Nova Scotia POWER
An Emera Company

JAN, 2017-SCIENTEC'S USER CONFERENCE

How PdP Enriches NSPI Maintenance Strategies

Warren Rodgers, P.Eng, CMRP

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Who Am I?

WARREN RODGERS, P.ENG, CMRP

FORMAL DISCIPLINE: MECHANICAL ENGINEER

JOB TITLE: SENIOR ENGINEER, ASSET MANAGEMENT

FROM: HALIFAX, NOVA SCOTIA

WHAT I DO: ASSET MANAGEMENT, RELIABILITY ENGINEERING AND APPLICATION

The New World of DATA!!!!

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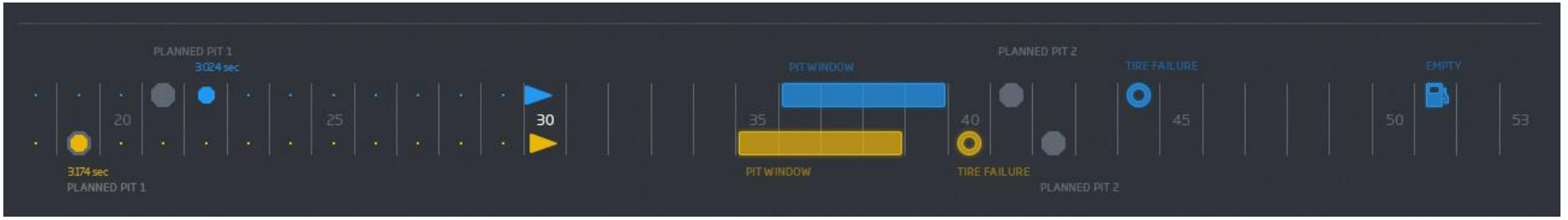
[Link for the F1 Video]

DATA

DATA



DATA

DATA

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What we will discuss today

WHO ARE WE?

OUR AM PROGRAM

WHAT IS A MAINTENANCE STRATEGY TO US?

ELEMENTS OF MAINTENANCE STRATEGIES

HOW WE UTILIZE PDP WITHIN MAINTENANCE STTRATEGIES

HOW PDP HELPS IN DECISION MAKING

EXAMPLES

Emera at a Glance

$USD[2]

Ticker Symbol: EMA (TSX)

$8.8bn
Total Assets
(March 31, 2016)

$2.2bn
Revenue
(Year-end 2015)

$254M
Adjusted Earnings
(Year-End 2015)

13.0%
(S&P TSX Utilities Index 5.2%)
Five Year Annualized Total Shareholder Return
(March 31, 2016)

22.8%
(S&P TSX Utilities Index 2.2%)
2015 Total Shareholder Return
(December 31, 2015)

$7.3bn
Market Capitalization[1]
(March 31, 2016)

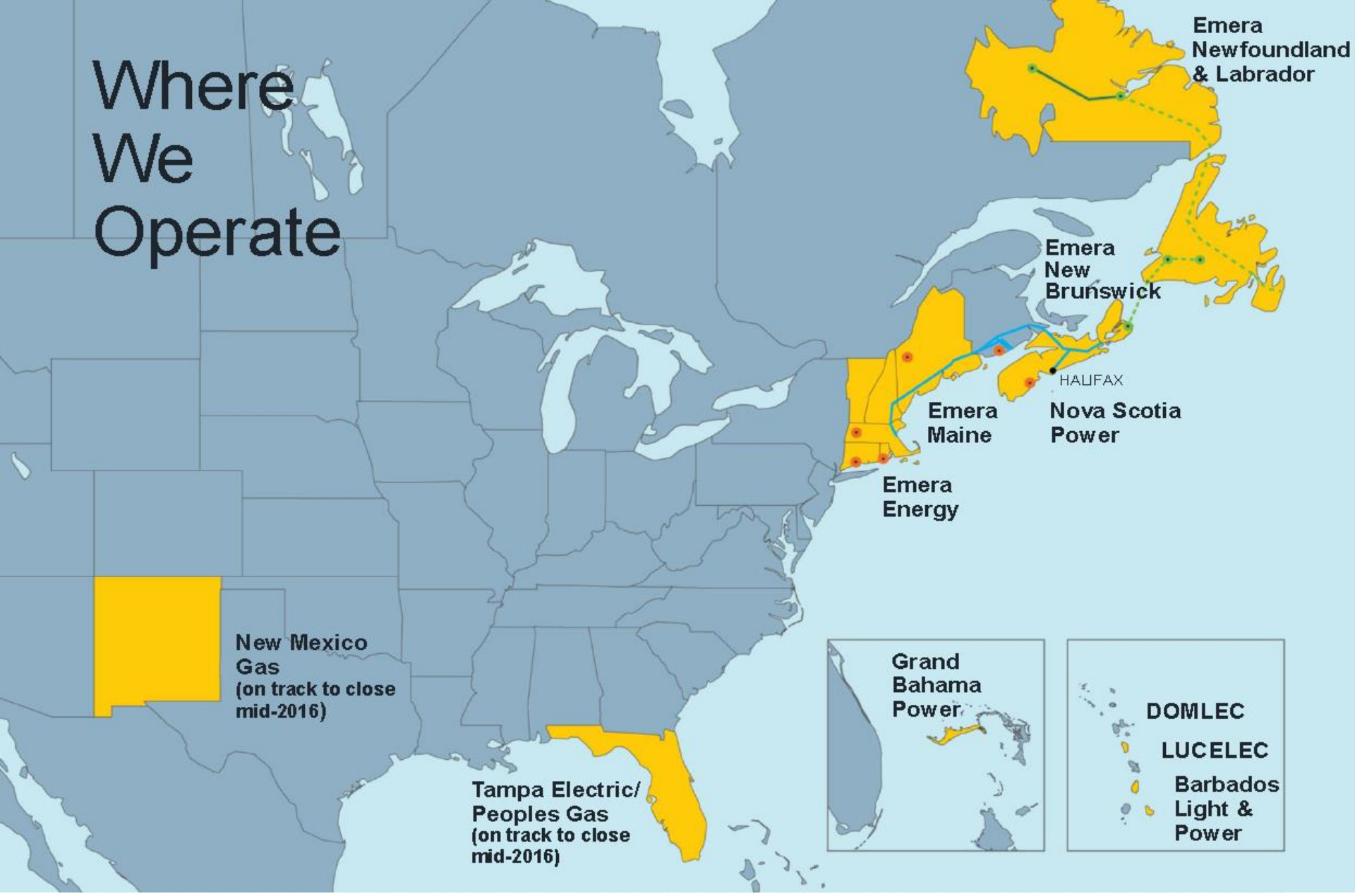
9.1%
Five Year Compound Annual Growth rate in Adjusted EPS.
(March 31, 2016)

4.0%
Dividend Yield
(March 31, 2016)

845,000
Approx. Total Electric Customers
(2015)

3,500
Approx. Employees
(2015)

BBB+/ Baa3
S&P/Moodys Rating
(2016)



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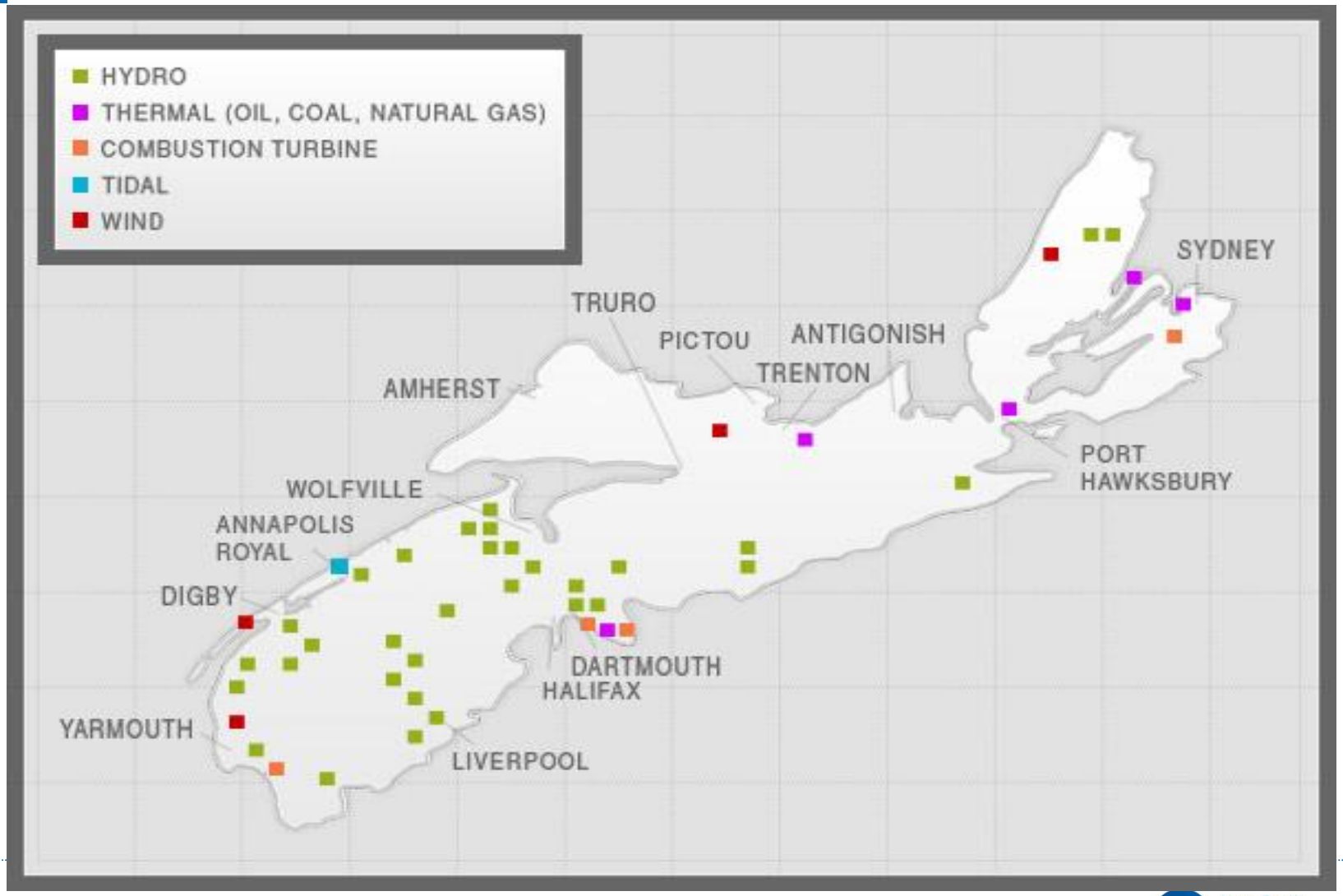
NOVA SCOTIA POWER (100%) (RI)	TECO ENERGY (RI)	EMERA MAINE (100%) (RI)	EMERA NEWFOUNDLAND LABRADOR (RI)	EMERA CARIBBEAN (RI)	EMERA ENERGY	CORPORATE AND OTHER	PIPELINES (RI)
USD$3.5 billion in assets 29% of earnings	USD$8.9 billion in assets Expected close mid-2016	USD$1.2 billion in assets 11% of earnings	Estimated USD$1.2 billion in assets by 2017 7% of earnings	USD$1.0 billion in assets 10% of earnings	USD$1.2 billion in assets 25% of earnings	8% of earnings	USD$625 million in assets 10% of earnings
	New Mexico Gas (100%) Peoples Gas (100%) Tampa Electric (100%)		Maritime Link* (100%) Labrador Island Link* (59%)	Emera (Caribbean) Inc. (100%) • Barbados Light & Power (100%) • Lucelec (19.1%) • DOMLEC (51.9%) EUS Bahamas (100%) Grand Bahama Power Company (80.4%)	Bayside (100%) Bear Swamp (50%) US Gas Generation (100%) Brooklyn Energy (100%)	Emera Utility Services (100%) Algonquin Power (~5%)'	• Brunswick Pipeline (100%) • Maritimes & Northeast Pipeline (12.9%)

RI Regulated Investments

NSPI Generation

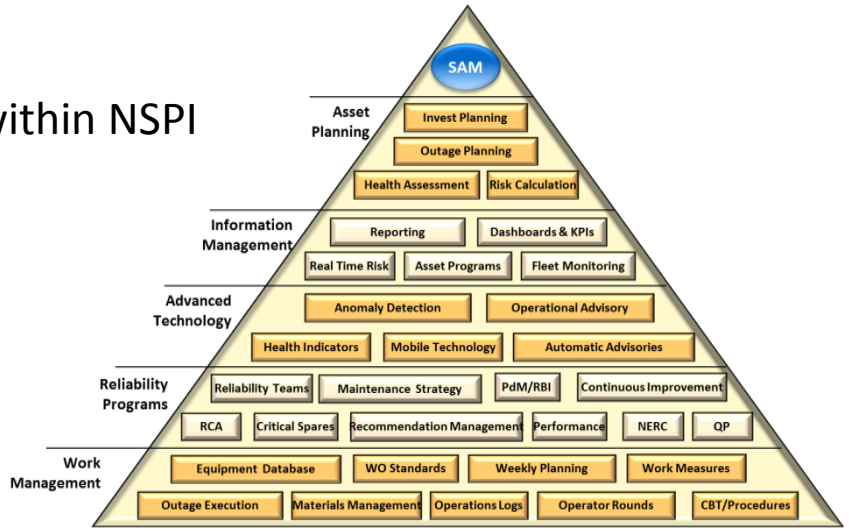


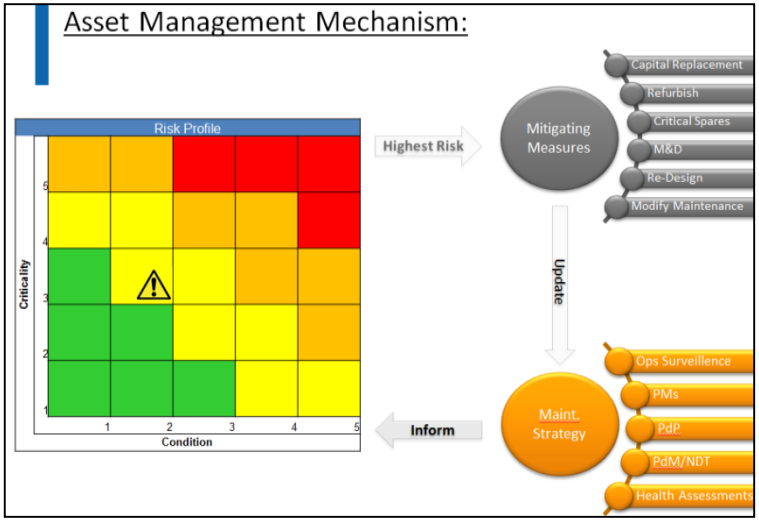
NSPI Summary

- 95 per cent of the generation, transmission and distribution of electricity in nova scotia
- 500,000 residential, commercial and industrial customers
- 1,700 dedicated, safety-focused employees
- $4.1billion worth of generation, transmission and distribution assets
- More than 10,000 gigawatt hours of electricity each year
- We can generate as much as 2,453 megawatts of electricity that is delivered across 32,000 km of transmission and distribution lines throughout.

NSPI AM Core

- Comprehensive methodology deployed within NSPI
- Design leveraged:
  - NSPI operational expertise
  - ISO 55000 (PAS-55)
  - Industry reliability orgs and experts
  - Industry relationships





Key features:

- Holistic
- Highly integrated processes
- Data integration and synthesis
- Fleet deployment
- Proactive programs and technology
- Engagement

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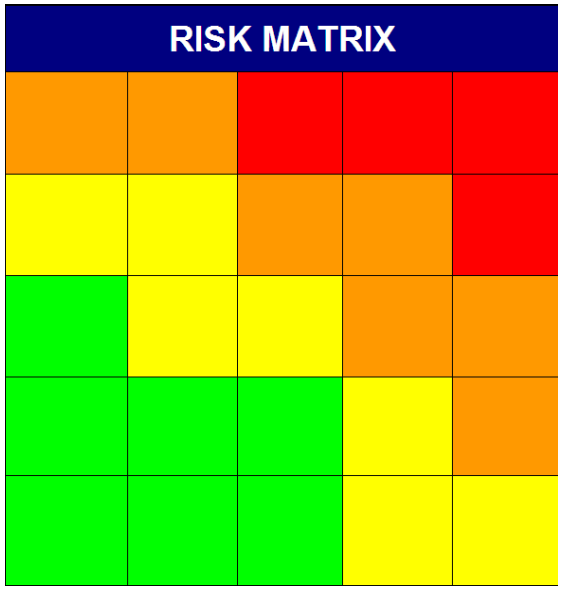
NSPI Strategic AMP

NSPI AM Mechanism



Highest Risk

Mitigate

- Investment
- Major Refurbish
- Major Critical Spares
- Re-Design

Update

Criticality

Condition

Risk Profile

Inform

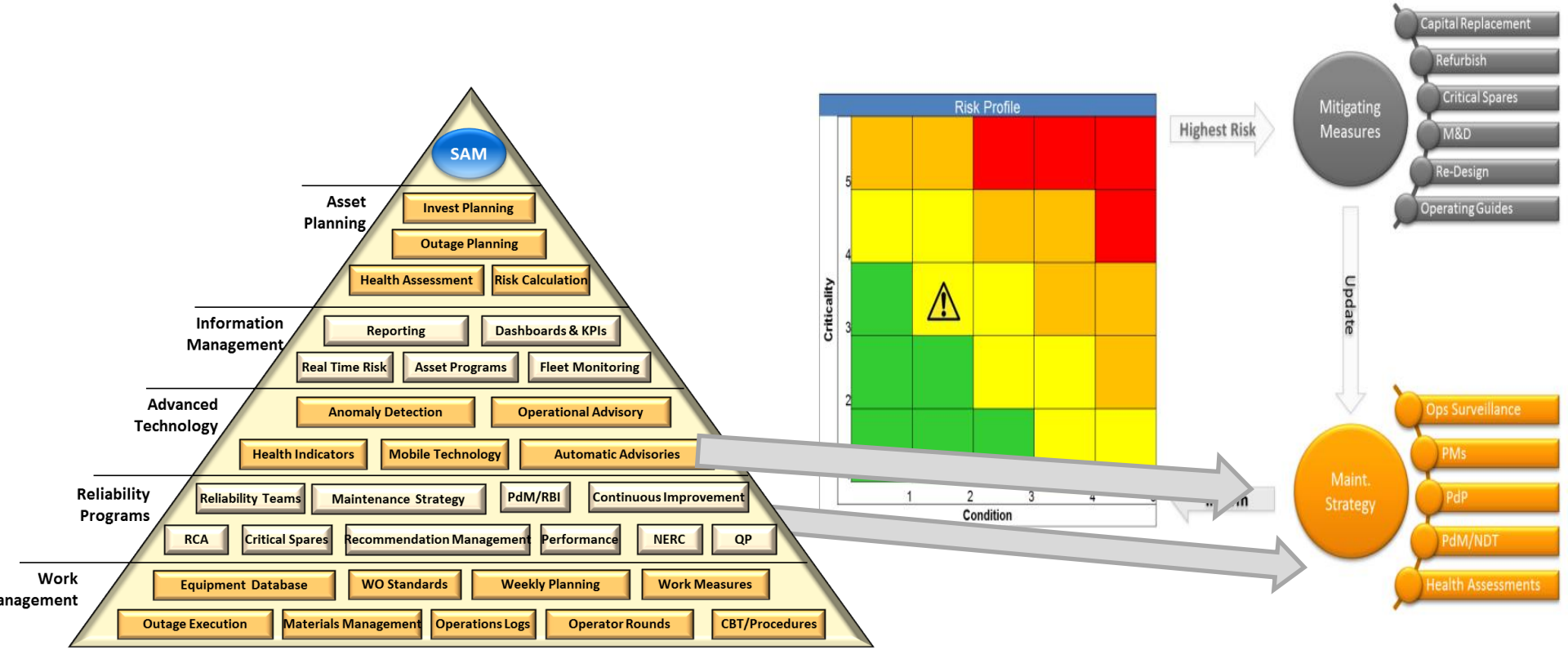
Maint Strategy

- Ops Surveillance
- PMs
- PdP
- PdM

Our Asset Management Award

Maintenance Strategy

Asset Management Mechanism:



What is a Maintenance Strategy?

Maintenance + Strategy

Maintenance: Act of preserving or maintaining a state

Strategy: defines a set of activities tasks or actions to achieve a specific goal

Can we do more than just physical actions on a machine to ensure its operating okay?

TRADITIONAL EXPECTATIONS OF A PREVENTATIVE MAINTENACE STRATEGY

- Primarily time based or hour driven
- Open the machine intrusively to see state
- Replace , inspect, measure or refurbish components
- Close the machine

TRADITIONAL EXPECTATIONS OF CORRECTIVE MAINTENACE STRATEGY

- You broke it
- You need to fix it

A Maintenance Strategy

Multiple activities designed to detect or prevent failures is a strategy for maintenance.

Pipe Inspection

Vibration Analysis

Oil Change & Analysis

Motor Current Analysis

Bearing Clearances

Operator Rounds

Balance and Alignment

Performance Testing

Infra Red

Designing Maintenance Strategies

RCM

- Uses FMEA, Block Diagrams, Reliability Data, functional falure modes
- Difficult to sustain in lean organization
- Principal outcome of RCM is maintenance strategy
- NSPI "short circuits" the process where possible
- Maintenance strategies purchased
- Applied via Meridium

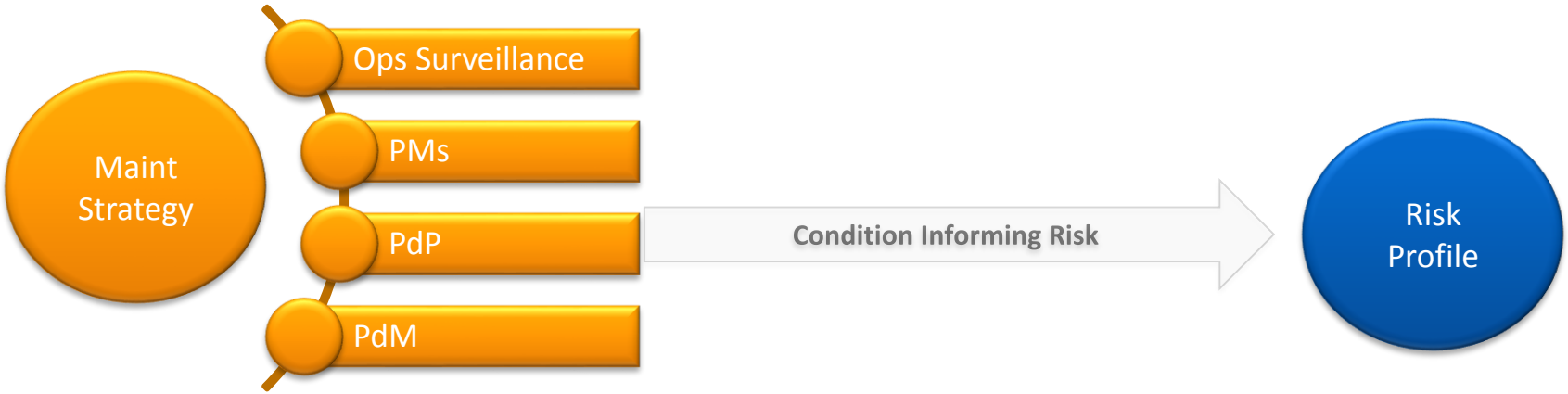
TYPICAL MAINTENANCE STRATEGY:

- Engages: Ops/Maint/Engineering
- Entails: Ops Rounds, PMs, PdMs, PdP, Performance Testing, Assessment

Maintenance Strategy Elements for NSPI

- PM's (Time or usage based)
- PdM (VA, OA, UE, IR…..)
- RBI (Traditional NDT)
- APR=PdP and PEMAX
- Operator Rounds
- Performance Testing
- DL Work Order Entries
- Advisories (internal and external)

Element Results Inform Risk



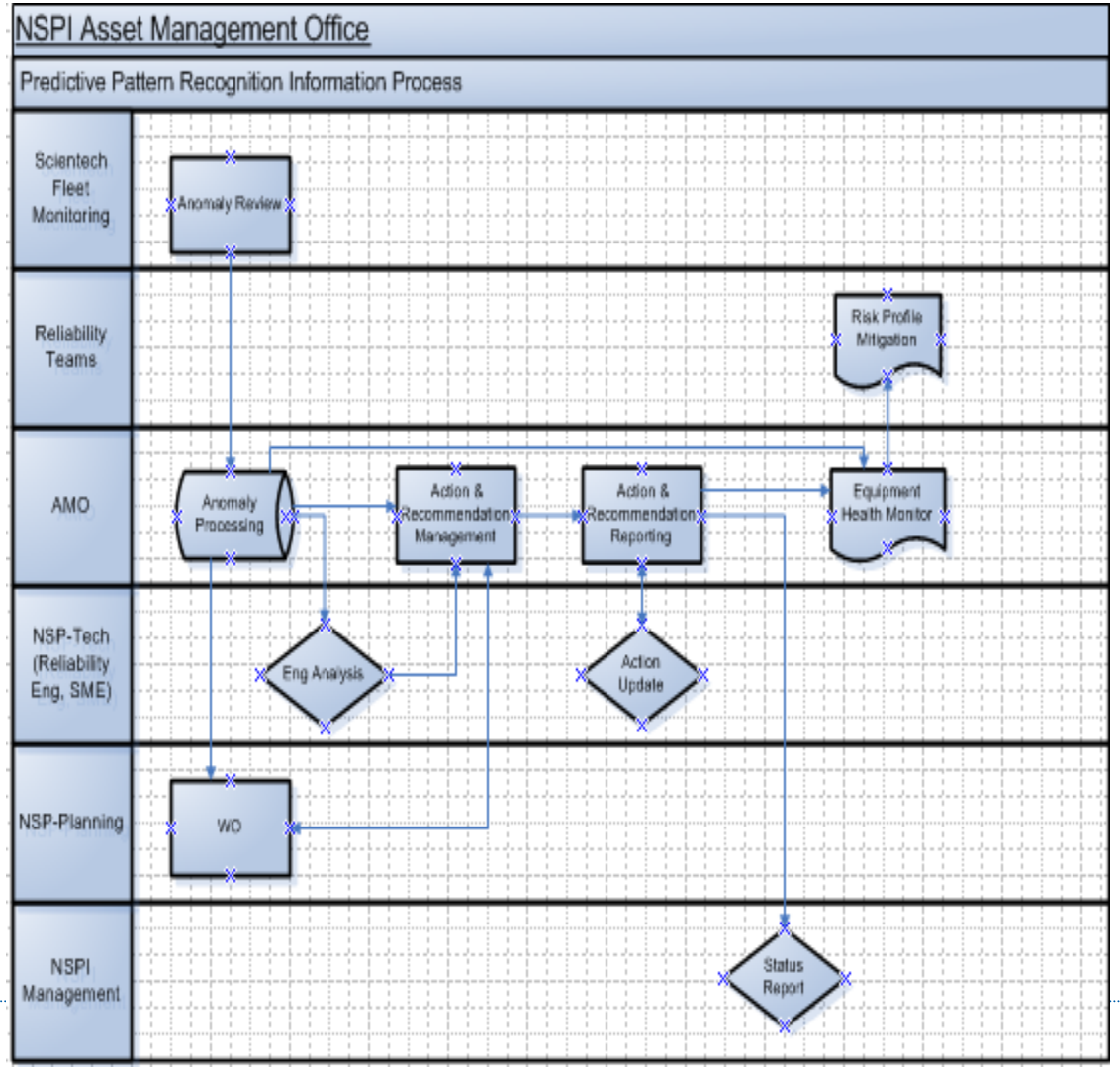
Maintenance Strategy Elements for NSPI

- PM's (Time or usage based)
- PdM (VA, OA, UE, IR.....)
- RBI (Traditional NDT)
- ***APR=PdP and PEMAX***
- Operator Rounds
- Performance Testing
- DL Work Order Entries
- Advisories (internal and external)

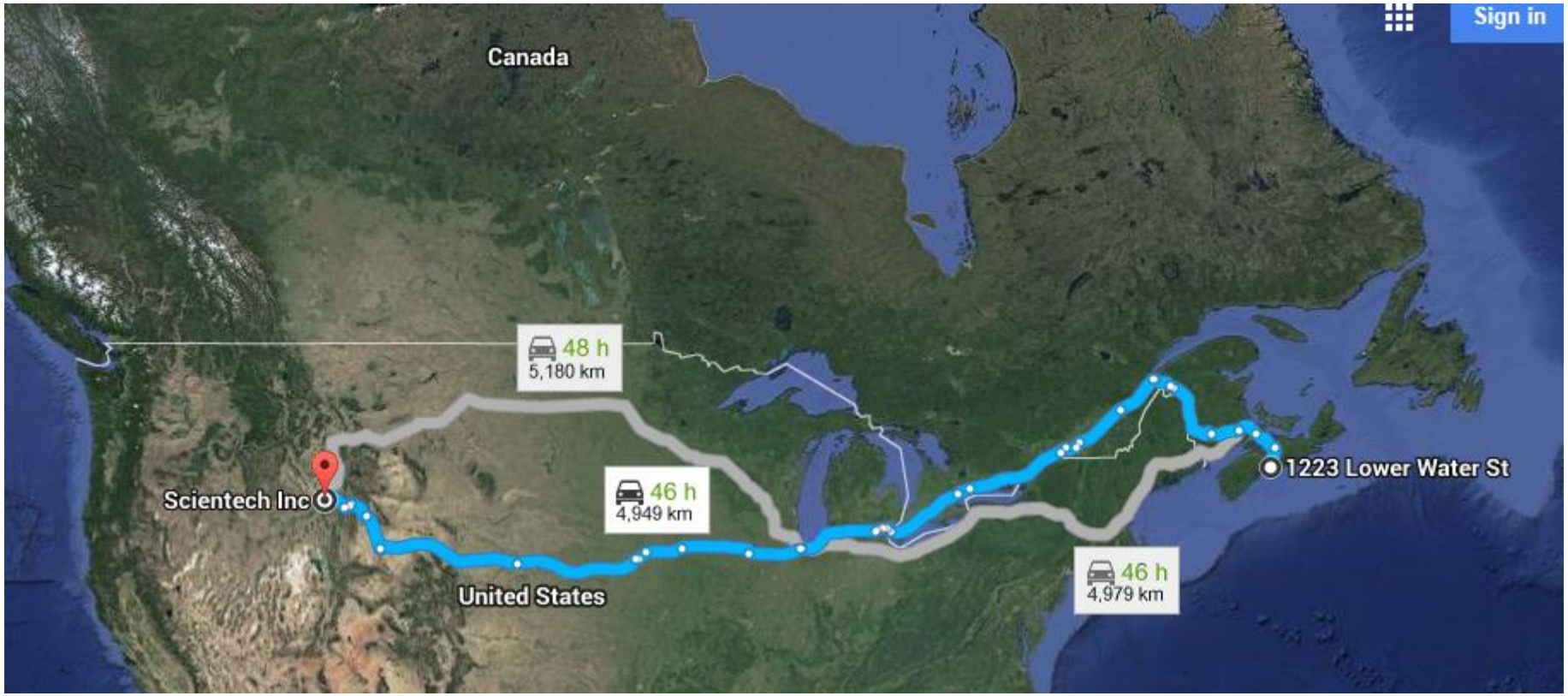
Our Essentials for APR

- Instrumentation
- Communications/DCS equipment functional
- Healthy Scada/ PI or other server
- AM and IT oversight arrangement
- Data management
- Management processes
- NERC Considerations
- DCS data connectivity into PI
- Data informing risk
- Routine Stewardship Meetings (monthly)

Managing PdP Alerts



APR Data Movement



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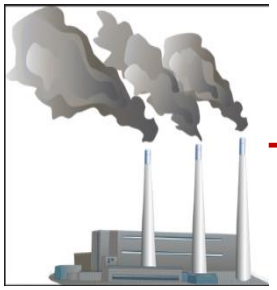
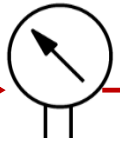
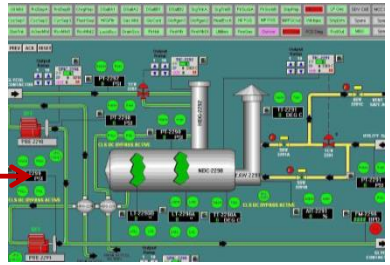
How does it work?





DCS



PI

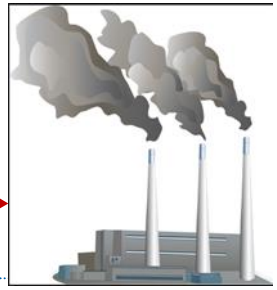
Data Synthesis

Data Analysis

Meridium

Risk
Notification

Post Processing



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Real Time Analytics Role in WO Identification

OPERATORS USING PMAX TO IDENTIFY MAINTENANCE WORK

- Early identification
- Losses determine urgency
- Enables proper consideration in planning process

PDP

PDP ALERTS USED TO RECOMMEND OPS AND MAINTENANCE ACTION

- Early Identification
- Analysis and Report
- WO recommendation
- WO process must support

PEMAX

EARLY AND ACCURATE WORK IDENTIFICATION
ENABLES PLANNING
INCREASES PROACTIVE % OF WORK
INCREASES PLANNED/UNPLANNED RATIO

M & D Weekly Overview

Date: 1/7 to 1/13

Issues reported: 4

Issues reviewed: 0

Plant	Recommendation ID	Model	Sensor	Functional Location ID	Functional Location Descrip	Work Order Number	Status	Recommendation Headline	Recommendation Description	Creation Date	NSP Work Request Generated	Reference
LIN	REC-16801	4bAirHtr	LG4VID_TE0321B	43324002	B-LJUNGSTRUM AIR HEATER		CREATED	(3) Low	4B Air Heater Air Outlet Temperature (B) has been steadily decreasing since 1/8/17. Air Outlet Temp (A) does not show a similar pattern. Air heater gas temperature profiles appear to be in limits. Inspect sensor installation and connections. Replace sensor if required. (LG4VID_TE0321B)	1/10/2017 12:38	FALSE	19995019
POT	REC-16786	2cMILLpm	TUP2VID_P1603	23315007	2CCOAL MILL		CREATED	(3) Low	Mill C Inlet Pressure is currently indicating flat-line at -0.195 in H2O. This issue had been resolved but the sensor output data failed again in mid-November '16. Check PI I/O interface. (TUP2VID_P1603)	1/9/2017 10:57	FALSE	19964338
									Turbine Bearing Oil Pressure decreased after the 12/9/16 unit start-up and is now			

PdP? Analytics Examples

Recommendation ID	Plant	Model	Sensor	Work Order Number	Recommendation Headline	Recommendation Description	Creation Date
REC-11411	TRE	6TURBm	TR6VID_P3464		(1) High	Since 7/17/15 the Turbine Control Oil Pressure	2015-07-22 14:31:47
REC-11410	TRE	5BOILRp	TR5VID_T2034		(2) Medium	The Stack Gas Temp has been flat-lining at -46	2015-07-22 11:53:51
REC-11409	TRE	5BOILRp	TR5VID_F2032		(2) Medium	The Stack Gas Flow has been flat-lining at	2015-07-22 11:47:34
REC-11408	LIN	3HP-IPp	LG3VID_TE1725B_C		(2) Medium	RH Steam Temp at the Reheat Valve is	2015-07-21 13:17:33
REC-11407	LIN	3DAHTRp	LG3VID_T7072		(3) Low	The Deaerator Terminal Diff has been reporting	2015-07-21 12:18:53
REC-11406	LIN	3bFDFNp	LG3VID_TE5363A		(3) Low	The Motor Phase Winding Temps on FD Fan B	2015-07-21 11:20:09
REC-11405	LIN	3aFDFNp	LG3VID_TE5364A		(3) Low	The Motor Phase Winding Temps on FD Fan A	2015-07-21 10:36:11
REC-11379	TUC	2CHEM	TUC2VID_AIT0097		(2) Medium	The Deaerator Inlet DO increased rapidly after	2015-07-15 10:40:31
REC-11345	LIN	4bCWP	LG4VID_TE5391		(3) Low	The indicated temperature for CWP B Motor	2015-07-14 10:48:08
REC-11340	TC	4GTTURBm	TUC4TE-61069		(2) Medium	The FIN/FAN Turbine Lube Oil Temp has	2015-07-13 13:45:57
REC-11339	POT	2sIDFNm	TUP2VID_T1225		(2) Medium	The O/B Bearing Temp on 2S ID Fan Motor has	2015-07-13 11:24:58
REC-11338	POT	2BOILRp	TUP2VID_F0102		(3) Low	Superheat Spray Flow has been indicating a	2015-07-13 11:12:42
REC-11336	POA	1aBFPpm	POA1VYFW244		(1) High	The output for DE Brg Y Vibration sensor on	2015-07-13 08:57:57
REC-11307	TUC	3TURBm	TUC3VID_TE1330		(1) High	The Front Temperature on Brg #1 HP Turbine	2015-07-08 11:22:49
REC-11305	TRE	6GENRr	TR6VID_I3088		(2) Medium	Generator Rotor Amps sensor output data is	2015-07-08 08:47:57
REC-11304	TRE	6bCWPm	TR6VID_T4087		(3) Low	The Stator Temp on 6B CWP is currently	2015-07-08 08:31:55
REC-11302	TRE	6aMILLpm	TR6VID_PD0488		(2) Medium	Mill 6A Diff Pressure increased as of the	2015-07-07 10:53:24
REC-11301	POA	1LPFWHp	POA1LTHD214		(2) Medium	LP Heater 1 Level is indicating a high degree of	2015-07-06 11:58:54
REC-11300	LIN	4HPFWHp	LG4VID_TE4740		(3) Low	The indicated temperature for Bled Steam at	2015-07-06 09:44:57
REC-11298	TRE	6bMILLpm	TR6VID_T0391		(3) Low	The Stator Temp on Mill 6B has been operating	2015-07-06 08:36:03

Example Outside the “Process”

CONTACTED BY SCIENTEC:

- Wednesday, January 04, 2017 10:07 AM
  - “both ID fans had noticeable increases in the Fan IB and OB bearing temperatures since start-up”
- SME verified-temp increase 10-20deg above expected-step change-warranted action
  - SME Contacted plant engineer 10:37AM
  - Plant engineers had cooling system back in servioce by 15:10
- Temperatures returned to normal within 45 mins.

Stats

2014---201 WORK ORDERS

2015—306 WORK ORDERS

2016—283 WORK ORDERS

2017---18 AND COUNTING

AVERAGE OF 4.8 ENTRIES PER WEEK SINCE 2013

111 CANCELLED

572 CLOSED

384 –OTHER STATUS (I.E. SCHEDULED, MATERIALS……)

In Conclusion

Designed maintenance strategies are critical to AM

Elements of maintenance strategies vary

Instrument health is very important

Apr through pdp and famous are key elements

Pdp helps in decision making against risk

Examples are numerous and help grow the program

QUESTIONS?