Speaker Bio

Jason Ballentine holds a Bachelor Degree in Mechanical Engineering and is a Certified Maintenance and Reliability Professional. At ARMS Reliability, Jason manages the multitude of reliability projects undertaken by ARMS Reliability Engineers in North America. This includes maintenance strategy development and optimization, RAMS studies and life cycle analysis studies for different industry sectors.

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Maintenance Strategy Development

Jason Ballentine

Engineering Manager

ARMS RELIABILITY

EMPOWER | EDUCATE | EQUIP

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What you will learn today

1. How to drive Maintenance Strategy Development
2. The elements required for Maintenance Strategy Development
3. How to select an effective maintenance task
4. Risks of a static asset strategy

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What needs to be considered when making maintenance strategy decisions?

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Maintenance Decision?

In its simplest form …

- Selecting what to do and when to do it
- Defining what spares are required
- Defining what resources are required
- Calculating what budget is needed

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Asset Managers Require

Maintenance decisions that …

- Can be justified against the business objectives
- Can respond to changing environments
- Proactive not reactive
- Judged against qualitative criteria
- Can be openly challenged
- Can be Measured
- Can be Improved
- Can be Planned and implemented efficiently

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Reliability Engineer Requires???

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Requirements

- Training
- Data
- Tool
- Plan and Schedule
- Support

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Training Requirements

- Criticality Analysis
- Strategy Development Methodologies
  - Maintenance Task Analysis
  - Preventive Maintenance Optimization
  - Failure Mode and Effects Analysis
  - Reliability Centered Maintenance
- Failure Detection Methodologies
- Facilitation

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Data Requirements

- Maintenance History
  - Planned
  - Unplanned
- Condition Reports
- Risk Thresholds
- Downtime Cost
- Labor Rates
- Spare Parts
  - Cost
  - Lead Time

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Tool Requirements

- Powerful overview and drill down
- Captures current knowledge
- Data driven
- Business decisions made at lowest level
- Simple decision making using models
- Define gap between current and optimum states
- Dynamic and easily updated
- Supports efficient implementation

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Plan & Schedule

- Manage as a Project
  - Set deliverables
  - Set deadlines
- Plan for implementation
- Provide updates on progress

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Support

- Senior Managers
- Direct Manager
- Tradesman

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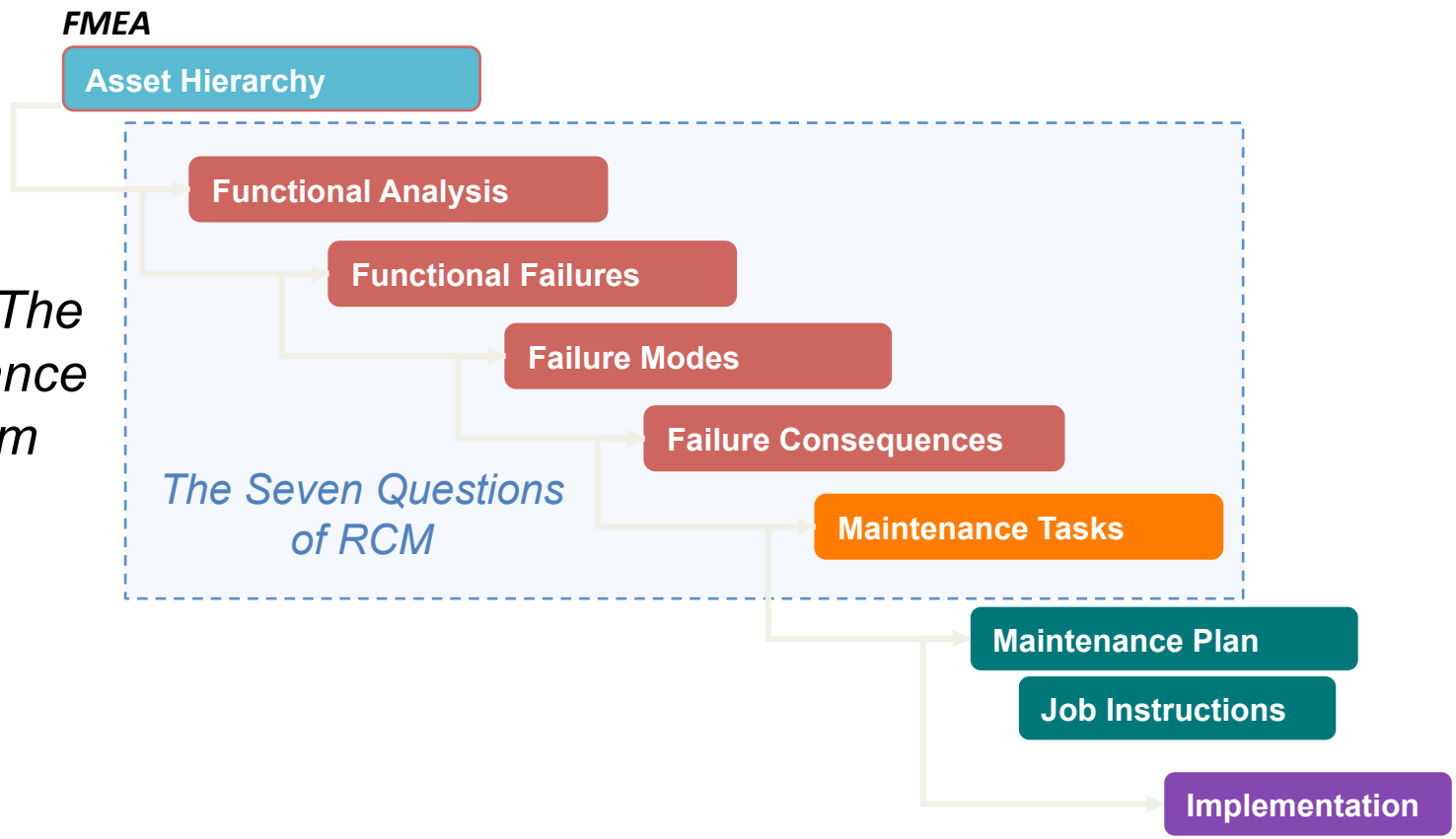
Maintenance Strategy Development

Building The Maintenance Program



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RCM Packages

- SR6BWBKT:SR6 Bucket Wheel Buckets
  - SR6BWBKT.1:Collect coal
    - SR6BWBKT.1.A:Reduced Collection
      - SR6BWBKT.1.A.1:Loose Buckets
      - SR6BWBKT.1.A.2:Worn Buckets
      - SR6BWBKT.1.A.3:Damaged Buckets
      - SR6BWBKT.1.A.4:Radial plates wear
      - SR6BWBKT.1.A.5:Bucketwheel Shaft Failure
      - SR6BWBKT.1.A.6:Bucketwheel structural wear
      - SR6BWBKT.1.A.7:Bucketwheel structural corrosion
- SR6BWGRZ:SR6 Bucket Wheel Grizzlies
  - SR6BWGRZ.1:Remove oversize foreign material
    - SR6BWGRZ.1.A:Pass oversize material
      - SR6BWGRZ.1.A.1:Worn
      - SR6BWGRZ.1.A.2:Loose
    - SR6BWGRZ.1.B:No throughput
      - SR6BWGRZ.1.B.1:Build up of foreign material
- SR6BWBCH:SR6 BW Blocked Chute Detect
- SR6BWCHT:SR6 BW Chute, Skirts & Tiles
- SR6BWED:SR6 BW Electrical Device
  - SR6BWEDUS:Bucketwheel Underspeed

Define **Functions, Functional Failure & Failure Modes**

Assign **Failure Effects**

Associate **Failure Distribution**

Estimate **Corrective Repair Resources and Duration**

Evaluate

- **Preventive Schemes**
- **Predictive Schemes**

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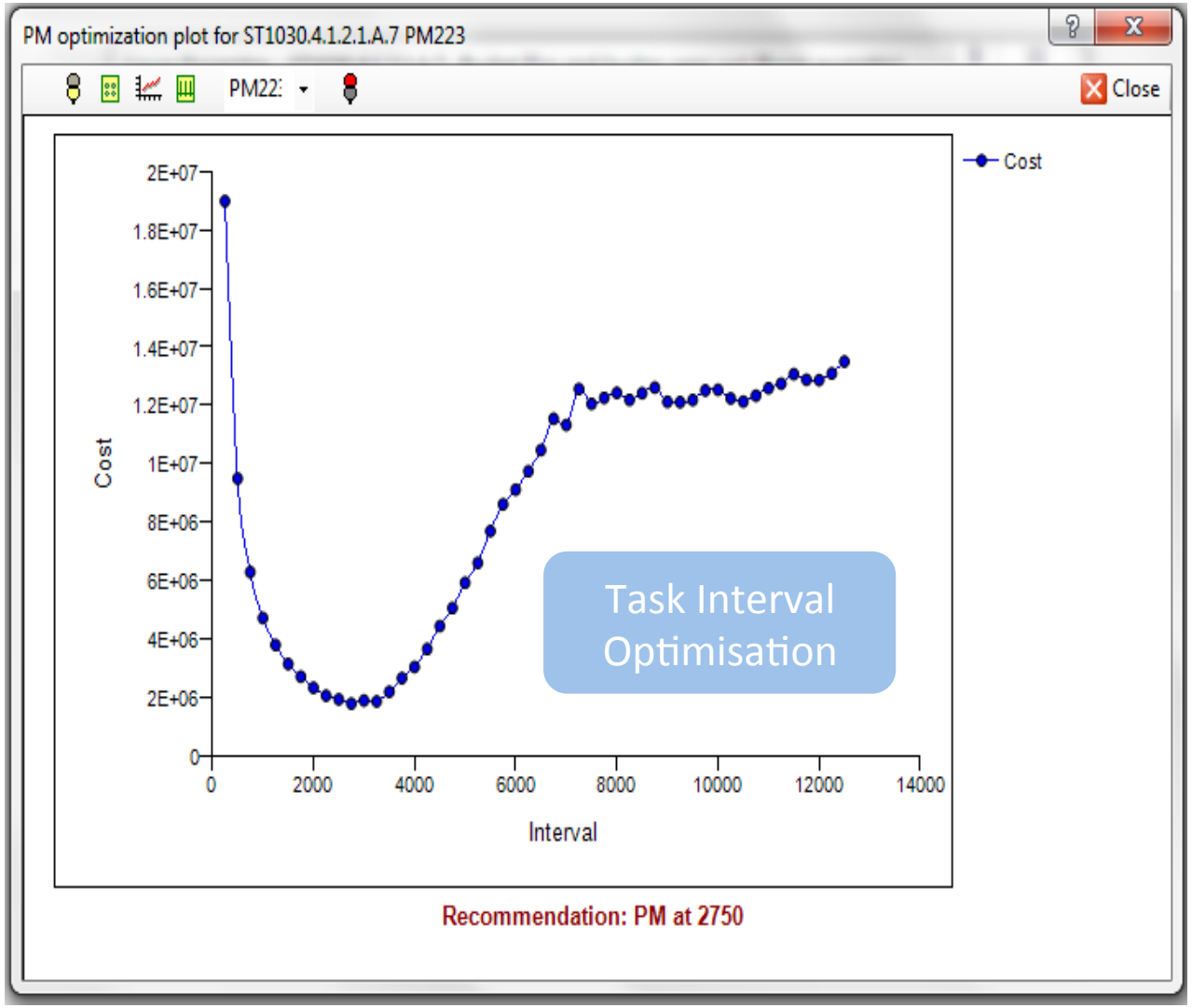
Task Interval Selection



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Task Effectiveness Simulation

Cause Properties - ST1030.4.1.2.1.A.7 : Bucket Pins and bushes wear out (Boom assembly)

General | Effects | Failure | Maintenance | Alarm | Commission | Redesign | Notes | Strategy

Maintenance and design strategy:

Strategy	Enabled	Interval	Group	Description
Planned Maintenance	☑	2880	4- Monthly Mech ...	Replace pins and bushes on bucke
Alarm	☐			
Commission	☐			
Redesign	☑			Implement 4 monthly planned replac

Interval optimization... | Edit task...

Predictions:

Cost:	1.86749E+06	Cost benefit ratio:	0.111171
Safety criticality:	0	Safety benefit ratio:	1
Operational criticality:	0	Operational benefit ratio:	1
Environmental criticality:	0	Environmental benefit ratio:	1
Failure down time:	2.15	Number lifetime failures:	0.2
PM down time:	232.727	Number lifetime PMs:	30
Inspection down time:	0	Number lifetime inspections:	0
Statistical error in TDT:	0.19418 %	Statistical error in cost:	2.72205 %

OK | Cancel

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Tactic Value

Reference	Description	Perform PM?	Perform Inspection?	CBR	TACTIC LIFETIME COST	RTF COST	RISK
SCALPING SCREEN.2.4.1.A.15	Outer longitudinal rail worn	No	Yes	0.567	$17,578,403.75	$31,004,819.91	$13,426,416.16
SCALPING SCREEN.2.4.1.A.17	Inner longitudinal lower deck rail worn	No	Yes	0.567	$17,578,909.75	$31,005,325.91	$13,426,416.16
SCALPING SCREEN.2.4.1.A.5	Inner longitudinal lower deck rail worn	No	Yes	0.567	$17,578,909.75	$31,005,325.91	$13,426,416.16
SCALPING SCREEN.2.4.1.A.9	Inner longitudinal lower deck rail worn	No	Yes	0.567	$17,578,909.75	$31,005,325.91	$13,426,416.16
SCALPING SCREEN.2.4.1.A.1	Inner longitudinal lower deck F/E rail worn	No	Yes	0.567	$17,578,909.75	$31,005,325.91	$13,426,416.16
SCALPING SCREEN.2.4.1.A.23	Inner longitudinal lower deck D/E rail worn	No	Yes	0.567	$17,578,657.35	$31,004,755.51	$13,426,098.16
EL JAY SCREEN A.4.4.1A.1	Liners holed	No	Yes	0.06	$823,149.89	$13,696,196.80	$12,873,046.91
GRIZZLY.2.7.1.A.5	End liner worn	No	Yes	0.833	$40,490,294.29	$48,585,724.80	$8,095,430.51
GRIZZLY.2.7.1.A.2	Side liners worn	No	Yes	0.834	$40,539,638.29	$48,635,068.80	$8,095,430.51
GRIZZLY.2.7.1.A.1	Front pan floor liners worn	No	Yes	0.833	$40,510,565.49	$48,605,803.20	$8,095,237.71
GRIZZLY.2.7.1.A.9	Rear pan floor liners worn	No	Yes	0.833	$40,510,565.49	$48,605,803.20	$8,095,237.71
GRIZZLY.2.7.1.A.8	Middle pan floor liners worn	No	Yes	0.833	$40,510,565.49	$48,605,803.20	$8,095,237.71
SCALPING SCREEN.2.2.1.A.1	Side plate cracked	No	Yes	1.187E-4	$807.35	$6,801,174.00	$6,800,366.65
SCALPING SCREEN.1.2.1.A.3	Drive shaft seized (lack of lube)	Yes	No	0.001	$5,155.68	$6,086,508.90	$6,081,353.22
SCALPING SCREEN.1.5.1.A.4	Bearings worn (lack of lube)	Yes	No	2.135E-5	$129.43	$6,061,794.60	$6,061,665.17

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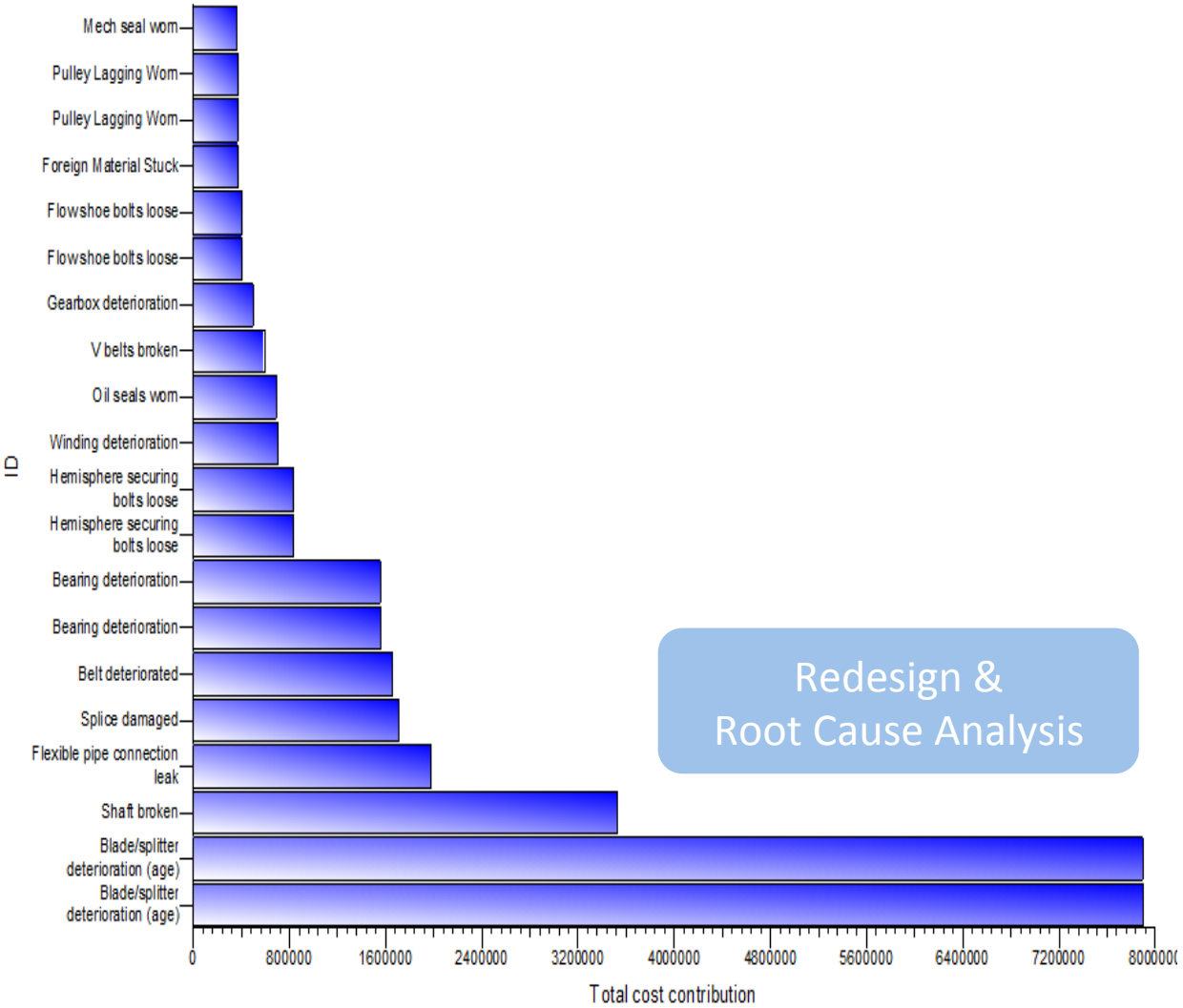
Continuous Improvement



Redesign &
Root Cause Analysis

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Maintenance Plans

MainWin - [Report - Maintenance Strategy - Task Groups]

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Cat 797 Dump Truck Maintenance Strategy

Compiled by : Mark Michael, ARMS Reliability Engineers
Approved by : Graham Gardner - Xstrata, Newlands Mine

GROUP	INTERVAL	ITEM DESCRIPTION	ITEM ID	PREVENT/PREDICT	TASK
1000HRCAT	1000.	1054 - Primary Filter	1.1.1.2	Primary Intake Filter Blockage	Change Primary Air Filter
		Oil Pump	1.4.4	Blocked Engine Oil Pump Screen - cat	Clean Pump Screen
		Start Electrics - truck is air start	1.6.6	Empty Ether Can- cat	Replace Ether Canister
		3030 - Transmission	2.1.1	Aged Transmission Oil - cat	Change Transmission Oil
		4251 - Service Brake	3.4.1	Worn Brake Group - catss?	Check brake pack heights - new method, just remove plug
		Park Brake System	3.4.8	Malfunction in Service Brake control Valve - catss - OEM	Inspect Service Brakes for operation. Check system pressures, checking spring length.
		4305 - Steering Linkage	3.5.2	Inspect for Steering Ball Stud cracks- cat?	Inspect Ball Stud for Looseness maximum play of .040 per CATSpecifications. Check with ultrasonic testing
		7050 - Frame	5.1	Worn Chassis Frame support Pads - cat	Clean and inspect worn frame and body pads
		7050 - Frame	5.1	Broken Chassis Bolts	Inspect chassis for broken bolts
		7050 - Frame	5.1	Missing Chassis Hardware	Replace missing bolts
		7320 - Airconditioning	5.4.2	Damaged Door Seal	Check for cab seal leaking with smoke bomb
		7325 - ROPS/FOPS Cab	5.4.3	Worn Cabin mounts- lib	Check condition of rubber on mounts
		7325 - ROPS/FOPS Cab	5.4.3	Damaged ROPS/FOPS Cab - cat	Inspect Rollover Protection Structure.

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CMMS Load Sheets

Review Data

PM	Job Plan	Interval	Operation Num...
12W CMon Insp Belt CV540	Inspect conveyor belt for top and bottom cover thickness at regular spacing's using Ultrasonic testing device.	12W	10
12W Elec Insp Drive Conveyer CV540	Clean product build up and debris from motor casing and fan cowling.	12W	10
12W Elec Insp Drive Conveyer CV540	Conduct vibration analysis on pulley bearings.	12W	20
12W Elec Insp Field Devices CV540	Check access to belt rip switch reset pushbutton. Clean and check condition of belt rip switch and reset pushbutton, mountings, te...	12W	10
12W Elec Insp Field Devices CV540	Check adjustment of belt rip detection wire.	12W	20
12W Elec Insp Field Devices CV540	Check condition of run off proximity switch, cables, swing arm and air gap adjustment.	12W	30
12W Elec Insp Field Devices CV540	Perform function test of run off switch.	12W	40
12W Elec Insp Field Devices CV540	Perform functional test of belt rip switch and reset pushbutton.	12W	50
12W Mech Insp Chute CV540	Check condition of chute wear liners and internal components such as training plate, skirt plate, surge bars and throat for wear an...	12W	10
12W Mech Svce Belt CV540	Check condition of belt plough, frame and support structures.	12W	10
12W Mech Svce Belt CV540	Check condition of belt scraper to confirm that the scraper blades are not excessively worn.	12W	20
12W Mech Svce Belt CV540	Check condition of conveyor belt splice or splices.	12W	30
12W Mech Svce Belt CV540	Check condition of conveyor skirting for damage, tears, cracks and correct clearance.	12W	40
12W Mech Svce Belt CV540	Check condition of pulley lagging while conveyor is offline.	12W	50
12W Mech Svce Belt CV540	Check condition of skirt clamping system for security.	12W	60
12W Mech Svce Belt CV540	Check condition scraper frames, support structures and mounting bolts.	12W	70
12W Mech Svce Conveyor CV540	Check condition of hatches and doors to ensure they open and close easily and are free from damage.	12W	10
12W Mech Svce Conveyor CV540	Clean and check condition of inline water strainer for damage and blockages. Replace if required.	12W	20
12W Oper Insp Conveyor CV540	Check condition of all pipes, hoses and fittings for damage, leaks, and wear.	12W	10
12W Oper Insp Conveyor CV540	Check condition of hydraulic pump for noise, leaks and security of fasteners.	12W	20
1W Lube Insp Conveyor CV540	Check the reservoir fluid level via the sight-glass, ensure it is above the Min and below the Max mark. Top up as required.	1W	10
1W Mech Insp Belt CV540	Check amount of adjustment or travel left in belt take up loop.	1W	10
1W Mech Insp Belt CV540	Check condition of belt plough, frame and support structures.	1W	20
1W Mech Insp Belt CV540	Check condition of conveyor skirting for damage, wear or spillage.	1W	30
1W Mech Insp Belt CV540	Check condition of idler frames and if defective place condition identification tags.	1W	40
1W Mech Insp Belt CV540	Check condition of idlers and place condition identification tags on idler frames for defective idlers.	1W	50

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Remaining Dynamic

- Triggers for review
  - Calendar
  - Changes in Consequence
    - The "New Reality"
  - Pareto
  - CI Process (Defect Elimination)

➢ *COMBINATION OF ABOVE*

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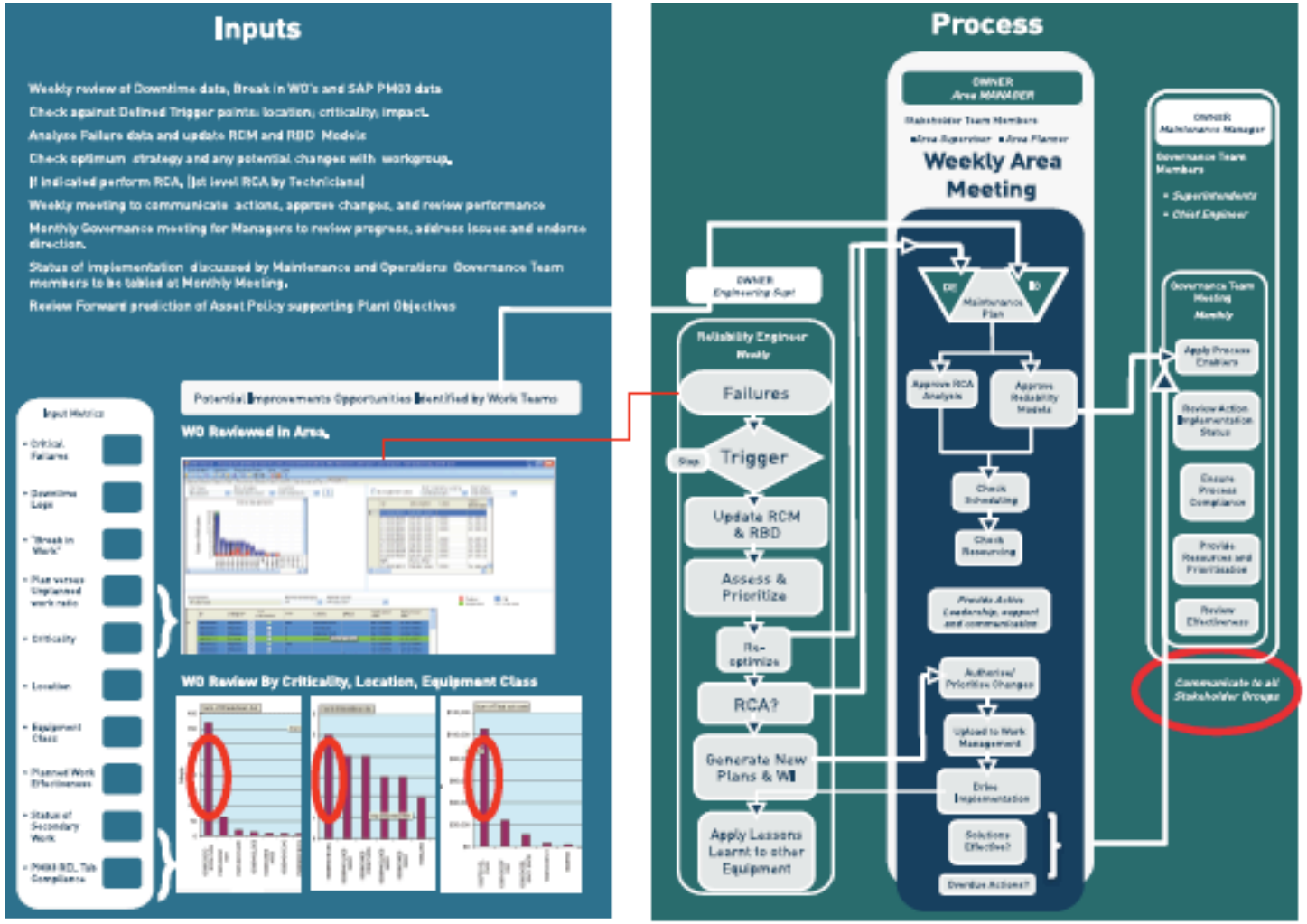
Process Map



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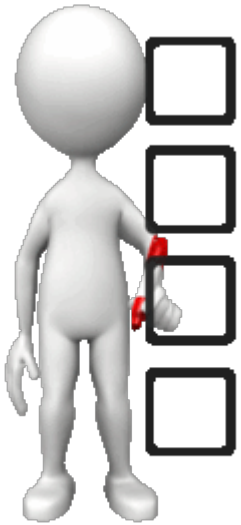
Key Points

1. RAMS should be linked to Maintenance Strategy
2. Ensure you have a plan and support
3. Make quantified decisions
4. Keep dynamic



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Questions?

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