FAMOS Energy Loss Events

2020 Curtiss Wright Plant Symposium

January 2020

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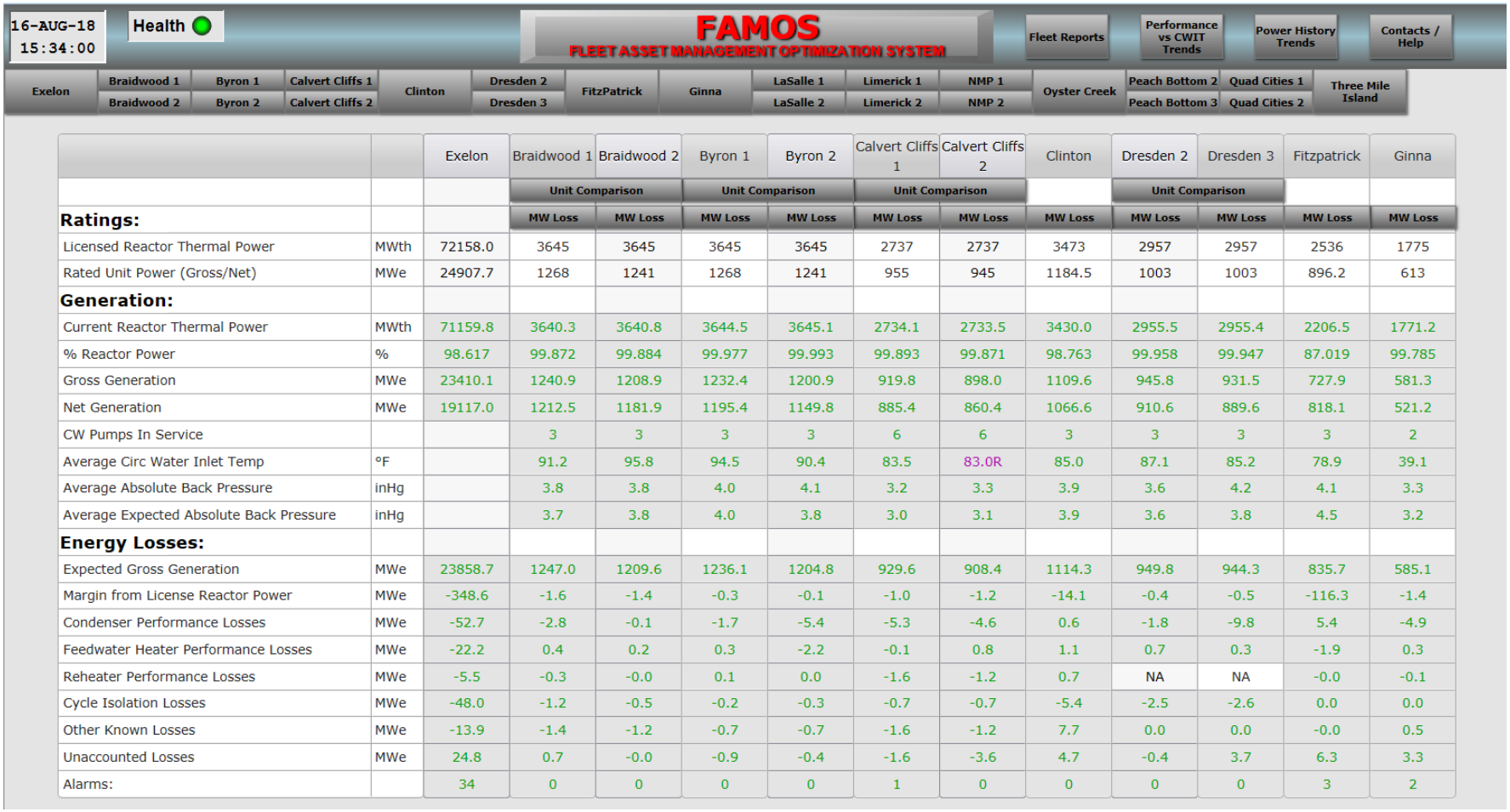
Exelon Generation®

FAMOS Fleet Level Display

- The default homepage serves as the center for each Site's trends and reports while providing a fleet overview



		Exelon	Braidwood 1	Braidwood 2	Byron 1	Byron 2	Calvert Cliffs 1	Calvert Cliffs 2	Clinton	Dresden 2	Dresden 3	Fitzpatrick	Ginna
			Unit Comparison		Unit Comparison		Unit Comparison			Unit Comparison			
Ratings:			MW Loss	MW Loss	MW Loss	MW Loss	MW Loss	MW Loss	MW Loss	MW Loss	MW Loss	MW Loss	MW Loss
Licensed Reactor Thermal Power	MWth	72158.0	3645	3645	3645	3645	2737	2737	3473	2957	2957	2536	1775
Rated Unit Power (Gross/Net)	MWe	24907.7	1268	1241	1268	1241	955	945	1184.5	1003	1003	896.2	613
Generation:													
Current Reactor Thermal Power	MWth	71159.8	3640.3	3640.8	3644.5	3645.1	2734.1	2733.5	3430.0	2955.5	2955.4	2206.5	1771.2
% Reactor Power	%	98.617	99.872	99.884	99.977	99.993	99.893	99.871	98.763	99.958	99.947	87.019	99.785
Gross Generation	MWe	23410.1	1240.9	1208.9	1232.4	1200.9	919.8	898.0	1109.6	945.8	931.5	727.9	581.3
Net Generation	MWe	19117.0	1212.5	1181.9	1195.4	1149.8	885.4	860.4	1066.6	910.6	889.6	818.1	521.2
CW Pumps In Service			3	3	3	3	6	6	3	3	3	3	2
Average Circ Water Inlet Temp	°F		91.2	95.8	94.5	90.4	83.5	83.0R	85.0	87.1	85.2	78.9	39.1
Average Absolute Back Pressure	inHg		3.8	3.8	4.0	4.1	3.2	3.3	3.9	3.6	4.2	4.1	3.3
Average Expected Absolute Back Pressure	inHg		3.7	3.8	4.0	3.8	3.0	3.1	3.9	3.6	3.8	4.5	3.2
Energy Losses:													
Expected Gross Generation	MWe	23858.7	1247.0	1209.6	1236.1	1204.8	929.6	908.4	1114.3	949.8	944.3	835.7	585.1
Margin from License Reactor Power	MWe	-348.6	-1.6	-1.4	-0.3	-0.1	-1.0	-1.2	-14.1	-0.4	-0.5	-116.3	-1.4
Condenser Performance Losses	MWe	-52.7	-2.8	-0.1	-1.7	-5.4	-5.3	-4.6	0.6	-1.8	-9.8	5.4	-4.9
Feedwater Heater Performance Losses	MWe	-22.2	0.4	0.2	0.3	-2.2	-0.1	0.8	1.1	0.7	0.3	-1.9	0.3
Reheater Performance Losses	MWe	-5.5	-0.3	-0.0	0.1	0.0	-1.6	-1.2	0.7	NA	NA	-0.0	-0.1
Cycle Isolation Losses	MWe	-48.0	-1.2	-0.5	-0.2	-0.3	-0.7	-0.7	-5.4	-2.5	-2.6	0.0	0.0
Other Known Losses	MWe	-13.9	-1.4	-1.2	-0.7	-0.7	-1.6	-1.2	7.7	0.0	0.0	-0.0	0.5
Unaccounted Losses	MWe	24.8	0.7	-0.0	-0.9	-0.4	-1.6	-3.6	4.7	-0.4	3.7	6.3	3.3
Alarms:		34	0	0	0	0	1	0	0	0	0	3	2

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MW Loss Event on Home Display

		LaSalle 1	LaSalle 2	Limerick 1	Limerick 2	Peach Bottom 2
		Unit Comparison		Unit Comparison		Unit Com
Ratings:		MW Loss	MW Loss	MW Loss	MW Loss	MW Loss
Licensed Reactor Thermal Power	MWth	3546	3546	3515	3515	4016
Rated Unit Power (Gross/Net)	MWe	1161	1159	1203	1206	1367
Generation:						
Current Reactor Thermal Power	MWth	3333.2	3541.6	3518.5	3515.1	4013.1
	%	94.003	99.875	100.005	100.003	99.924
	MWe	1133.4	1210.7	1172.1	1228.2	1374.0
	MWe	1120.2	1195.2	1135.1	1191.2	1352.0
		2	2	4	4	3
Average [illegible] Water Inlet Temp	°F	55.5	55.6	63.6	62.9	40.8
Average Absolute Back Pressure	inHg	2.2	2.0	1.9	2.0	1.9
Average Expected Absolute Back Pressure	inHg	2.1	2.0	1.8	2.0	1.4
Energy Losses:		MW Loss		MW Loss		
Expected Gross Generation	MWe	1214.0	1213.9	1229.6	1231.9	1379.1
Margin from License Reactor Power	MWe	-72.3	-1.5	0.1	0.0	-1.1
Condenser Performance Losses	MWe	-2.0	-0.0	-1.6	0.3	-5.4
Feedwater Heater Performance Losses	MWe	0.5	2.8	-51.2	2.5	-2.0
Reheater Performance Losses	MWe	0.2	-0.1	NA	NA	NA
Cycle Isolation Losses	MWe	-0.5	-5.5	-6.1	-3.7	-1.3
Other Known Losses	MWe	-0.3	-0.1	-8.5	0.0	-1.5
Unaccounted Losses	MWe	-8.2	-1.4	9.7	-3.8	7.3
Alarms:		6	12	13	5	1

MW Loss in red is shown for sites that are currently experiencing a MW Loss Event

FAMOS Lost MW Advisor

Energy Loss Event Identified by PMAX

Click to Access FAMOS Lost MW Event Tracker

17-JAN-20 15:21:19 | BAD 37 | IVM 4 | Health | Alarm

PMAX Lost MW Advisor

Calvert Cliffs Nuclear Station Unit 1

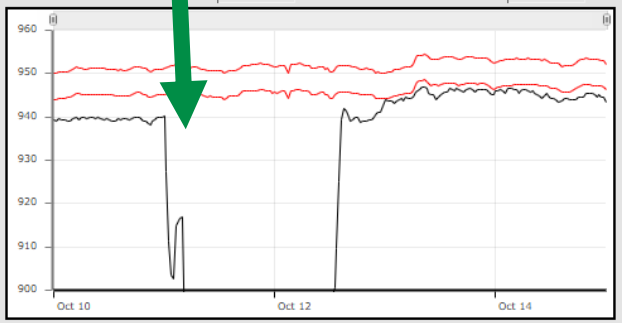
Gross MW 960 | Best Achievable (MW) 964.1 | Delta (MW) -4.2 | Thermal Power (MWth) 2732.5 | (%) 99.8

Lost MW Advisor | Lost MW Events | Plant Overview | Steam Generator | HP Turbine (LP A, LP B, LP C) | MSRs | Condensers | FWH (HP, LP) | Pumps | Generator | Cycle Isolation | Manual Inputs | What If? | DVR | Site Reports | PdP | Rules | CC2 | Unit Compare | Exelon

Item	Units	Actual	Expected
Reactor Power	MWt	2732.5	2737.0
Reactor Power			0.000
Gross Generatio			64.1
Gross Heat Rate			729
Net Generation			27.1
Net Heat Rate			0117
Auxiliary Power			67.0

Gross Generation vs Expected

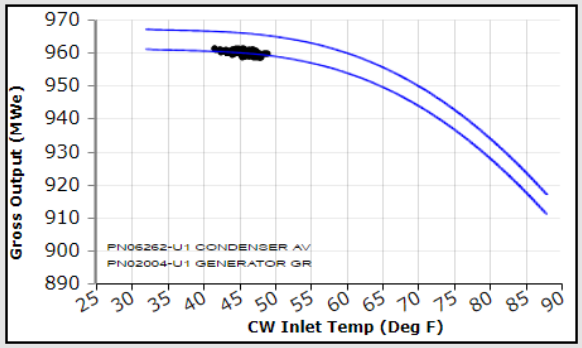
Actual MWe 960.0 | Expected MWe (Low Bound) 959.8 | Expected MWe (High Bound) 965.8



MW Deviations	MW Effect (MW)
Summary or Recoverable Losses	-3.4
Summary or Unrecoverable Losses	0.1
Total Accounted MW Deviations	-3.3
Unaccounted MW Deviations	-0.9

HP Turbine Normal	MSRs Normal	Condensers Normal	Circ Water Normal	Unit Down Powered	6th Stg FWH OOS
LP Turbines Normal	FWHs In Alarm!	Pumps Normal	Generator Normal	CWP OOS	5th & 6th Stg FWH OOS

Performance vs CWIT



Recoverable Losses (-Loss +Gain)	Units	Actual	Expected	MW Effect (MW)
Reactor Power Less than 100%	MWth	2732.5	2737.0	-1.6
Condenser and CW Performance	in hga	1.2	1.2	-0.1
Off-nominal MSR (or Moist. Sep.) Operation/Condition				0.1
--MS MR Effectiveness Recoverable Losses				0.0J
--Reheater TTD Recoverable Losses				0.1
Generator Electrical Loss Adjustment				-0.1
--Generator Hydrogen Pressure	psig	60.0J	60.0	In PF Loss
--Generator Hydrogen Purity	%	98.0J	98.0	0.0
Off-nominal FW Heater Performance				-1.0
--FW Heater TTD & DCA Losses				-1.0
--FWH Tube Leakage				0.0J
Cycle Isolation and Valve Leakage				-0.6
--Cycle Isolation Losses (exc. FWH Vents)				-0.6
Feedwater Errors (including Venturi Fouling & LEFM errors)				0.0

Start Time: 01/10/2020 15:14:57

End Time: 01/17/2020 15:14:57

Archive Rate: 30 minutes

Update Rate: 5 minutes

Unrecoverable Losses: (-Loss + Gain)	Units	Actual	Expected	MW Effect (MW)
Turbine Design Input Doesn't Match Reactor Licensed Power				0.0J
Nominal FW Heater Variations and Adjustments				0.0
--Vent Losses				0.0
--Difference from Design				0.0J

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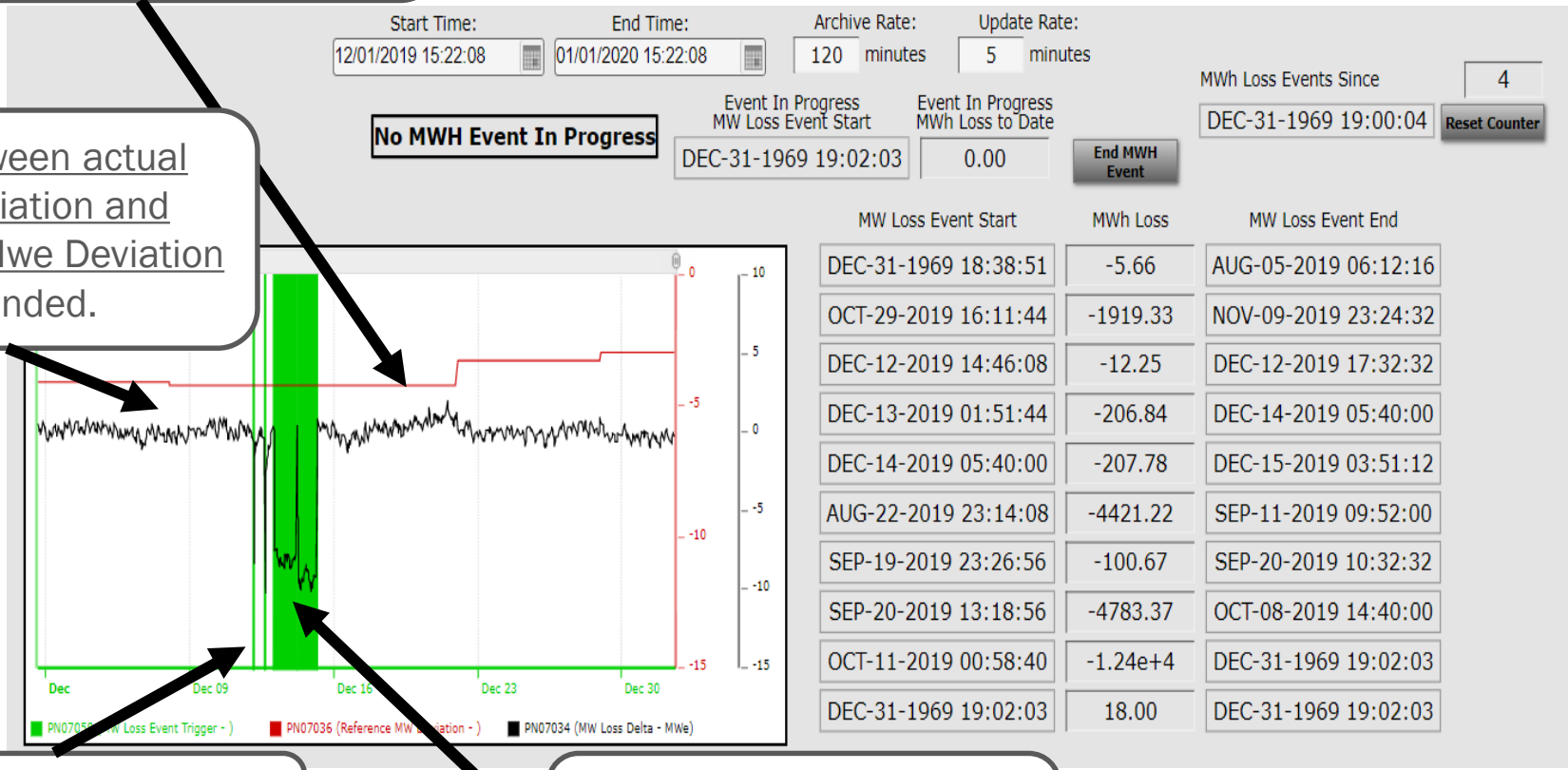
FAMOS Lost MW Events Tracker

Reference Mwe Deviation from expected. Updated weekly to prevent flagging slow declines as “events”.

Delta between actual Mwe Deviation and Reference Mwe Deviation is trended.

Small events are not saved or reported

Events tracked and loss integrated when MW loss exceeds threshold



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FAMOS Lost MW Events Tracker

- Energy Loss Events are automatically exported to Excel for use in KPI's and Equip. Reliability Reporting
  - Provided on Individual Site Level and Fleetwide Level
- Thermal Performance Engineers input Description and Energy Loss Categorization

Summary of Energy Losses and On-line Reliability Loss Factors (ORLF) for the Exelon Fleet

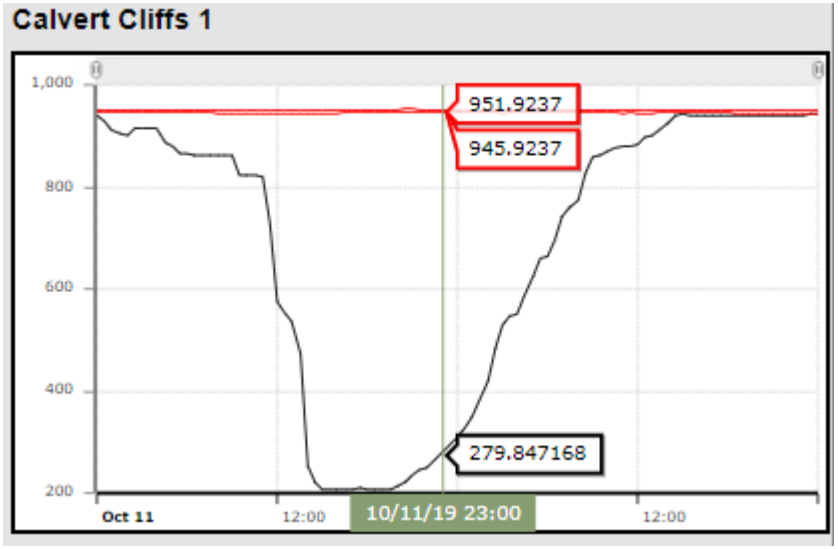
December 2019

Station	Unit	Date	Energy Loss Event	PEL MWh	EREL MWh	RFO MWh	UPEL MWh	UPELOE MWh	Excluded MWh
BRW	1	12/1/2019	No Energy Loss Events						
BRW	2	12/1/2019	No Energy Loss Events						
BYR	1	12/1/2019	No Energy Loss Events						
BYR	2	12/1/2019	No Energy Loss Events						
CC	1	12/13/2019	Condenser Tube Bulleting	415.0	415.0				
CC	2	12/28/2019	Turbine Valve Testing	554.0	554.0				
CPS		12/1/2019	Advanced Nuclear Dispatch for Month						207.0
CPS		12/7/2019	Sequence Exchange	242.0	242.0				
CPS		12/22/2019	Sequence Exchange	1,429.0	1,429.0				
DRE	2	12/9/2019	D2F28 Forced Outage to Repair Drywell Leak (IR ####)				32,560.1		
DRE	2	12/14/2019	Control Rod Pattern Adjustment	1,685.0	1,685.0				
DRE	2	12/21/2019	Control Rod Pattern Adjustment	1,419.0	1,419.0				
DRE	2	12/26/2019	D2F29 Forced Outage to Repair Generator H2 Leak (IR ####)				113,131.3		
DRE	3	12/3/2019	Sequence Exchange	958.0	958.0				

Applications of MWe Loss Event Tracker

- Automation of Thermal Performance Engineer Duties
  - By automatically flagging Energy Loss Events through the Tracker Engineers are able to find dates and match Operator Log Entries to Energy Loss Events

1	Night	10/11/2019 3:50:00	Notified BGE TSO (Vespucci) and Gen Dispatch (Simpson) that Unit 1 will be starting the scheduled downpower to 96% Reactor Power for waterboxes cleaning. 3-Way Communication was used.
1	Day	10/11/2019 17:32:00	Secured 15 Circulating Water pump per OI-14A, section 6.2 for Waterbox Cleaning.
1	Day	10/11/2019 17:32:00	Secured 15 Circulating Water pump per OI-14A, section 6.2 for Waterbox cleaning. Chemistry (Hancock) informed.
1	Day	10/12/2019 8:05:00	Started 12 Circulating Water pump per OI-14A, section 6.1 following Waterbox cleaning.
1	Day	10/12/2019 8:15:00	Started 11 Saltwater Pump and secured 13 Saltwater Pump per OI-29, Section 6.14 in preparation for cleaning 13B Waterbox.



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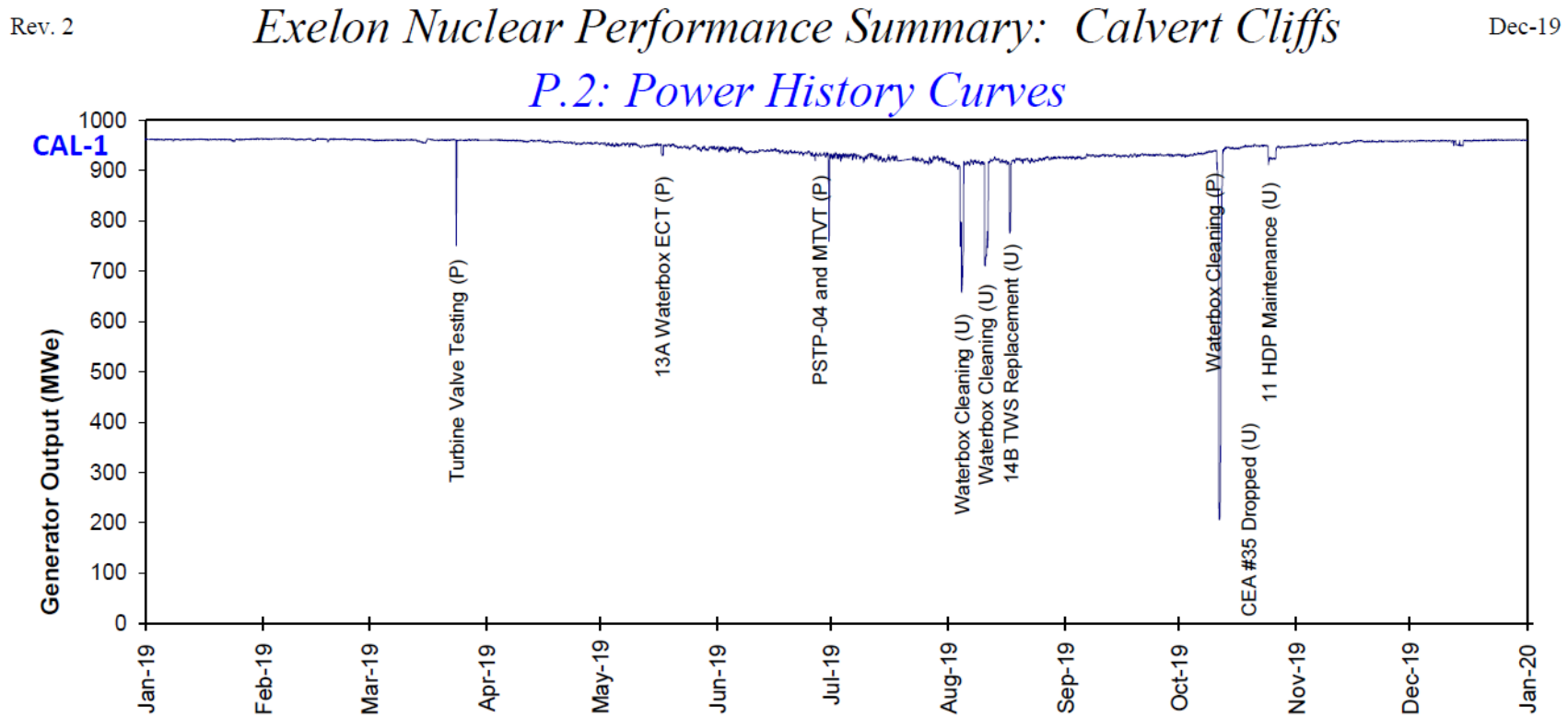
Power History Curves

- Site Power History Curves have been standardized across the Exelon Fleet and are designed to graphically represent Energy Loss Events



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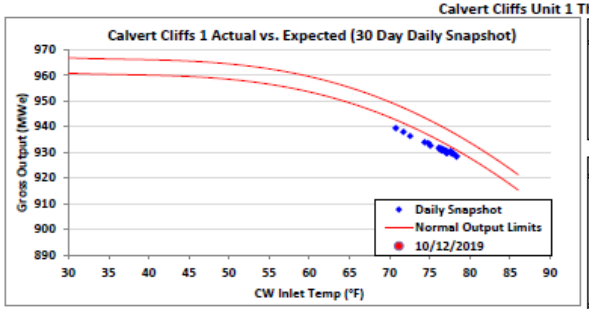
Site Thermal Performance Reports (POD)

Calvert Cliffs Power Station Thermal Performance Report

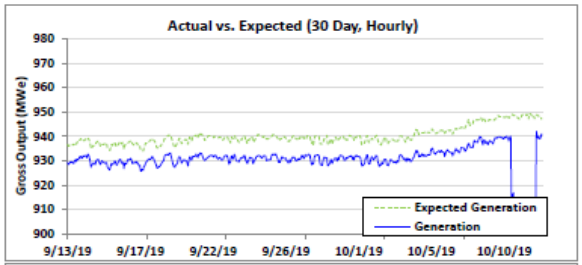
30 Days Ending October 13, 2019

Calvert Cliffs Unit 1 Thermal Performance Report

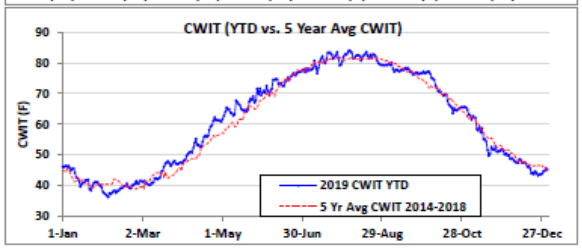


Calvert Cliffs Unit 1 Thermal Performance for 10/12/2019					
Reactor Thermal Power	(MWth)	Measured	2,320.33	% Pwr	84.75
Gross Generation	(MWe)	Expected	948.36	Actual	780.75
CW Inlet Temperature	(°F)	5 Year Avg.	69.92	Actual	70.48
Absolute Back Pressure	(inHg)	Expected	1.63	Actual	2.14
Reactor Thermal Power	(MWth)	Licensed	2,737	CWP in Serv	5.96

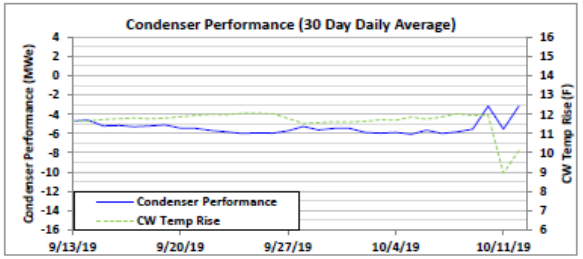
Calvert Cliffs Unit 1 Energy Losses for 10/12/2019	
Margin from License Reactor Power	-140.9 MWe
Condenser Performance	-3.1 MWe
Feedwater Heater Performance	+4.6 MWe
Cycle Isolation Losses	-0.6 MWe
Other Recoverable Losses	+0.9 MWe
Non-Recoverable Losses	-0.0 MWe
Unidentified Losses /Gains	-28.4 MWe
Total Energy Losses	-167.6 MWe



Date	Energy Loss Events During Past 30 Days	
11-Oct	Waterbox Cleaning	2,027 MWh
11-Oct	CEA #35 Dropped	10,400 MWh
	TOTAL Energy Losses Past 30 Days	12,427 MWh



Thermal Performance Related Action Items				
IR or W/O	Component	Description	MW Loss	Due Date
C93707959	1CV1437	Valve or Orifice Leak-by	0.1	2022
C93707957	1CV1441	Valve or Orifice Leak-by	0.1	2022
C93707956	1MOV1525	Valve or Orifice Leak-by	0.1	2022
C93710483	1-MOV-6601	Valve or Orifice Leak-by	0.1	2022
C93710482	1-MOV-6602	Valve or Orifice Leak-by	0.2	2022
C93654711	1-MOV-4658	Valve or Orifice Leak-by	0.1	2022
C93717386	1-CV-1445	Valve or Orifice Leak-by	0.2	2022
			0.9 MWe	



Comments:
Engineering and Outage Management working to get top-hitters of the above leaking valves scoped into the 2020 RFO.

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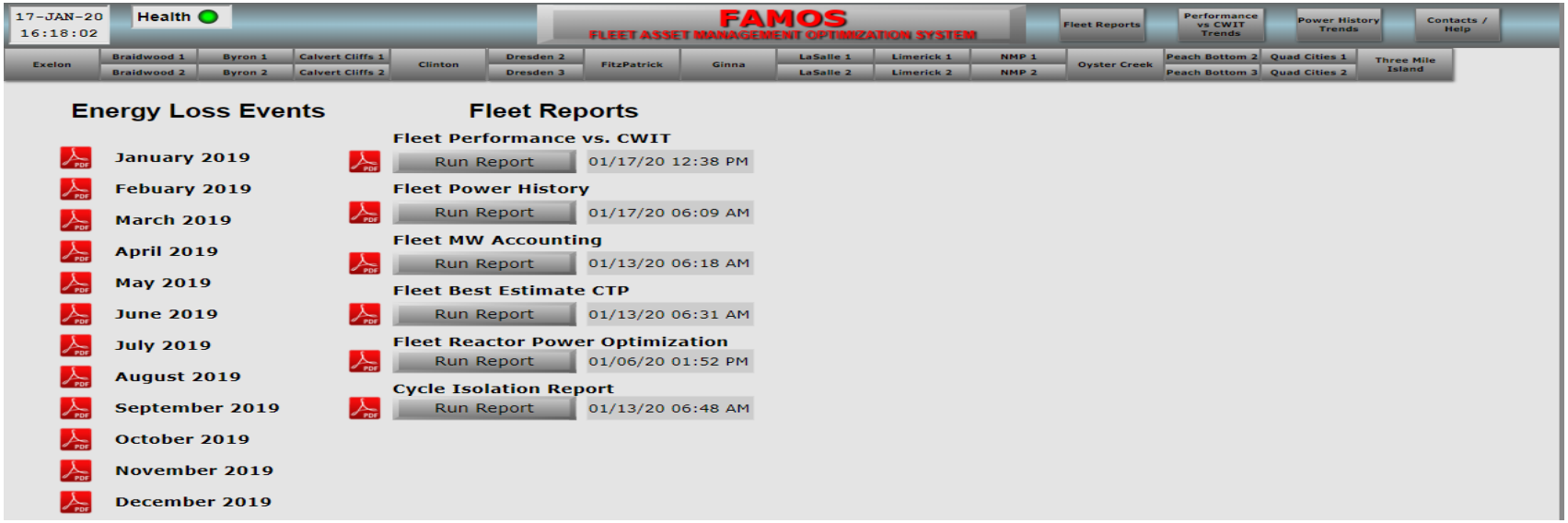
Goals of MWe Loss Tracking

- The goal of tracking MWe losses is to increase accuracy and efficiency of the Thermal Performance Program
- Monitoring losses across each site should be consistently managed by each Corporate Thermal Performance Engineer
- Tools like these enable Engineers to have automatically generating reports that enable them to quickly understand plant evolutions



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Questions?

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