Cycle Isolation Monitoring

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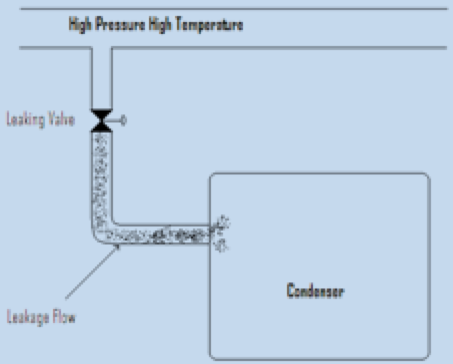
Introduction

- Generating plants often suffer from power losses due to leakages through valves that are faulty and/or do not seat correctly.
- Often these losses are significant and have been difficult to quantify.



Cycle Isolation Monitoring

- Monitor high energy valve leakage
- High energy valve leakage leads to:
  - Increased heat rate
  - Reduced plant efficiency
  - Potential valve damage
  - LOST MW!

1% Leakage Effect on Heat Rate

Location of Leakage in Cycle	Heat Rate Impact
Main Steam	0.80%
Hot Reheat	0.62%

Types of Leakage

- Leakage due to tank level control problems
- Leakage due to AOV valve setting issues
- Leakage due to MOV thermal expansion
- Relief valve drifting
- Steam cutting of valves
- Improper valve alignment
- Leakage resulting from maintenance on the system
- Leakage due to foreign material in the valve
- Leakage from startup valves being left open

What Valves Should Be Monitored

- Feedwater heater dump valves
- Main steam line drain valves
- Gland seal unloader valve
- Turbine bypass valves
- Feedwater heater vent valves
- Gland steam isolation valves
- Extraction steam line drain valves
- Heater bypass valves
- Feed pump recirc valves
- Before and after seat drain valves
- Steam drain line orifices (and orifice bypass valves)

Prioritization of Leakage

- Valve leakage should be frequently identified and tracked
- Prioritization basis
  - Energy level of liquid or vapor upstream of the valve
  - Thermodynamic Impact on cycle
  - Extent of the valve leakage
- Large valves are expensive to repair so make sure the benefit is there
- Also include additional checks that confirm the valve is leaking

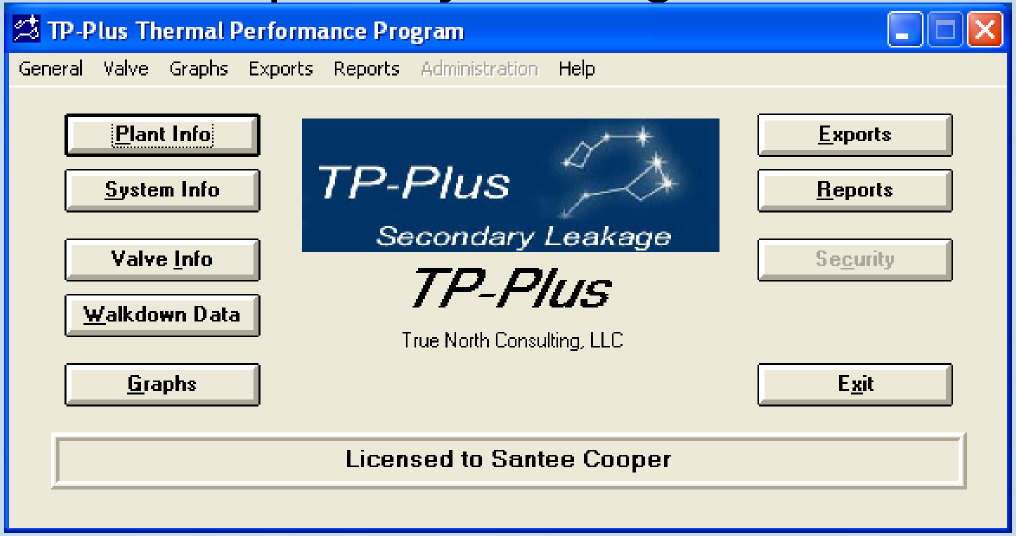
One thing to remember - the size of the leak today will not be the size of the leak tomorrow

Cycle Isolation Monitoring

- True North's TP-Plus Cycle Isolation Monitoring software provides advanced cycle leakage detections.
- This is a valuable tool for any thermal performance program to help quantify both heat rate loss and flow loss from valve problems.
- Uses five different methods to predict valve leakages providing the user with confidence in the results.
- This information is then used to prioritize maintenance and repair of valves.

Cycle Isolation Monitoring

- Data for each valve is entered into input forms or can be imported from spreadsheets which then produce results from advanced cycle isolation loss calculations which can be graphed and reported to monitor valve degradation over time.
- With this new product and associated services, plant personnel can quickly detect and quantify leakage losses in a plant cycle.



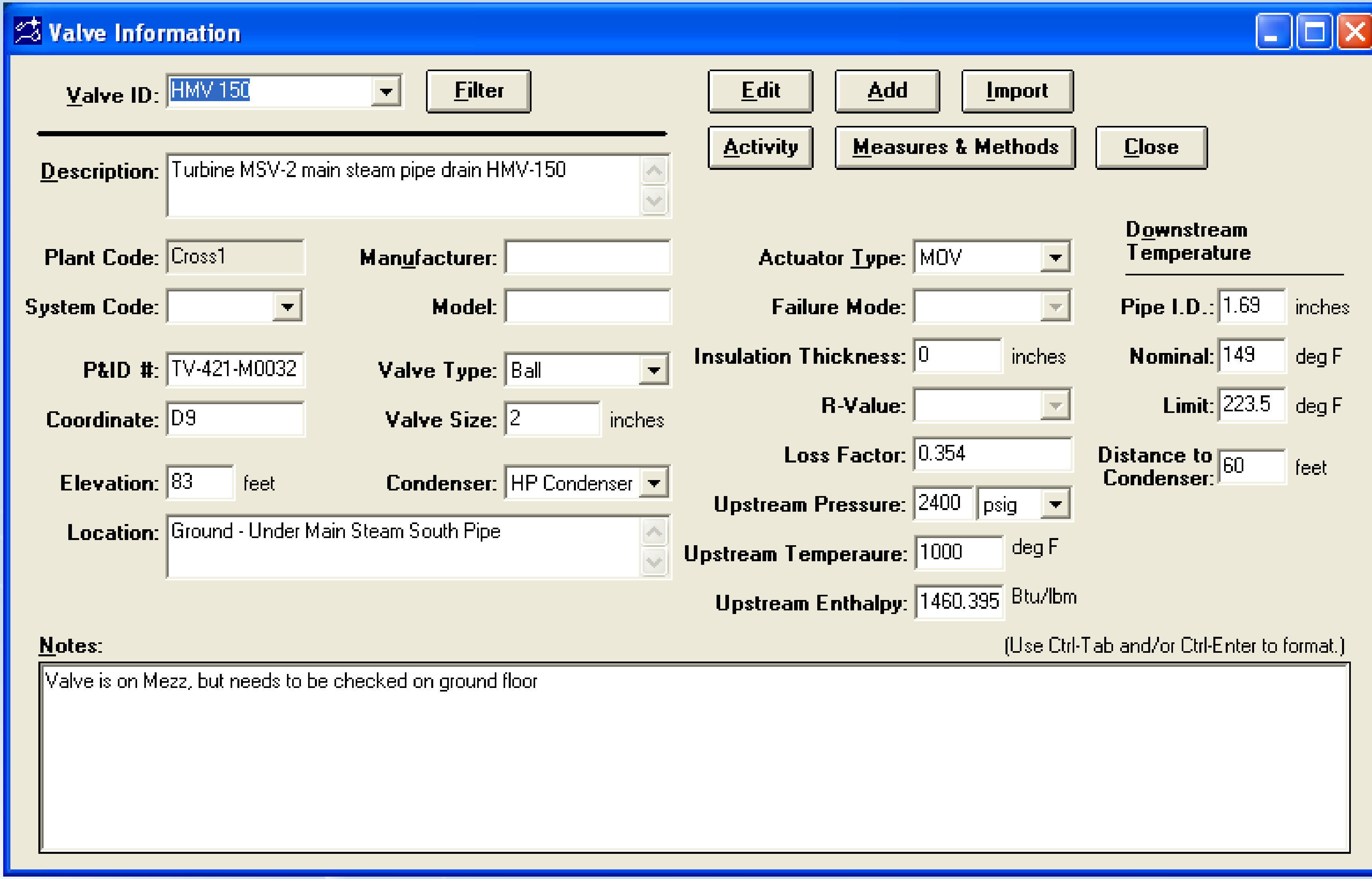
Santee Cooper Cross Station

- Cross Unit 1, authorized by the Santee Cooper Board of Directors in 1990, came online in May 1995, ahead of schedule and under budget.
- 1000F/1000F/2400 psig reheat coal unit rated at 605 MWe gross. It has Scrubbers, SCR, precipitators, and a cooling tower.

Santee Cooper Cross Station

- Santee Cooper has been proactive in testing valves for potential leaks for some time.
- Cross Unit 1 was selected for implementation of TP-Plus to assist their existing program in monitoring and tracking valves and estimating the impact on plant cycle performance.
- Santee Cooper wanted a tool to estimate valve leak flows to quantify the impact on heat rate.
- Results from TP-Plus help to prioritize leaking valves and assist in justification for repair or replacement.

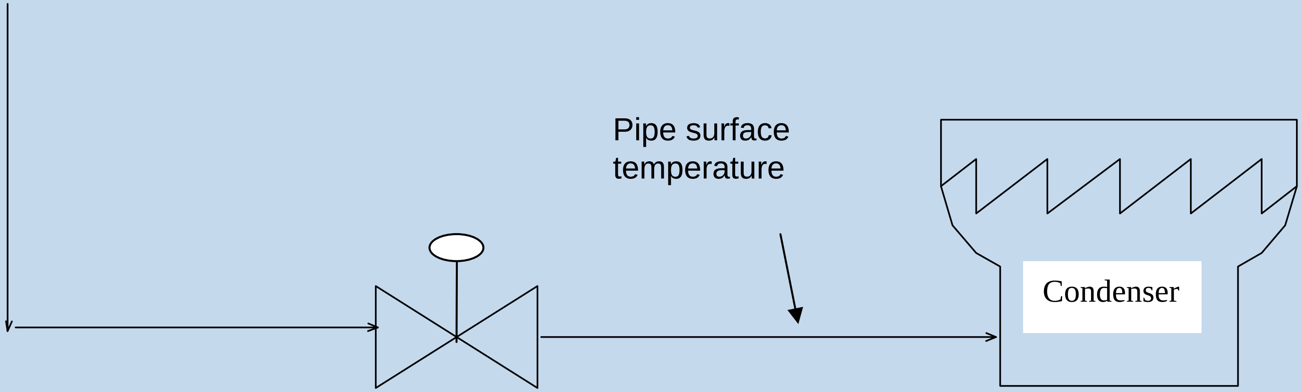
Valve Information Screen



Plant Walkdowns

- Santee Cooper performs frequent walkdowns of valves at Cross 1 taking downstream measurements of temperatures using handheld equipment.
  - Some users of TP-Plus install thermocouples to record temperature measurements.
- Each measurement is recorded using TP-Plus Walkdown Worksheet forms or can be uploaded from spreadsheets or handheld recording devices.

Measurement Locations



- Measure temperature as far downstream of the valve as possible. Be careful of conduction across the valve and piping.

- If using infrared insure it will be in the line of site from a safe location, but getting the device as close as possible to the pipe. Make sure the pipe is not “shiny” and that the hole in the insulation is adequate.

- Know the drawings; look for other paths that could be a source of heat into the location you are measuring.

Walkdown Worksheet

Santee Cooper - Walkdown 057 Worksheet

Walkdown Order	Valve ID	Description	Elevation (feet)	Location	Measure	Previous Value	Current Value
			83		Ambient Temperature		
1	HMV 150	Turbine MSV-2 main steam pipe drain HMV-150	83	Ground - Under Main Steam South Pipe	Downstream Temperature	155.0	
2	HMV 151	Turbine MSV-1 main steam pipe drn HMV-151	83	Ground - Under Main Steam North Pipe	Downstream Temperature	550.0	
3	HMV 152	Turbine reheat steam drain (HRH) HMV-152	83	Ground - Under area between HRH North and South pipes	Downstream Temperature	100.0	
4	HMV 153	Turbine reheat steam drain (HRH) HMV-153	83	Ground - Under area between HRH North and South pipes	Downstream Temperature	104.0	
5	HMV 154	Turbine reheat steam drain (CRH) HMV-154	83	Ground - Under HRH South Pipe (overhead)	Downstream Temperature	130.0	
6	HMV 155	Turbine reheat steam drain (CRH) HMV-155	83	Ground - Under HRH South Pipe (overhead)	Downstream Temperature	100.0	
7	HMV 2027	Turbine steam leads manifold drain HMV-2027	83	Ground - Overhead near HRH North Pipe	Downstream Temperature	160.0	
8	LCV 820	FW Heater 1 A Alternate Drain	83	Ground - Condenser - East Wall	Downstream Temperature	170.0	
9	LCV 821	FW Heater 1 B Alternate Drain	83	Ground - Condenser - East Wall	Downstream Temperature	140.0	
10	LCV 822	FW Heater 2 Alternate Drain	83	Ground - Condenser - East Wall	Downstream Temperature	110.0	
11	LCV 823	FW Heater 3 Alternate Drain	83	Ground - Condenser - East Wall	Downstream Temperature	110.0	
12	LCV 824	FW Heater 4 Alternate Drain	83	Ground - Condenser - West Wall	Downstream Temperature	120.0	
			112		Ambient Temperature		
13	HMV 3275	Boiler hdr and wall drain HMV-3275	112	Between Ground and Mezz - Boiler - SW Corner	Downstream Temperature	115.0	
14	HMV 3276	Boiler hdr and wall drain HMV-3276	112	Between Ground and Mezz - Boiler - SW Corner	Downstream Temperature	125.0	
15	HMV 3269	Boiler hdr and wall drain HMV-3269	112	Between Ground and Mezz - Boiler - SW Corner	Downstream Temperature	260.0	
16	HMV 3270	Boiler hdr and wall drain HMV-3270	112	Between Ground and Mezz - Boiler - SE Corner	Downstream Temperature	105.0	
17	HMV 3271	Boiler hdr and wall drain HMV-3271	112	Between Ground and Mezz - Boiler - SE Corner	Downstream Temperature	210.0	
18	HMV 3272	Boiler hdr and wall drain HMV-3272	112	Between Ground and Mezz - Boiler - NW Corner	Downstream Temperature	265.0	
19	HMV 3284	Boiler hdr and wall drain HMV-3284	112	Between Ground and Mezz - Boiler - NE Corner	Downstream Temperature	200.0	
20	HMV 3273	Boiler hdr and wall drain HMV-3273	112	Between Ground and Mezz - Boiler - NE Corner	Downstream Temperature	120.0	

Valve Leakage Summary

Santee Cooper - Valve Leakage Summary

Walkdown 056 - Monday, 28 July 2008 13:17

Valve ID	Description	Type	Size (inches)	System Code	Temperature Limit (deg F)	Downstream Temperature (deg F)	Average Leakage (lbm/hr)	Average Loss (MWe)
LV364	#4 Htr Ext. before NR valve drain - orifice	Globe	2		190.0	300.0	2717.6	0.1
LV365	#4 Htr Ext. before NR valve drain - orifice	Globe	2		180.0	280.0	2859.2	0.1
HMV2026	Turbine CRV-2 after seat drain (HRH) HMV-2026	Globe	2		195.0	230.0	579.7	0.1

Valve Leakage Detail

Santee Cooper - Valve Leakage Detail
Walkdown 056 - Monday, 28 July 2008 13:17

Valve ID: LV 364
Description: #4 Htr Ext. before NR valve drain - orifice

System: :
Manufacturer:
Model:
Actuator Type: AOV
Failure Mode:
Loss Factor: 0.0737

PID: EX-421-M0015
Coordinate: G5
Valve Type: Globe
Valve Size: 2 inches
Upstream Pressure: 67.9 psia
Upstream Temperature: 493.7 deg F
Upstream Enthalpy: 1279.3 Btu/lbm

Elevation: 122 feet
Condenser: LP Condenser
Pipe I.D.: 1.94 inches
Distance to Condenser: 55 feet

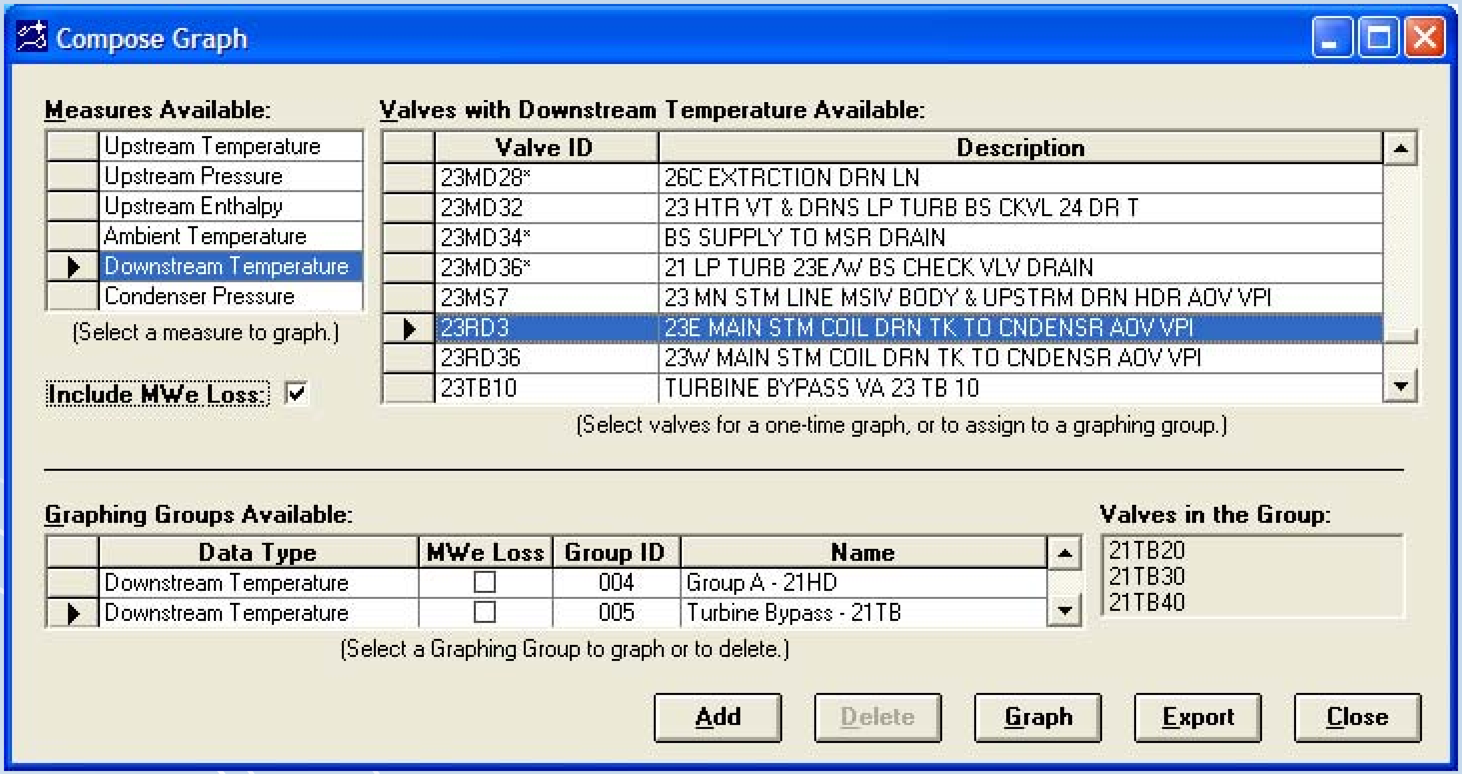
Location: Mezzanine - Between BFP A and Htr 1B

Notes:

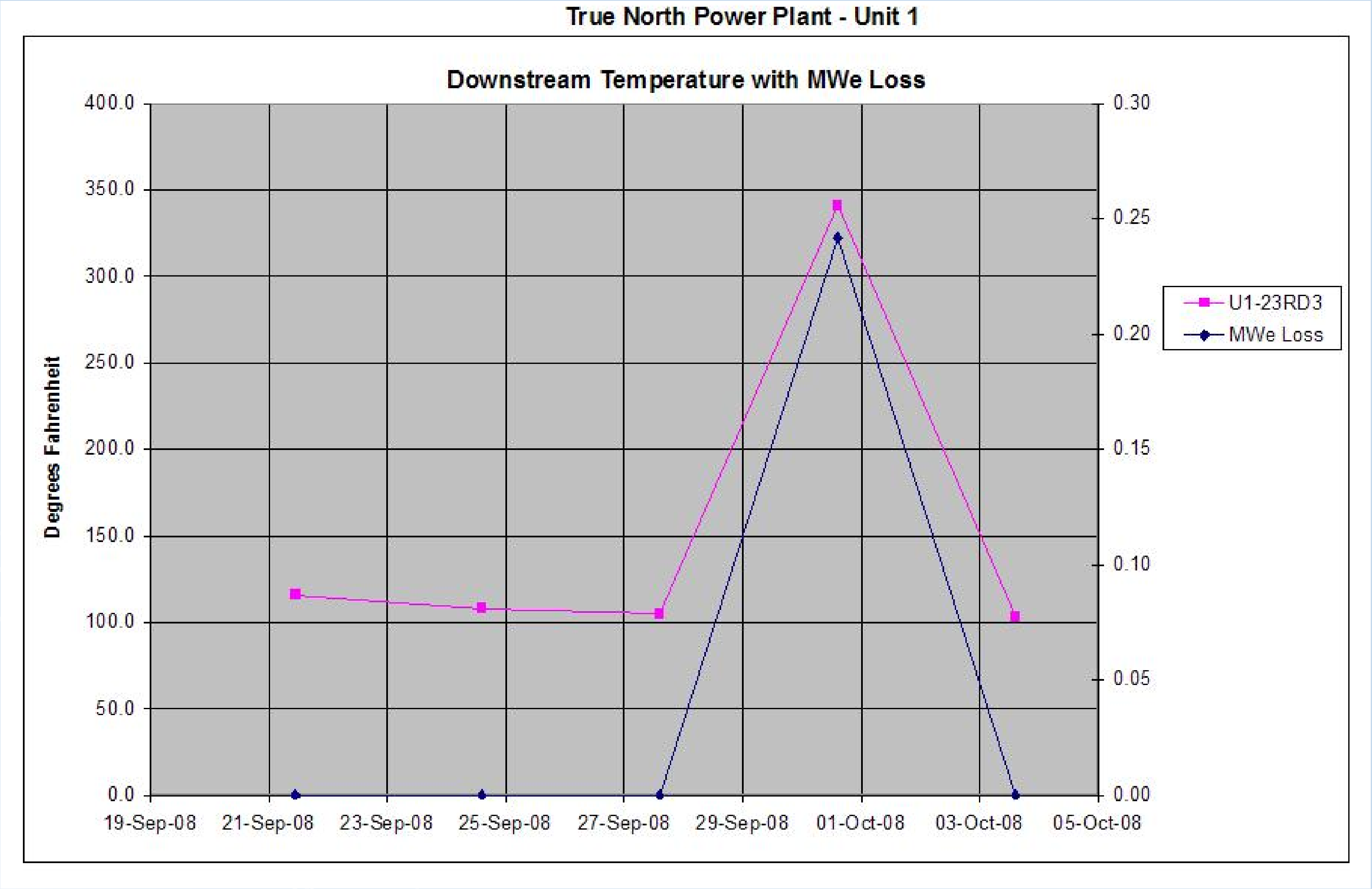
Measurement	***	Walkdown Value	Walkdown 056 Value	Nominal	Limit	Avg	Std Dev	Avg - SD	Avg + SD	Min	Median	Max
Upstream Temperature			493.7			493.7	0.0	493.7	493.7	493.7	493.7	493.7
Upstream Pressure			67.9			67.9	0.0	67.9	67.9	67.9	67.9	67.9
Upstream Enthalpy			1279.3			1279.3	0.0	1279.3	1279.3	1279.3	1279.3	1279.3
Ambient Temperature			90.0			90.0	0.0	90.0	90.0	90.0	90.0	90.0
Downstream Temperature			300.0	130.0	190.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Condenser Pressure			3.0			3.0	0.0	3.0	3.0	3.0	3.0	3.0

	Leakage (lbm/hr)	Loss (MWe)
	2715.6	0.1
	2683.9	0.1
	2787.9	0.1
	2657.6	0.1
	2742.8	0.1
Average:	2717.6	0.1

Graphing Interface Menu

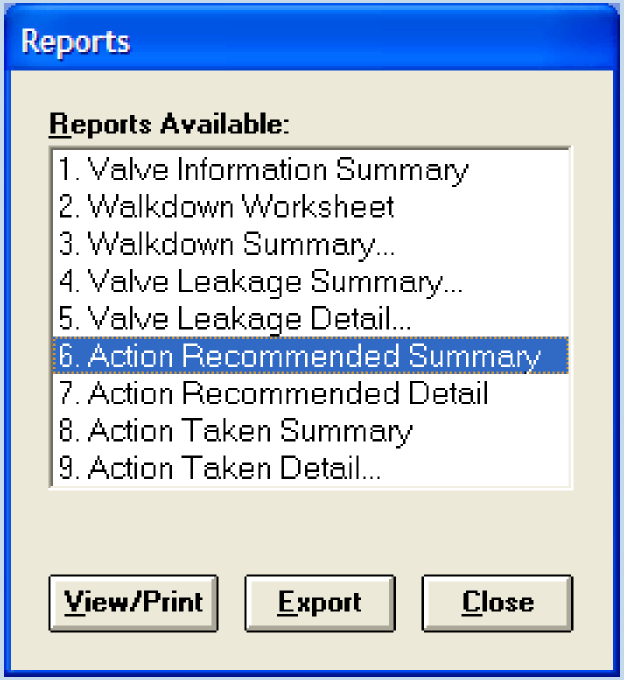


Graphing



True North Power Plant - Unit 1
Downstream Temperature with MWe Loss
Degrees Fahrenheit
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0.30
0.25
0.20
0.15
0.10
0.05
0.00
19-Sep-08
21-Sep-08
23-Sep-08
25-Sep-08
27-Sep-08
29-Sep-08
01-Oct-08
03-Oct-08
05-Oct-08
U1-23RD3
MWe Loss

Action Reports



Action Recommended Reports

TRUE NORTH CONSULTING, LLC

Demo Plant 4 - Action Recommended Summary

As of Thursday, 10 Jan 2008 15:34

(This is a list of the valves for which remedial action has been recommended, but action has not yet been taken.)

Valve ID	Description	System Code	System Name	Walkdown ID, Date	Workorder Request	Workorder	Avg. Loss (MWe)
21BF32	21 SGFP RECIRC CONTROL VALVE VPI	BF		069: Monday 07 Jan 2008 11:43	1234	1A	0.032
21HD37	24A FW HTR DRN CLR BYPASS DRN TO CNDENSR ADV VPI	HD		067: Saturday 05 Jan 2008 11:33	1235	1B	0.027

Action Taken Reports

Demo Plant 4 - Action Taken Summary

As of Thursday, 10 Jan 2008 16:18

(This is a list of the valves for which remedial action has been performed, for a given walkdown.)

Valve ID	Description	System Code	System Name	Walkdown ID, Date	Workorder Request	Workorder	Action Taken	Retest Result	Avg. Loss (MWe)
21BF32	21 SGFP RECIRC CONTROL VALVE VPI	BF		069: Sunday 06 01 2008 11:38	1234	1A	Repaired	Passed	0.0
21HD2	26A FW HTR DRN CLR BYPASS DRN TO CNDENSR ADV VPI	HD		069: Monday 07 01 2008 11:43	1235	1B	Repaired	Passed	0.0
21HV9	23 FWH VENT	HV		069: Monday 07 01 2008 11:43	1236	1C	Repaired	Passed	0.0

Conclusion

- Prioritize valve leakages
- Program to structure leakage measurement
- Tracking of leaking valves can be very rewarding
  - Estimate flow losses to cycle
  - Estimate lost generation and heat rate impact

Recent Results