

10th Annual ACC User Group Meeting

Colorado Springs, CO Oct 8-11,

A Vacuum Leak Odyssey

Presented by Don Wright

Combined Cycle Plant Configuration

- 2 GE 7HA.02 Gas Turbines & GE D602 Steam Turbine
- 1100 MW Total (~490 Mw STG)
- Air Cooled Condenser
- Commercial Operation Summer of 2017



Air Cooled Condenser Design

- TED Steam Flow ~2,500,00 lb/h
- Inlet Dry Bulb/Outlet - 95°F/120°F
- Fin/Tube Technology
- 11 Streets / 55 Cell
- 4 Hoppers - Liquid Ring Vacuum Pumps @ 6,300 scfm ea.
- 2 Steam Jet Air Ejectors (SJAE) @ 33 scfm ea.
- 1 Air Eductor (added to protect vacuum pumps)

Problem - Summer of 2017

Vacuum above design curve 1-1.5 inHg

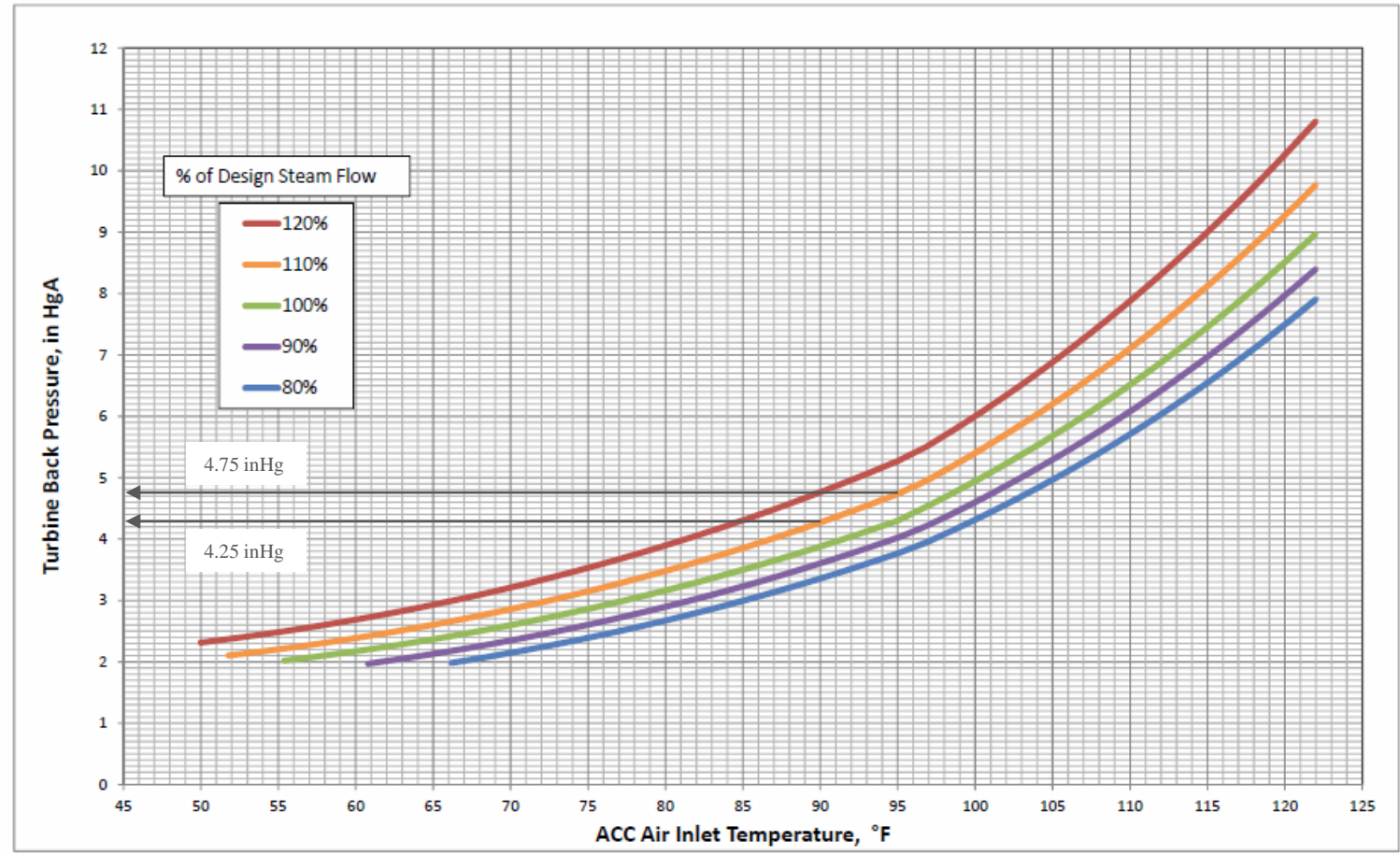
Dissolved Oxygen 60 – 100+ ppb

Hoggers intended for startup were running constantly to maintain vacuum

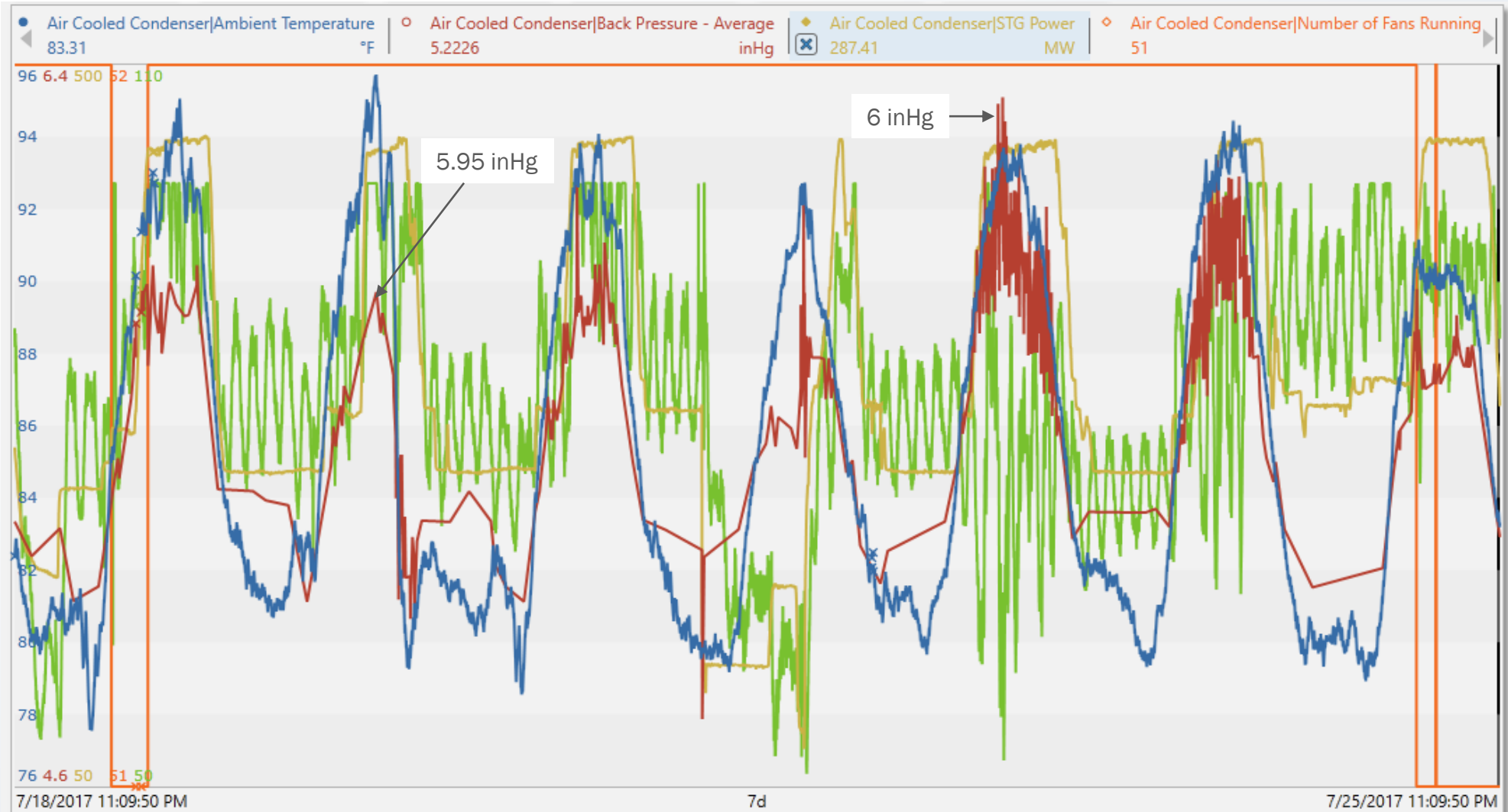
50+ fans running 24/7

Thermography reveal large cold areas in many streets

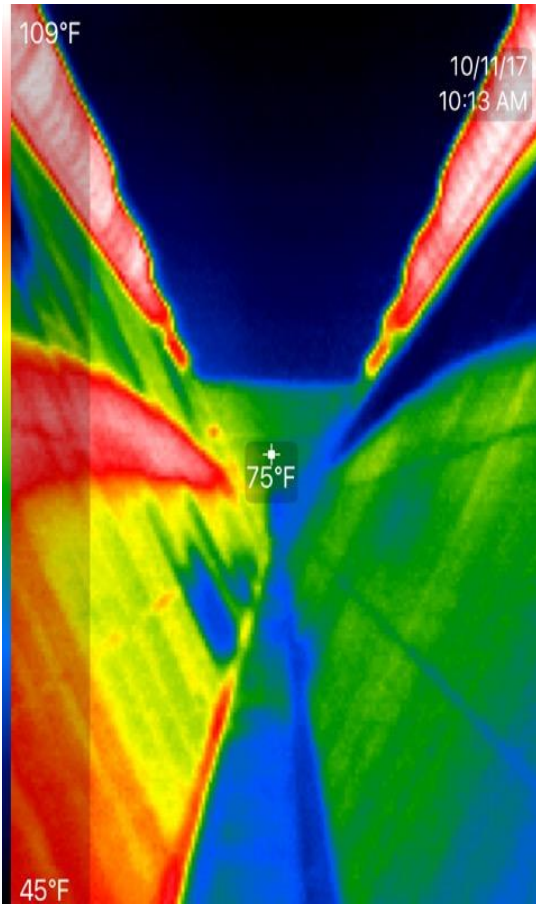
	SI Units	IP Units		SI Units	IP Units
Steam Flow Rate	318.6 kg/s	2,528,905 lb/h	ACC Inlet Dry Bulb Temperature	35.0 °C	95 °F
Steam Quality	92.7%	92.7%	Relative Humidity	44%	44%
Turbine Back Pressure	145.6 mbara	4.30 in HgA	Atmospheric Pressure	1009 mbara	29.8 inHgA



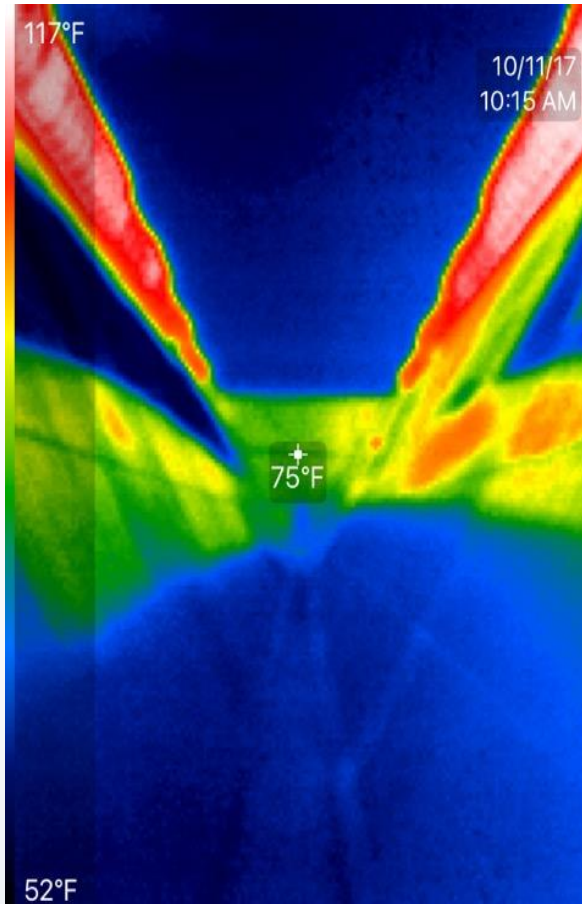
Summer 2017 Data



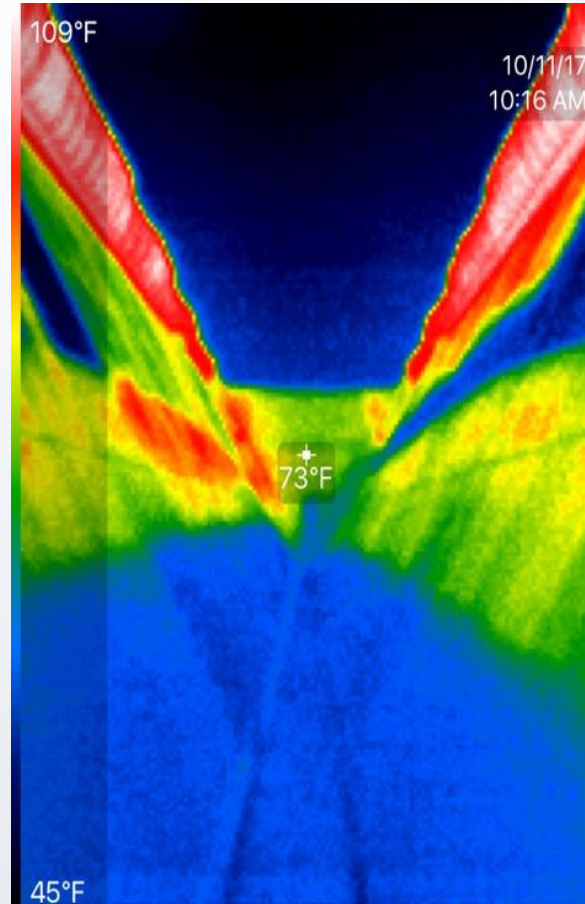
August 2017 ACC Thermography Data



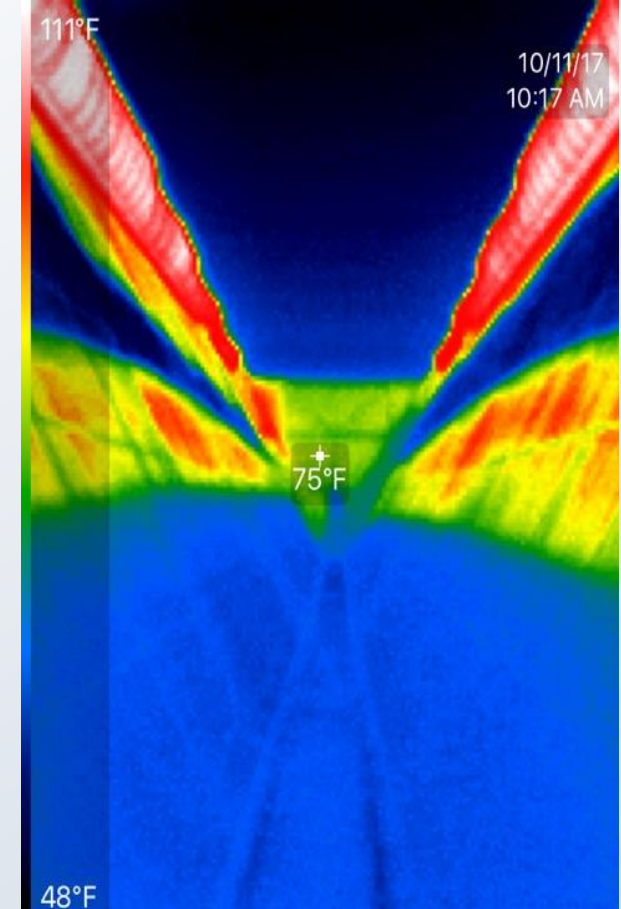
1/2



2/3



3/4



4/5

	STG Load	287 MW			
	TED Temp	132 F			
Street 1	Street 2	Street 3	Street 4	Street 5	
HOT	COLD	COLD	COLD	COLD	
Street 6	Street 7	Street 8	Street 9	Street 10	Street 11
HOT	COLD	COLD	COLD	COLD	COLD

Initial Actions June of 2017

1. Walkdown system listening/looking for signs of leaks
2. Verify Valve configurations
3. Performed He leak Testing to locate leaks
 - Note: Hogger outlet used due to no visible SJAE discharge

Results:

- No valve alignments issues identified
- Minor He leaks at TED Rupture Disk and a drain pot; long delays
- Significant He leaks at hogger shaft seals

Follow-up: replace pump seals, review operating data and inspect air ejectors nozzles

Follow Up Actions July/August of 2017

1. SJAE nozzle removed and inspected no issue
2. SJAE (Temp. & Pressure) adjustments made to bring within specification, operational testing passed, still no visible discharge
 - Sister plant with no vacuum issue also had intermittent SJAE discharge with hoppers on
3. Loop seal off SJAE verified to be filled
4. Vacuum pump seals replaced
5. Vacuum breakers water seals filled
6. Temporary repair on leaking TED rupture disc
7. Logic review with sister plant and more system walkdowns
8. Vacuum decay Test < 30 min. hold

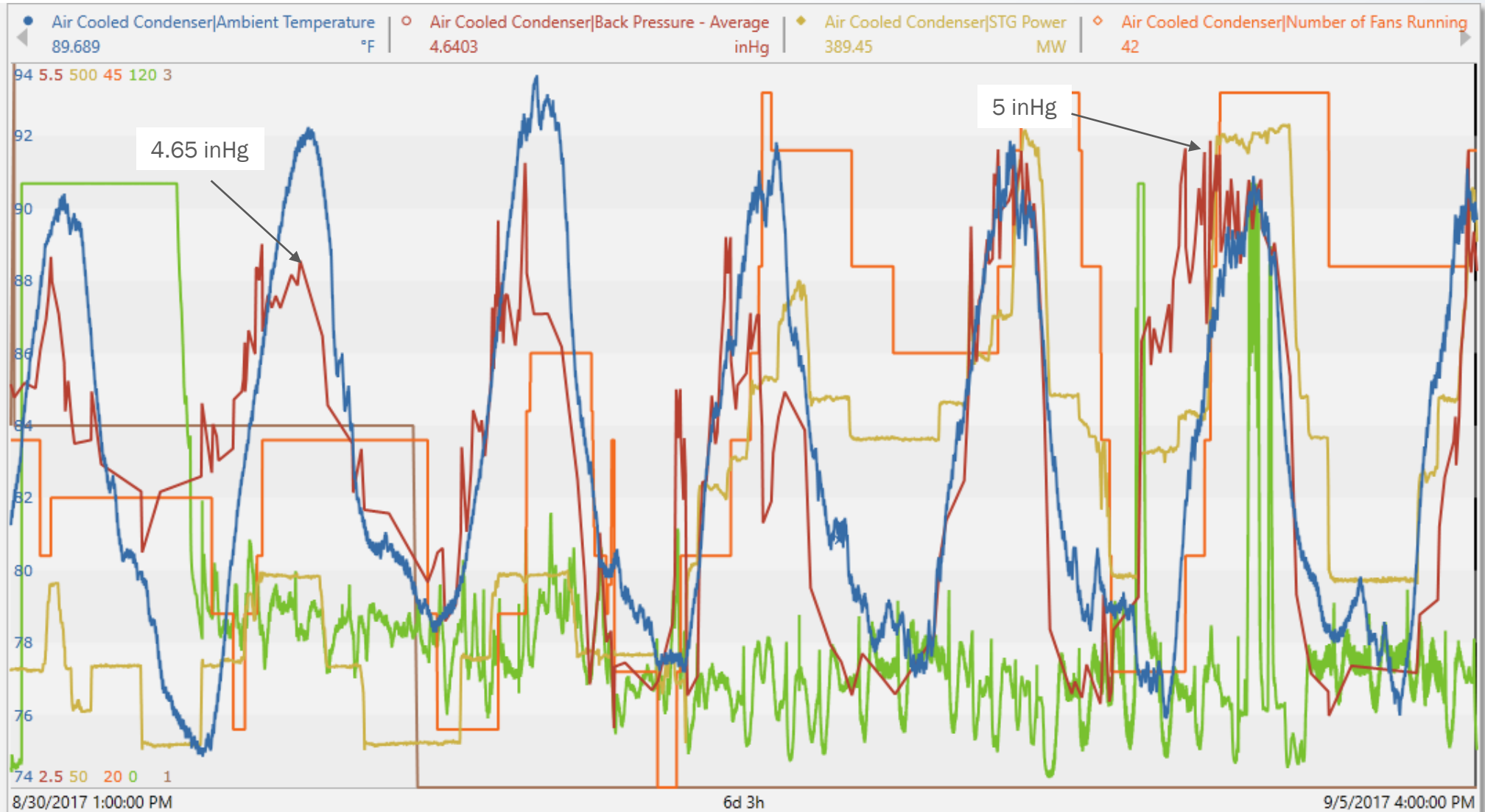
Results: No change in Vacuum performance

Follow Up – SJAE OEM scheduled to inspect Nov. outage

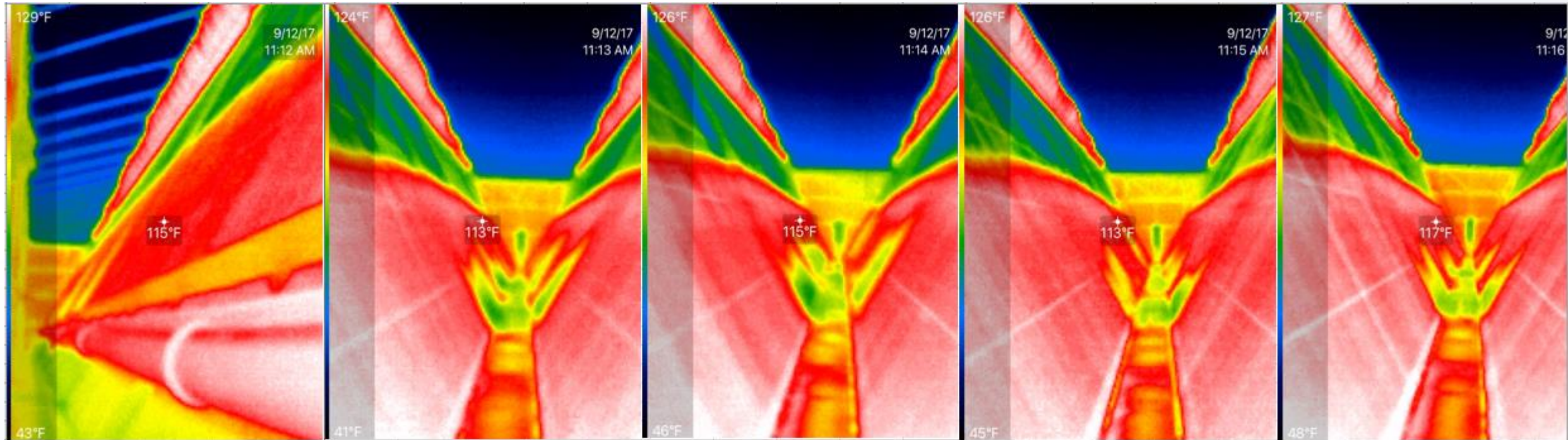
Extreme Weather Event – Hurricane Harvey 8/28/17 – 8/30/17

- Plant shutdown for several days due to flooding and drying out equipment
- After restart vacuum & DO improved significantly
- Initial thought was some further walkdown and tightening of valves just prior to event accounted for improvement
- Thermography showed good temperature ACC distribution
- Significant reduction in number of fans running
- Still running hogger to maintain vacuum
- SJAE still had no visible discharge

Post Hurricane Harvey



Post Hurricane Harvey Thermal Survey



	Street 1	Streets 1/2	Streets 2/3	Street 3/4	Streets 4/5
	1	2	3	4	
STG Load	290 MW				
TED Temp	130 F				
Street 1	Street 2	Street 3	Street 4	Street 5	
HOT	HOT	HOT	HOT	HOT	
Street 6	Street 7	Street 8	Street 9	Street 10	Street 11
HOT	HOT	HOT	HOT	HOT	HOT

Vacuum & DO degraded to similar condition before Harvey



November 2017 Outage - SJAE OEM Identifies stuck check valves

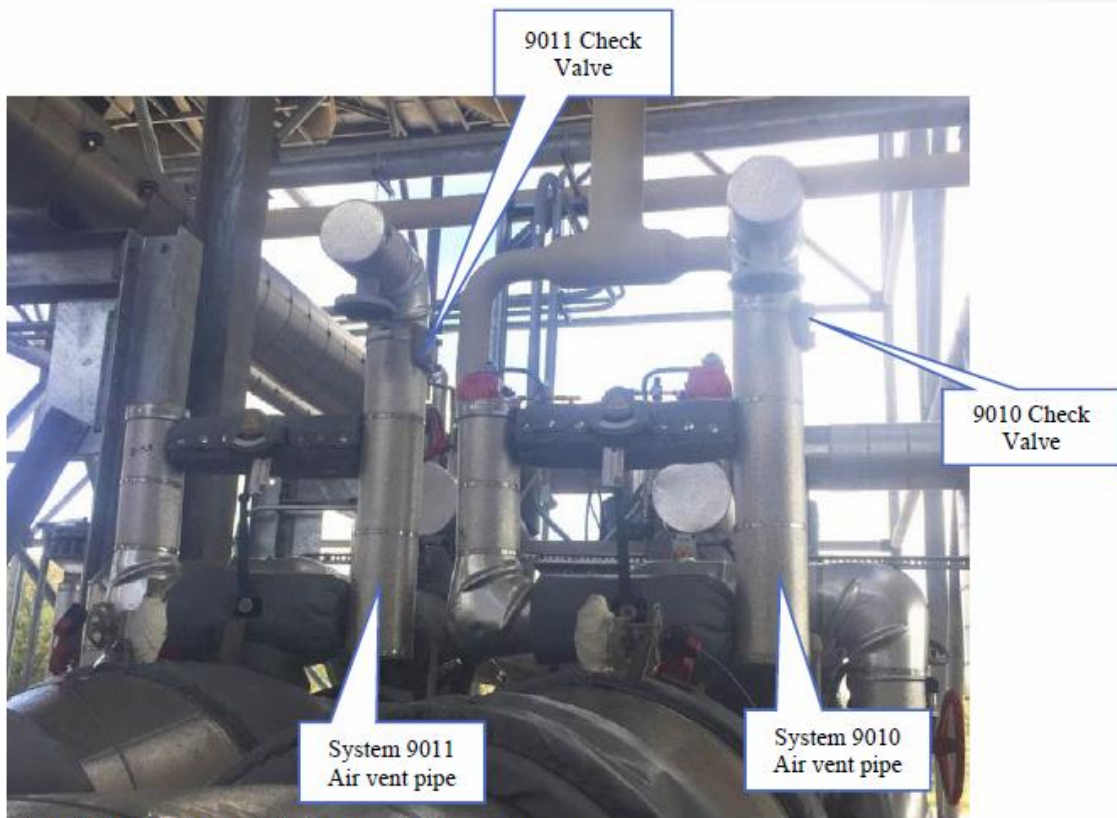


Photo #1) Air Vent lines for both systems' Aftercondensers.



Photo #2



Photo #3) Check Valve Internal disk rusted in place.

Photo #4) Check Valve with internal disk & Spring removed.

After Nov. 2018 Outage

- SJAE check valves removed
- SJAE now discharging
- Reduced DO (20-40 ppb)
- Vacuum improved slightly but still above design
- Hogger still needed to maintain vacuum
- Vacuum decay test resulted in immediate loss of vacuum

Follow up – Schedule He testing Prior to Spring 2019 Outage

April 2018 – Pre Spring Outage He Testing

- ❖ SJAE discharge used for improved sensitivity
- ❖ Isolation of each SJAE for testing
- ❖ Prioritized list of components Identified
- ❖ Planning meetings with He leak testing company
- ❖ Mechanical contractor support to assist and address findings
- ❖ JLG available to access some elevated areas

April 2018 – Pre Outage He Testing RESULTS

- ❖ Out of service SJAE not isolated (drains not closed)
- ❖ Major Leaks
 - SJAE steam ejector flanged joints
 - TED Drain Tank- Drain Valve
 - Bonnet of 4 drain valves off condensate line to deaerator
- ❖ Minor Leaks
 - Street 2 & 7 defleg section
 - LP turbine rupture disk
 - LP turbine gland seal
 - Exhaust Duct Flange

April 2018 – Pre Outage He Testing RESULTS

Out of Service SJAE



April 2018 – Pre Outage He Testing RESULTS

Leak 4.) Drain below exhaust duct drain tank header. Drain valve appears to have trouble sealing.

Leak response was large 60,000 Divisions until tightened.



April 2018 – Pre Outage He Testing RESULTS

Leak 6.) South jet flange on air ejector. Gasket failing.
Leak is large 24,000 Divisions



April 2018 – Pre Outage He Testing RESULTS

**Leak 7.) South jet flange on air ejector. Secondary jet. Gasket failing.
Leak is large 60,000 Divisions**



April 2018 – Pre Outage He Testing RESULTS

Leak 7.) North jet flange on air ejector. Flange appears misaligned. Gasket failing.
Leak is large >100,000 Divisions



April 2018 – Pre Outage He Testing RESULTS

Leaks 8, 9, 10 and 11.) 4 Drain lines from ACC condensate lines to deaerator. Leaks are at bonnets on valves. Valves appear to have been installed for post construction clearing of ACC and collector lines. Leaks were not on flanges but on bonnets.

Leak responses were large, 24,000 –90,000 Divisions



April 2018 – Pre Outage He Testing RESULTS

Leak 12.) Street 2, fan room B, south Defleg section, south end. Leak could not be pinpointed due to limited access and may be along base of exhaust duct to bundle weld. It is also possible that a crack on a defleg pipe weld may exist. In either case, moisture/rust marks may be present or striations where air has leaked into the duct weld may be visible.

Leak response was small but gas access was limited, 6,000 Divisions



After 2018 Spring Outage

- All Major leaks repaired during the outage
- Minor leaks still remain (ACC tube/header ??)
- No Hoggers needed to maintain vacuum
- Single SJAE maintaining vacuum near design
- DO (15- 30 ppb) reduced but still slightly elevated
- Fans cycling as expected between 50 – 100% during the summer

Plant Data Summer 2018

