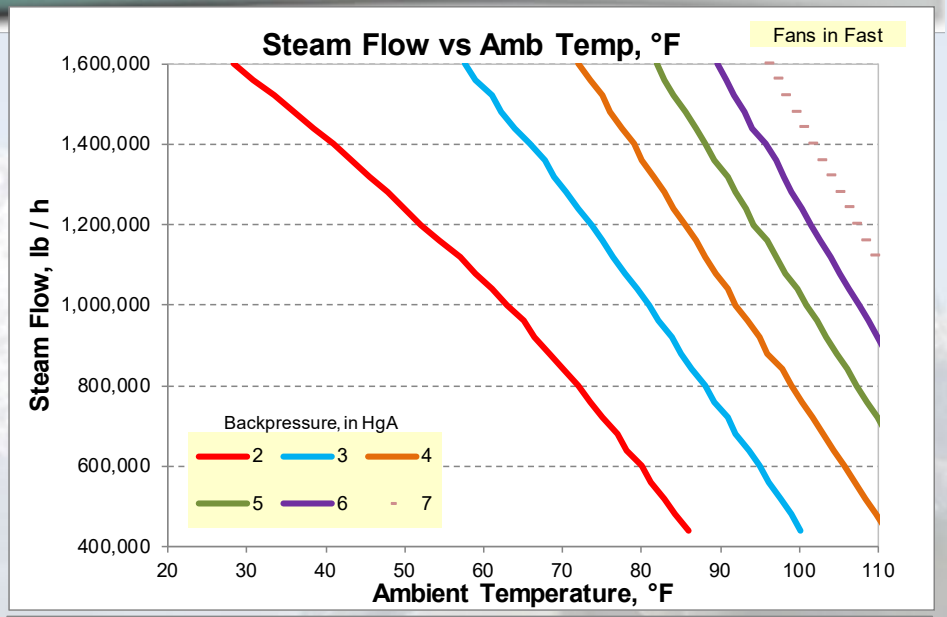
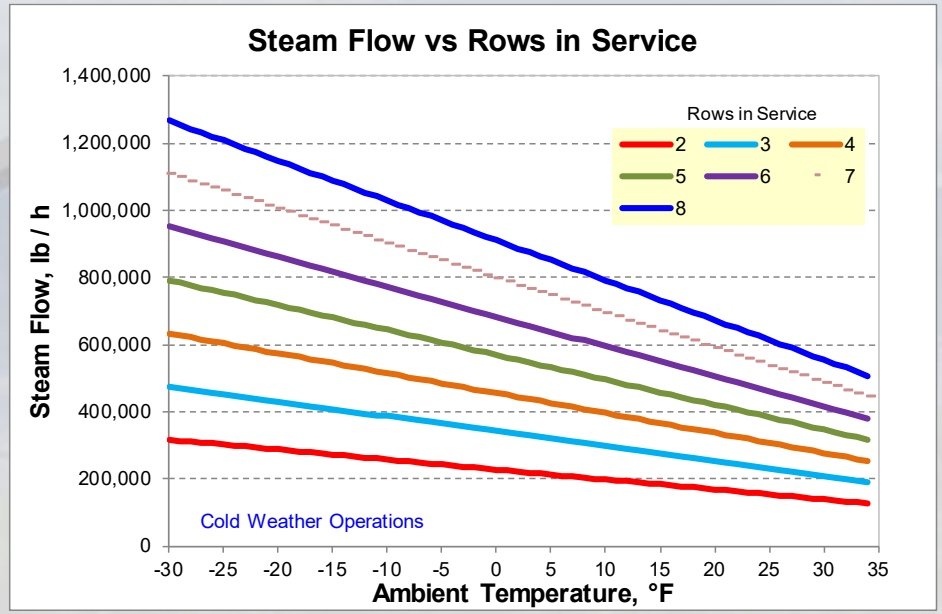
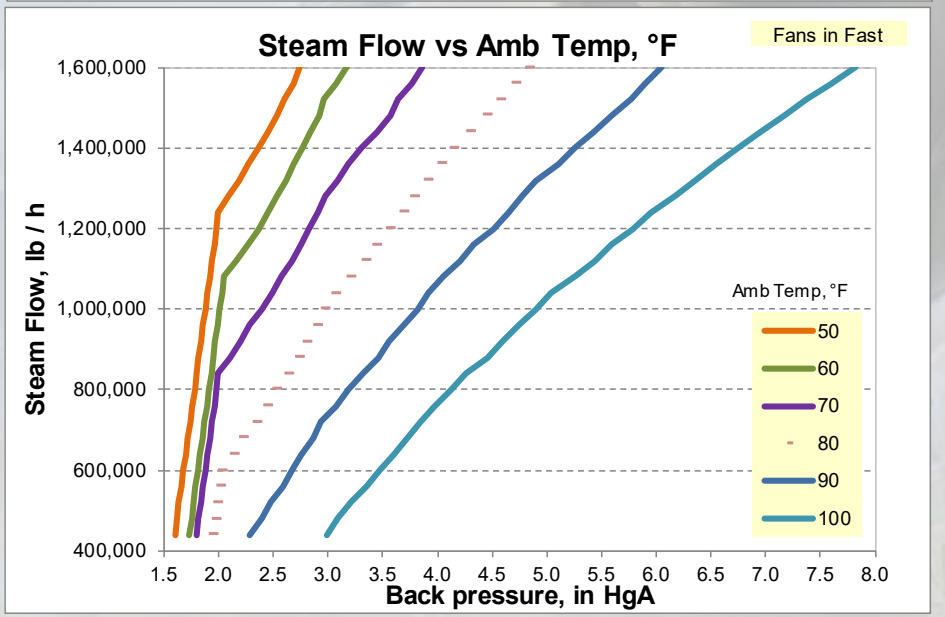
Manufacturer Performance Curves



Cold Weather Operations





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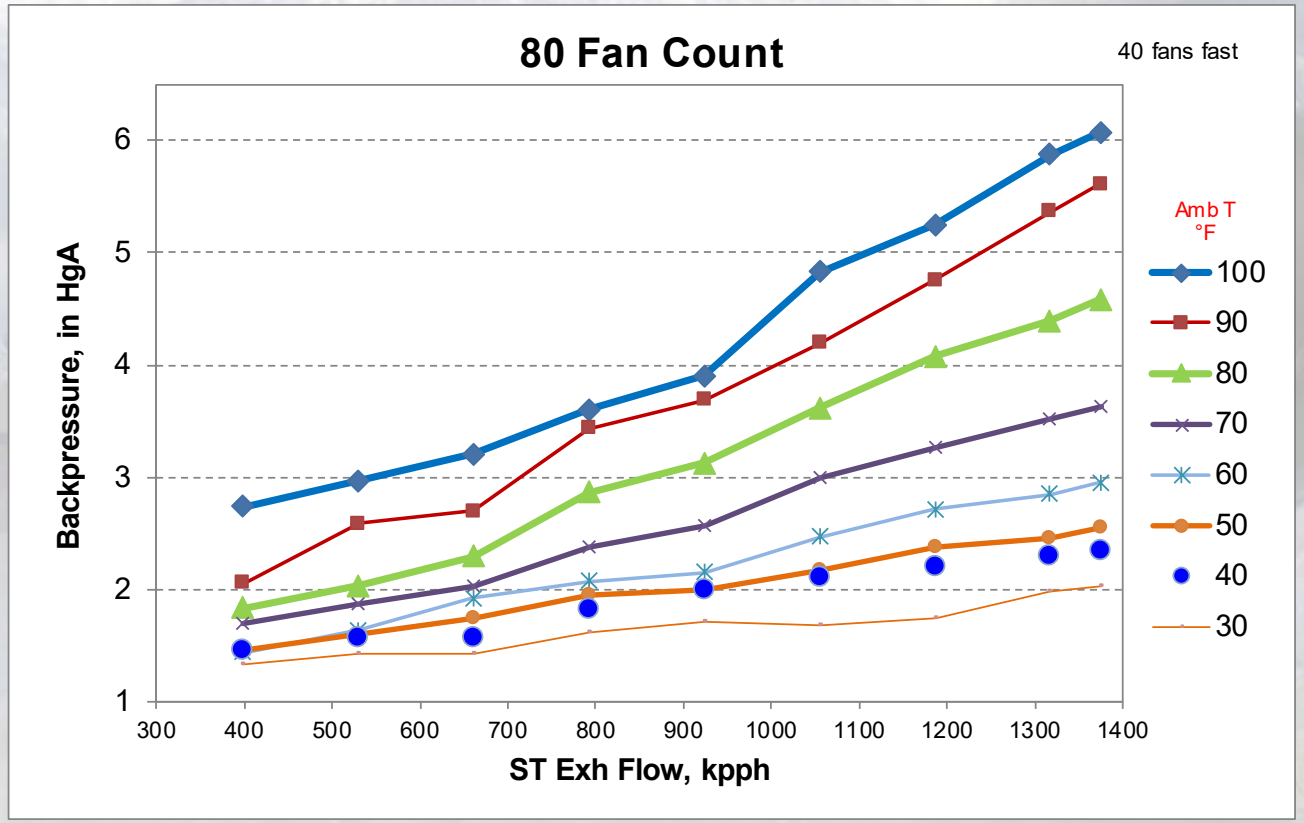
Self-Developed Performance Curves

15 to 80 fan count, where
0 = fan off
1 = fan on slow
2 = fan on fast

- Defined at 'new & clean'
- Used for trending

Mfr supplied curves applicable only for 40, 50 & 80 fan count.



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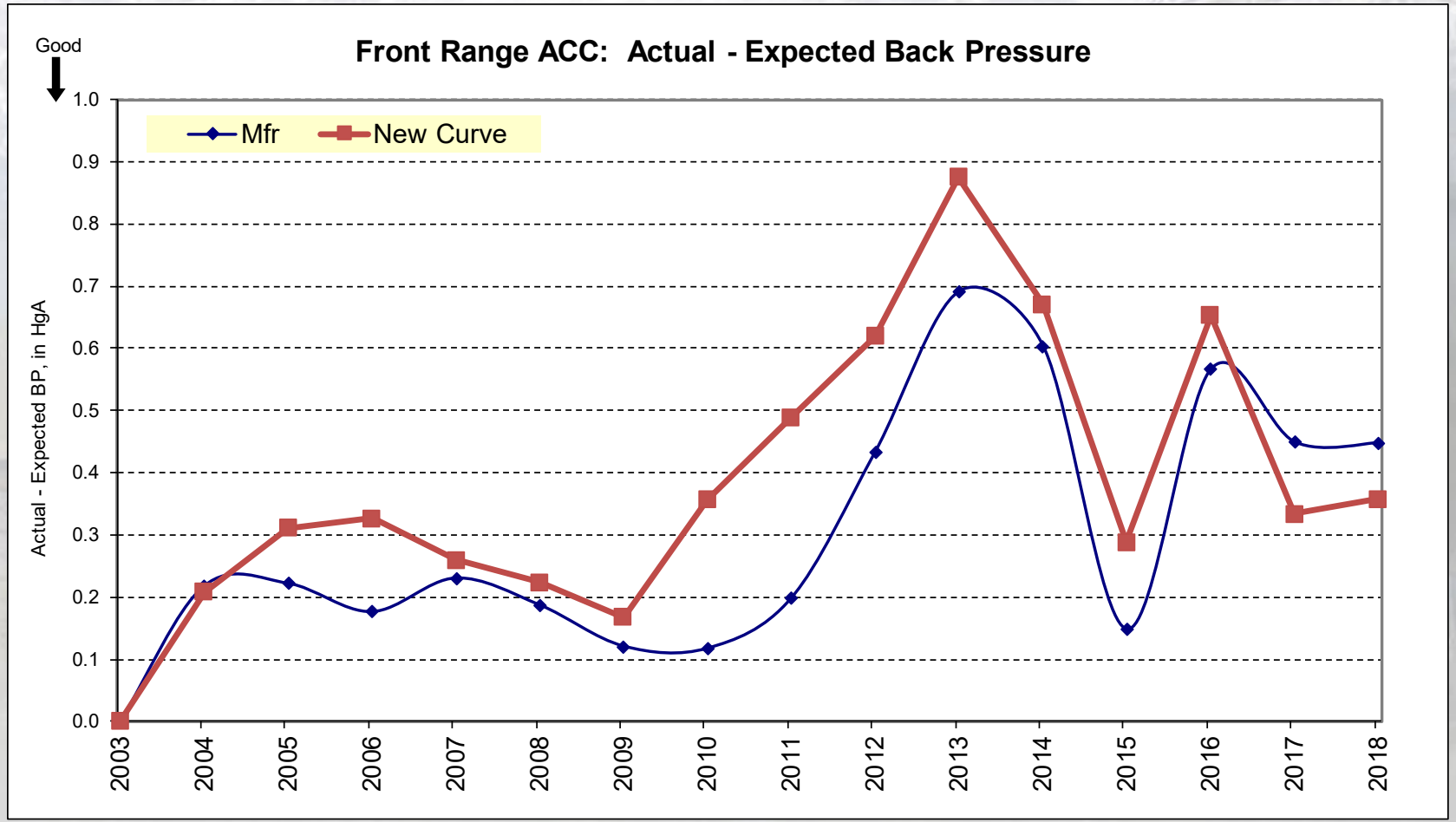
Water washing lowers the Actual – Expected Difference



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Key Performance Indicators

Actual vs New & Clean Backpressure
Air Side differential ($T_{cond} - T_{air\ removal}$) (by row)
Ambient conditions (Baro, RH, Wind Speed / Dir
Fan Aux Load (kW / kpph)
Fan static pressure (future consideration; Hi/Low, before/after wash)

Other KPI's

SJAE, GSC duty & Temp rise (SJAE nozzles replaced at ~9 years)
Subcooling

Performance-Based Recommendations

- Water wash annually (0.4 to 0.7 in HgA improvement)
- Helium leak tests
- Careful with using inlet air temperature RTD's (air recirc bias)

Water-washes

- Contractor supplied wash skid. (OEM skid / rig insufficient quality)

ACC Maintenance / Inspections

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Inspection Summary

- LP turbine rotor deposits
- Ductwork & Piping (passivated, free of significant iron removal, FAC evidence)
- Standing water / rusting in the valley walkways
- Structural review

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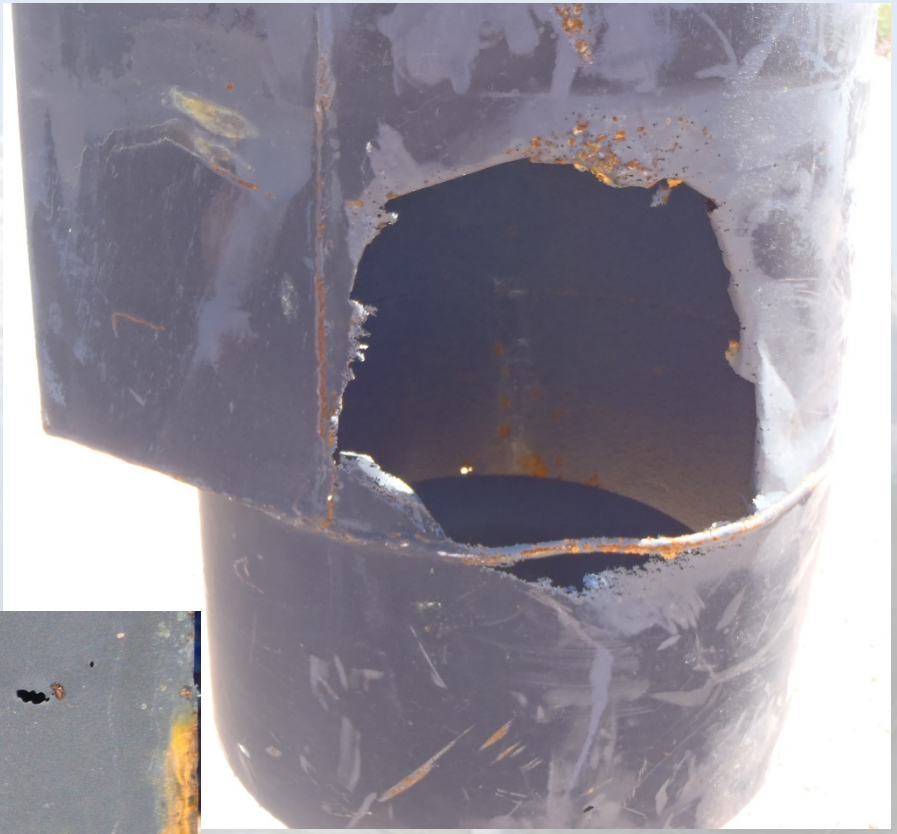
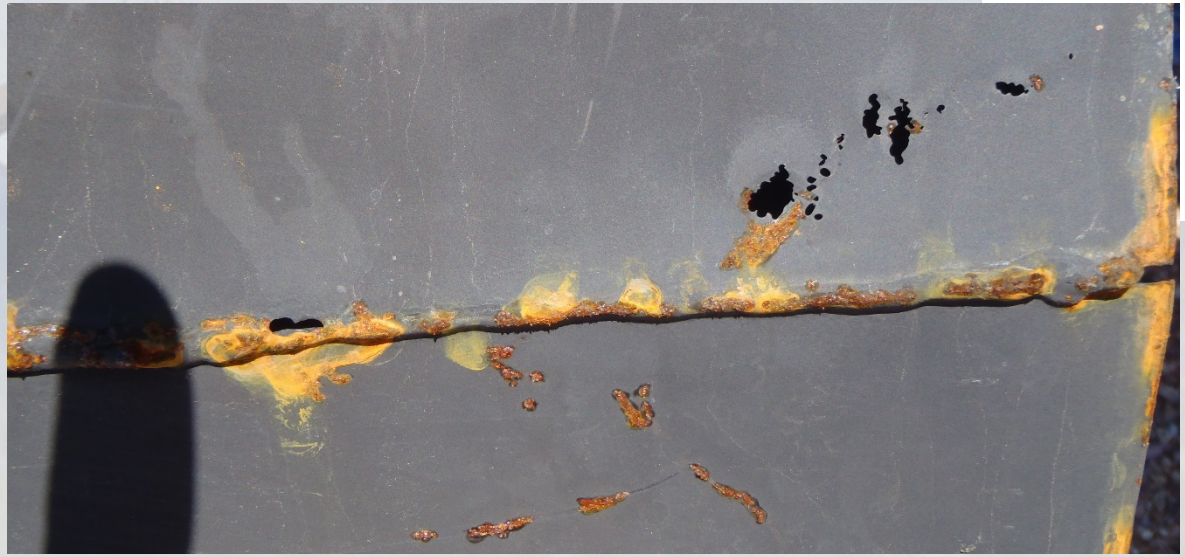
IP Drum steam separator flow-assisted corrosion





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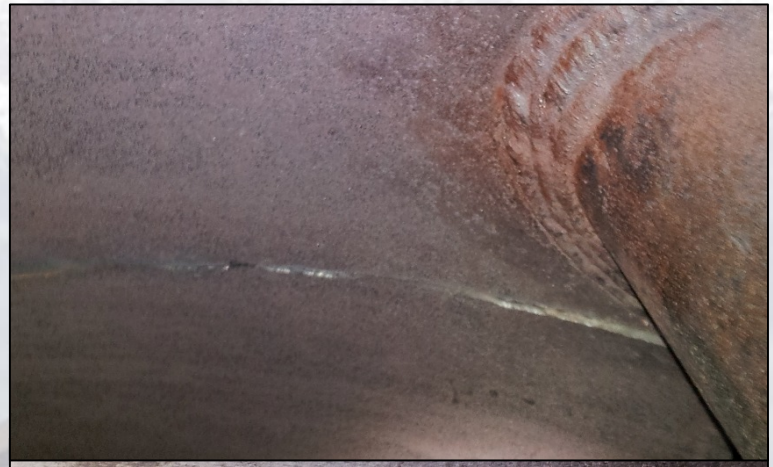
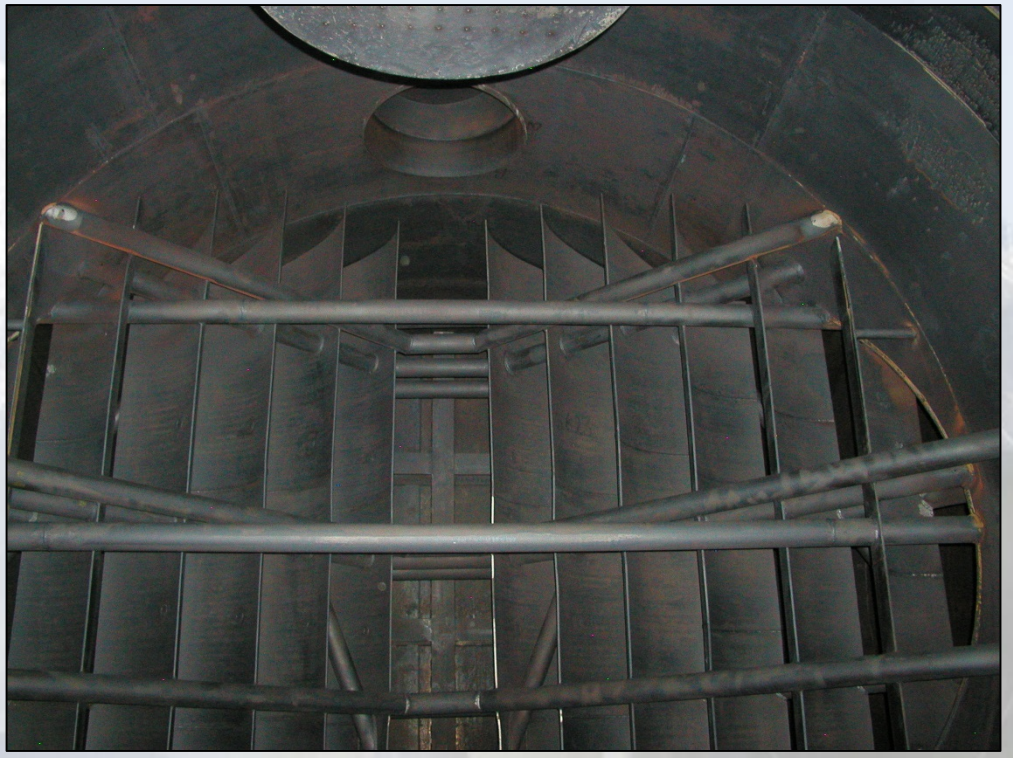
Stationary Vane Cracks





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Stationary Vane Cracks

Crack at weld in turning vane support

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Tube Connections

Historical: 1 tube repaired, 1 small crack. Found during Helium leak testing

Center trough between tube entry with standing water and rust

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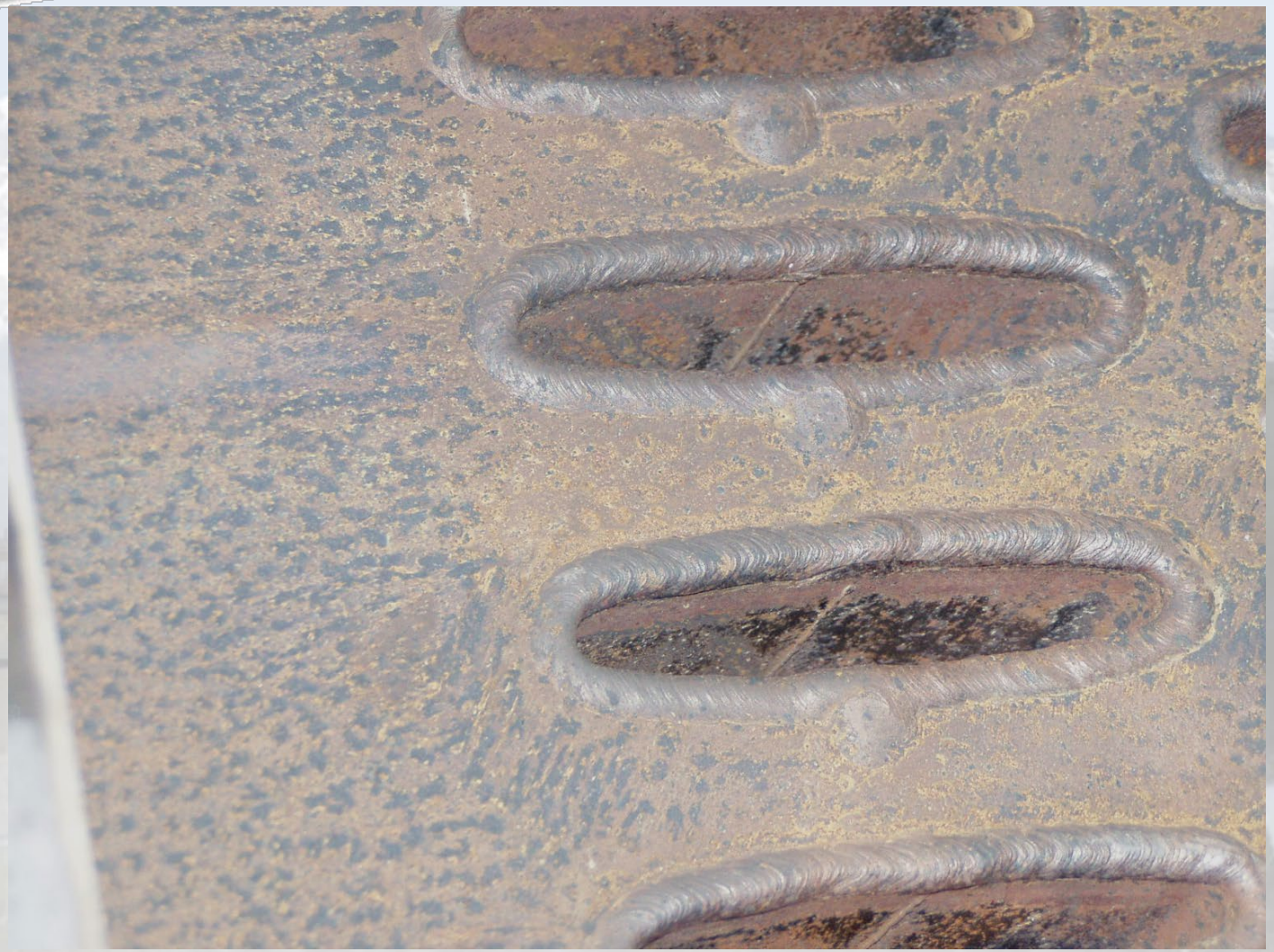

Tube inlets; area around black scale in tubes is FAC

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Steam bypass on top of exhaust duct, FAC at wall impact point

FAC on support pipe (shiny spot) at entry to lower distribution duct

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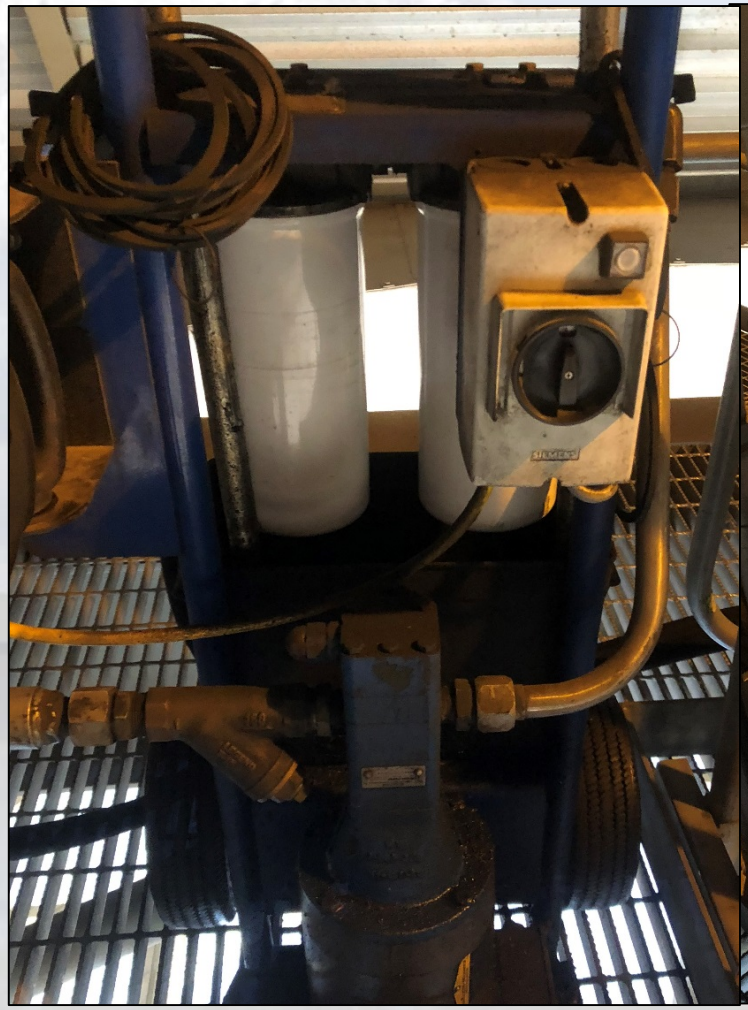
Oil Filter Cart

- 2 elements: 6 & 12 µ
- Moved every 2-3 days
- 10 gph



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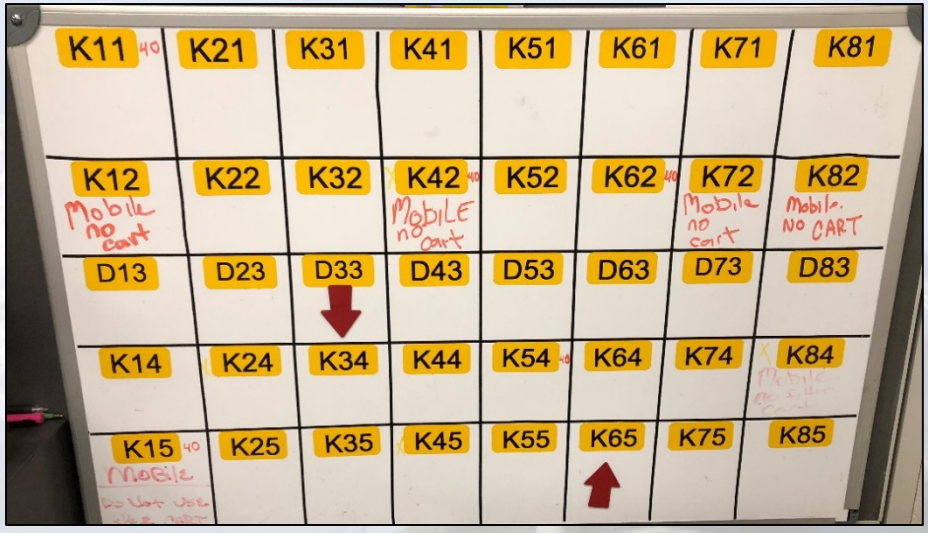
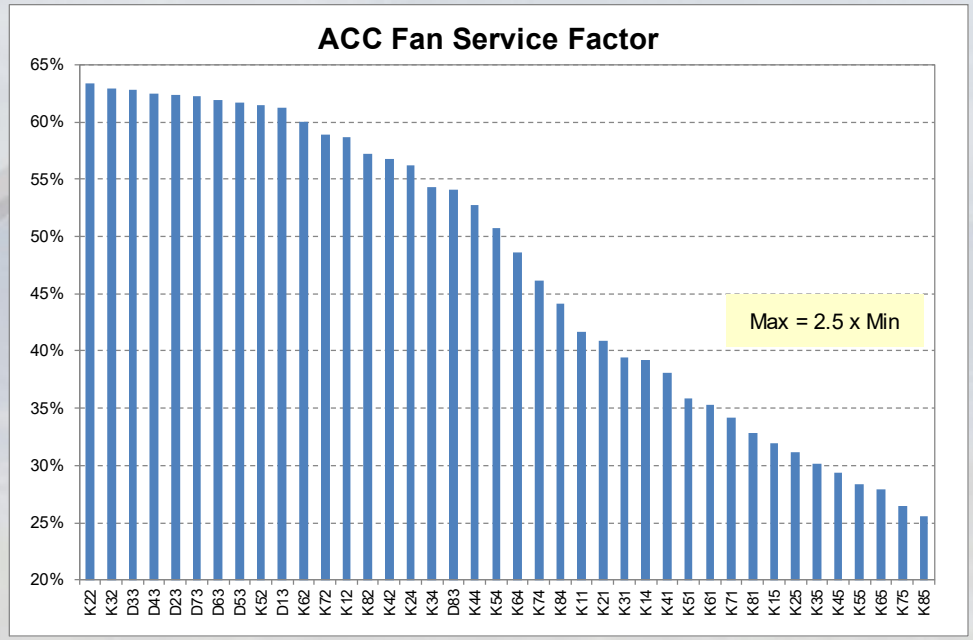
Fan Gearbox Oil Changes

- Changed oil based on oil sample results
- Changing from Amsoil to Mobil 632





Gearbox Oil Testing

- Particulate based focus

Fan Gearbox Oil Filtering

- Duty cycle basis is a consideration
- 2 Carts in service ~3 days per cell

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Lesson learned: Don't use a silica-based filter element

Condensate Side-stream filter

- start-up iron throw sends magnetite layer to HRSG
- used during full-plant start ups
- Condensate pump suction strainers not clogging (with current operation)

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Insulated & heat traced loop seals

Upgrades / Modifications

- Built in ladders & platforms to upper ACC ducts
- Heat trace condensate tank level sensors

Hogger isolation valves: reduce atmospheric leakage into ACC.

Oil Storage Deck

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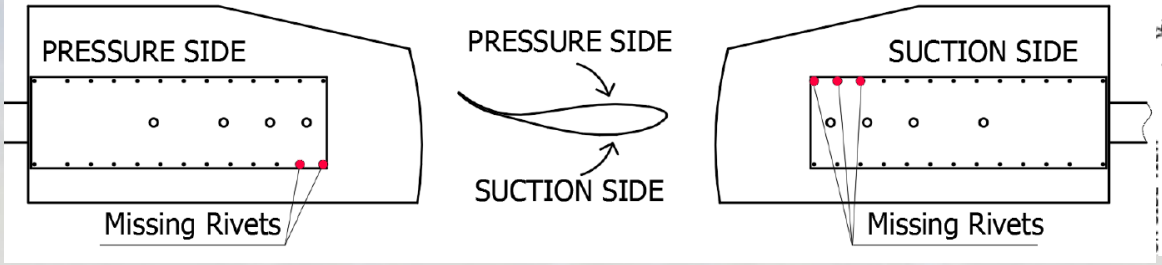
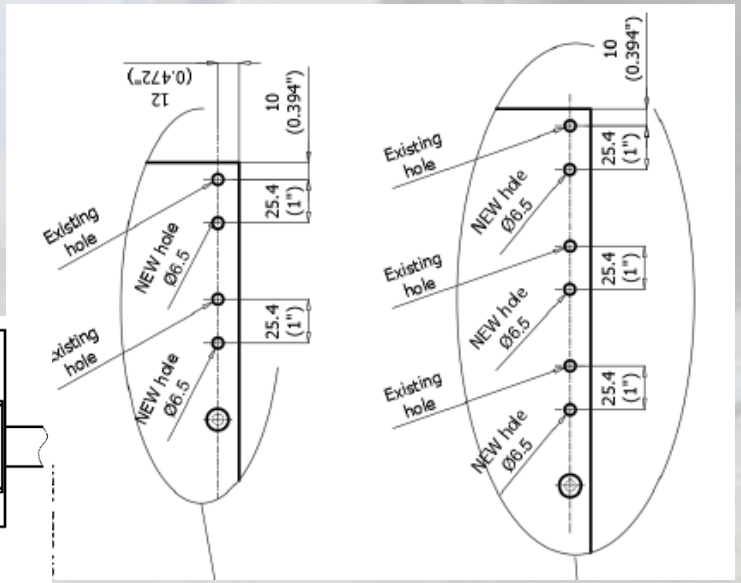
Fan Blade Inspections

New Rivet Installation:
Engineered metric rivets
6x12 mm UNI 9200-A, DIN 7337-A
Note: Blades are fixed pitch

Warning: Blades drop with no alarms / warnings





ACC Operating Practices

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Freeze Protection

- Know design # of rows vs steam flow
- Verify controls / operations
- Thawing cells
- Walk the rows (thermal scans if freezing is suspected)

Air Removal

- Automatic burp cells / rows (was manual)
- Helium leak testing (annually)
- Monitor ΔT (Condensate T – Air Removal T < 20°F)
- DA non-condensable-gas vent directed back to the ACC

ACC Operating Practices

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Walkdowns

- Weekly row walks
- Motor vibrations: on routes (looking into a vibration trip switch & potentially on-line vibration monitoring)

Chemistry

O_2 Control: hydrazine then carbohydrazide then nothing. O_2 is maintained 10 - 20 ppb by the deaerator

Chemistry / corrosion. Some surface corrosion. Very minimal

Internal Inspections. Every 2-3 years.

Watch IP Drum Steam separators (replaced in 2010, no issues since)

Thank You

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What Questions May I Address?

Commitment - Excellence – Courage – Persistence – Honor – Joy
Ethical – Respect – Dignity – Patience – Collaboration – Skilled
Constructive – Solution – Engaging – Positive – Learning – Giving
Admiration – Leading – Aligned – Focused – Practical – Humble
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