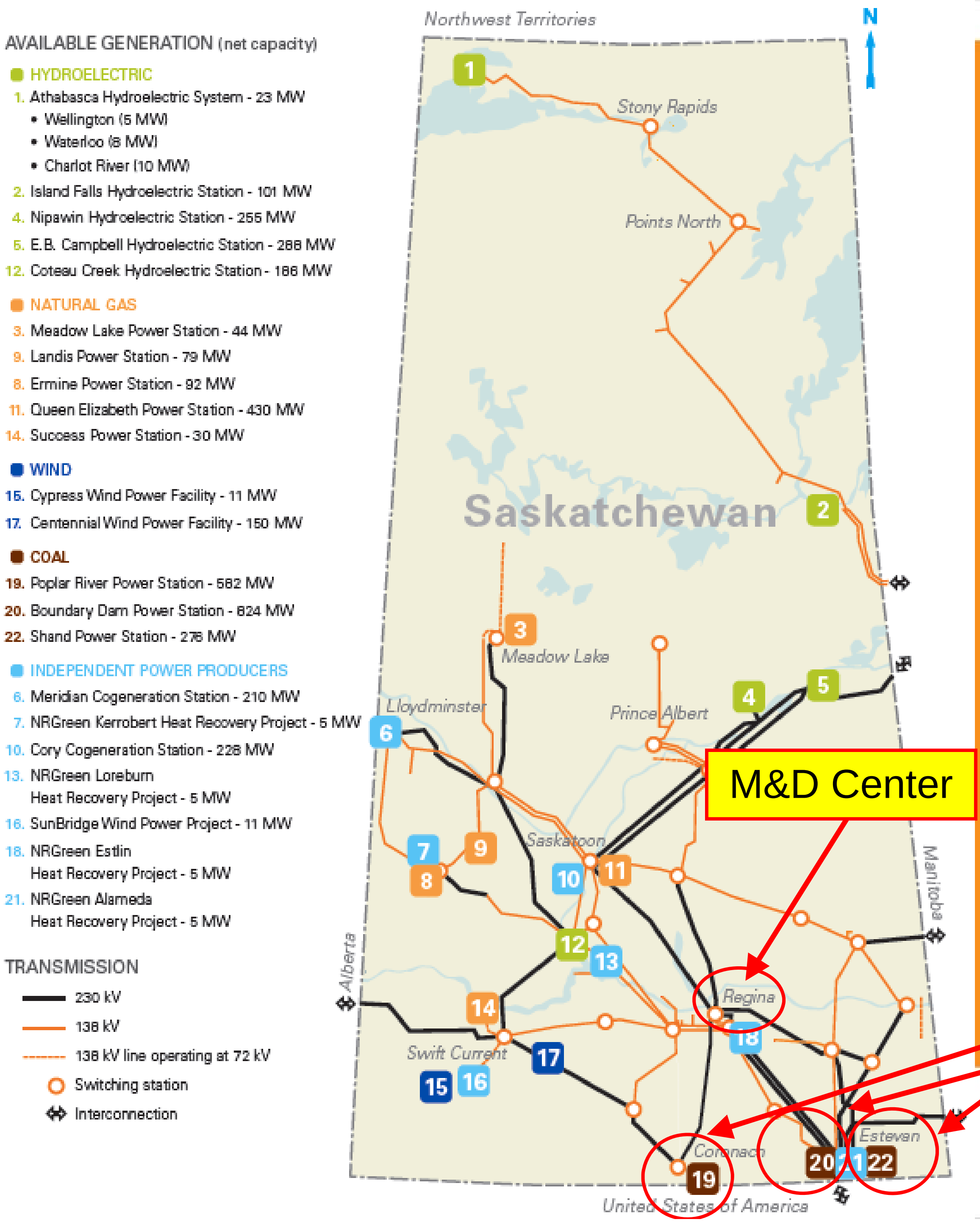
Benefits of SaskPower's
Monitoring & Diagnostics (M&D) Center

Presented by:
Alyssa Beisel
Scientech Symposium
Managing Plant Assets and Performance
January 19 2012

SaskPower
Powering the future


Northwest Territories
N
Stony Rapids
Points North
Saskatchewan
Meadow Lake
Prince Albert
Lloydminster
Saskatoon
Regina
Swift Current
Coronach
Estevan
Manitoba
Alberta
United States of America
1
2
3
4
5
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12
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14
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16
17
18
19
20
21
22

AVAILABLE GENERATION (net capacity)

🟩 HYDROELECTRIC

1. Athabasca Hydroelectric System - 23 MW
   - Wellington (5 MW)
   - Waterloo (8 MW)
   - Charlot River (10 MW)
2. Island Falls Hydroelectric Station - 101 MW
4. Nipawin Hydroelectric Station - 255 MW
5. E.B. Campbell Hydroelectric Station - 288 MW
12. Coteau Creek Hydroelectric Station - 186 MW

🟧 NATURAL GAS

3. Meadow Lake Power Station - 44 MW
9. Landis Power Station - 79 MW
8. Ermine Power Station - 92 MW
11. Queen Elizabeth Power Station - 430 MW
14. Success Power Station - 30 MW

🟦 WIND

15. Cypress Wind Power Facility - 11 MW
17. Centennial Wind Power Facility - 150 MW

🟫 COAL

19. Poplar River Power Station - 582 MW
20. Boundary Dam Power Station - 824 MW
22. Shand Power Station - 276 MW

🟦 INDEPENDENT POWER PRODUCERS

6. Meridian Cogeneration Station - 210 MW
7. NRGreen Kerrobert Heat Recovery Project - 5 MW
10. Cory Cogeneration Station - 228 MW
13. NRGreen Loreburn Heat Recovery Project - 5 MW
16. SunBridge Wind Power Project - 11 MW
18. NRGreen Estlin Heat Recovery Project - 5 MW
21. NRGreen Alameda Heat Recovery Project - 5 MW

TRANSMISSION

- 230 kV
- 138 kV
- 138 kV line operating at 72 kV
- ○ Switching station
- ⇔ Interconnection

M&D Center

Coal Plants

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Generation

- **3,513 MW Total Generating Capacity**
- **3 Coal-fired power stations**
- **7 Hydroelectric power stations**
- **7 Natural Gas power stations**
- **2 Wind Facilities**

Transmission and Distribution

- **We maintain approximately 12,212 kilometres (km) of transmission lines and 142,843 km of distribution lines.**

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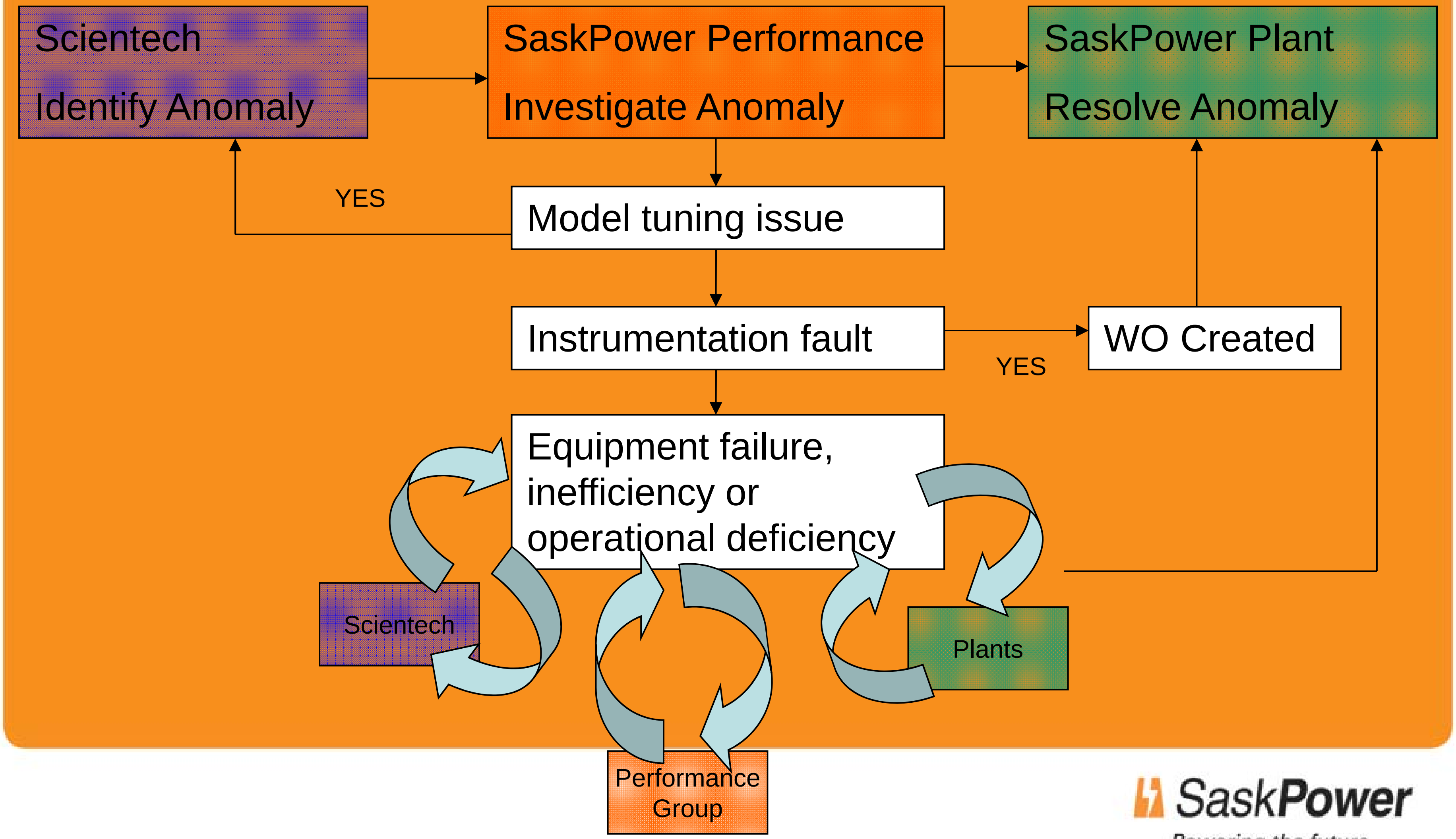
Outline of Presentation

- M&D Process
  - Relationship with Scientech
  - Roles and Responsibilities
- Anomaly example
- Reporting and Managing M&D Process
  - Cost-Benefit Spreadsheet

M&D Process



Scientech

Identify Anomaly

SaskPower Performance

Investigate Anomaly

SaskPower Plant

Resolve Anomaly

Model tuning issue

YES

Instrumentation fault

YES

WO Created

Equipment failure, inefficiency or operational deficiency

Scientech

Performance Group

Plants

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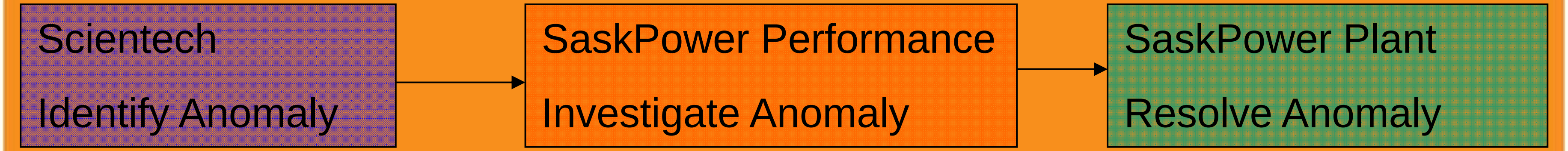
Prioritization



Scientech

Identify Anomaly

SaskPower Performance

Investigate Anomaly

SaskPower Plant

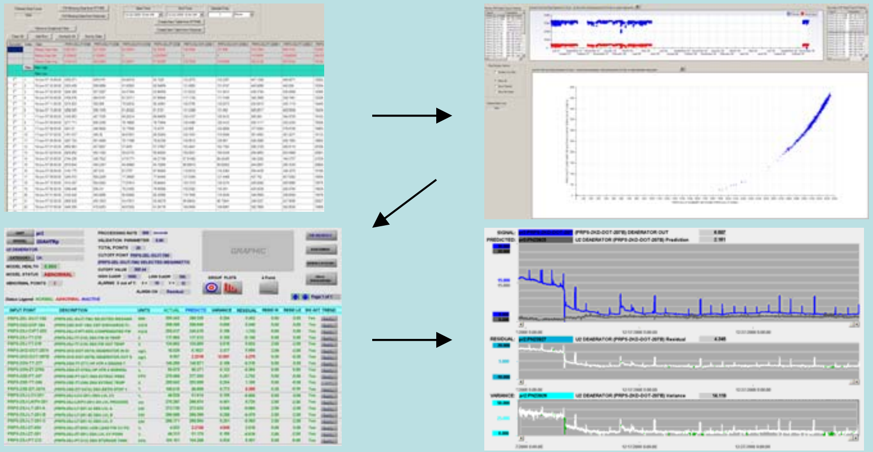
Resolve Anomaly

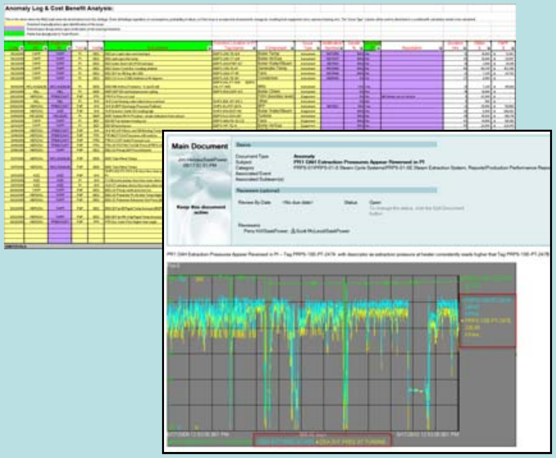
- **Monitoring efforts are prioritized:**
  - **Units back from forced/planned outages**
  - **300 MW units**
  - **150 MW units**
  - **Units < 150 MW**

SaskPower M&D Center
Roles & Responsibilities

Scientech

Monitor/Maintain/tune PdP models

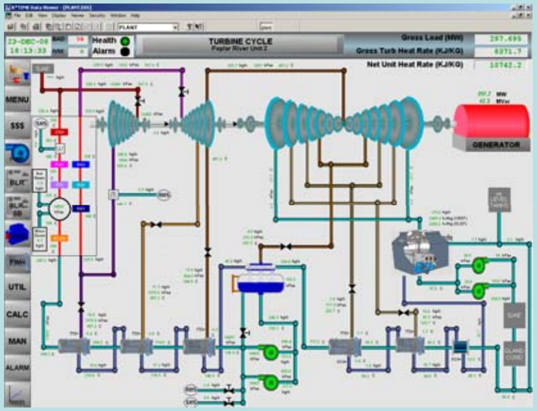



Anomaly Log & Cost Benefit Analysis:
Main Document

Anomaly Documentation

1. Team Room

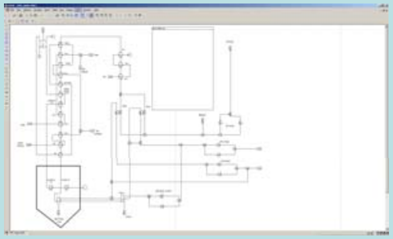
2. Cost Benefit Spreadsheet

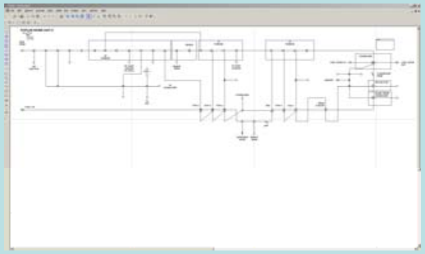

Health
Alarm
TURBINE CYCLE
Poplar River Unit 2
Gross Load (MW)
Gross Turb Heat Rate (KJ/KG)
Net Unit Heat Rate (KJ/KG)
GENERATOR
MENU
SSS
UTIL
CALC
MAN
ALARM

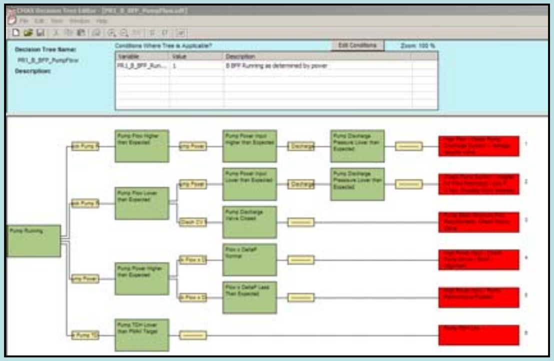
PMAX

Monitoring, IVM's & Tuning

PEPSE Modeling, Upgrades & Tuning






Decision Tree Name:
Description:
Pump Running

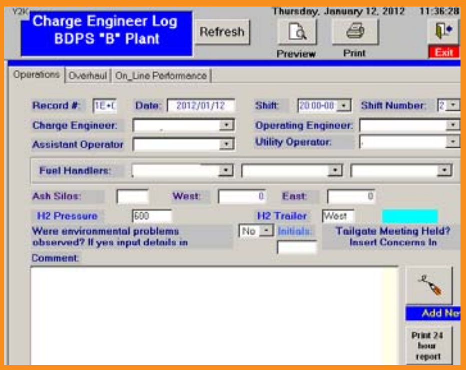
RULES

Rules Monitoring & Continuous Improvement

SaskPower M&D Center
Roles & Responsibilities

Performance Group:

Review items logged by Scientech



Thursday, January 12, 2012 11:36:28

Record #:	1E+(	Date:	2012/01/12	Shift:	20:00-08	Shift Number:	2
Charge Engineer:				Operating Engineer:			
Assistant Operator				Utility Operator:			
Fuel Handlers:							
Ash Silos:		West:	0	East:	0		
H2 Pressure	600			H2 Trailer	West		

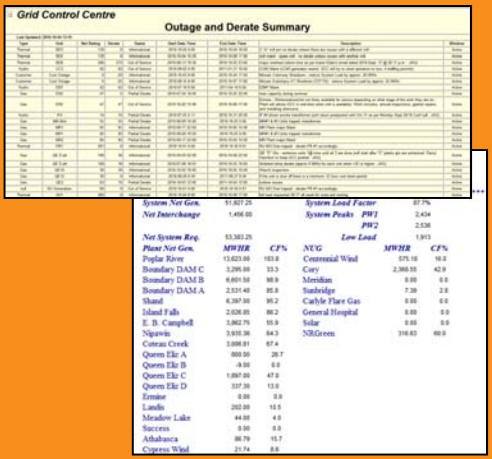
Were environmental problems observed? If yes input details in: No

Initials:

Tailgate Meeting Held? Insert Concerns In

Comment:

Review Unit Logs



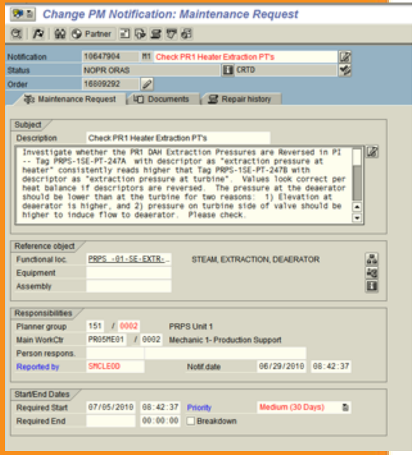
Grid Control Centre

Outage and Derate Summary

System Net Gen.	51,927.25	System Load Factor	87.7%
Net Interchange	1,456.00	System Peaks PW1	2,434
		PW2	2,536
Net System Req.	53,383.25	Low Load	1,913

Plant Net Gen.	MWHR	CF%	NUG	MWHR	CF%
Poplar River	13,623.00	103.8	Centennial Wind	575.18	16.8
Boundary DAM C	3,295.00	33.3	Cory	2,366.55	42.8
Boundary DAM B	6,601.50	98.9	Meridian	0.00	0.0
Boundary DAM A	2,531.40	85.8	Sunbridge	7.39	2.8
Shand	6,397.00	95.2	Carlyle Flare Gas	0.00	0.0
Island Falls	2,026.85	86.2	General Hospital	0.00	0.0
E. B. Campbell	3,862.75	55.9	Solar	0.00	0.0
Nipawin	3,938.36	84.3	NRGreen	316.83	60.0
Coteau Creek	3,006.81	67.4			
Queen Eliz A	800.00	26.7			
Queen Eliz B	-9.00	0.0			
Queen Eliz C	1,897.00	47.0			
Queen Eliz D	337.30	13.0			
Ermine	0.00	0.0			
Landis	202.00	10.5			
Meadow Lake	44.00	4.0			
Success	0.00	0.0			
Athabasca	86.79	15.7			
Cypress Wind	21.74	8.6			

Review GCC reports



Change PM Notification: Maintenance Request

Notification	10647904	M1	Check PR1 Heater Extraction PT's
Status	NOPR ORAS		CRTD
Order	16809292		

Subject

Description: Check PR1 Heater Extraction PT's

```
Investigate whether the PR1 DAH Extraction Pressures are Reversed in PI
-- Tag PRPS-1SE-PT-247A  with descriptor as "extraction pressure at
heater" consistently reads higher that Tag PRPS-1SE-PT-247B with
descriptor as "extraction pressure at turbine".  Values look correct per
heat balance if descriptors are reversed.  The pressure at the deaerator
should be lower than at the turbine for two reasons:  1) Elevation at
deaerator is higher, and 2) pressure on turbine side of valve should be
higher to induce flow to deaerator.  Please check.
```

Reference object

Functional loc.	PRPS -01-SE-EXTR-...	STEAM, EXTRACTION, DEAERATOR
Equipment		
Assembly		

Responsibilities

Planner group	151 / 0002	PRPS Unit 1		
Main WorkCtr	PR05ME01 / 0002	Mechanic 1- Production Support		
Person respons.				
Reported by	SMCLEOD	Notif.date	06/29/2010	08:42:37

Start/End Dates

Required Start	07/05/2010	08:42:37	Priority	Medium (30 Days)
Required End		00:00:00	☐ Breakdown	

Search existing / enter SAP Work notifications

Notify operations of critical issues (liason w Shift lead)

Manage / prioritize issues

Site Inspections & Testing

Site meetings

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Roles & Responsibilities

	W. Perry Hill Supervisor 566-3339 phill@saskpower.com Plant Contact: None		**Scott McLeod** Senior Performance Engineer 566-2243 smcleod@saskpower.com Plant Contact: BDPS C Plant, Western Plants (& assigned to FAMOS project)
	Alyssa Beisel Performance Engineer 566-3171 amclaughlin@saskpower.com Plant Contact: BDPS B Plant		**Scott Prokopetz** Performance Engineer 566-4054 sprokopetz@saskpower.com Plant Contact: SHPS, PRPS
	Luke Montague Grad Works Engineer 566-3431 lmontague@saskpower.com Plant Contact: BDPS A Plant		

Plant Services

Digital Systems Technologist

Senior Electrical Controls Engineers

Electrical Controls Engineers and EITs

Mechanical Engineer

Chemical Services

Senior Chemists

Chemists

Senior Metallurgist

Environmental Initiatives

Environmental Engineer

Environmental Chemist

Equipment Integrity

QC Assurance Project Leaders

Senior Maintenance Support Engineer

Maintenance Support Specialist

Maintenance Support Engineer

Mechanical Engineer

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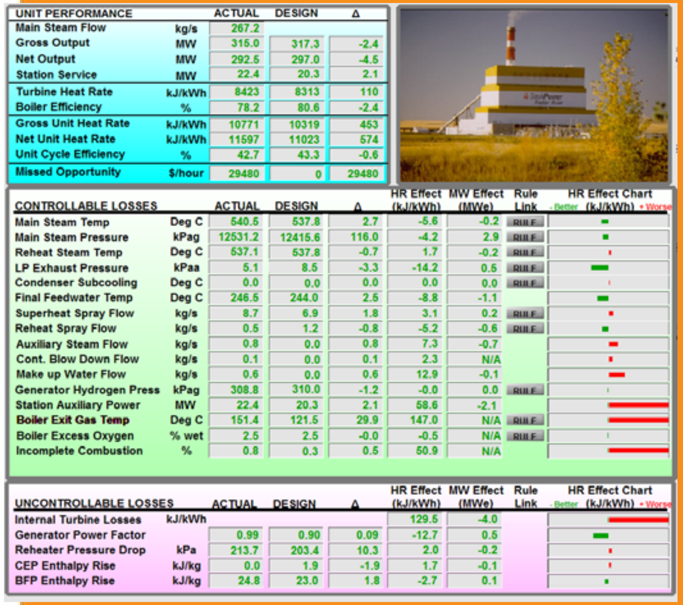
SaskPower M&D Center
Roles & Responsibilities

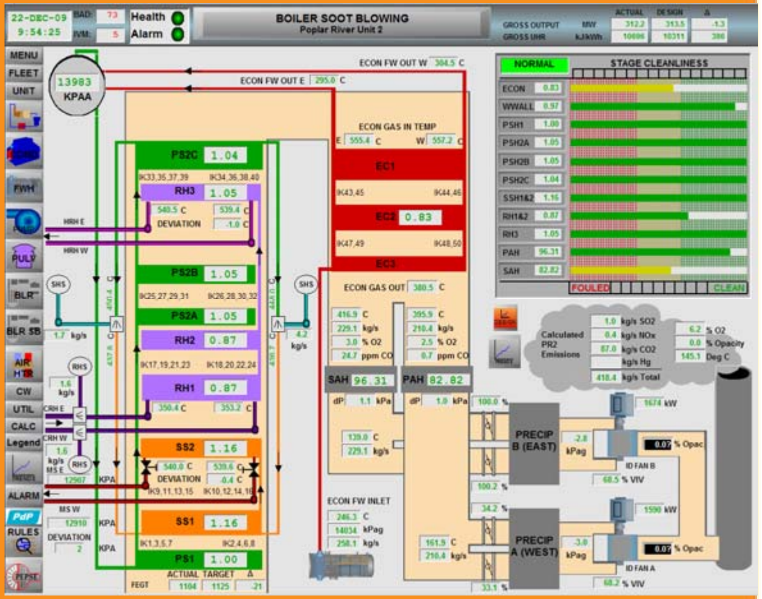
Plant Operations: Monitor & Optimize variables that change frequently.



UNIT PERFORMANCE		ACTUAL	DESIGN	Δ
Main Steam Flow	kg/s	267.2		
Gross Output	MW	315.0	317.3	-2.4
Net Output	MW	292.5	297.0	-4.5
Station Service	MW	22.4	20.3	2.1
Turbine Heat Rate	kJ/kWh	8423	8313	110
Boiler Efficiency	%	78.2	80.6	-2.4
Gross Unit Heat Rate	kJ/kWh	10771	10319	453
Net Unit Heat Rate	kJ/kWh	11597	11023	574
Unit Cycle Efficiency	%	42.7	43.3	-0.6
Missed Opportunity	$/hour	29480	0	29480

CONTROLLABLE LOSSES		ACTUAL	DESIGN	Δ	HR Effect (kJ/kWh)	MW Effect (MWe)	Rule Link	HR Effect Chart - Better (kJ/kWh) + Worse
Main Steam Temp	Deg C	540.5	537.8	2.7	-5.6	-0.2	RULE	🟩
Main Steam Pressure	kPag	12531.2	12415.6	116.0	-4.2	2.9	RULE	🟩
Reheat Steam Temp	Deg C	537.1	537.8	-0.7	1.7	-0.2	RULE	🟥
LP Exhaust Pressure	kPaa	5.1	8.5	-3.3	-14.2	0.5	RULE	🟩
Condenser Subcooling	Deg C	0.0	0.0	0.0	0.0	0.0	RULE	🟥
Final Feedwater Temp	Deg C	246.5	244.0	2.5	-8.8	-1.1		🟩
Superheat Spray Flow	kg/s	8.7	6.9	1.8	3.1	0.2	RULE	🟥
Reheat Spray Flow	kg/s	0.5	1.2	-0.8	-5.2	-0.6	RULE	🟩
Auxiliary Steam Flow	kg/s	0.8	0.0	0.8	7.3	-0.7		🟥
Cont. Blow Down Flow	kg/s	0.1	0.0	0.1	2.3	N/A		🟥
Make up Water Flow	kg/s	0.6	0.0	0.6	12.9	-0.1		🟥
Generator Hydrogen Press	kPag	308.8	310.0	-1.2	-0.0	0.0	RULE	🟩
Station Auxiliary Power	MW	22.4	20.3	2.1	58.6	-2.1		🟥
Boiler Exit Gas Temp	Deg C	151.4	121.5	29.9	147.0	N/A	RULE	🟥
Boiler Excess Oxygen	% wet	2.5	2.5	-0.0	-0.5	N/A	RULE	🟩
Incomplete Combustion	%	0.8	0.3	0.5	50.9	N/A		🟥

UNCONTROLLABLE LOSSES		ACTUAL	DESIGN	Δ	HR Effect (kJ/kWh)	MW Effect (MWe)	Rule Link	HR Effect Chart - Better (kJ/kWh) + Worse
Internal Turbine Losses	kJ/kWh				129.5	-4.0		🟥
Generator Power Factor		0.99	0.90	0.09	-12.7	0.5		🟩
Reheater Pressure Drop	kPa	213.7	203.4	10.3	2.0	-0.2		🟥
CEP Enthalpy Rise	kJ/kg	0.0	1.9	-1.9	1.7	-0.1		🟥
BFP Enthalpy Rise	kJ/kg	24.8	23.0	1.8	-2.7	0.1		🟩



BOILER SOOT BLOWING
Poplar River Unit 2

22-DEC-09 9:54:25
BAD: 73
IVM: 5
Health ●
Alarm ●

		ACTUAL	DESIGN	Δ
GROSS OUTPUT	MW	312.2	313.5	-1.3
GROSS UHR	kJ/kWh	10696	10311	386

NORMAL — STAGE CLEANLINESS

ECON	0.83
WWALL	0.97
PSH1	1.00
PSH2A	1.05
PSH2B	1.05
PSH2C	1.04
SSH1&2	1.16
RH1&2	0.87
RH3	1.05
PAH	96.31
SAH	82.82

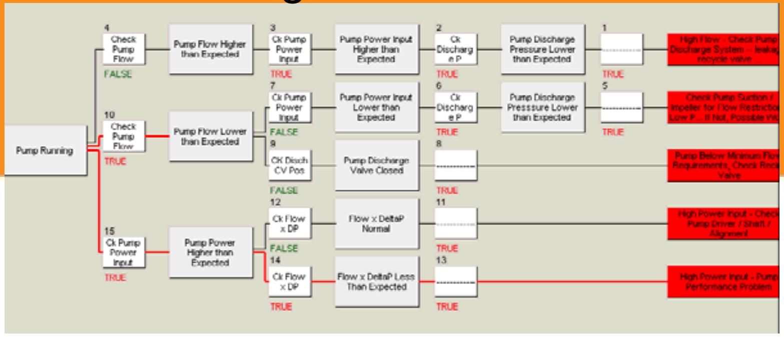
FOULED — CLEAN

MENU
FLEET
UNIT
FWH
PULV
BLR
BLR SB
AIR HTR
CW
UTIL
CALC
Legend
ALARM
PdP
RULES
13983 KPAA
ECON FW OUT W 304.5 C
ECON FW OUT E 295.0 C
ECON GAS IN TEMP E 555.4 C W 557.2 C
PS2C 1.04
RH3 1.05
DEVIATION
HRH E
HRH W
EC1
EC2 0.83
EC3
PS2B 1.05
PS2A 1.05
RH2 0.87
RH1 0.87
SS2 1.16
SS1 1.16
PS1 1.00
ECON GAS OUT 380.5 C
SAH 96.31
PAH 82.82
ECON FW INLET
PRECIP B (EAST)
PRECIP A (WEST)
ID FAN B
ID FAN A
Calculated PR2 Emissions
1.0 kg/s SO2
0.4 kg/s NOx
87.0 kg/s CO2
kg/s Hg
418.4 kg/s Total
6.2 % O2
0.0 % Opacity
145.1 Deg C
FEGT
ACTUAL TARGET Δ
1104 1125 -21

Controllable losses

Diagnostic Rules

Boiler Cleanliness


Pump Running
4
Check Pump Flow
FALSE
Pump Flow Higher than Expected
3
Ck Pump Power Input
TRUE
Pump Power Input Higher than Expected
2
Ck Discharg e P
TRUE
Pump Discharge Pressure Lower than Expected
1
TRUE
High Flow - Check Pump Discharge System -- leakag recycle valve ...
10
Check Pump Flow
TRUE
Pump Flow Lower than Expected
7
Ck Pump Power Input
FALSE
Pump Power Input Lower than Expected
6
Ck Discharg e P
TRUE
Pump Discharge Presssure Lower than Expected
5
TRUE
Check Pump Suction / Impeller for Flow Restrictio Low P... If Not, Possible VW
9
CK Disch CV Pos
FALSE
Pump Discharge Valve Closed
8
TRUE
Pump Below Minimum Flow Requirements, Check Reci Valve
15
Ck Pump Power Input
TRUE
Pump Power Higher than Expected
12
Ck Flow x DP
FALSE
Flow x DeltaP Normal
11
TRUE
High Power Input - Check Pump Driver / Shaft / Alignment
14
Ck Flow x DP
TRUE
Flow x DeltaP Less Than Expected
13
TRUE
High Power Input - Pump Performance Problem

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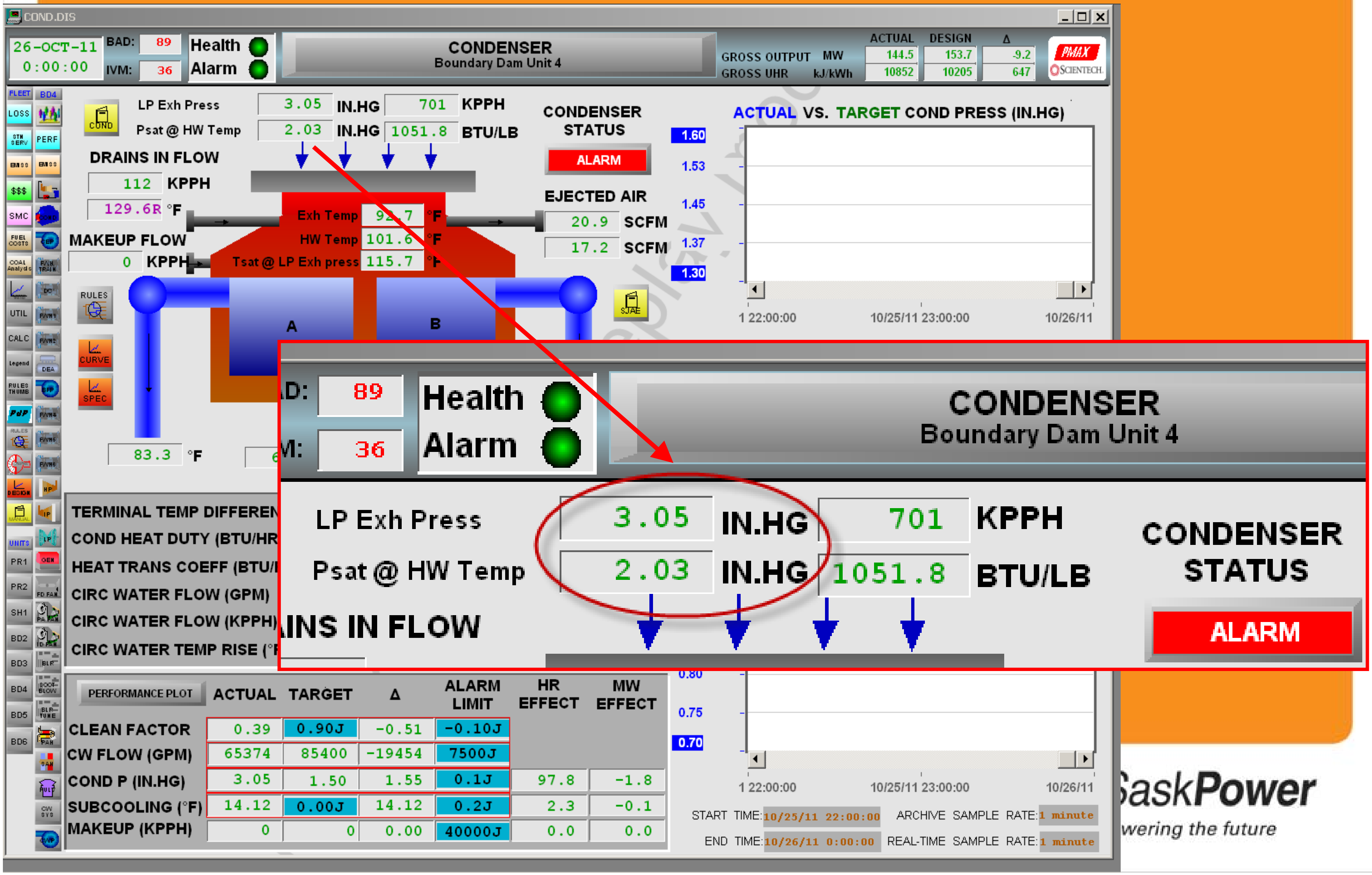
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example


COND.DIS
FLEET
BD4
LOSS
STN SERV
PERF
EMISS
$$$
SMC
FUEL COSTS
COAL Analysis
UTIL
CALC
Legend
RULES THUMB
PdP
DESIGN
MANUAL
UNITS
PR1
PR2
SH1
BD2
BD3
BD4
BD5
BD6
COND
RULES
CURVE
SPEC
SJAE
A
B
PMAX
SCIENTECH

26-OCT-11 0:00:00

BAD: 89

IVM: 36

Health ●

Alarm ●

CONDENSER
Boundary Dam Unit 4

		ACTUAL	DESIGN	Δ
GROSS OUTPUT	MW	144.5	153.7	-9.2
GROSS UHR	kJ/kWh	10852	10205	647

LP Exh Press 3.05 IN.HG 701 KPPH

Psat @ HW Temp 2.03 IN.HG 1051.8 BTU/LB

DRAINS IN FLOW
112 KPPH
129.6R °F

MAKEUP FLOW
0 KPPH

Exh Temp 92.7 °F
HW Temp 101.6 °F
Tsat @ LP Exh press 115.7 °F

83.3 °F

CONDENSER STATUS
ALARM

EJECTED AIR
20.9 SCFM
17.2 SCFM

ACTUAL VS. TARGET COND PRESS (IN.HG)

1.60
1.53
1.45
1.37
1.30

1 22:00:00 10/25/11 23:00:00 10/26/11

TERMINAL TEMP DIFFEREN
COND HEAT DUTY (BTU/HR
HEAT TRANS COEFF (BTU/
CIRC WATER FLOW (GPM)
CIRC WATER FLOW (KPPH)
CIRC WATER TEMP RISE (°F

PERFORMANCE PLOT	ACTUAL	TARGET	Δ	ALARM LIMIT	HR EFFECT	MW EFFECT
CLEAN FACTOR	0.39	0.90J	-0.51	-0.10J		
CW FLOW (GPM)	65374	85400	-19454	7500J		
COND P (IN.HG)	3.05	1.50	1.55	0.1J	97.8	-1.8
SUBCOOLING (°F)	14.12	0.00J	14.12	0.2J	2.3	-0.1
MAKEUP (KPPH)	0	0	0.00	40000J	0.0	0.0

0.80
0.75
0.70

1 22:00:00 10/25/11 23:00:00 10/26/11

START TIME: 10/25/11 22:00:00 ARCHIVE SAMPLE RATE: 1 minute

END TIME: 10/26/11 0:00:00 REAL-TIME SAMPLE RATE: 1 minute

D: 89

M: 36

Health ●

Alarm ●

CONDENSER
Boundary Dam Unit 4

LP Exh Press 3.05 IN.HG 701 KPPH

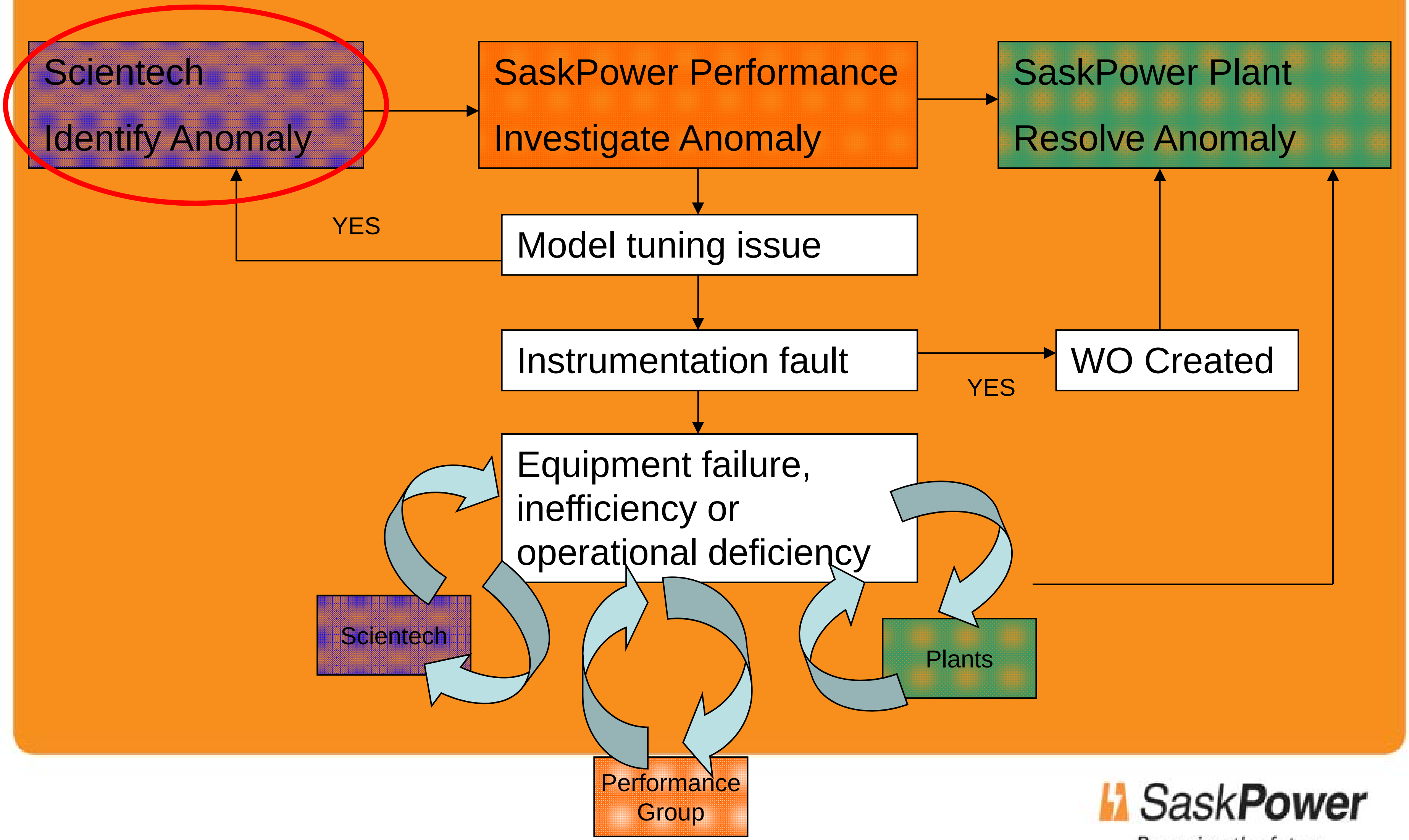
Psat @ HW Temp 2.03 IN.HG 1051.8 BTU/LB

INS IN FLOW

CONDENSER STATUS
ALARM

askPower
wering the future

M&D Process



Scientech

Identify Anomaly

SaskPower Performance

Investigate Anomaly

SaskPower Plant

Resolve Anomaly

YES

Model tuning issue

Instrumentation fault

YES

WO Created

Equipment failure, inefficiency or operational deficiency

Scientech

Performance Group

Plants

SaskPower

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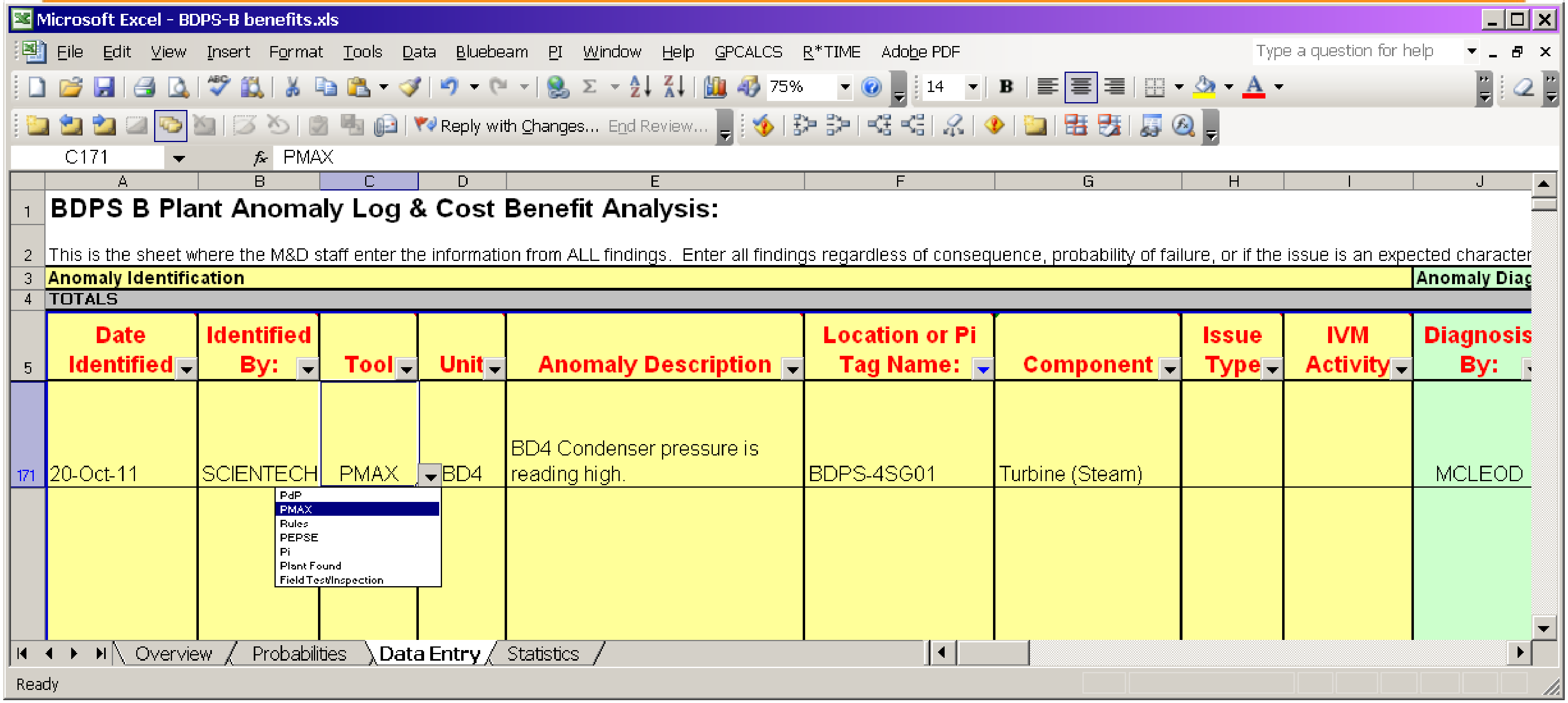
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 1: Add anomaly to cost benefits spreadsheet**


Microsoft Excel - BDPS-B benefits.xls
File Edit View Insert Format Tools Data Bluebeam PI Window Help GPCALCS R*TIME Adobe PDF
Type a question for help
75%
14
Reply with Changes... End Review...
A B C D E F G H I J
PdP
PMAX
Rules
PEPSE
Pi
Plant Found
Field Test/Inspection
Overview Probabilities Data Entry Statistics
Ready

C171 PMAX

BDPS B Plant Anomaly Log & Cost Benefit Analysis:

This is the sheet where the M&D staff enter the information from ALL findings. Enter all findings regardless of consequence, probability of failure, or if the issue is an expected character

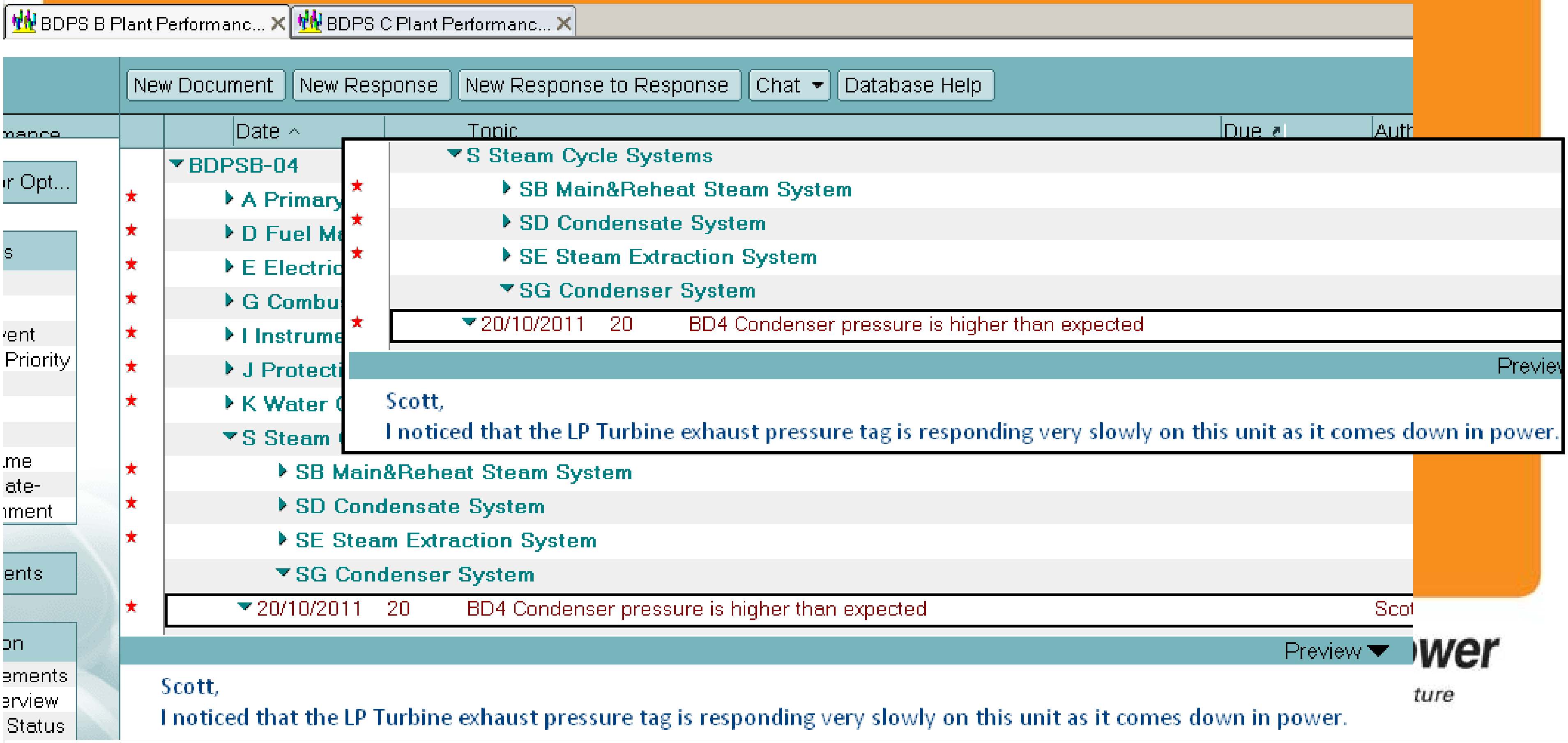
Anomaly Identification | **Anomaly Diag**

TOTALS

Date Identified	Identified By:	Tool	Unit	Anomaly Description	Location or Pi Tag Name:	Component	Issue Type	IVM Activity	Diagnosis By:
20-Oct-11	SCIENTECH	PMAX	BD4	BD4 Condenser pressure is reading high.	BDPS-4SG01	Turbine (Steam)			MCLEOD

BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 1 (continued): Add to Lotus Notes Team Room & Notify Performance contact**


BDPS B Plant Performanc...
BDPS C Plant Performanc...
New Document
New Response
New Response to Response
Chat
Database Help
Date
Topic
Due
Auth
BDPSB-04
A Primary
D Fuel M
E Electric
G Combu
I Instrume
J Protecti
K Water
S Steam
S Steam Cycle Systems
SB Main&Reheat Steam System
SD Condensate System
SE Steam Extraction System
SG Condenser System
Preview
r Opt...
Priority

20/10/2011 20 BD4 Condenser pressure is higher than expected

Scott,

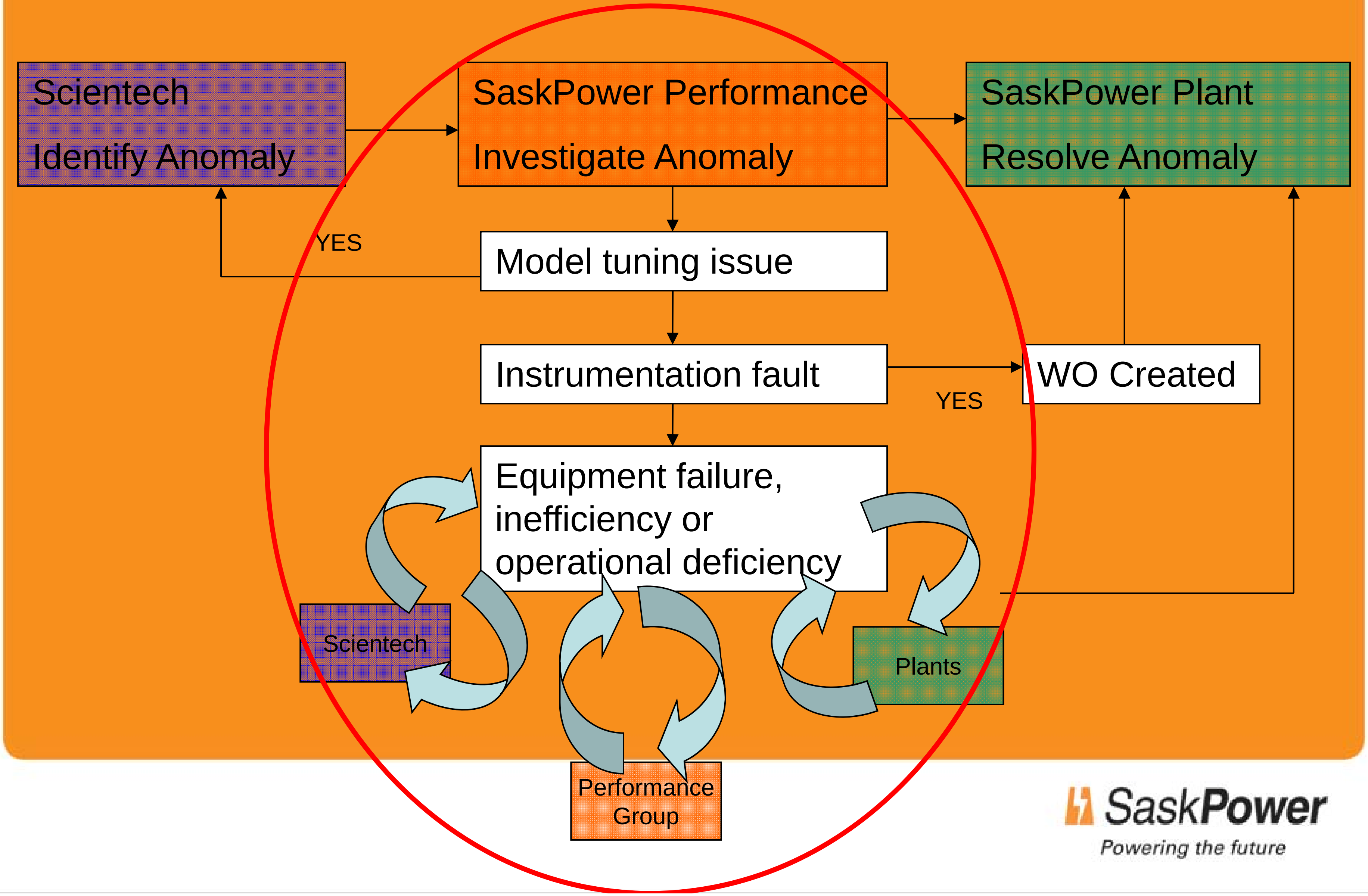
I noticed that the LP Turbine exhaust pressure tag is responding very slowly on this unit as it comes down in power.

20/10/2011 20 BD4 Condenser pressure is higher than expected Scot

Scott,

I noticed that the LP Turbine exhaust pressure tag is responding very slowly on this unit as it comes down in power.

M&D Process



Scientech

Identify Anomaly

SaskPower Performance

Investigate Anomaly

SaskPower Plant

Resolve Anomaly

Model tuning issue

YES

Instrumentation fault

YES

WO Created

Equipment failure, inefficiency or operational deficiency

Scientech

Performance Group

Plants

SaskPower

Powering the future

BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2: Investigate anomaly**
  - **Dig into background**
  - **Compare historical trends**
  - **Compare with other units**
  - **Compare with similar equipment**
  - **Shift log**
  - **Search work orders**

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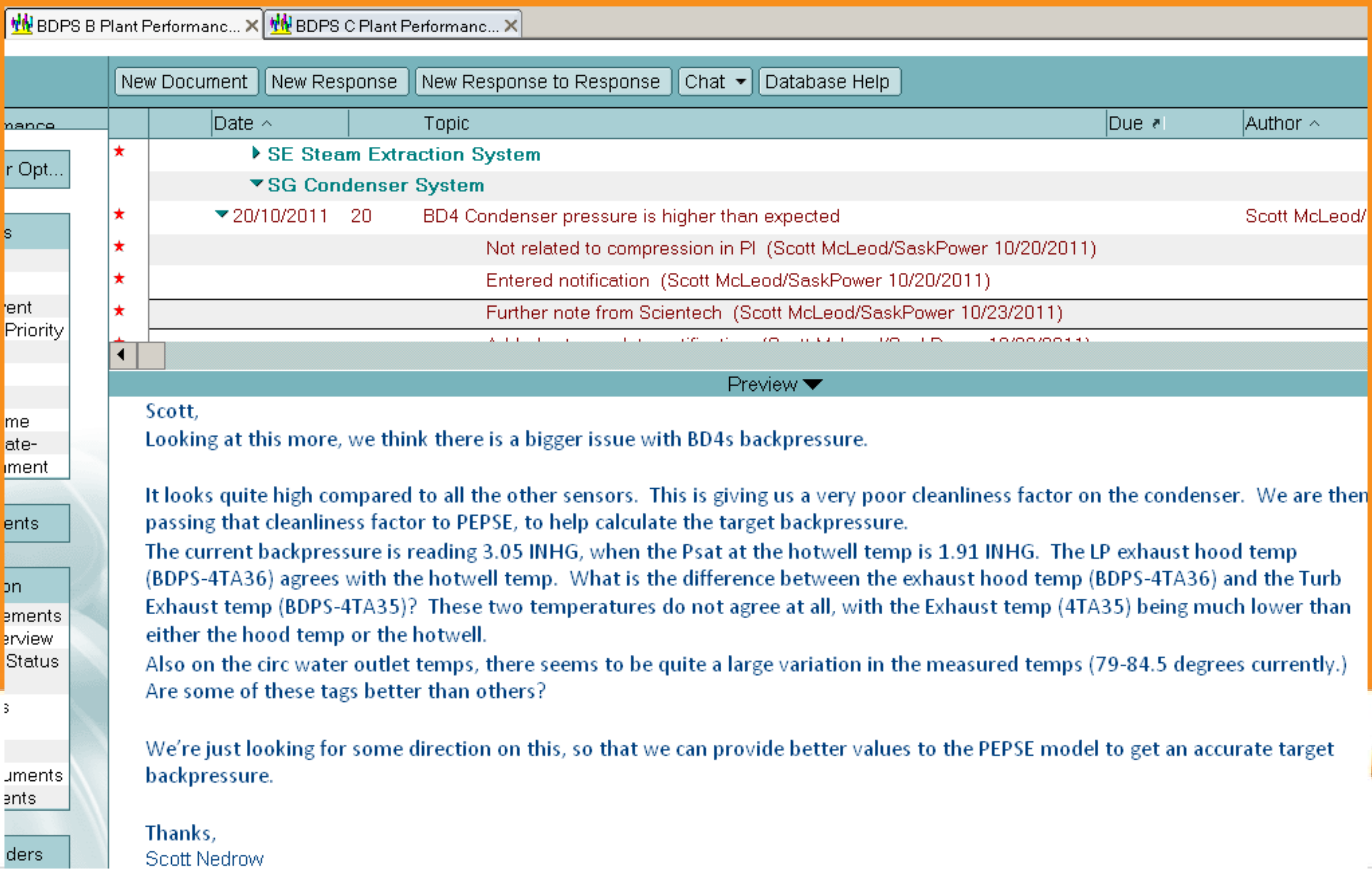
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2 (continued): Investigate anomaly**
  - **Discuss with Scientech**



SE Steam Extraction System

SG Condenser System

20/10/2011 20 BD4 Condenser pressure is higher than expected Scott McLeod/

Not related to compression in PI (Scott McLeod/SaskPower 10/20/2011)

Entered notification (Scott McLeod/SaskPower 10/20/2011)

Further note from Scientech (Scott McLeod/SaskPower 10/23/2011)

Scott,
Looking at this more, we think there is a bigger issue with BD4s backpressure.

It looks quite high compared to all the other sensors. This is giving us a very poor cleanliness factor on the condenser. We are then passing that cleanliness factor to PEPSE, to help calculate the target backpressure.
The current backpressure is reading 3.05 INHG, when the Psat at the hotwell temp is 1.91 INHG. The LP exhaust hood temp (BDPS-4TA36) agrees with the hotwell temp. What is the difference between the exhaust hood temp (BDPS-4TA36) and the Turb Exhaust temp (BDPS-4TA35)? These two temperatures do not agree at all, with the Exhaust temp (4TA35) being much lower than either the hood temp or the hotwell.
Also on the circ water outlet temps, there seems to be quite a large variation in the measured temps (79-84.5 degrees currently.) Are some of these tags better than others?

We're just looking for some direction on this, so that we can provide better values to the PEPSE model to get an accurate target backpressure.

Thanks,
Scott Nedrow

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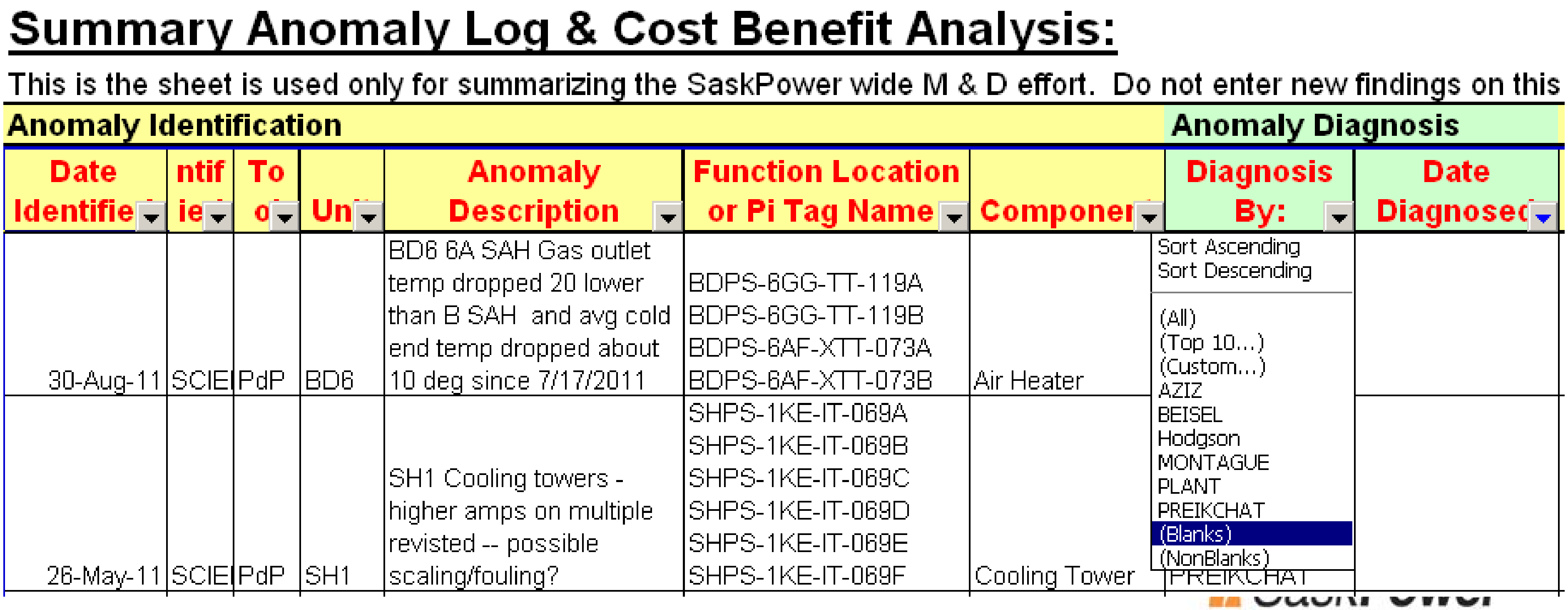
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2 (continued): Investigate anomaly**
  - **Weekly group anomaly discussion**



Summary Anomaly Log & Cost Benefit Analysis:

This is the sheet is used only for summarizing the SaskPower wide M & D effort. Do not enter new findings on this

Anomaly Identification							Anomaly Diagnosis	
Date Identifie	ntif ie	To o	Un	Anomaly Description	Function Location or Pi Tag Name	Componen	Diagnosis By:	Date Diagnosec
30-Aug-11	SCIE	PdP	BD6	BD6 6A SAH Gas outlet temp dropped 20 lower than B SAH and avg cold end temp dropped about 10 deg since 7/17/2011	BDPS-6GG-TT-119A BDPS-6GG-TT-119B BDPS-6AF-XTT-073A BDPS-6AF-XTT-073B	Air Heater		
26-May-11	SCIE	PdP	SH1	SH1 Cooling towers - higher amps on multiple revisted -- possible scaling/fouling?	SHPS-1KE-IT-069A SHPS-1KE-IT-069B SHPS-1KE-IT-069C SHPS-1KE-IT-069D SHPS-1KE-IT-069E SHPS-1KE-IT-069F	Cooling Tower	PREIKCHAT	

Sort Ascending
Sort Descending
(All)
(Top 10...)
(Custom...)
AZIZ
BEISEL
Hodgson
MONTAGUE
PLANT
PREIKCHAT
(Blanks)
(NonBlanks)

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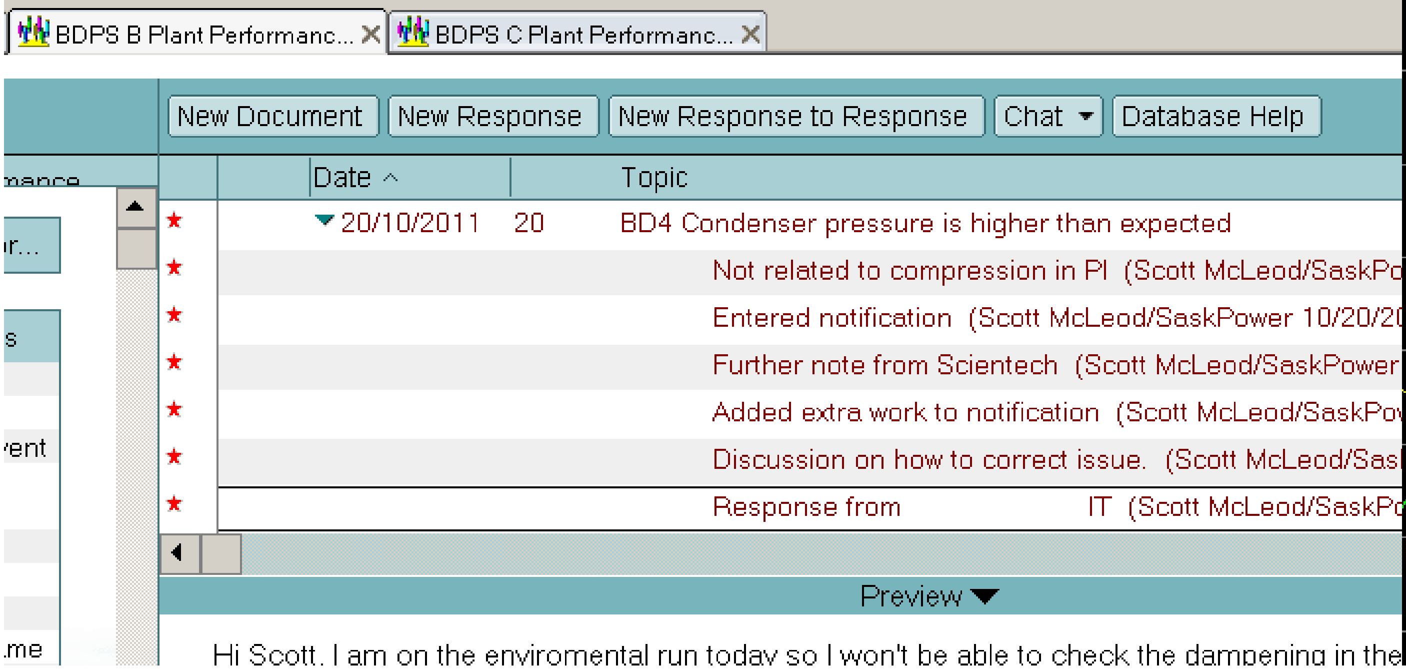
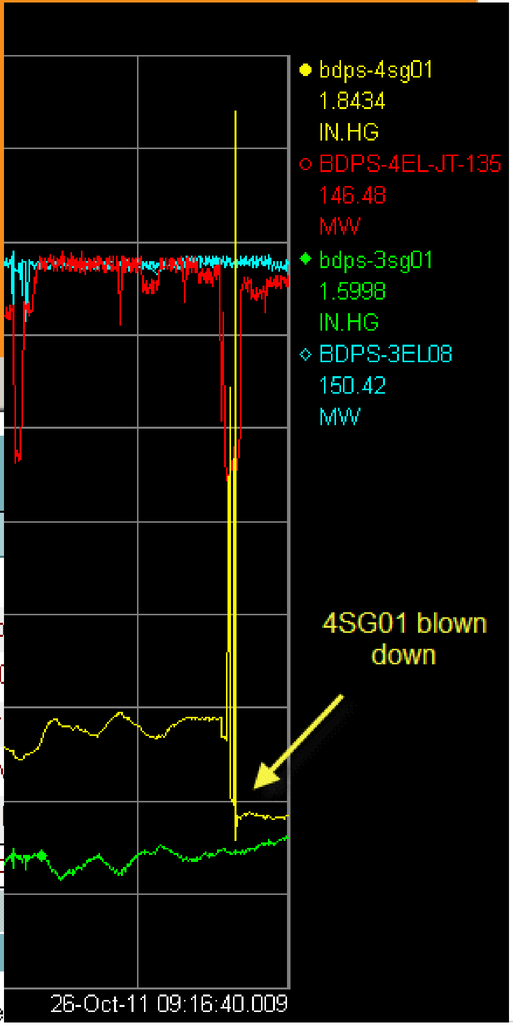
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2 (continued): Investigate anomaly**
  - **Discuss with local experts & plant**


BDPS B Plant Performanc...
BDPS C Plant Performanc...
New Document
New Response
New Response to Response
Chat
Database Help
Date
Topic
Preview

Date		Topic
20/10/2011	20	BD4 Condenser pressure is higher than expected
		Not related to compression in PI (Scott McLeod/SaskPo
		Entered notification (Scott McLeod/SaskPower 10/20/20
		Further note from Scientech (Scott McLeod/SaskPower
		Added extra work to notification (Scott McLeod/SaskPo
		Discussion on how to correct issue. (Scott McLeod/Sas
		Response from IT (Scott McLeod/SaskPo

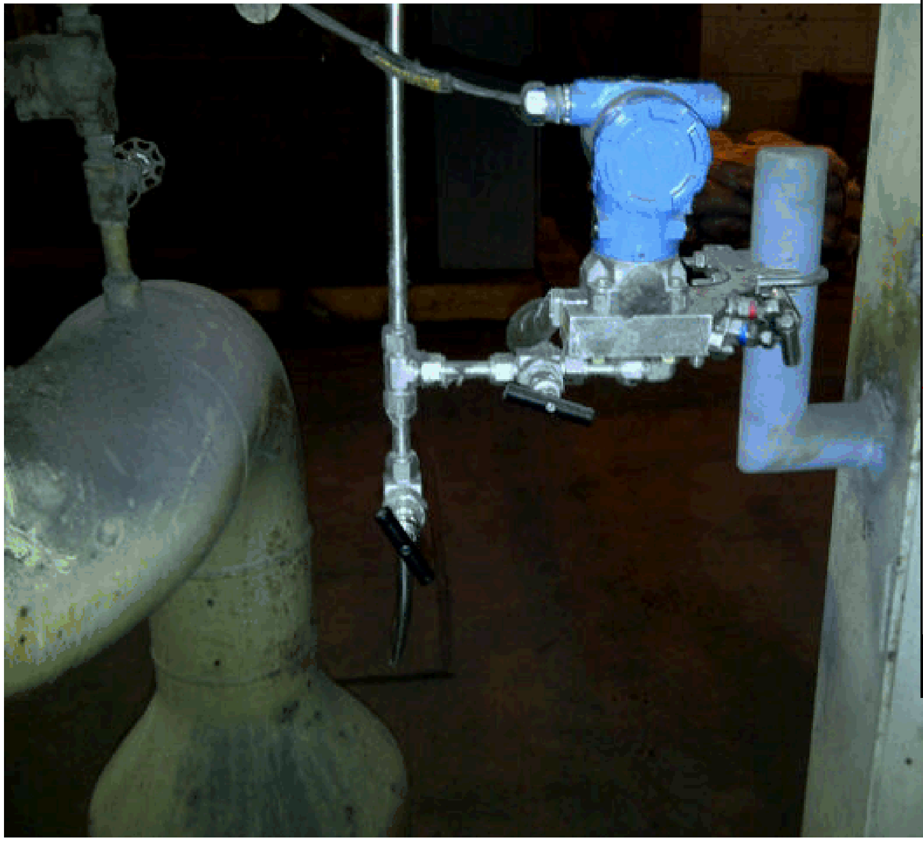
Hi Scott. I am on the enviromental run today so I won't be able to check the dampening in the

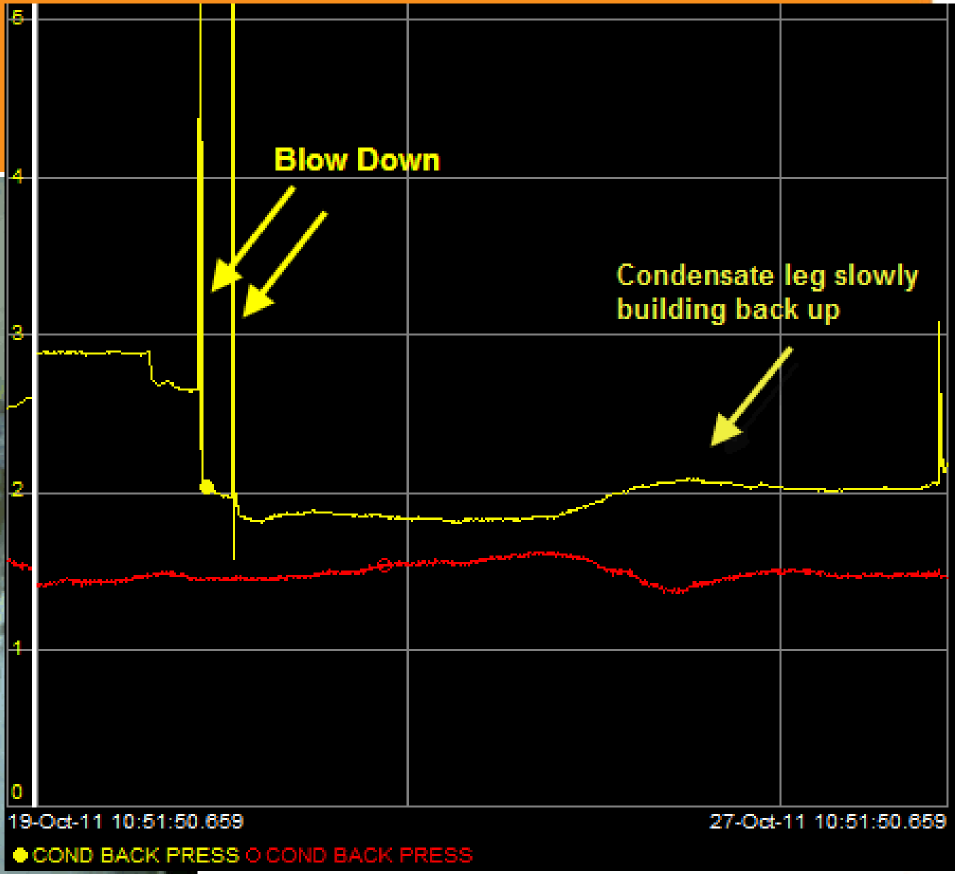


4SG01 blown down

BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2 (continued): Investigate anomaly**
  - **Site visit**





Blow Down

Condensate leg slowly building back up

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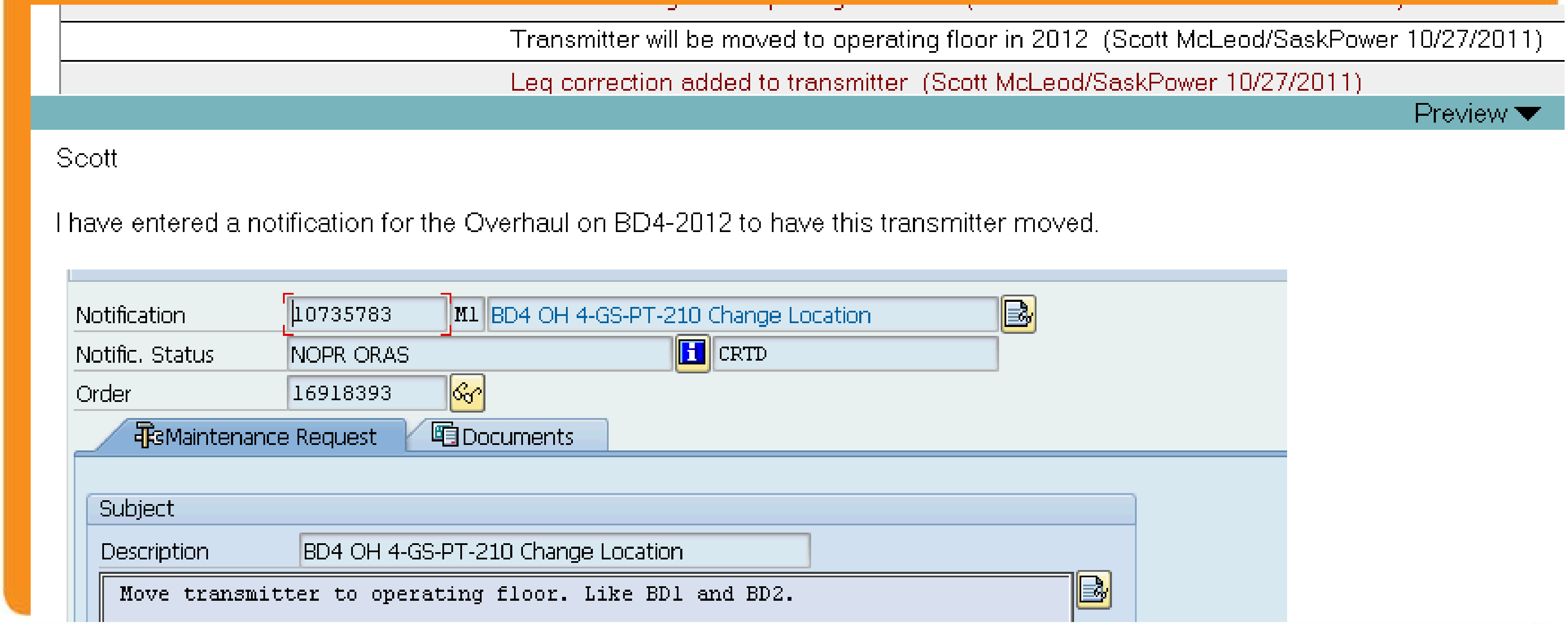
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2 (continued): Investigate anomaly**
  - **Work order**



Transmitter will be moved to operating floor in 2012 (Scott McLeod/SaskPower 10/27/2011)

Leq correction added to transmitter (Scott McLeod/SaskPower 10/27/2011)

Scott

I have entered a notification for the Overhaul on BD4-2012 to have this transmitter moved.

Notification	10735783	M1	BD4 OH 4-GS-PT-210 Change Location
Notific. Status	NOPR ORAS		CRTD
Order	16918393		

Subject

Description: BD4 OH 4-GS-PT-210 Change Location

```
Move transmitter to operating floor. Like BD1 and BD2.
```

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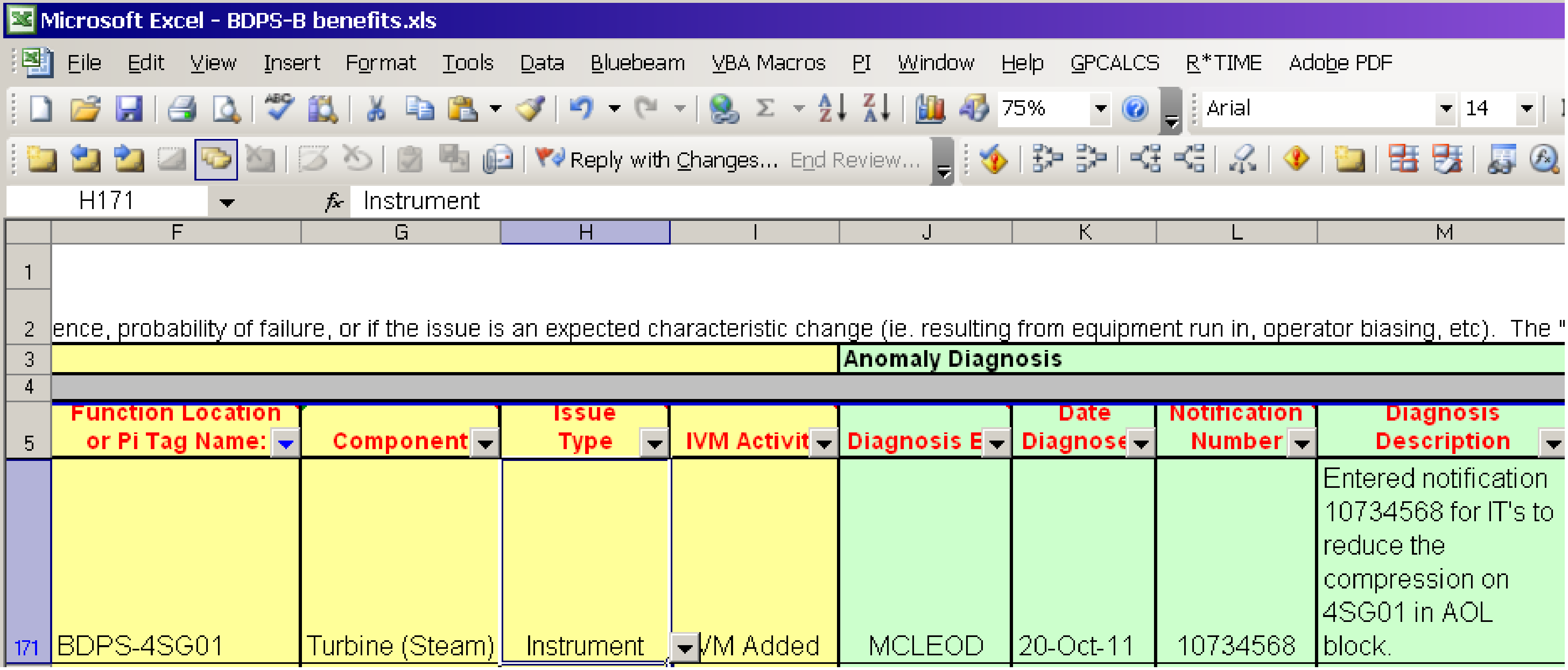
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 2 (continued): Investigate anomaly**
  - **Document in the cost benefit spreadsheet**

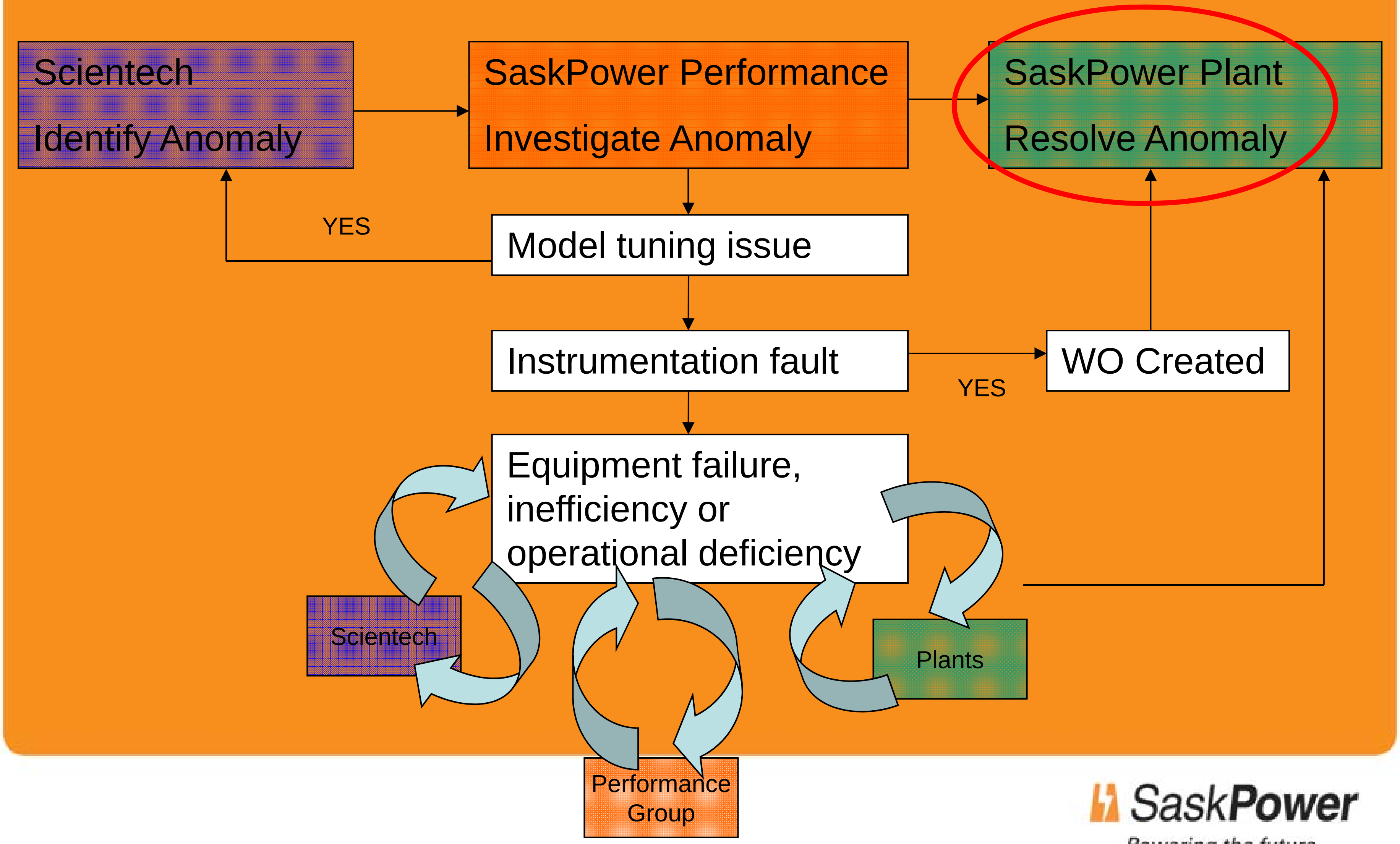

Microsoft Excel - BDPS-B benefits.xls
File Edit View Insert Format Tools Data Bluebeam VBA Macros PI Window Help GPCALCS R*TIME Adobe PDF
75%
Arial
14
Reply with Changes... End Review...

H171 Instrument

ence, probability of failure, or if the issue is an expected characteristic change (ie. resulting from equipment run in, operator biasing, etc). The "

	F	G	H	I	J	K	L	M
3					Anomaly Diagnosis			
4								
5	Function Location or Pi Tag Name:	Component	Issue Type	IVM Activit	Diagnosis E	Date Diagnose	Notification Number	Diagnosis Description
171	BDPS-4SG01	Turbine (Steam)	Instrument	/M Added	MCLEOD	20-Oct-11	10734568	Entered notification 10734568 for IT's to reduce the compression on 4SG01 in AOL block.

M&D Process



Scientech

Identify Anomaly

SaskPower Performance

Investigate Anomaly

SaskPower Plant

Resolve Anomaly

YES

Model tuning issue

Instrumentation fault

YES

WO Created

Equipment failure, inefficiency or operational deficiency

Scientech

Performance Group

Plants

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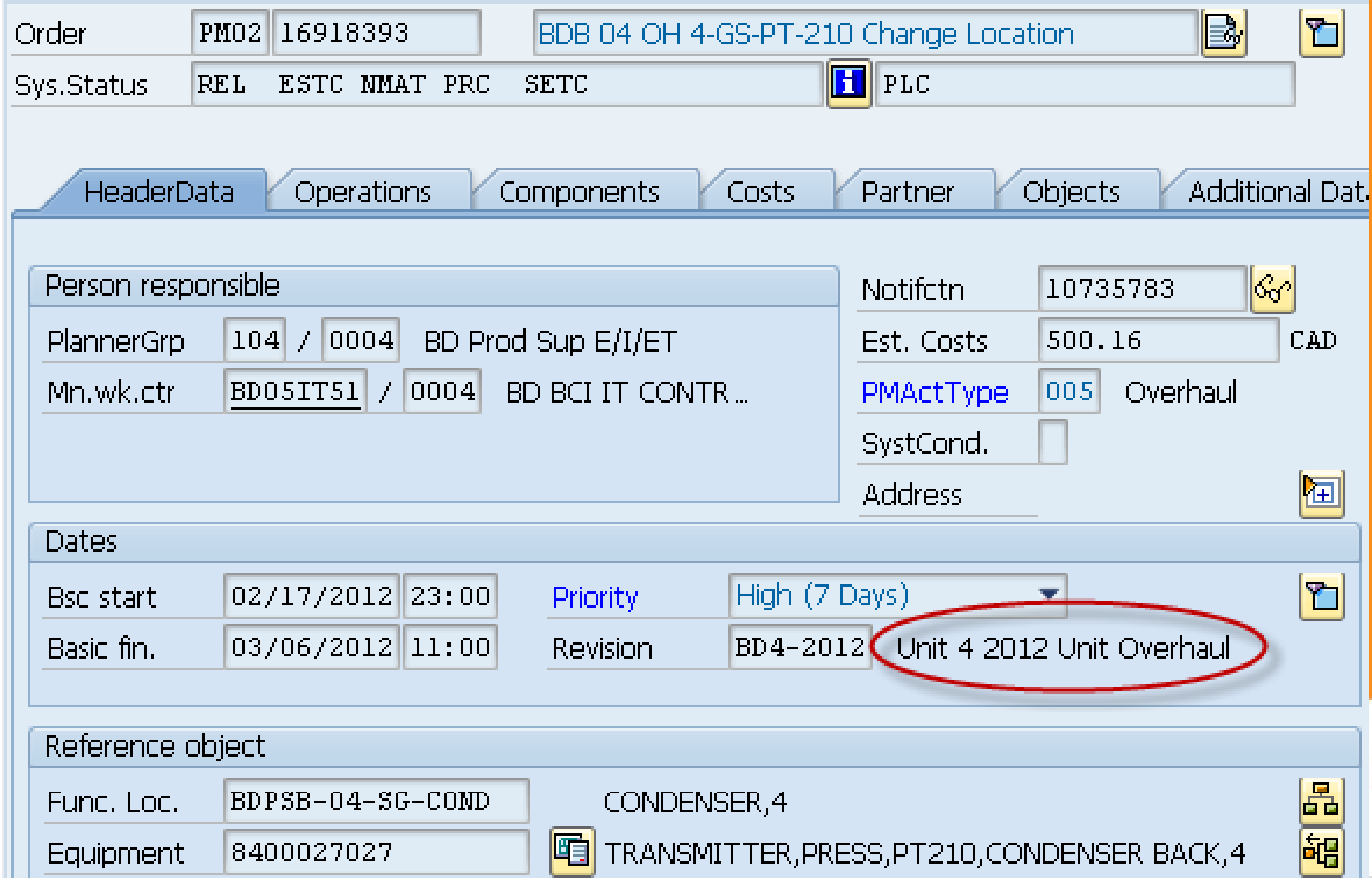
BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 3: Resolve anomaly**
  - **Work order or operational changes**


HeaderData
Operations
Components
Costs
Partner
Objects
Additional Dat

Order PM02 16918393 BDB 04 OH 4-GS-PT-210 Change Location

Sys.Status REL ESTC NMAT PRC SETC PLC

Person responsible

PlannerGrp 104 / 0004 BD Prod Sup E/I/ET

Mn.wk.ctr BD05IT51 / 0004 BD BCI IT CONTR...

Notifctn 10735783

Est. Costs 500.16 CAD

PMActType 005 Overhaul

SystCond.

Address

Dates

Bsc start 02/17/2012 23:00

Priority High (7 Days)

Basic fin. 03/06/2012 11:00

Revision BD4-2012 Unit 4 2012 Unit Overhaul

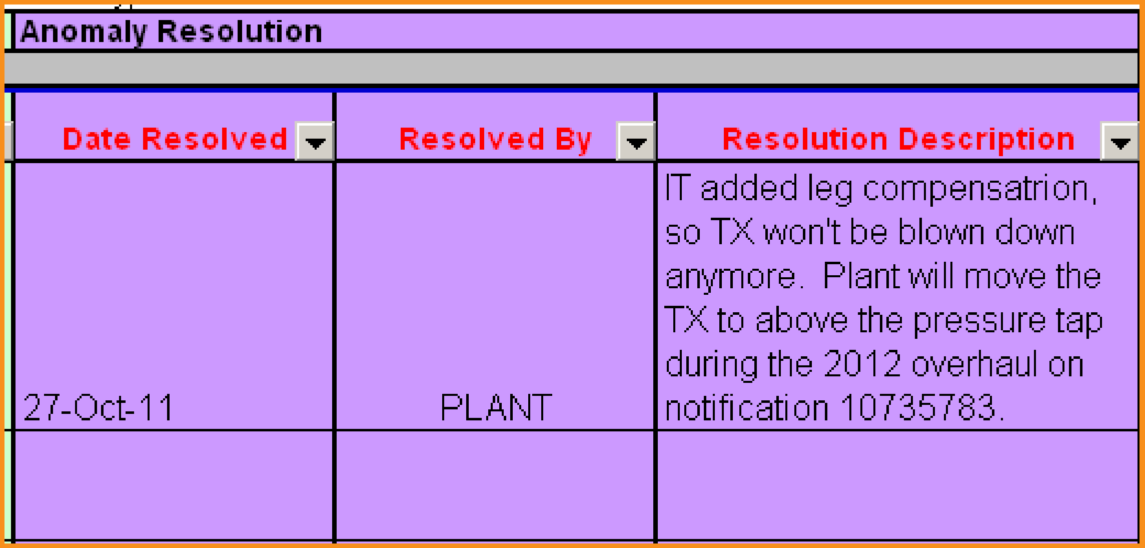
Reference object

Func. Loc. BDPSB-04-SG-COND CONDENSER,4

Equipment 8400027027 TRANSMITTER,PRESS,PT210,CONDENSER BACK,4

BDPS Unit #4 Condenser Exhaust Pressure Anomaly Example

- **Step 3: Resolve anomaly**
  - **Document in cost benefit spreadsheet**



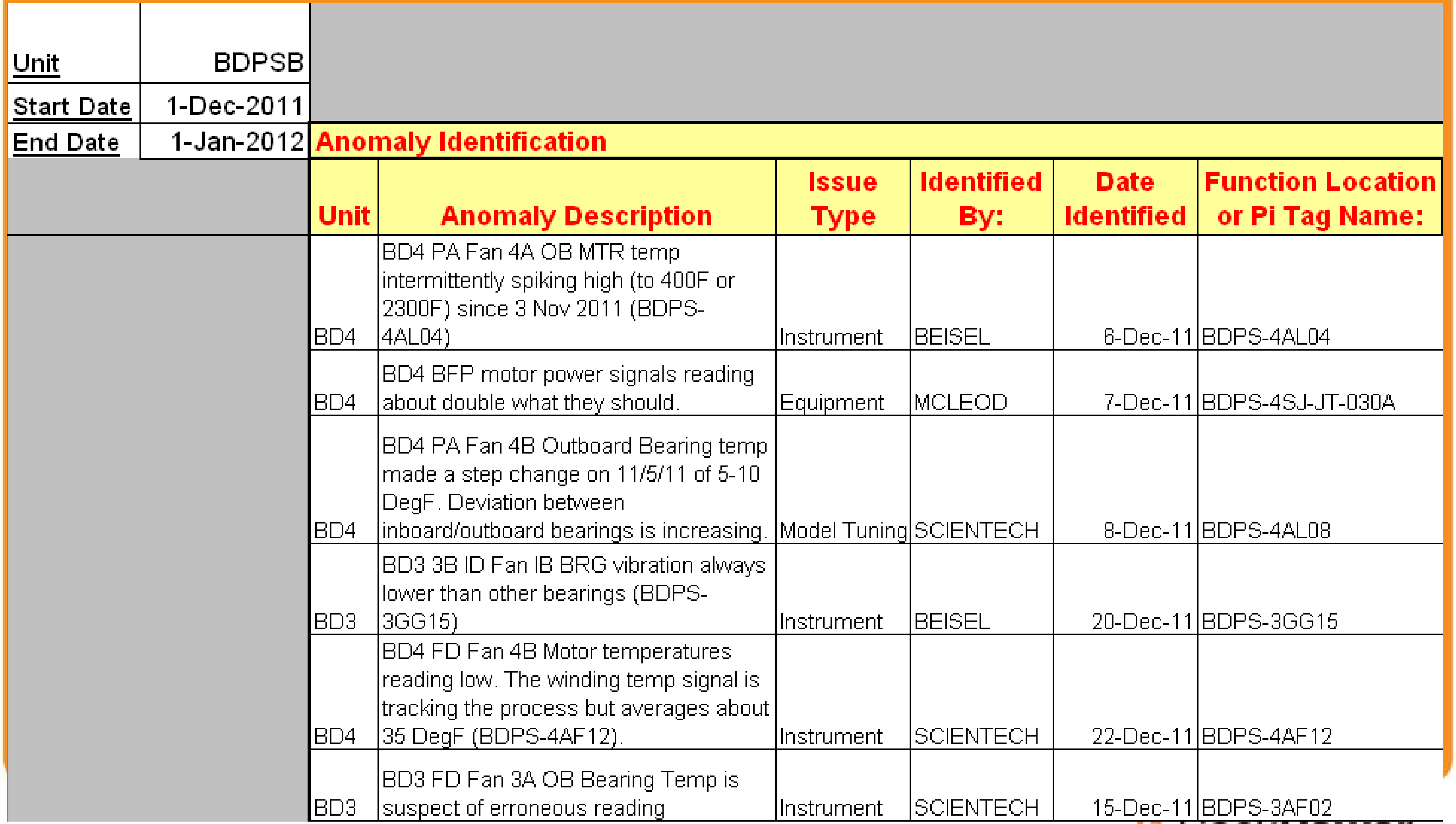
Anomaly Resolution

Date Resolved	Resolved By	Resolution Description
27-Oct-11	PLANT	IT added leg compensatrion, so TX won't be blown down anymore. Plant will move the TX to above the pressure tap during the 2012 overhaul on notification 10735783.

Reporting and Managing M&D

- **Unit Cost Benefit Sheet**
  - Work management
  - Documentation
  - Prioritization
- **Summary Benefits Sheet**
  - Weekly M&D Discussion Meetings
  - Weekly and monthly reporting
  - Distribution of resources

Reporting and Managing M&D



Unit	BDPSB
Start Date	1-Dec-2011
End Date	1-Jan-2012

Anomaly Identification

Unit	Anomaly Description	Issue Type	Identified By:	Date Identified	Function Location or Pi Tag Name:
BD4	BD4 PA Fan 4A OB MTR temp intermittently spiking high (to 400F or 2300F) since 3 Nov 2011 (BDPS-4AL04)	Instrument	BEISEL	6-Dec-11	BDPS-4AL04
BD4	BD4 BFP motor power signals reading about double what they should.	Equipment	MCLEOD	7-Dec-11	BDPS-4SJ-JT-030A
BD4	BD4 PA Fan 4B Outboard Bearing temp made a step change on 11/5/11 of 5-10 DegF. Deviation between inboard/outboard bearings is increasing.	Model Tuning	SCIENTECH	8-Dec-11	BDPS-4AL08
BD3	BD3 3B ID Fan IB BRG vibration always lower than other bearings (BDPS-3GG15)	Instrument	BEISEL	20-Dec-11	BDPS-3GG15
BD4	BD4 FD Fan 4B Motor temperatures reading low. The winding temp signal is tracking the process but averages about 35 DegF (BDPS-4AF12).	Instrument	SCIENTECH	22-Dec-11	BDPS-4AF12
BD3	BD3 FD Fan 3A OB Bearing Temp is suspect of erroneous reading	Instrument	SCIENTECH	15-Dec-11	BDPS-3AF02

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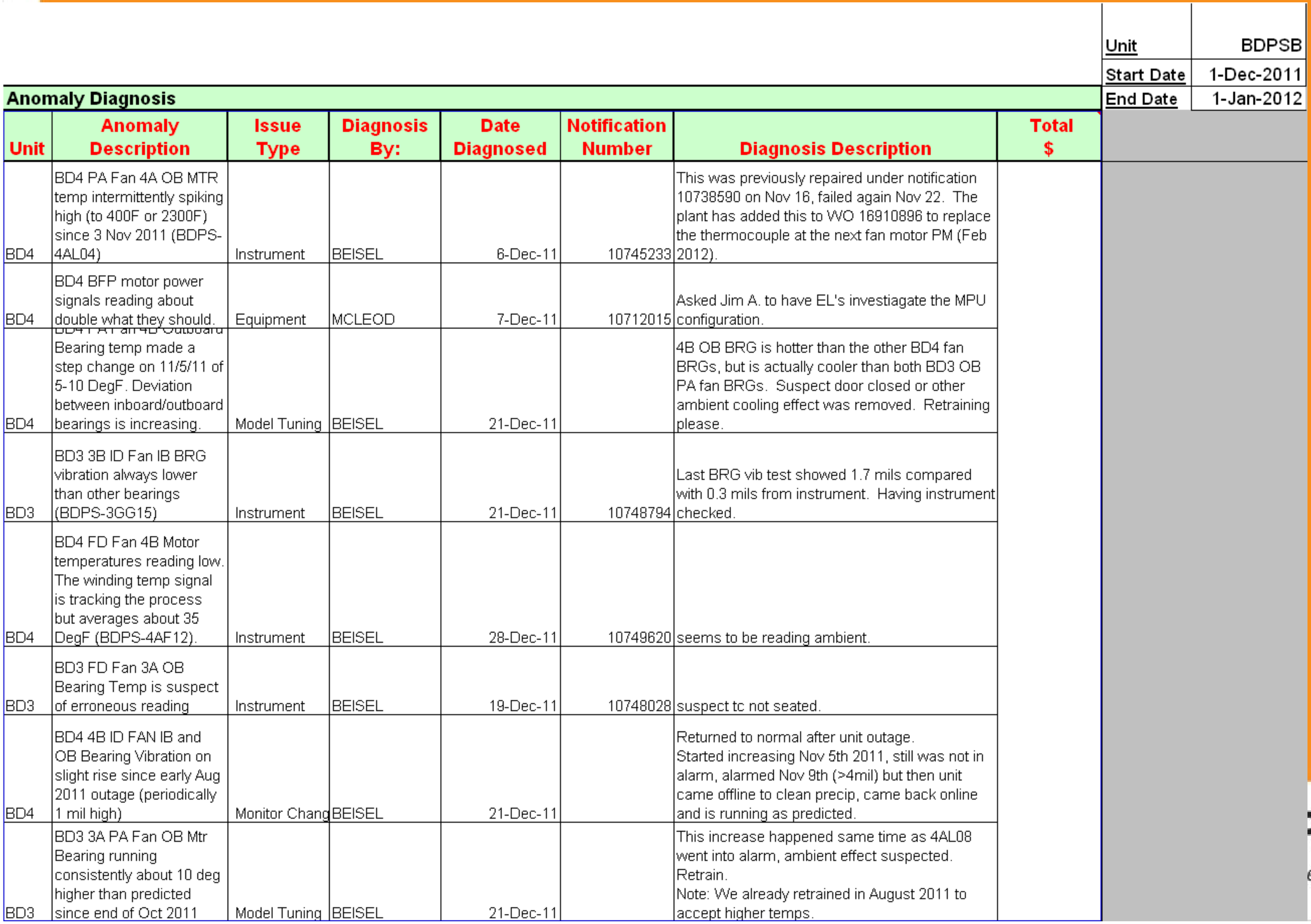
Reporting and Managing M&D

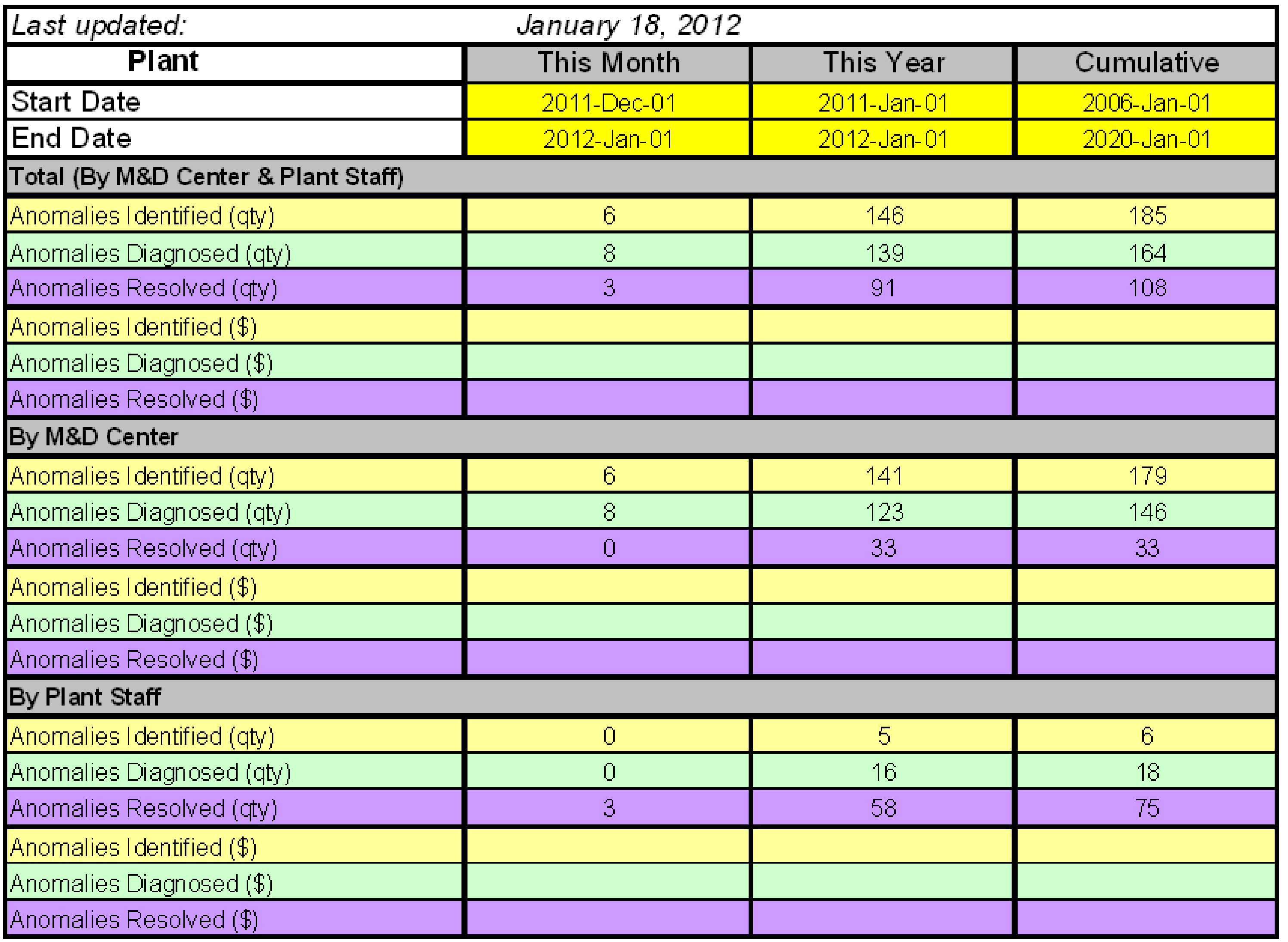


Unit	BDPSB
Start Date	1-Dec-2011
End Date	1-Jan-2012

Anomaly Diagnosis

Unit	Anomaly Description	Issue Type	Diagnosis By:	Date Diagnosed	Notification Number	Diagnosis Description	Total $
BD4	BD4 PA Fan 4A OB MTR temp intermittently spiking high (to 400F or 2300F) since 3 Nov 2011 (BDPS-4AL04)	Instrument	BEISEL	6-Dec-11	10745233	This was previously repaired under notification 10738590 on Nov 16, failed again Nov 22. The plant has added this to WO 16910896 to replace the thermocouple at the next fan motor PM (Feb 2012).	
BD4	BD4 BFP motor power signals reading about double what they should.	Equipment	MCLEOD	7-Dec-11	10712015	Asked Jim A. to have EL's investiagate the MPU configuration.	
BD4	BD4 PA Fan 4B Outboard Bearing temp made a step change on 11/5/11 of 5-10 DegF. Deviation between inboard/outboard bearings is increasing.	Model Tuning	BEISEL	21-Dec-11		4B OB BRG is hotter than the other BD4 fan BRGs, but is actually cooler than both BD3 OB PA fan BRGs. Suspect door closed or other ambient cooling effect was removed. Retraining please.	
BD3	BD3 3B ID Fan IB BRG vibration always lower than other bearings (BDPS-3GG15)	Instrument	BEISEL	21-Dec-11	10748794	Last BRG vib test showed 1.7 mils compared with 0.3 mils from instrument. Having instrument checked.	
BD4	BD4 FD Fan 4B Motor temperatures reading low. The winding temp signal is tracking the process but averages about 35 DegF (BDPS-4AF12).	Instrument	BEISEL	28-Dec-11	10749620	seems to be reading ambient.	
BD3	BD3 FD Fan 3A OB Bearing Temp is suspect of erroneous reading	Instrument	BEISEL	19-Dec-11	10748028	suspect tc not seated.	
BD4	BD4 4B ID FAN IB and OB Bearing Vibration on slight rise since early Aug 2011 outage (periodically 1 mil high)	Monitor Chang	BEISEL	21-Dec-11		Returned to normal after unit outage. Started increasing Nov 5th 2011, still was not in alarm, alarmed Nov 9th (>4mil) but then unit came offline to clean precip, came back online and is running as predicted.	
BD3	BD3 3A PA Fan OB Mtr Bearing running consistently about 10 deg higher than predicted since end of Oct 2011	Model Tuning	BEISEL	21-Dec-11		This increase happened same time as 4AL08 went into alarm, ambient effect suspected. Retrain. Note: We already retrained in August 2011 to accept higher temps.	

Reporting and Managing M&D



Last updated: *January 18, 2012*

Plant	This Month	This Year	Cumulative
Start Date	2011-Dec-01	2011-Jan-01	2006-Jan-01
End Date	2012-Jan-01	2012-Jan-01	2020-Jan-01
Total (By M&D Center & Plant Staff)			
Anomalies Identified (qty)	6	146	185
Anomalies Diagnosed (qty)	8	139	164
Anomalies Resolved (qty)	3	91	108
Anomalies Identified ($)			
Anomalies Diagnosed ($)			
Anomalies Resolved ($)			
By M&D Center			
Anomalies Identified (qty)	6	141	179
Anomalies Diagnosed (qty)	8	123	146
Anomalies Resolved (qty)	0	33	33
Anomalies Identified ($)			
Anomalies Diagnosed ($)			
Anomalies Resolved ($)			
By Plant Staff			
Anomalies Identified (qty)	0	5	6
Anomalies Diagnosed (qty)	0	16	18
Anomalies Resolved (qty)	3	58	75
Anomalies Identified ($)			
Anomalies Diagnosed ($)			
Anomalies Resolved ($)			

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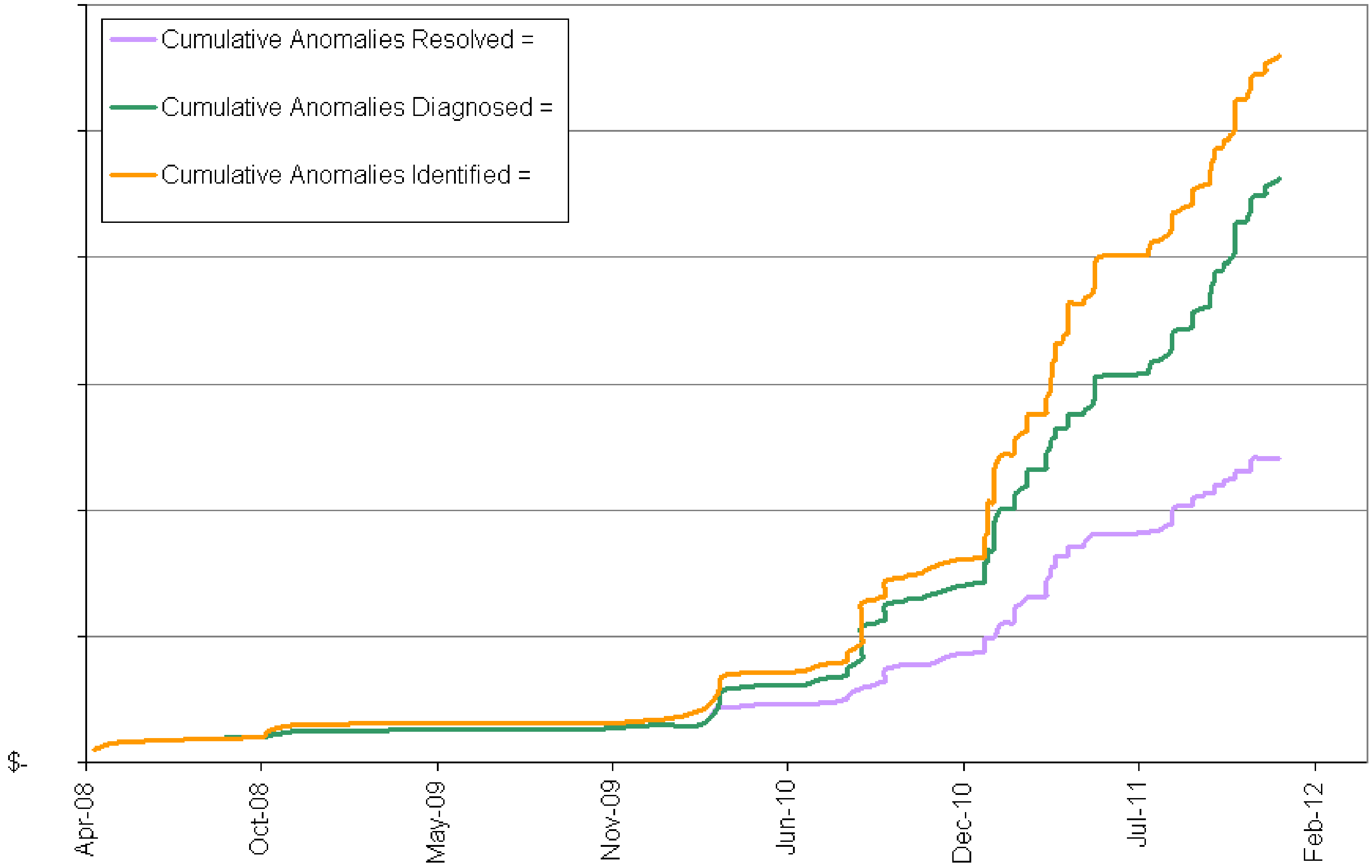
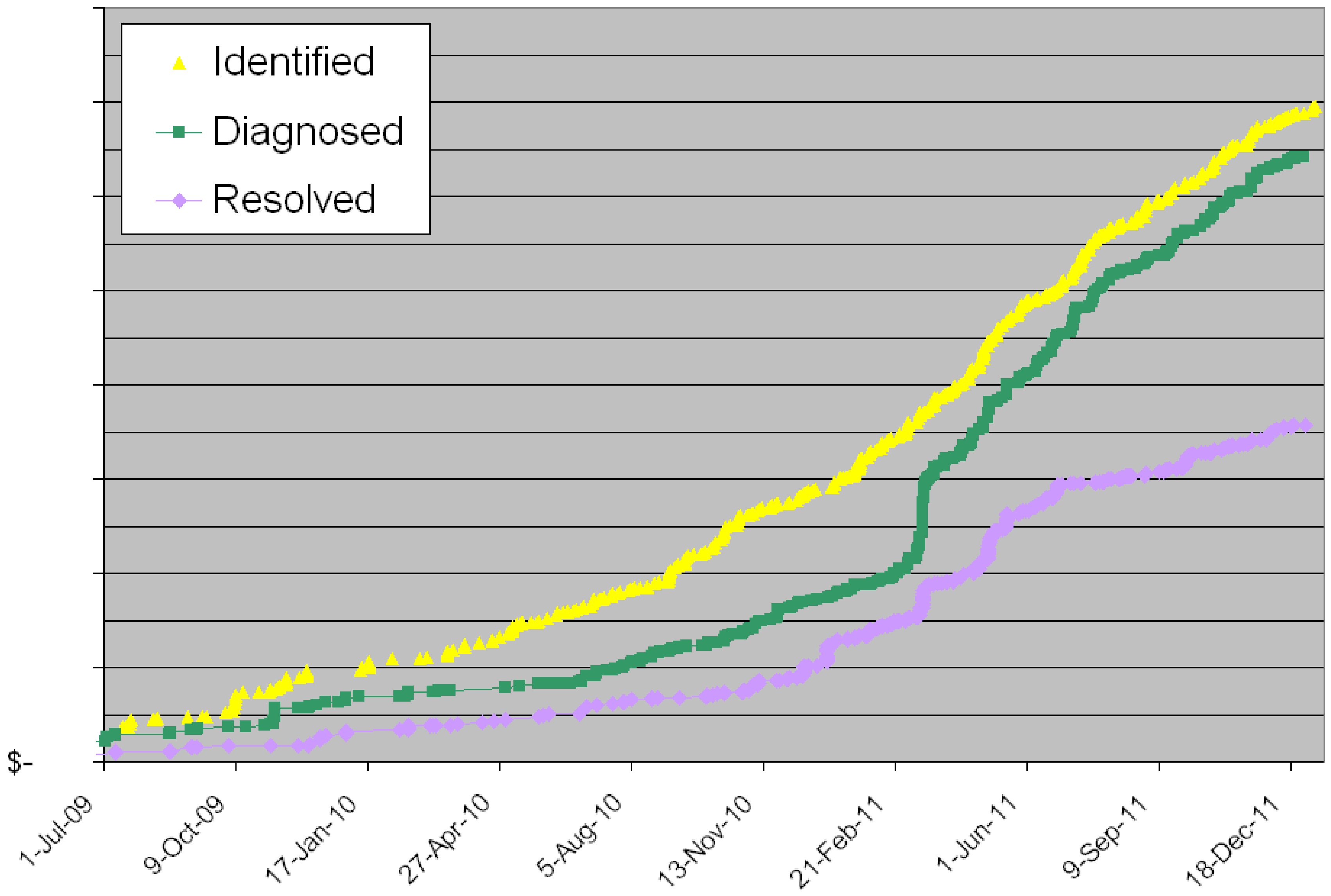
Reporting and Managing M&D



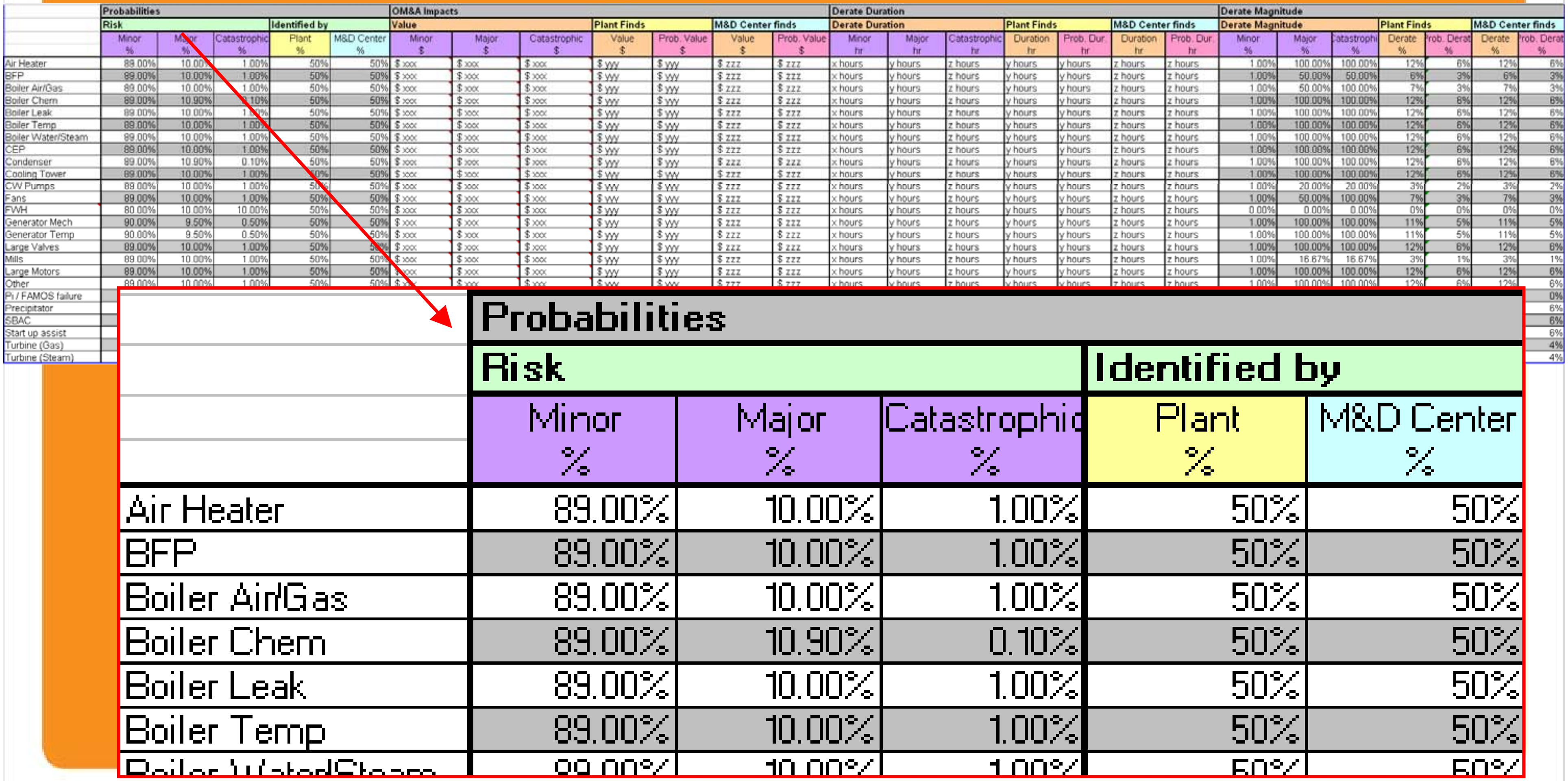
Powering the future

SaskPower Monitoring & Diagnostics
Cumulative Potential Cost Savings (OM&A, Replacement Energy)



Probability, OM&A Impact and Duration

Estimated Costs



	Probabilities					OM&A Impacts							Derate Duration							Derate Magnitude						
	Risk			Identified by		Value			Plant Finds		M&D Center finds		Derate Duration			Plant Finds		M&D Center finds		Derate Magnitude			Plant Finds		M&D Center finds	
	Minor %	Major %	Catastrophic %	Plant %	M&D Center %	Minor $	Major $	Catastrophic $	Value $	Prob. Value $	Value $	Prob. Value $	Minor hr	Major hr	Catastrophic hr	Duration hr	Prob. Dur hr	Duration hr	Prob. Dur hr	Minor %	Major %	atastrophi %	Derate %	rob. Derat %	Derate %	rob. Derat %
Air Heater	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
BFP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	50.00%	6%	3%	6%	3%
Boiler Air/Gas	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	100.00%	7%	3%	7%	3%
Boiler Chem	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Leak	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Temp	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Water/Steam	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
CEP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Condenser	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Cooling Tower	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
CW Pumps	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	20.00%	20.00%	3%	2%	3%	2%
Fans	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	100.00%	7%	3%	7%	3%
FWH	80.00%	10.00%	10.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	0.00%	0.00%	0.00%	0%	0%	0%	0%
Generator Mech	90.00%	9.50%	0.50%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	11%	5%	11%	5%
Generator Temp	90.00%	9.50%	0.50%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	11%	5%	11%	5%
Large Valves	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Mills	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	16.67%	16.67%	3%	1%	3%	1%
Large Motors	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Other	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Pi / FAMOS failure																										0%
Precipitator																										6%
SBAC																										6%
Start up assist																										6%
Turbine (Gas)																										4%
Turbine (Steam)																										4%

	Probabilities				
	Risk			Identified by	
	Minor %	Major %	Catastrophic %	Plant %	M&D Center %
Air Heater	89.00%	10.00%	1.00%	50%	50%
BFP	89.00%	10.00%	1.00%	50%	50%
Boiler Air/Gas	89.00%	10.00%	1.00%	50%	50%
Boiler Chem	89.00%	10.90%	0.10%	50%	50%
Boiler Leak	89.00%	10.00%	1.00%	50%	50%
Boiler Temp	89.00%	10.00%	1.00%	50%	50%
Boiler Water/Steam	89.00%	10.00%	1.00%	50%	50%

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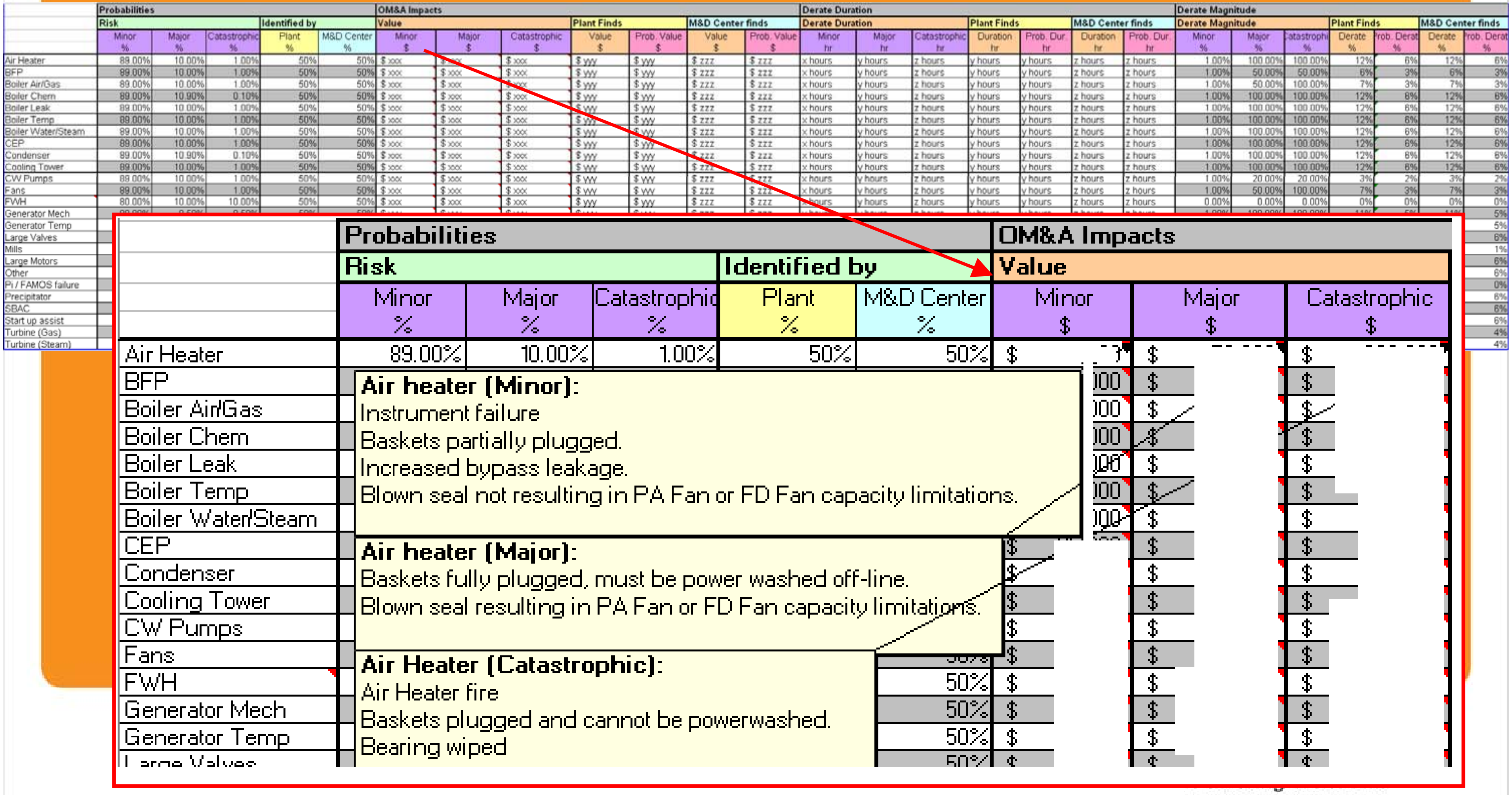
Probability, OM&A Impact and Duration

Estimated Costs



	Probabilities					OM&A Impacts							Derate Duration							Derate Magnitude						
	Risk			Identified by		Value			Plant Finds		M&D Center finds		Derate Duration			Plant Finds		M&D Center finds		Derate Magnitude			Plant Finds		M&D Center finds	
	Minor %	Major %	Catastrophic %	Plant %	M&D Center %	Minor $	Major $	Catastrophic $	Value $	Prob. Value $	Value $	Prob. Value $	Minor hr	Major hr	Catastrophic hr	Duration hr	Prob. Dur hr	Duration hr	Prob. Dur hr	Minor %	Major %	Catastrophi %	Derate %	Prob. Derat %	Derate %	Prob. Derat %
Air Heater	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
BFP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	50.00%	6%	3%	6%	3%
Boiler Air/Gas	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	100.00%	7%	3%	7%	3%
Boiler Chem	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Leak	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Temp	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Water/Steam	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
CEP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Condenser	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Cooling Tower	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
CW Pumps	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	20.00%	20.00%	3%	2%	3%	2%
Fans	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	100.00%	7%	3%	7%	3%
FWH	80.00%	10.00%	10.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours	0.00%	0.00%	0.00%	0%	0%	0%	0%
Generator Mech																										5%
Generator Temp																										5%
Large Valves																										6%
Mills																										1%
Large Motors																										6%
Other																										6%
Pi / FAMOS failure																										0%
Precipitator																										6%
SBAC																										6%
Start up assist																										6%
Turbine (Gas)																										4%
Turbine (Steam)																										4%

	Probabilities					OM&A Impacts		
	Risk			Identified by		Value		
	Minor %	Major %	Catastrophic %	Plant %	M&D Center %	Minor $	Major $	Catastrophic $
Air Heater	89.00%	10.00%	1.00%	50%	50%	$	$	$
BFP							$	$
Boiler Air/Gas							$	$
Boiler Chem							$	$
Boiler Leak							$	$
Boiler Temp							$	$
Boiler Water/Steam							$	$
CEP						$	$	$
Condenser						$	$	$
Cooling Tower						$	$	$
CW Pumps						$	$	$
Fans						$	$	$
FWH					50%	$	$	$
Generator Mech					50%	$	$	$
Generator Temp					50%	$	$	$

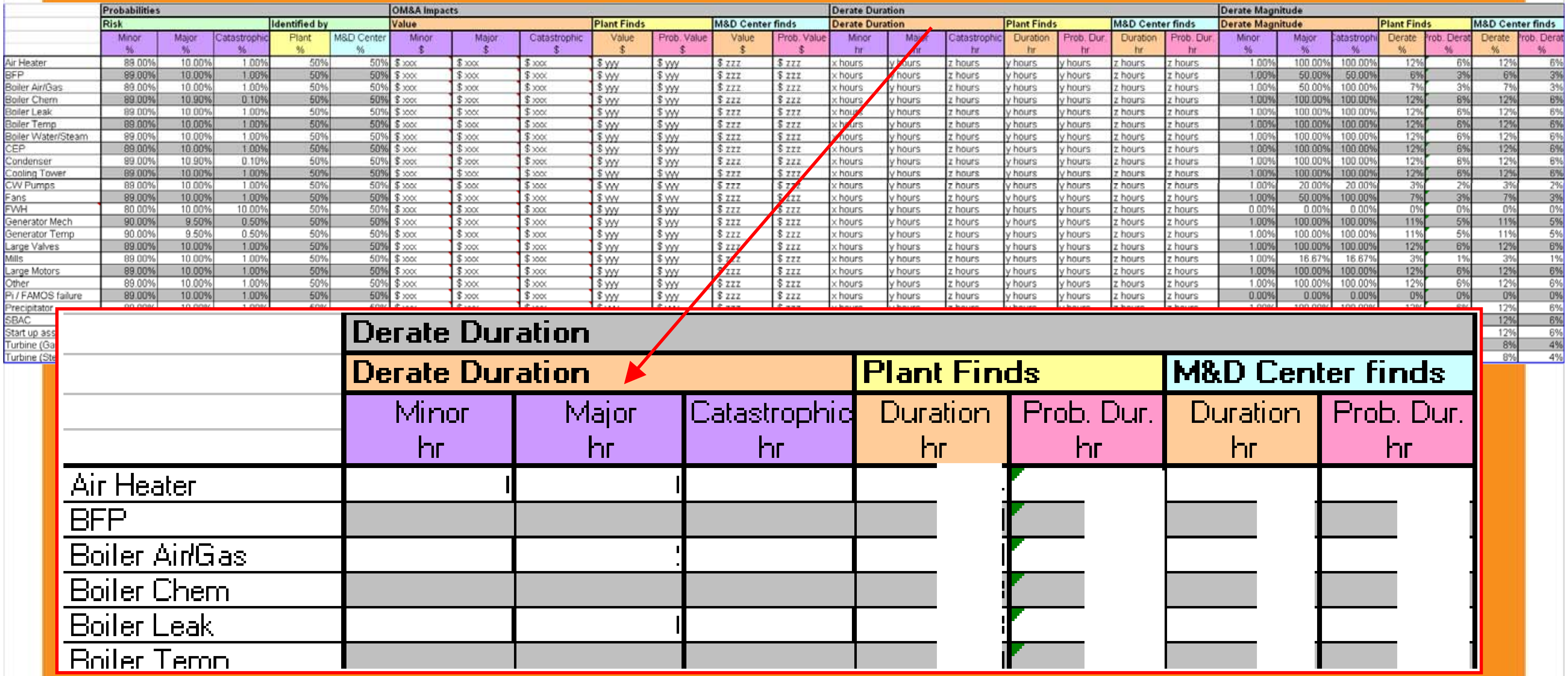
Air heater (Minor):
Instrument failure
Baskets partially plugged.
Increased bypass leakage.
Blown seal not resulting in PA Fan or FD Fan capacity limitations.

Air heater (Major):
Baskets fully plugged, must be power washed off-line.
Blown seal resulting in PA Fan or FD Fan capacity limitations.

Air Heater (Catastrophic):
Air Heater fire
Baskets plugged and cannot be powerwashed.
Bearing wiped

Probability, OM&A Impact and Duration

Estimated Costs



	Probabilities					OM&A Impacts						
	Risk			Identified by		Value			Plant Finds		M&D Center finds	
	Minor %	Major %	Catastrophic %	Plant %	M&D Center %	Minor $	Major $	Catastrophic $	Value $	Prob. Value $	Value $	Prob. Value $
Air Heater	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
BFP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Boiler Air/Gas	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Boiler Chem	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Boiler Leak	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Boiler Temp	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Boiler Water/Steam	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
CEP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Condenser	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Cooling Tower	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
CW Pumps	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Fans	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
FWH	80.00%	10.00%	10.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Generator Mech	90.00%	9.50%	0.50%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Generator Temp	90.00%	9.50%	0.50%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Large Valves	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Mills	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Large Motors	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Other	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Pi / FAMOS failure	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz
Precipitator												
SBAC												
Start up ass												
Turbine (Ga												
Turbine (Ste												

	Derate Duration							Derate Magnitude						
	Derate Duration			Plant Finds		M&D Center finds		Derate Magnitude			Plant Finds		M&D Center finds	
	Minor hr	Major hr	Catastrophic hr	Duration hr	Prob. Dur hr	Duration hr	Prob. Dur hr	Minor %	Major %	Catastrophi %	Derate %	Prob. Derat %	Derate %	Prob. Derat %
Air Heater	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
BFP	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	50.00%	6%	3%	6%	3%
Boiler Air/Gas	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	100.00%	7%	3%	7%	3%
Boiler Chem	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Leak	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Temp	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Water/Steam	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
CEP	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Condenser	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Cooling Tower	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
CW Pumps	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	20.00%	20.00%	3%	2%	3%	2%
Fans	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	50.00%	100.00%	7%	3%	7%	3%
FWH	x hours	y hours	z hours	y hours	y hours	z hours	z hours	0.00%	0.00%	0.00%	0%	0%	0%	0%
Generator Mech	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	11%	5%	11%	5%
Generator Temp	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	11%	5%	11%	5%
Large Valves	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Mills	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	16.67%	16.67%	3%	1%	3%	1%
Large Motors	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Other	x hours	y hours	z hours	y hours	y hours	z hours	z hours	1.00%	100.00%	100.00%	12%	6%	12%	6%
Pi / FAMOS failure	x hours	y hours	z hours	y hours	y hours	z hours	z hours	0.00%	0.00%	0.00%	0%	0%	0%	0%
Precipitator													12%	6%
SBAC													12%	6%
Start up ass													12%	6%
Turbine (Ga													8%	4%
Turbine (Ste													8%	4%

	Derate Duration						
	Derate Duration			Plant Finds		M&D Center finds	
	Minor hr	Major hr	Catastrophic hr	Duration hr	Prob. Dur. hr	Duration hr	Prob. Dur. hr
Air Heater							
BFP							
Boiler Air/Gas							
Boiler Chem							
Boiler Leak							
Boiler Temp							

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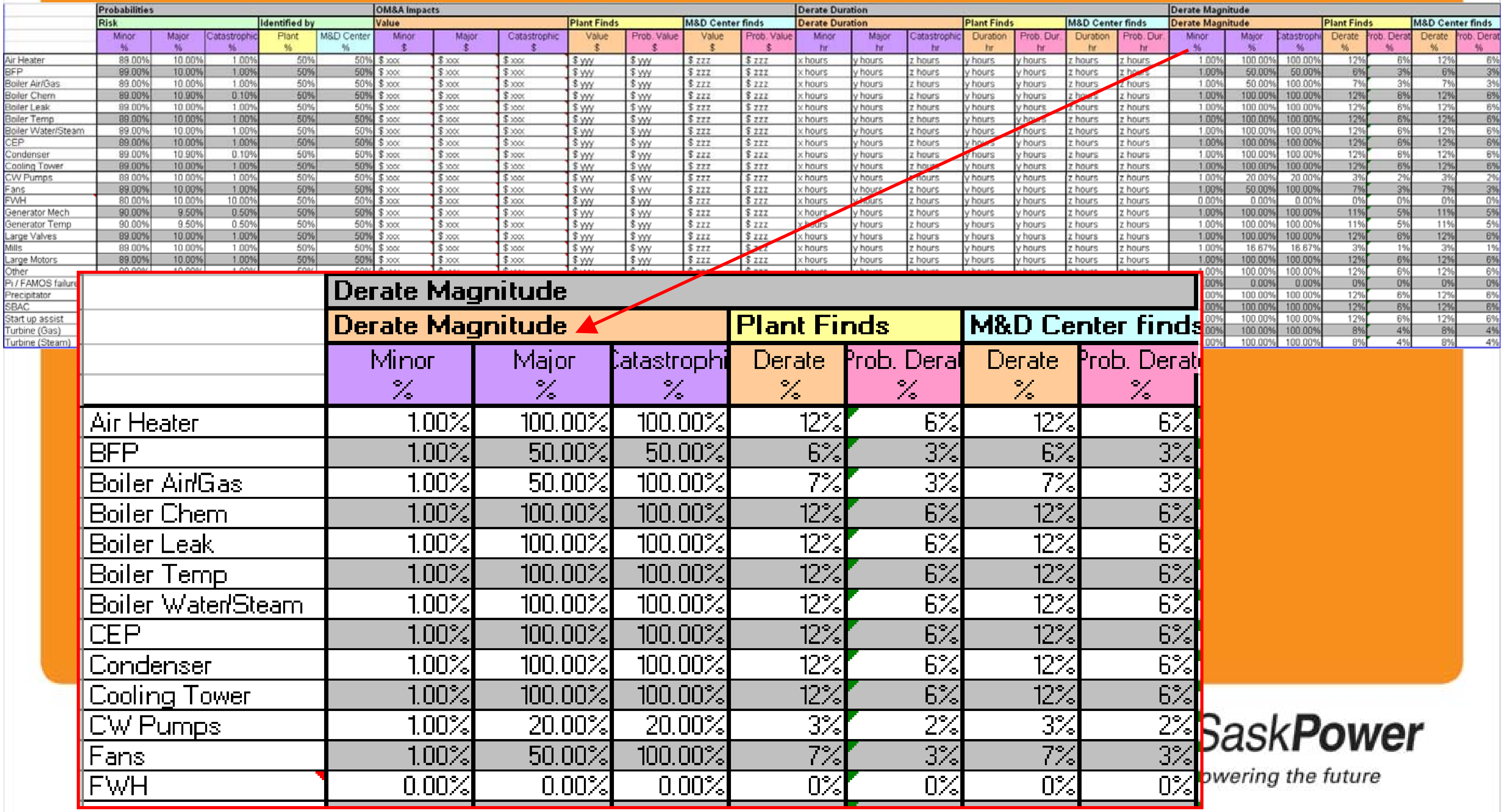
Probability, OM&A Impact and Duration

Estimated Costs



Probabilities					OM&A Impacts							Derate Duration						
Risk			Identified by		Value			Plant Finds		M&D Center finds		Derate Duration			Plant Finds		M&D Center finds	
Minor %	Major %	Catastrophic %	Plant %	M&D Center %	Minor $	Major $	Catastrophic $	Value $	Prob. Value $	Value $	Prob. Value $	Minor hr	Major hr	Catastrophic hr	Duration hr	Prob. Dur hr	Duration hr	Prob. Dur hr

	Minor %	Major %	Catastrophic %	Plant %	M&D Center %	Minor $	Major $	Catastrophic $	Value $	Prob. Value $	Value $	Prob. Value $	Minor hr	Major hr	Catastrophic hr	Duration hr	Prob. Dur hr	Duration hr	Prob. Dur hr
Air Heater	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
BFP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Boiler Air/Gas	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Boiler Chem	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Boiler Leak	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Boiler Temp	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Boiler Water/Steam	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
CEP	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Condenser	89.00%	10.90%	0.10%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Cooling Tower	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
CW Pumps	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Fans	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
FWH	80.00%	10.00%	10.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Generator Mech	90.00%	9.50%	0.50%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Generator Temp	90.00%	9.50%	0.50%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Large Valves	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Mills	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours
Large Motors	89.00%	10.00%	1.00%	50%	50%	$ xxx	$ xxx	$ xxx	$ yyy	$ yyy	$ zzz	$ zzz	x hours	y hours	z hours	y hours	y hours	z hours	z hours

	Derate Magnitude						
	Derate Magnitude			Plant Finds		M&D Center finds	
	Minor %	Major %	atastrophi %	Derate %	rob. Derat %	Derate %	rob. Derat %
Air Heater	1.00%	100.00%	100.00%	12%	6%	12%	6%
BFP	1.00%	50.00%	50.00%	6%	3%	6%	3%
Boiler Air/Gas	1.00%	50.00%	100.00%	7%	3%	7%	3%
Boiler Chem	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Leak	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Temp	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Water/Steam	1.00%	100.00%	100.00%	12%	6%	12%	6%
CEP	1.00%	100.00%	100.00%	12%	6%	12%	6%
Condenser	1.00%	100.00%	100.00%	12%	6%	12%	6%
Cooling Tower	1.00%	100.00%	100.00%	12%	6%	12%	6%
CW Pumps	1.00%	20.00%	20.00%	3%	2%	3%	2%
Fans	1.00%	50.00%	100.00%	7%	3%	7%	3%
FWH	0.00%	0.00%	0.00%	0%	0%	0%	0%
Generator Mech	1.00%	100.00%	100.00%	11%	5%	11%	5%
Generator Temp	1.00%	100.00%	100.00%	11%	5%	11%	5%
Large Valves	1.00%	100.00%	100.00%	12%	6%	12%	6%
Mills	1.00%	16.67%	16.67%	3%	1%	3%	1%
Large Motors	1.00%	100.00%	100.00%	12%	6%	12%	6%
Other	1.00%	100.00%	100.00%	12%	6%	12%	6%
Pi / FAMOS failure	[illegible]	0.00%	0.00%	0%	0%	0%	0%
Precipitator	[illegible]	100.00%	100.00%	12%	6%	12%	6%
SBAC	[illegible]	100.00%	100.00%	12%	6%	12%	6%
Start up assist	[illegible]	100.00%	100.00%	12%	6%	12%	6%
Turbine (Gas)	[illegible]	100.00%	100.00%	8%	4%	8%	4%
Turbine (Steam)	[illegible]	100.00%	100.00%	8%	4%	8%	4%

	Derate Magnitude						
	Derate Magnitude			Plant Finds		M&D Center finds	
	Minor %	Major %	atastrophi %	Derate %	rob. Dera %	Derate %	rob. Derat %
Air Heater	1.00%	100.00%	100.00%	12%	6%	12%	6%
BFP	1.00%	50.00%	50.00%	6%	3%	6%	3%
Boiler Air/Gas	1.00%	50.00%	100.00%	7%	3%	7%	3%
Boiler Chem	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Leak	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Temp	1.00%	100.00%	100.00%	12%	6%	12%	6%
Boiler Water/Steam	1.00%	100.00%	100.00%	12%	6%	12%	6%
CEP	1.00%	100.00%	100.00%	12%	6%	12%	6%
Condenser	1.00%	100.00%	100.00%	12%	6%	12%	6%
Cooling Tower	1.00%	100.00%	100.00%	12%	6%	12%	6%
CW Pumps	1.00%	20.00%	20.00%	3%	2%	3%	2%
Fans	1.00%	50.00%	100.00%	7%	3%	7%	3%
FWH	0.00%	0.00%	0.00%	0%	0%	0%	0%

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Probability, OM&A Impact and Duration

Estimated Costs

- **Probabilistic Costing Calculations**
  - Minor
  - Major
  - Catastrophic
  - Risk
  - Dollar values
  - Derate Duration
  - Derate Magnitude

Questions or Comments

- How are your monitoring and diagnostics findings being *quantified?*
- How are your monitoring and diagnostics findings being *communicated?*

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Thank you!

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