REPAIR &
MITIGATION

HRH Bypass Cracking

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Goreway Power Station

- Brampton, ONT, CAN (Toronto)
- Commercial June 2009
- 875MW 3-on-1
- GE 7FB*.04 Gas Turbines
- SST-5000 Steam Turbine
- EPC – SNC Lavalin

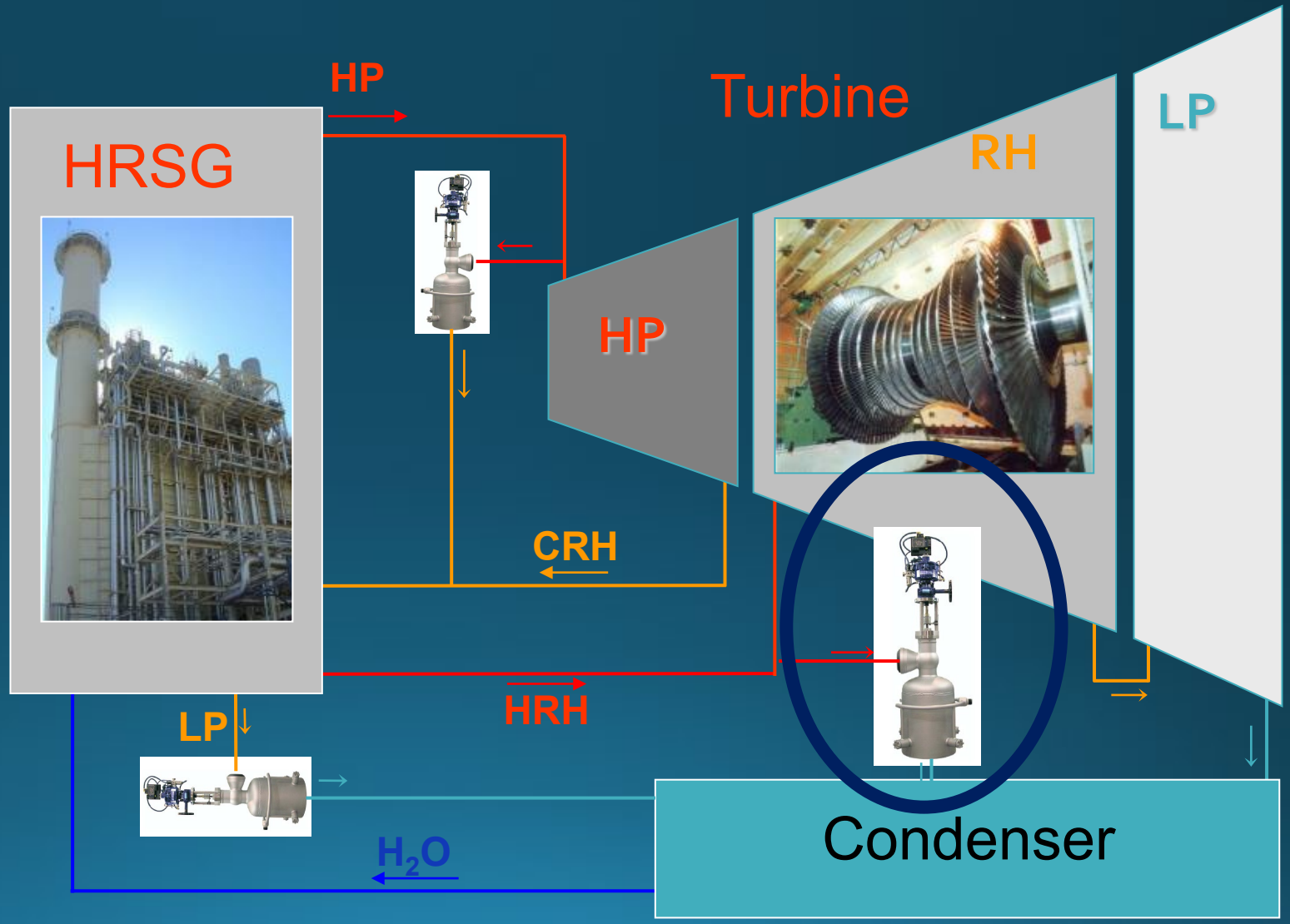
- Purchased by Capital Power in 2019

HRH Bypass – Application Overview

- Bypass HRH steam to condenser during startup, shutdown & trips
- Largest Bypass Valves
  - 16 - 20” Inlet
  - 24 - 42” Outlet
- Highest temperature differences
  - STEAM = ~1050F
  - WATER = ~120F

    >900F Difference!
- Largest spray

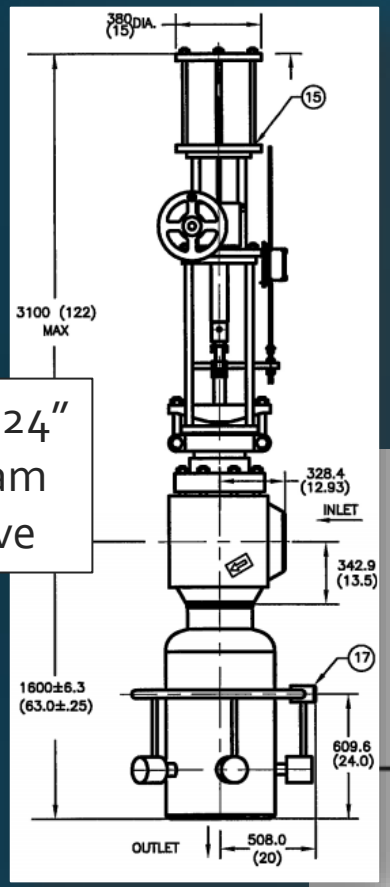
  30% Water to Steam



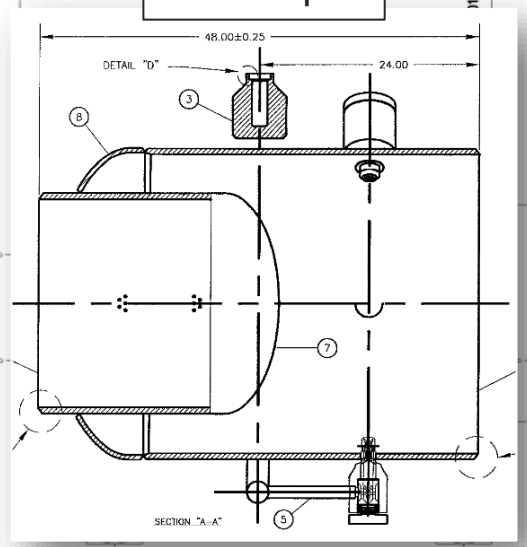
HRH Bypass @ Goreway

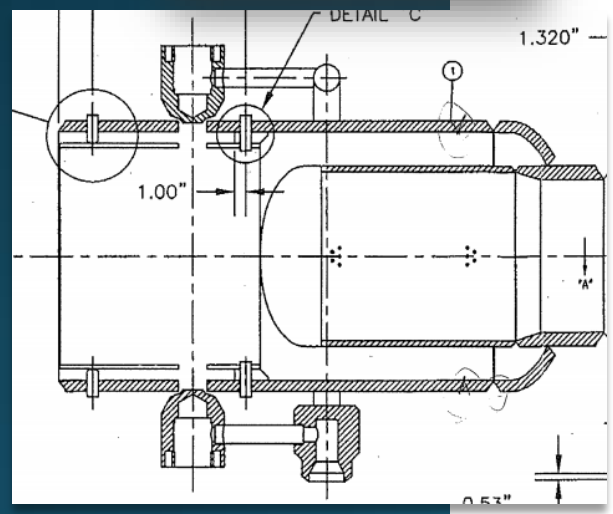
Unique: Dump to ACC, 2-stage desuperheating, Low-Noise

16" x 24" Steam Valve



24" x 34" 2nd Stage Desup





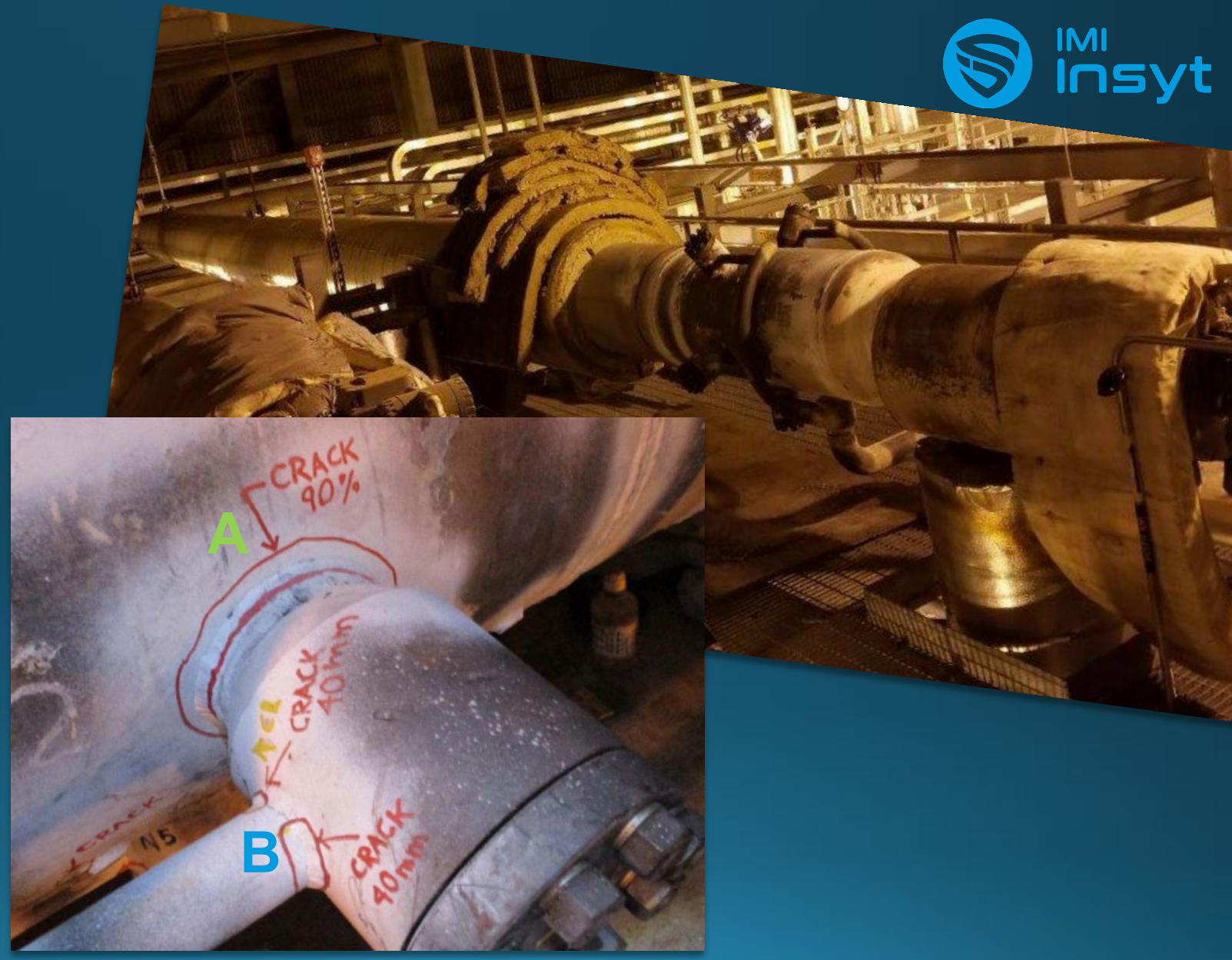
34" Dump to ACC Low-Noise Resistor

Capital Power

IMI Insyt

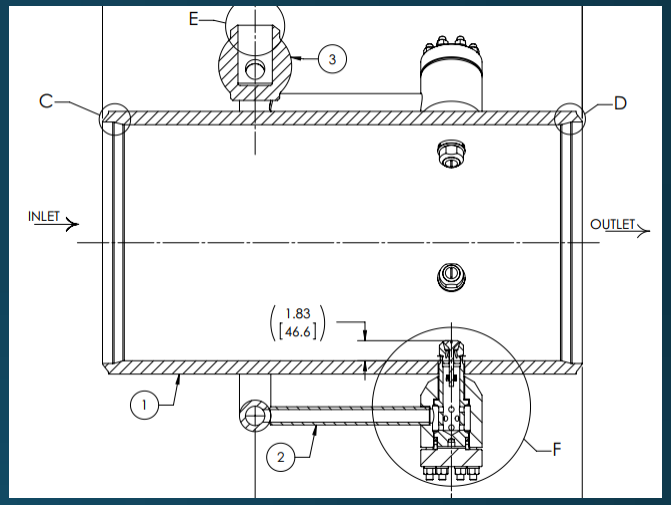
Initial Failures

- Liners removed several years into operation due to cracks
- Cracks at nozzle housing to pipe connections [point **A**]
- Water manifold cracks [point **B**]
- Severity required a new desuperheater



New Desuperheater Installation

- New upgraded desuperheater purchased – only the outer pipe spool, nozzles and manifold
- Major finding during first installation – DIFFUSER FAILURE
  - END PLATE LIBERATION
  - INTERNAL EROSION DAMAGE ON DIFFUSER
- Upgrade design modified to include new diffusers

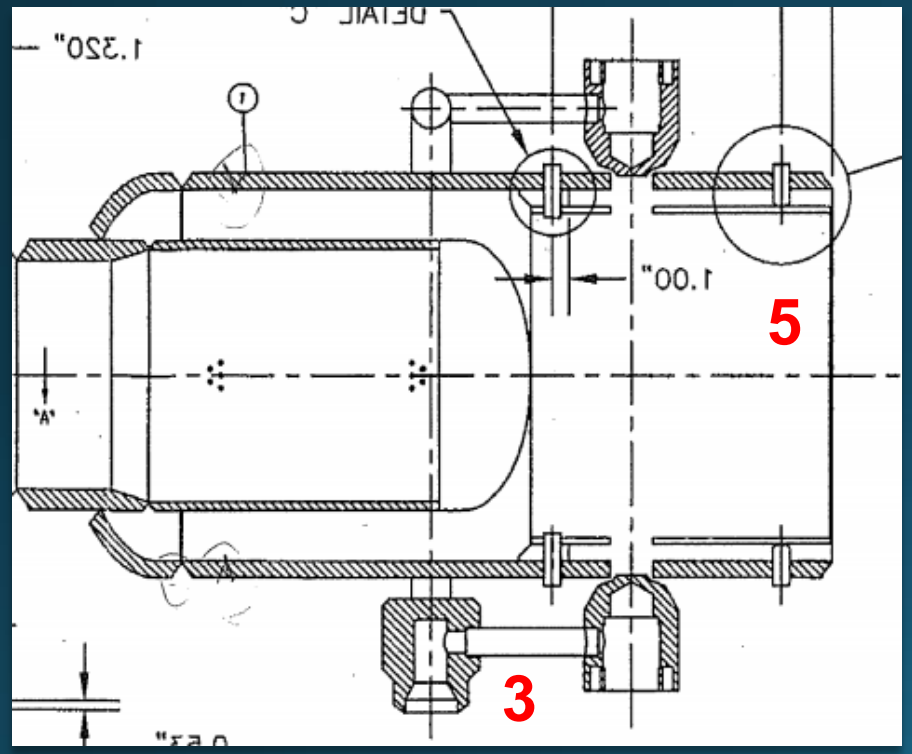


New Desuperheater w/ Diffuser

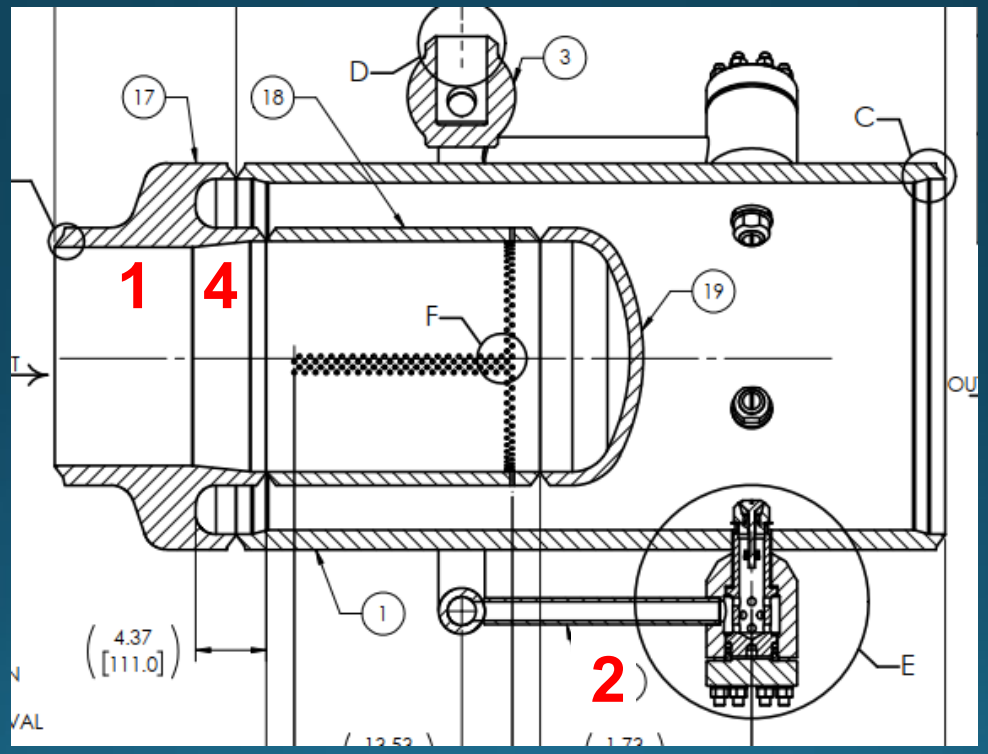
- Original "spool only" desuperheater sent back and modified to include new diffuser
- Final unit being installed this week!

Hardware Upgrade

ORIGINAL DESUPERHEATER



UPGRADED DESUPERHEATER



1. New forged transition piece
2. Longer water legs
3. No water leg into water connection
4. Longer transition to diffuser
5. Liner removed

Mitigation: Root Cause

- Your Problem
- Your Data
- Your System

- Our Knowledge
- Our History
- Our Tools

IMI Insyt

- Solutions
- Savings
- Safety
- Value

Be proactive

Identify plant and equipment issues before cracks and leaks occur.

Delve into data

Use data-driven analytics to improve plant safety and performance.

Improve your ROI

A system-wide analysis saves plant costs and avoids shutdowns.

Data Set

- 4 weeks of data provided – 28 total starts across 3 units
- 104 discrete process variables across 3 units
- 10 second interval
- 25M data points loaded

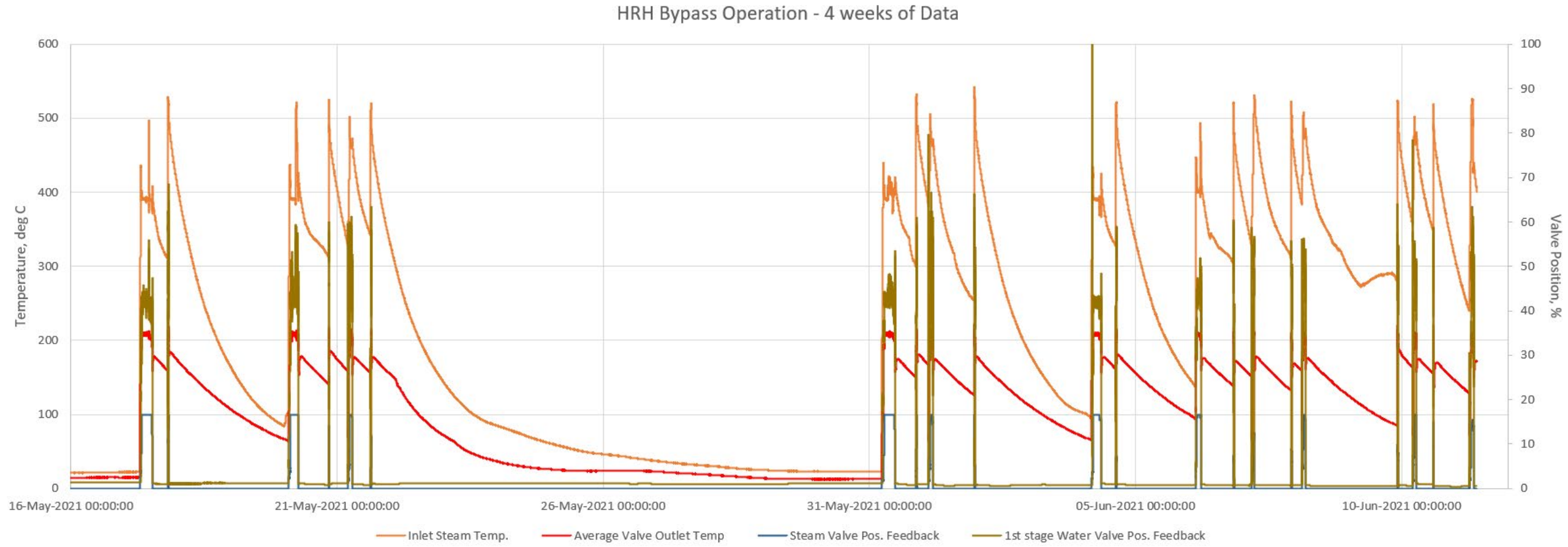
UNIT 11 – 10 Starts	
17-MAY-21	COLD START 6:41AM
17-MAY-21	Shutdown 20:12
20-MAY-21	WARM START 1:50AM
20-MAY-21	Shutdown 20:22
21-MAY-21	HOT START 4:55AM
21-MAY-21	Shutdown 15:22
31-MAY-21	COLD START 5:12AM
31-MAY-21	Shutdown 21:31
01-JUN-21	HOT START 2:40AM
01-JUN-21	Shutdown 23:36
04-JUN-21	WARM START 3:49AM
04-JUN-21	Shutdown 15:23
06-JUN-21	WARM START 2:47AM
06-JUN-21	Shutdown 20:22
07-JUN-21	HOT START 4:22AM
07-JUN-21	Shutdown 22:30
08-JUN-21	HOT START 2:54AM
09-JUN-21	Shutdown 22:22
10-JUN-21	HOT START 5:01AM
10-JUN-21	Shutdown 14:22

UNIT 12 – 9 Starts	
17-MAY-21	COLD START 5:21AM
17-MAY-21	Shutdown 20:12
20-MAY-21	WARM START 1:22AM
20-MAY-21	Shutdown 20:44
21-MAY-21	HOT START 4:40AM
21-MAY-21	Shutdown 15:47
31-MAY-21	COLD START 4:55AM
31-MAY-21	Shutdown 21:31
-	-
-	-
04-JUN-21	COLD START 3:34AM
04-JUN-21	Shutdown 15:42
06-JUN-21	WARM START 2:21AM
06-JUN-21	Shutdown 20:42
07-JUN-21	HOT START 1:32AM
07-JUN-21	Shutdown 22:46
08-JUN-21	HOT START 2:42AM
09-JUN-21	Shutdown 22:42
10-JUN-21	HOT START 4:45AM
10-JUN-21	Shutdown 14:43

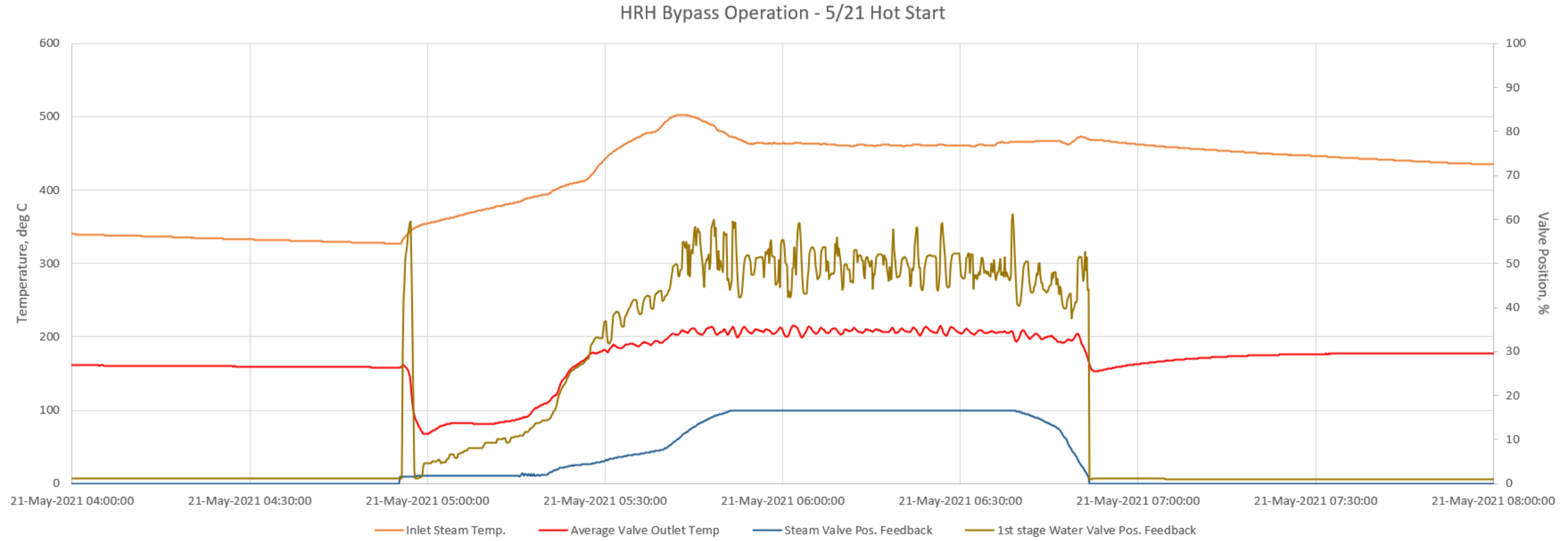
UNIT 13 – 9 Starts	
-	-
-	-
20-MAY-21	COLD START 1:22AM
20-MAY-21	Shutdown 20:43
21-MAY-21	HOT START 4:39AM
21-MAY-21	Shutdown 15:47
31-MAY-21	COLD START 4:53AM
31-MAY-21	Shutdown 18:21
01-JUN-21	HOT START 2:40AM
01-JUN-21	Shutdown 14:40
04-JUN-21	WARM START 3:28AM
04-JUN-21	Shutdown 15:42
06-JUN-21	WARM START 8:23AM
06-JUN-21	Shutdown 20:42
07-JUN-21	HOT START 1:38AM
07-JUN-21	Shutdown 22:46
08-JUN-21	HOT START 2:43AM
09-JUN-21	Shutdown 22:43
10-JUN-21	HOT START 4:45AM
10-JUN-21	Shutdown 14:43

Where to Start?

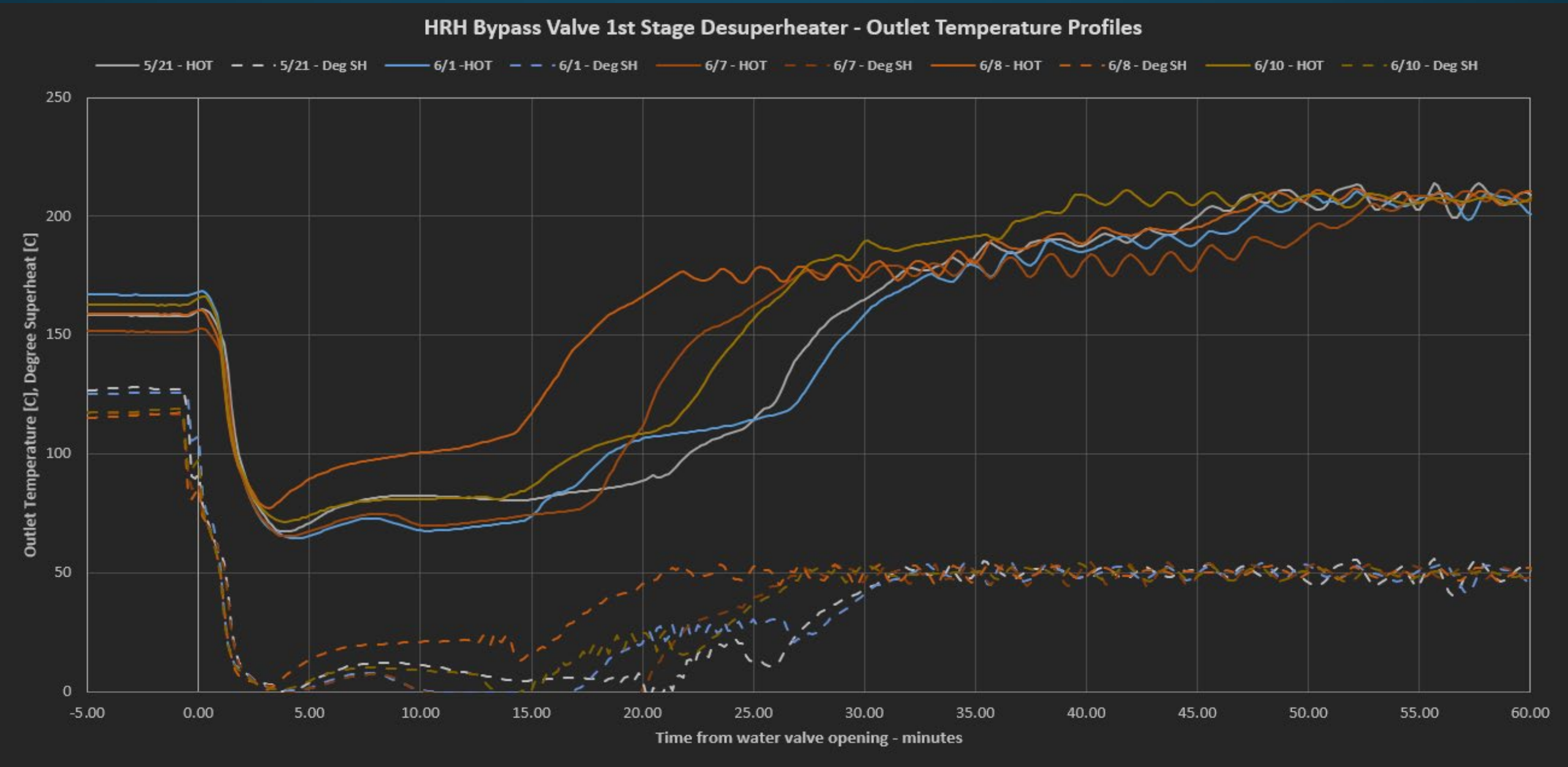
- Visualize the full data set? – Excel UGH!
- What am I looking for? – How deep do I go?



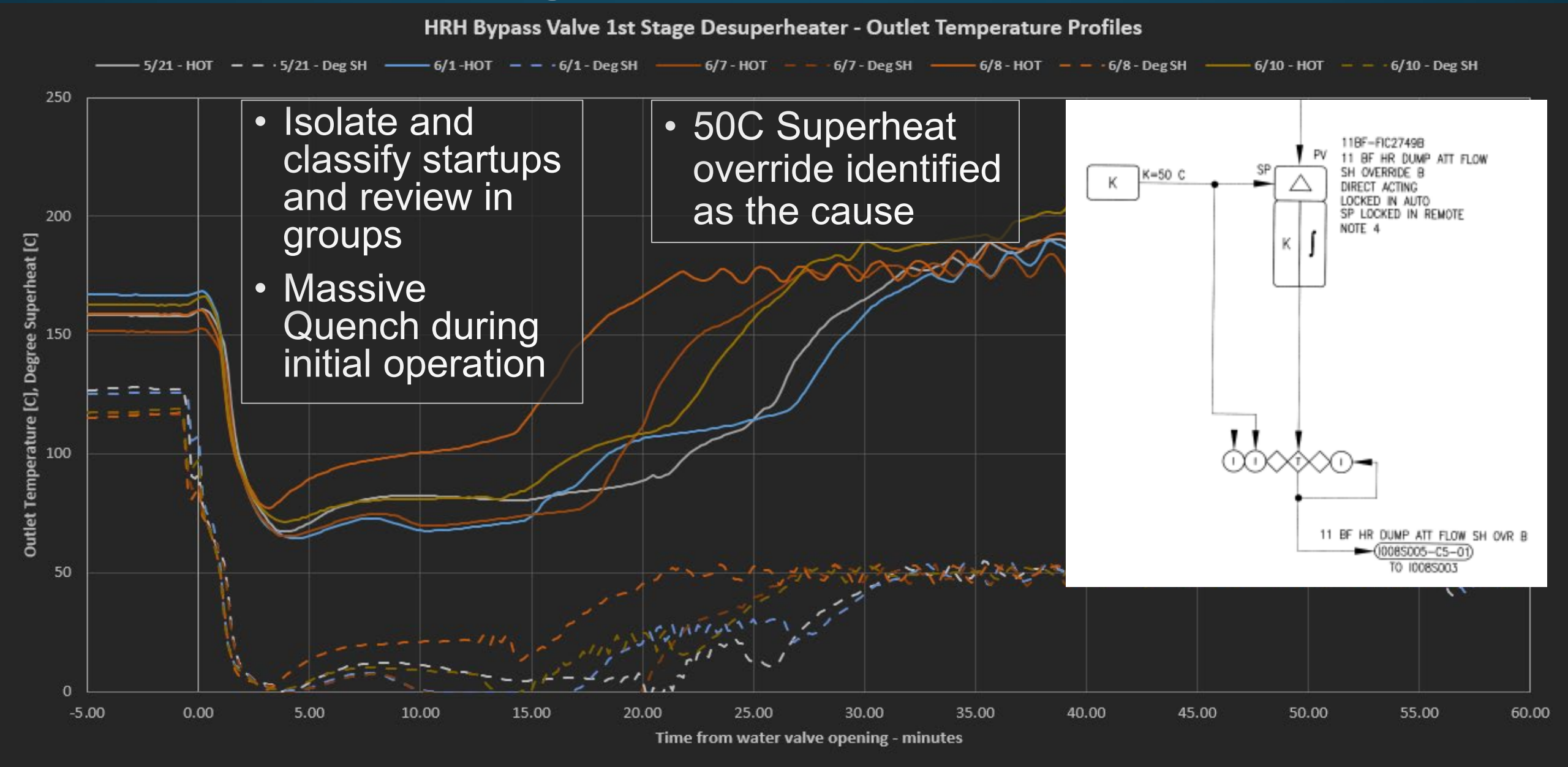
"Strip Chart" of Startup



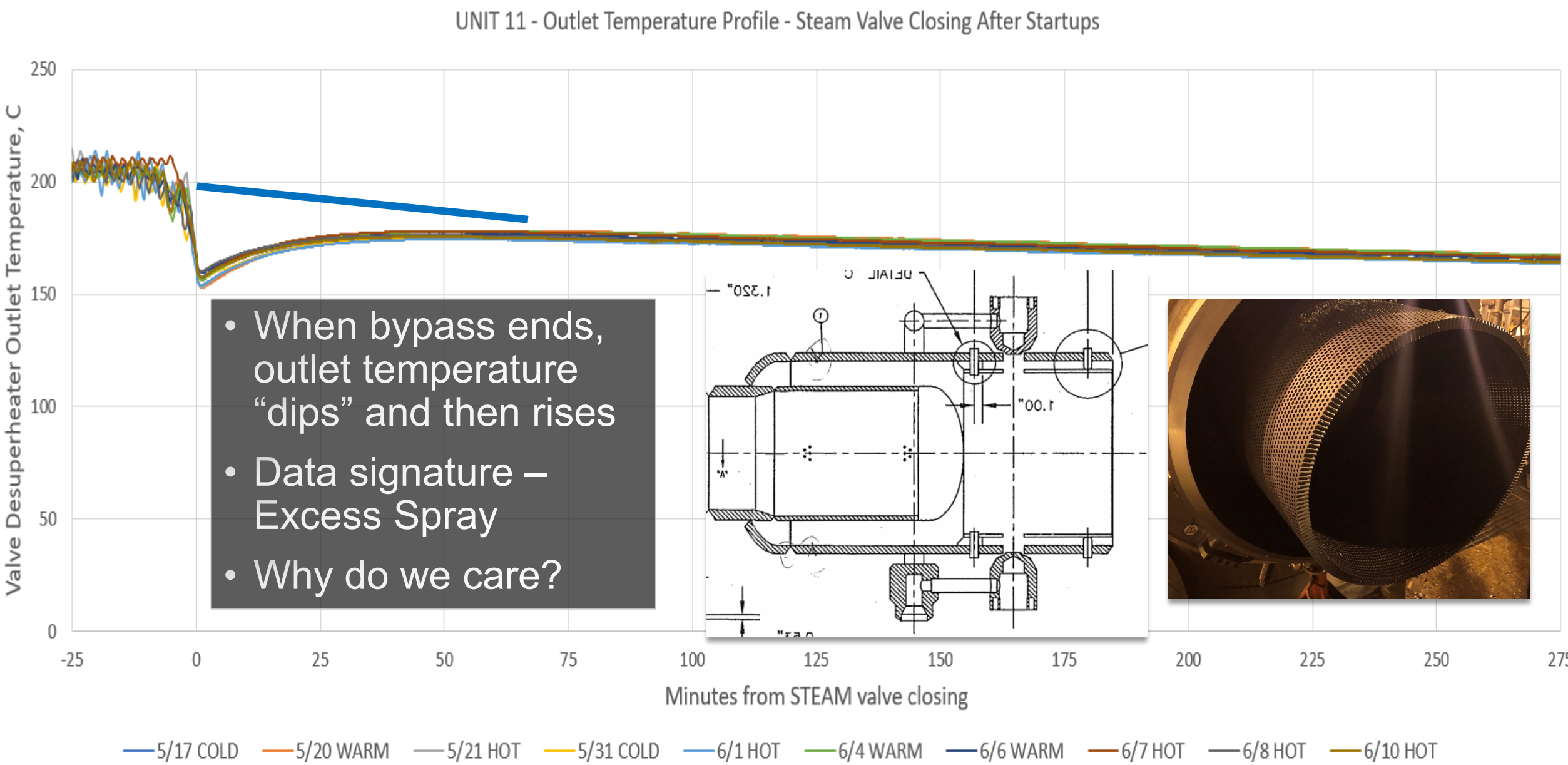
Automation!


HRH Bypass Valve 1st Stage Desuperheater - Outlet Temperature Profiles
5/21 - HOT
5/21 - Deg SH
6/1 -HOT
6/1 - Deg SH
6/7 - HOT
6/7 - Deg SH
6/8 - HOT
6/8 - Deg SH
6/10 - HOT
6/10 - Deg SH
Outlet Temperature [C], Degree Superheat [C]
250
200
150
100
50
0
-5.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
Time from water valve opening - minutes

Critical Finding #1

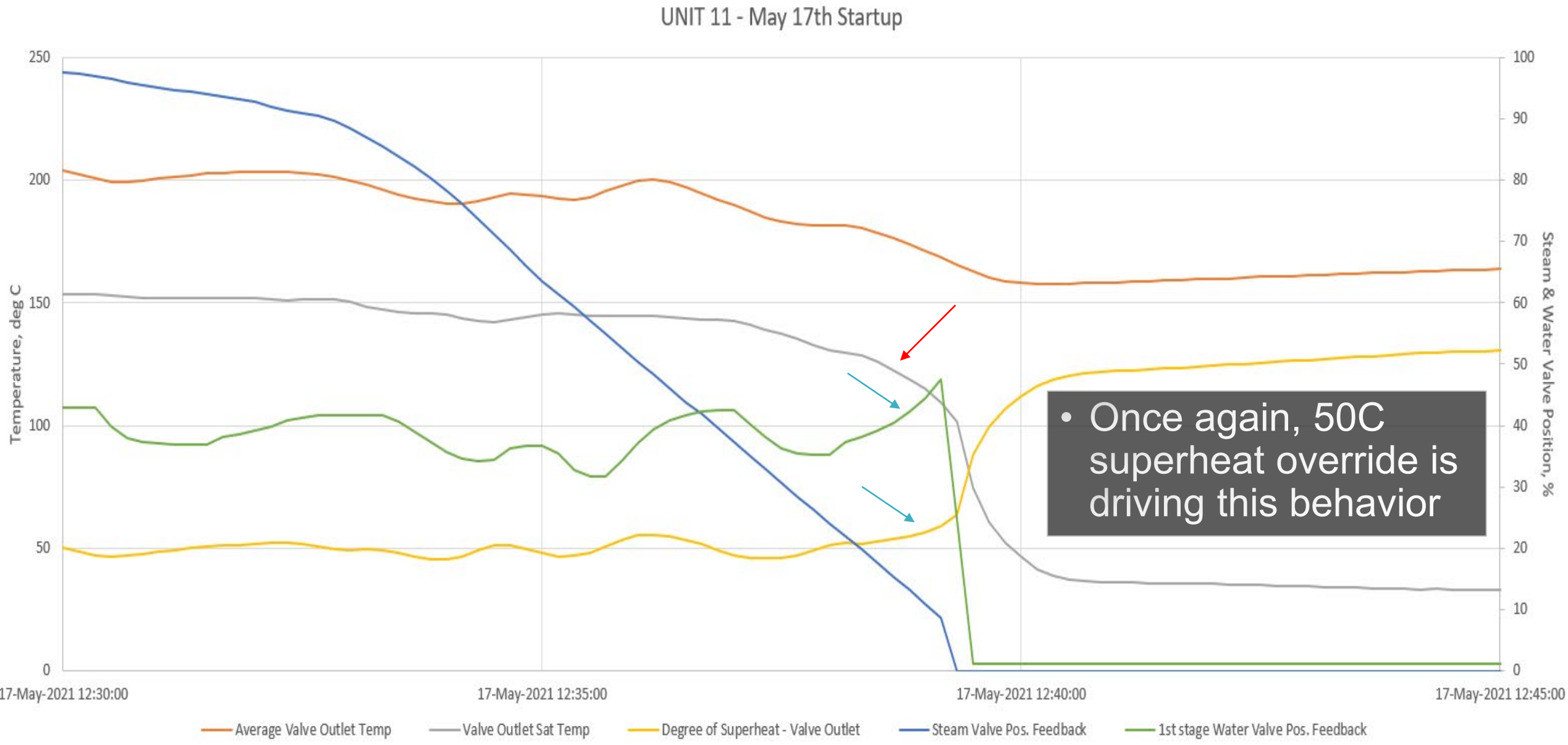


Critical Finding #2



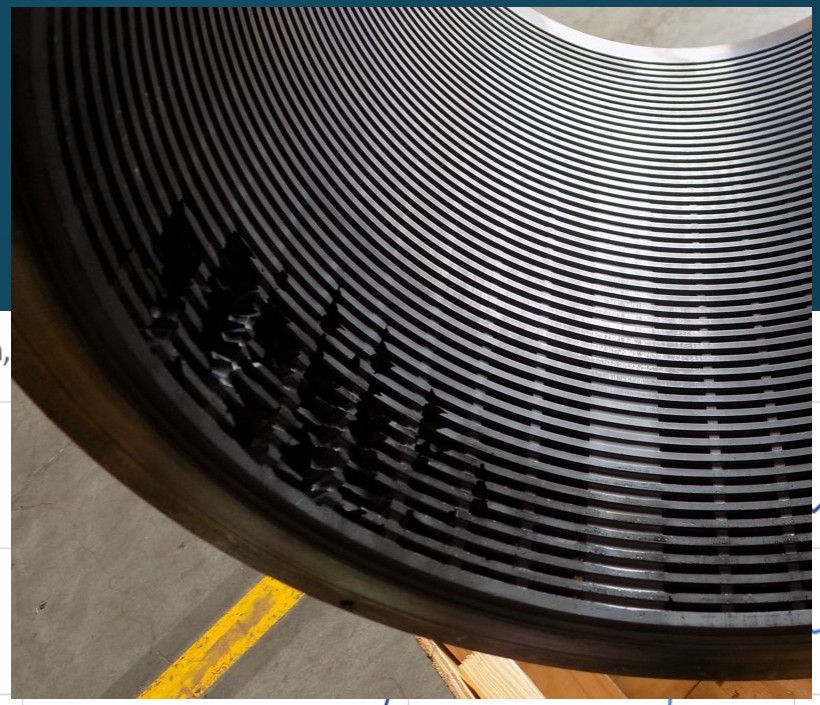
- When bypass ends, outlet temperature "dips" and then rises
- Data signature – Excess Spray
- Why do we care?

Critical Finding #2



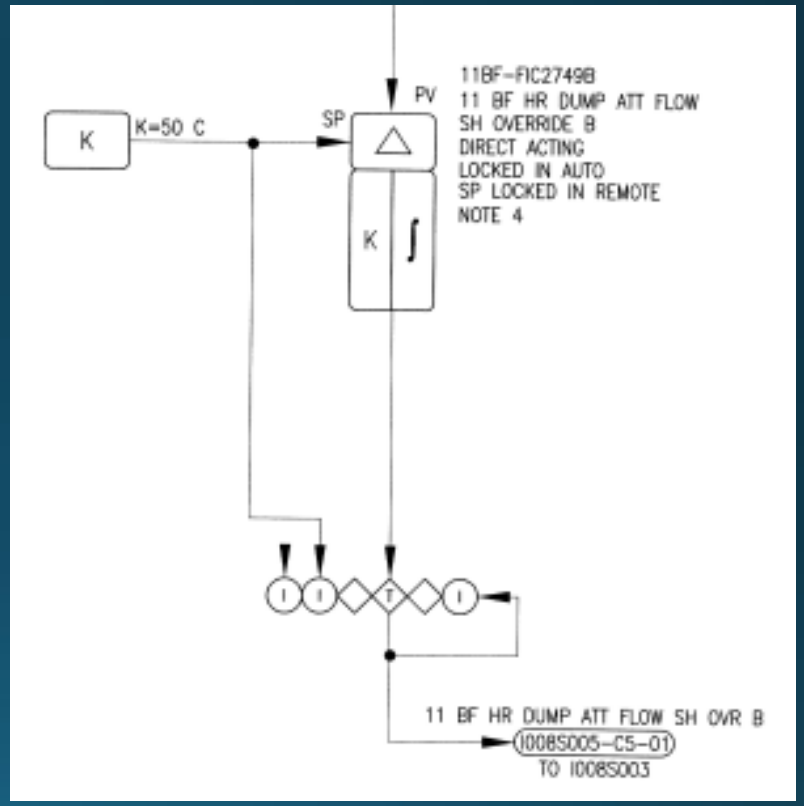
Critical Finding #3

- All Cold and Warm starts had operation with <15C of superheat
- Average of 5 mins per start, Cold & Warm
- >100 PSI differential across valve with potential condensate



Site Modifications

- Desuperheater hardware already upgraded
  - Final assembly being installed this week
- Third party process and controls specialist enlisted to modify control logic – IN PROCESS
  - Modify 50C superheat override
  - Modify bypass lift point during startup
- Evaluating hardware upgrades for wet-steam erosion, EroSolve Trim



Summary

- Bypass valve cracking continues to plague Combined Cycle Plants
- Solution is multi-pronged
  - Hardware Upgrades
  - Data Review
  - Modify Operation
- Each system is Unique – Thorough review required to completely mitigate failure
- If you haven't inspected recently…

  DO IT NOW!