SUSTAINED GROWTH WITH MAINTENANCE BEST PRACTICES AND RE-ENGINEERING EFFORTS IN TNPL

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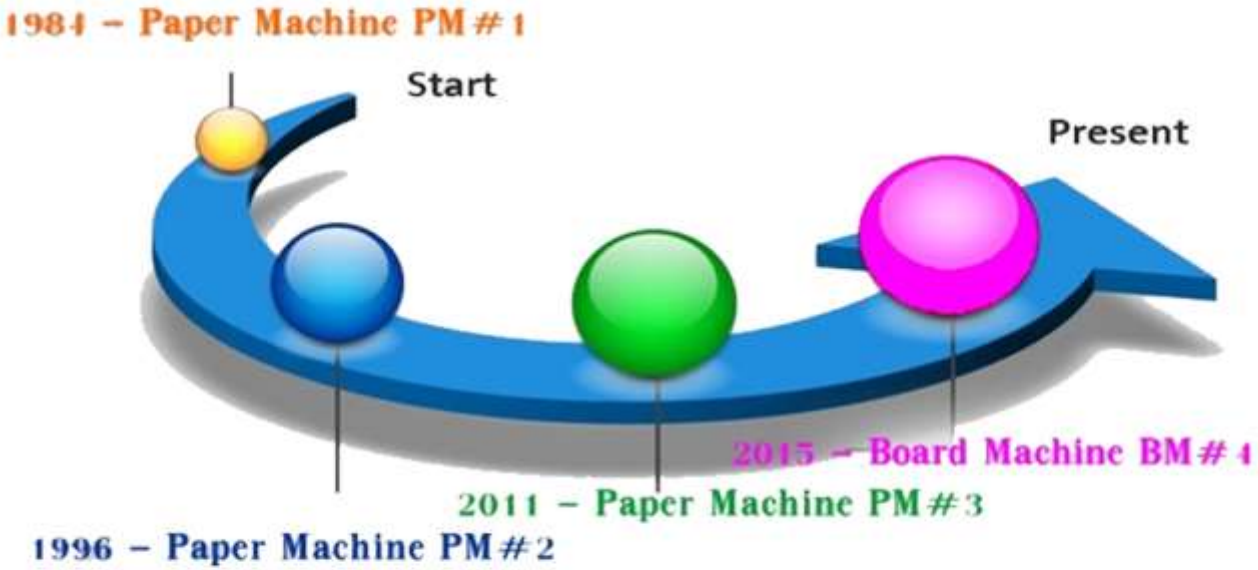
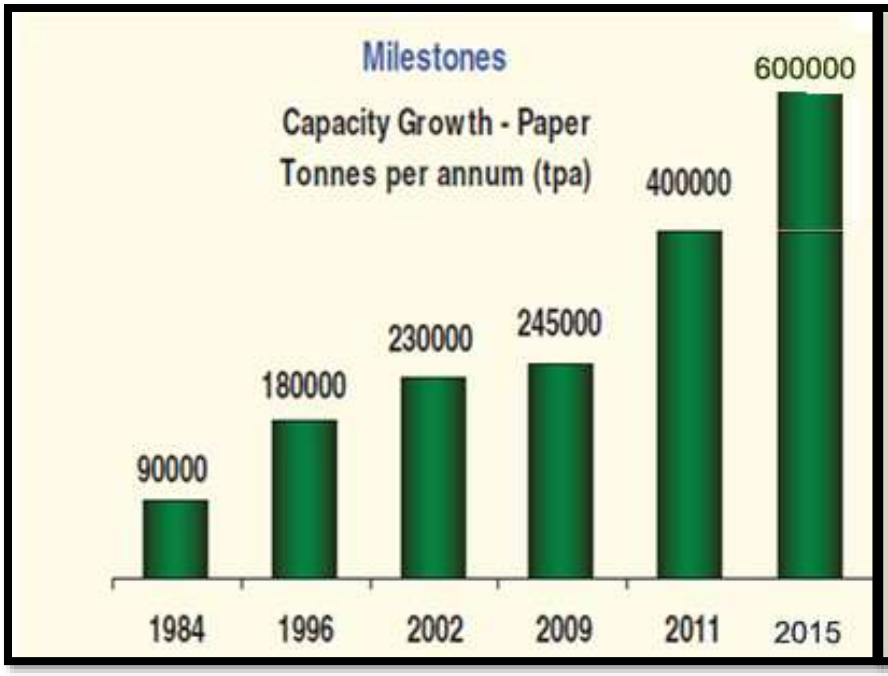
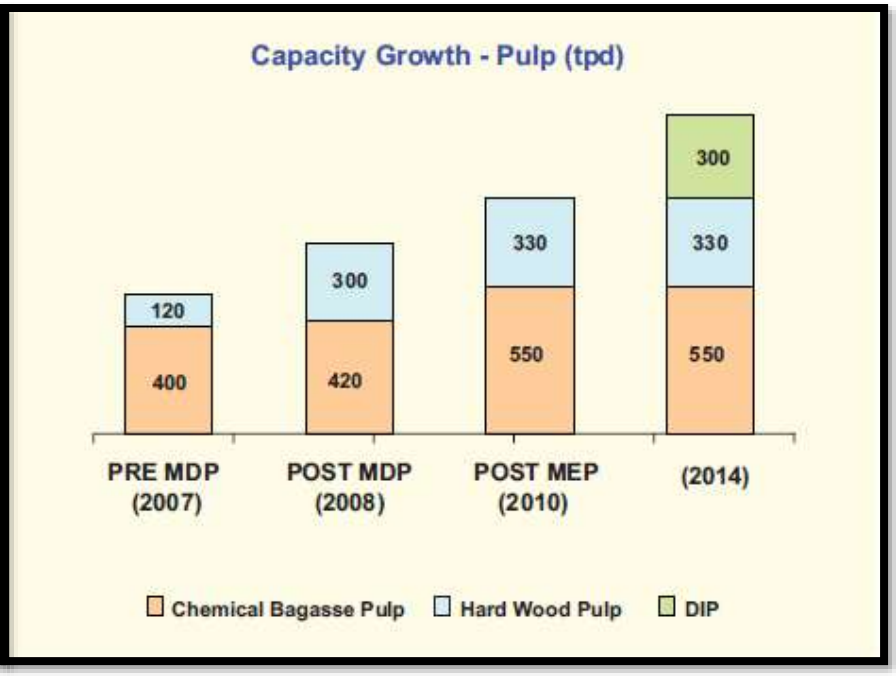
TNPL – Road Map

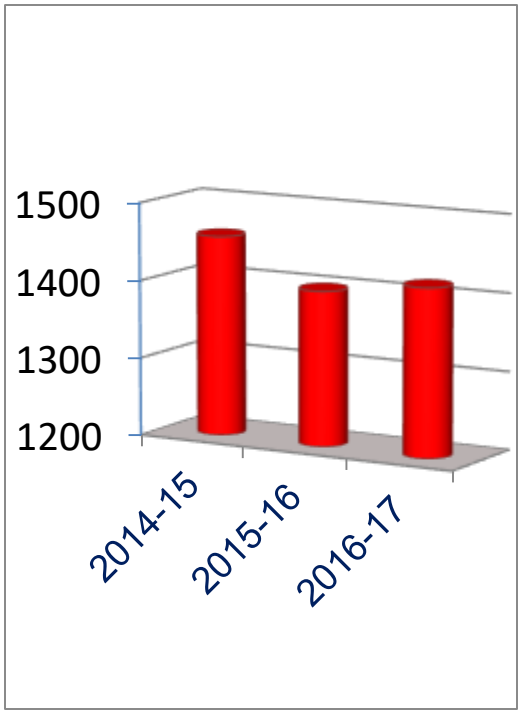


TNPL – Capacity Growth

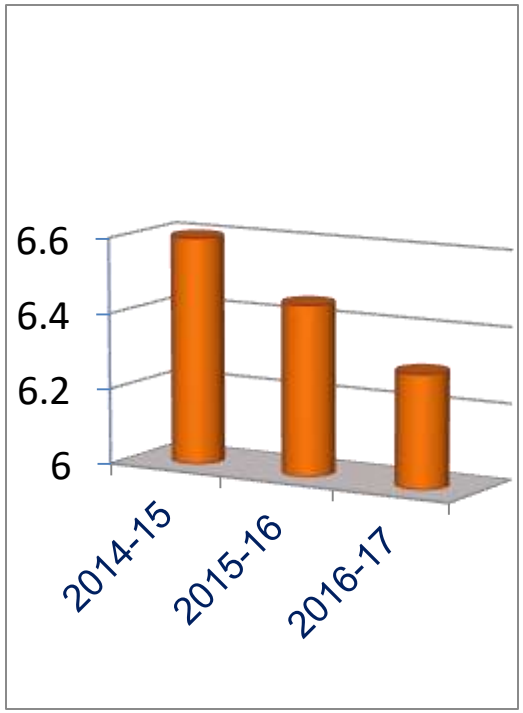




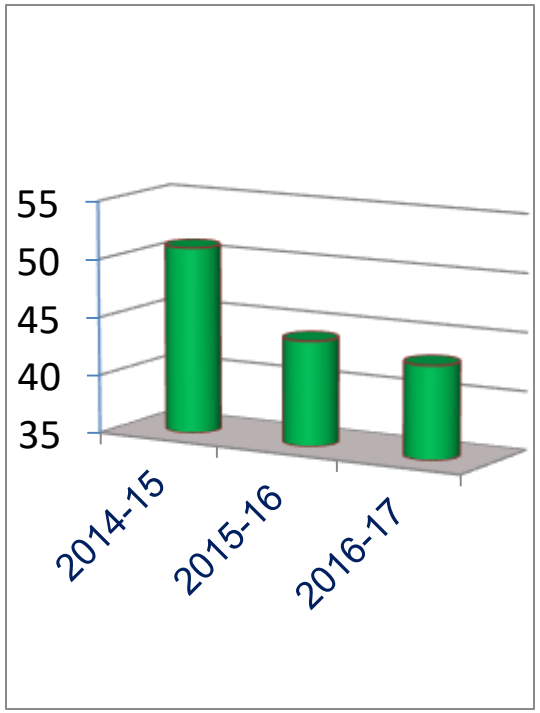
Specific Consumption



Electrical Energy kWh/T

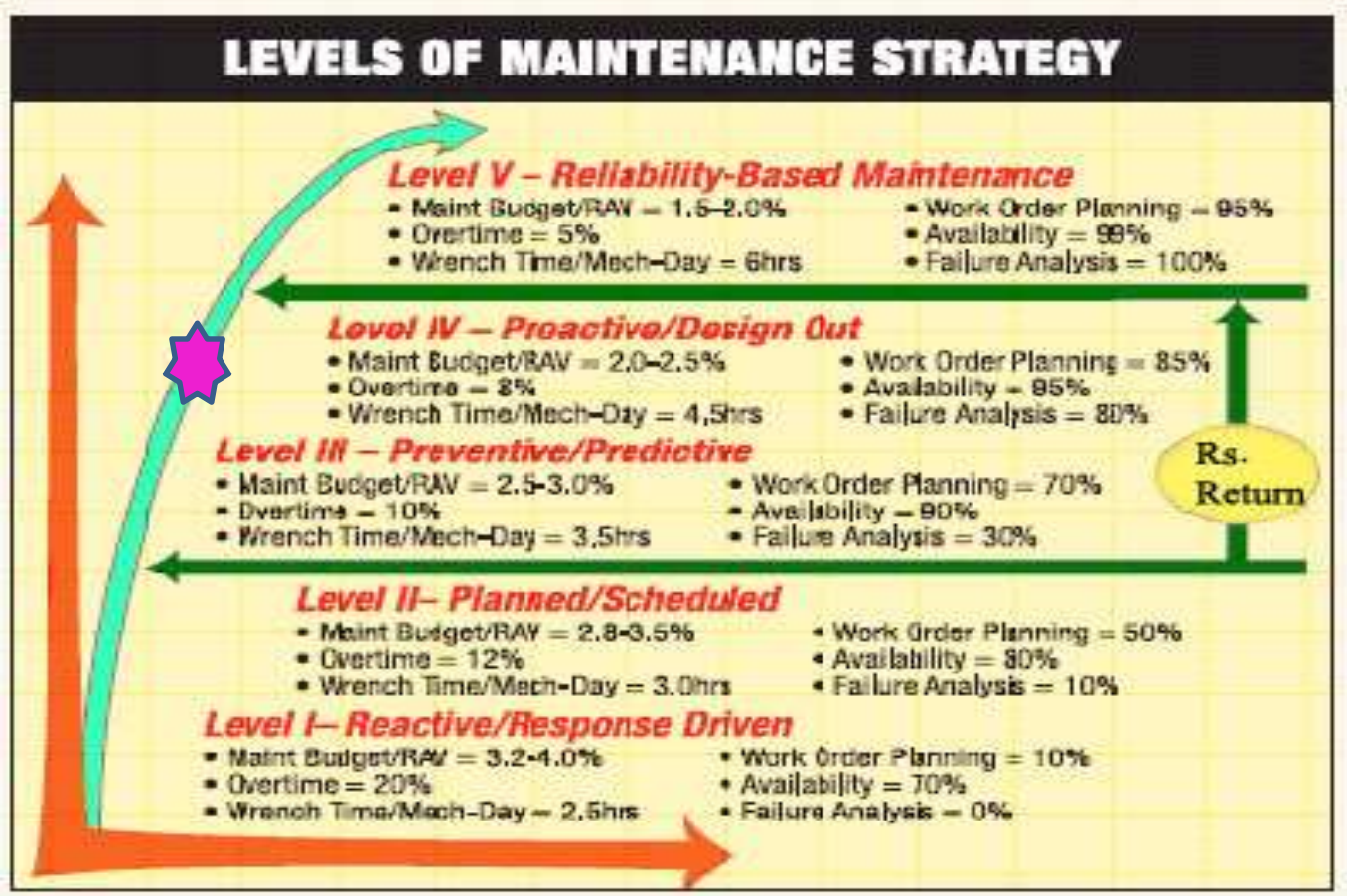


Steam T/T



Water Cu.Mtr/T

Maintenance Management



Maintenance Best Practices in TNPL

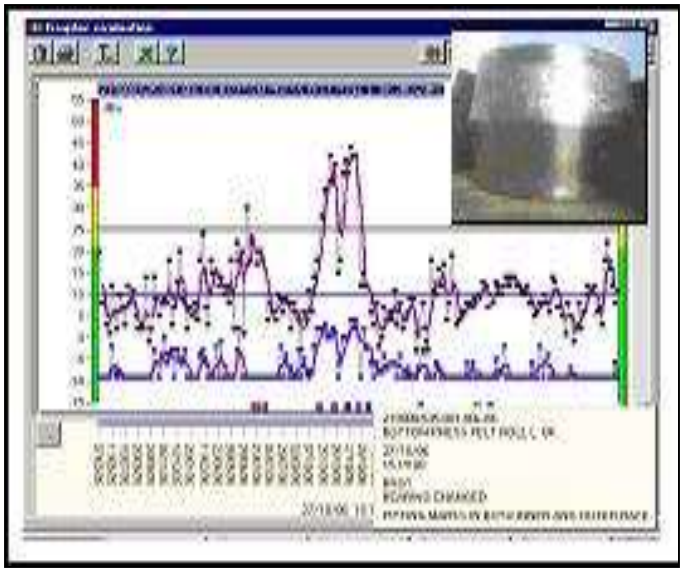
- Diagnosis and Monitoring of Bearing
- Sustained health of Lubrication and Hydraulic Systems
- Root Cause Failure Analysis
- System and Machine Audits
- Continual Improvement
- Computerised Maintenance Management
- Economics of Maintenance

Best Practice 1:
Bearing Condition Monitoring

- Why Bearing condition monitoring
  - Bearing form the heart of any rotating equipment
  - No two bearing are identical in behaviour
  - Bearing condition is influenced by installation, operating condition and maintenance
  - Successful monitoring techniques available are Shock Pulse Method and Vibration method

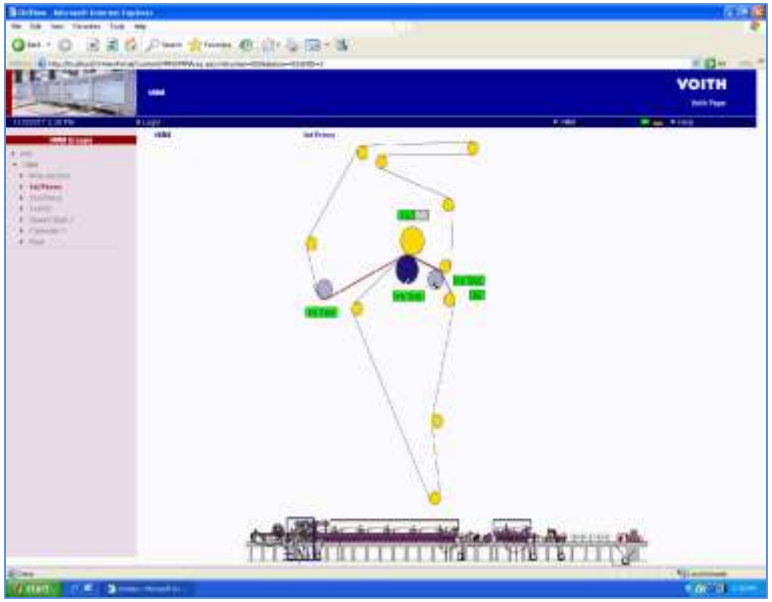
Bearing Condition Monitoring …

- Shock Pulse Method (SPM)
  - SPM T2001 & SPM Leonova



Bearing Condition Monitoring …

- Vibration Method
  - Online bearing monitoring system



Bearing Condition Monitoring …

- Bearing Monitoring Success Rate

	2014	2015	2016	2017
No of Bearings Changed due to SPM abnormality	61	28	51	22
No. of Bearings failed without SPM abnormality	3	3	3	2
% of correct prediction by SPM	95	89	94	92

Best Practice 2 :
Lubrication & Hydraulic System

- Importance of Health of Lub & Hyd Systems
  - Moden machines are with automatic lub systems
  - Hydraulic systems are integral part of any machine
  - Sophisticated hydraulic systems call for clean oil
  - Water entry into lubrication oil is common

Lubrication & Hydraulic System …

- Health of Lub & Hyd systems
  - Patch test of oil samples periodically
  - Viscosity test for oils in periodical interval
  - Spectrum analysis of oil when ever required

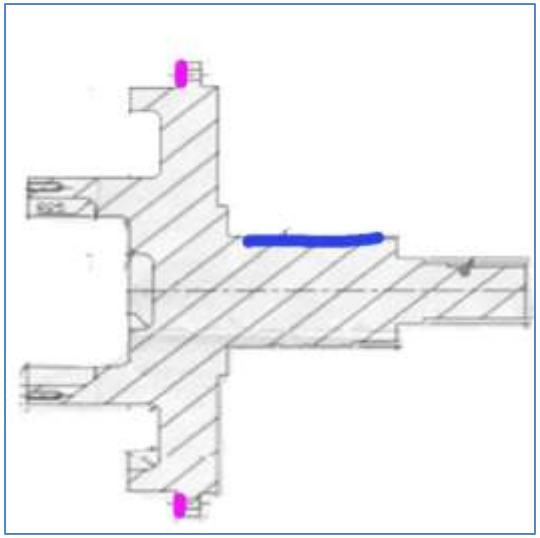
Lubrication & Hydraulic System …

- Health of Lub & Hyd systems
  - Monitoring and controlling water level in oil
  - Dedicated oil purification system for each tank
  - Operating oil cleaners on a regular basis
  - Oil filling through filter unit

Best Practice 3:
Root Cause Failure Analysis

- PM1 Suction Couch Roll Back Bearing Failure
  - Average bearing life was about 250 days
  - Roll change was necessary due to bearing failures

Root Cause Failure Analysis …



- Failure Analysis :
  - Lubrication
  - Water entry
  - Assembly
  - Alignment
  - Dimensional checks on back head
    - *run-out of back head in the bearing seating area*
    - *Perpendiculatiry of bearing seating area with reference to head mounting face*

Root Cause Failure Analysis …

- Root Cause :
  - Deviation of 260 microns in the perpendicularity of bearing seating area with respect to the head mounting face
- Corrective actions:
  - Metal spraying the bearing seating area
  - Re-machining to tolerances specified by manufacturer
- RCA Benefits :
  - No similar failure till date (Bearing was changed after a run time of almost 2000 days)

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Best Practice 4:
System and Machine Audits

- Why Audits?
  - To increase efficiency of systems/machines
  - To identify weak links in systems/machines
  - To generate data for future upgradations
  - To check the success rate of any changes

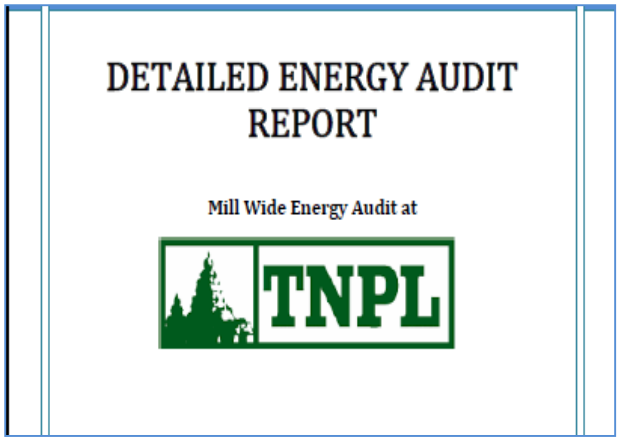
System and Machine Audits …

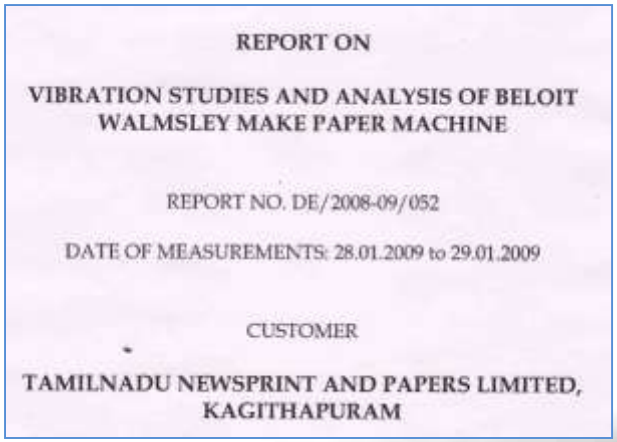
- Audits done

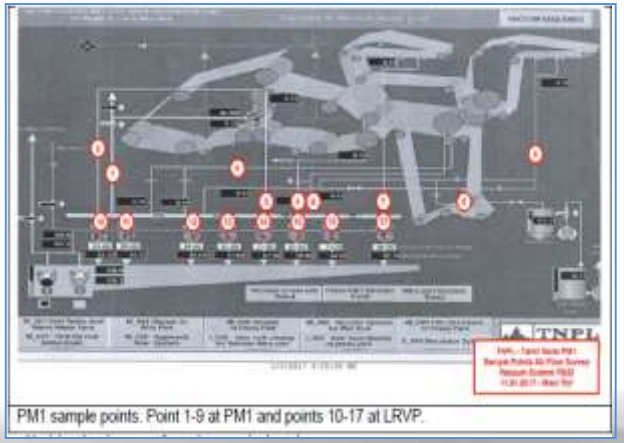
– PM1 Deculator Cleaning System	-	2003
– PM1 Wet end and Headbox	-	2006
– PM1 Dryer Section	-	2009
– Winder 1	-	2013
– Mill wide Energy	-	2015
– PM1 & PM2 Vacuum System	-	2017

System and Machine Audits …

- Audit of Vacuum Systems in PM1 and PM2







Best Practice 5:
Continual Improvement

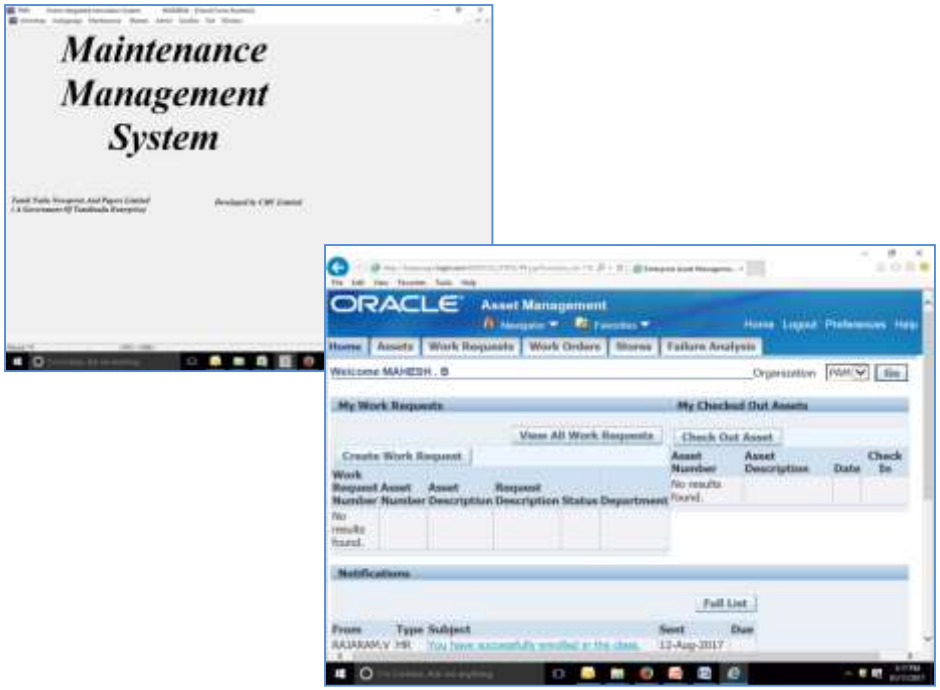
- LT drive gearboxes in EOT cranes
  - Motor-Gearbox-connecting shaft arrangement
  - Highly maintenance prone
  - Uneven movement of wheels leading to other damages

Continual Improvement …

- Modifications
  - Shaft mounted gearmotor introduced
  - Maitenance free
  - Smooth operation
  - Power saving (5.5 kW motor replaced with 4 kW motor with VFD)

Best Practice 6 :
Computerised Maintenance Management

- CMMS
  - Dbase
  - MS Access
  - OIIS
  - ERP



Computerised Maintenance Management …

- Benefits of CMMS
  - Complete history of maintenance activities
  - Maintenance cost for each asset / work order
  - Resource utilisation details
  - Scheduling preventive maintenance activities

Best Practice 7:
Economics of Maintenance

- Why Economics?
  - Maintenance cost is major part that can affect the bottom line
  - Bearings constitute a major portion of maintenance cost
  - Large size bearings are more in Paper Machine
  - Numerous technologies available to revamp a used bearing

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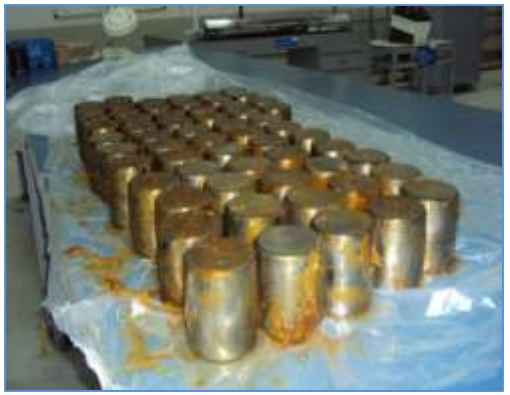
Economics of Maintenance …

- Reconditioning of Large Size Bearing
  - Bearing 230/850 CAK/C083W33
  - Technology available with bearing manufacturers .



Economics of Maintenance …

- Economics
  - Cost of new bearing (approx) = Rs. 30 lakhs
  - Cost of reconditioning = Rs. 11.2 lakhs
- Results
  - Bearing installed during April 2013
  - Running time of over 1000 days
  - Condition found good till date

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Maintenance Re-engineering

- Why Re-engineering?
  - Failure pattern undergoes change with time
  - Bring back the machine to its original condition
  - Improve performance of a machine
  - Maintenance costs are very high
  - Ease of maintenance

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Re-engineering Effort 1: Roll Grinding Machine

- Issues encountered:
  - Roll Grinding Machine was in the same building as the Paper Machine
  - Vibration from Winder transferred to Roll Grinding Machine
  - Roll finish was very severely affected
  - Chattering marks on roll surfaces
  - Twist observed in RG machine bed

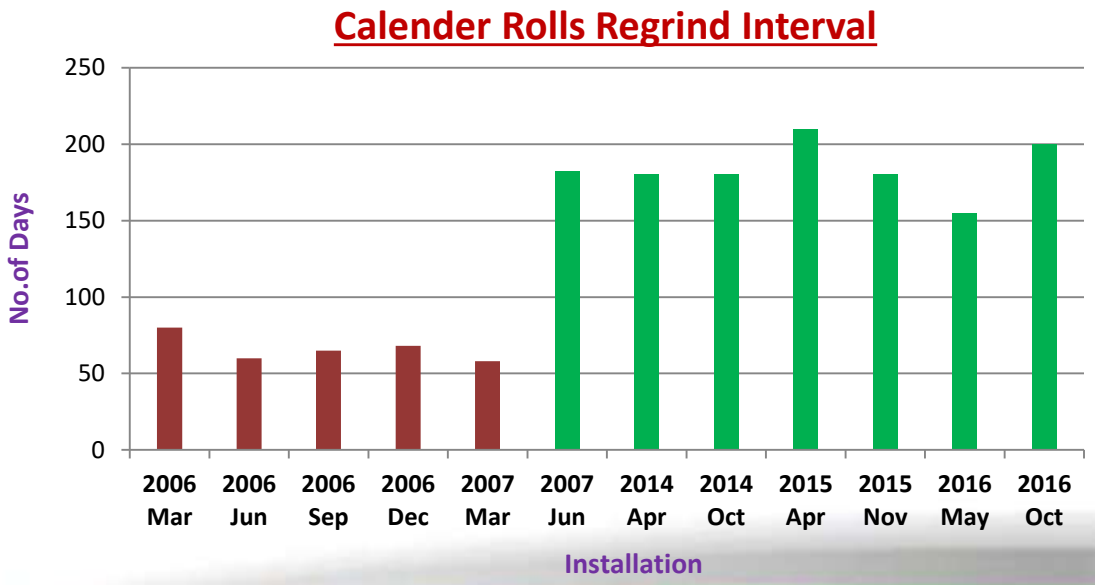
Roll Grinding Machine …

- Actions Taken:
  - Efforts to reduce vibration dampening in winder failed
  - Shifting of RG Machine was the only option
  - Floating concrete bed was made ready weighing 450 MT
  - Concrete was laid over 10 springs to dampen vibrations
  - RG Machine alignment done
  - RG Machine was upgraded with CNC controls

Roll Grinding Machine …

Roll Grinding Machine …

- Benefits of Re-engineering:
  - Better roll finishes
  - Increased re-grinding intervals
  - Lower grinding time
  - Ability to grind any customised profile



Re-engineering 2 : Change in Lubrication Arrangement

- Concept, Changes and Benefits:
  - Felt rolls in screen stretcher circuits were with grease lubrication
  - Life of oil lubricated bearings are higher than grease lubricated bearings
  - Re-engineered bearing housings to suit oil lubrication
  - Benefits of lower bearing failures

Change in Lubrication Arrangement …

Period	Maint.Type /Lubrication	Bearing Population	Bearing Location	
			Drive side	Tender side
			14	14
1985 to 1998	Preventive / Grease	Changed as per Schedule	3	3
		Breakdown	2	1
		Total replaced	5	3
1989 to 2002	Predictive / Grease	Changed as per SPM value	27	23
		Breakdown	0	1
		Total brgs replaced	27	24
2003 to 2016	Proactive / Oil	Changed as per SPM value	4	2
		Breakdown	0	1
		Total brgs replaced	**4**	**3**

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Re-engineering 3 : PM1 Press Part Frames

- Cause and Effect:
  - Audit of entire wet end for structural stability
  - Identified structures to be weak
  - Re-engineered frames to introduce cantilevers
  - Project taken up as ‘Life Cycle Extension’

PM1 Press Part Frames …

- Benefits of Re-engineering
  - Stable structures. Hence higher machine speeds
  - Easy felt changes. Hence lower downtime
  - Better operational control with hydraulic systems

Re-engineering 4 :
PM1 Press Part CC Roll Covering

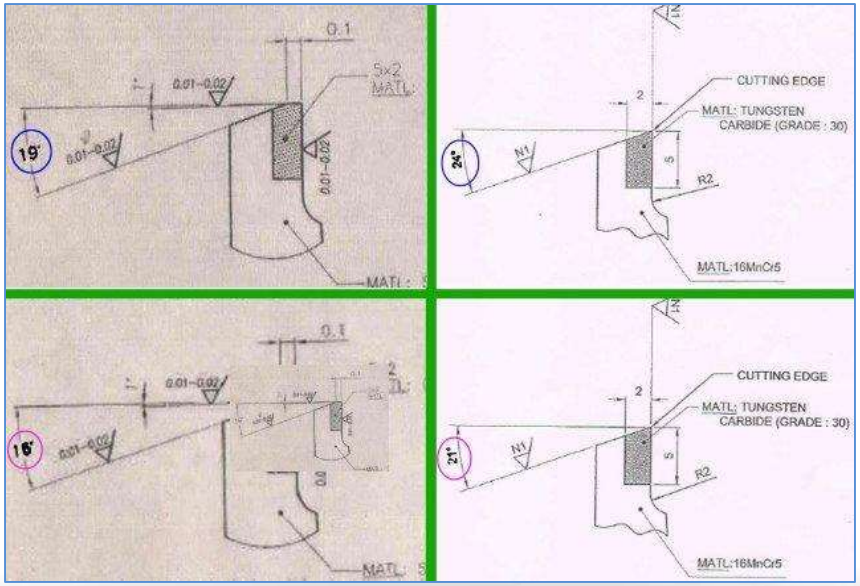
- Re-engineering with Value Engineering:
  - Original shell – Wound steel wire
  - Groove depth decreased and recovering was due
  - Alternatives Identified:
    - Steel Sleeve
    - PU cover
    - Composite cover
  - Evaluation done based on
    - Grinding Interval
    - Heat and Chemical resistance
    - Physical impact resistance

PM1 Press Part CC Roll Covering …

- Results:
  - PU cover technically meeting the requirement
  - Cost of PU cover is just 1/3rd the cost of steel covering
  - Recovered in 2005 and no significant damage till now
  - Properties of paper maintained with slight increase in bulk

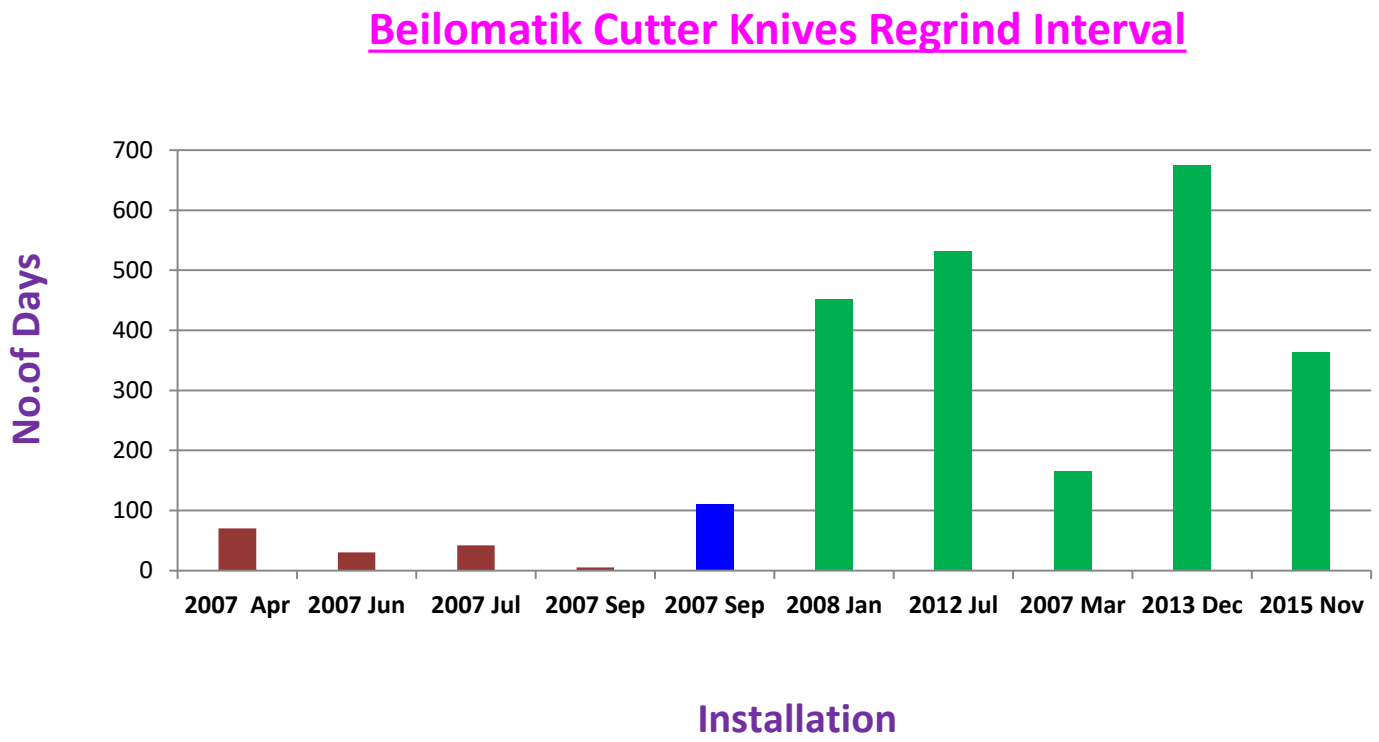
Re-engineering 5 :
Cutter Knive Angles Optimisation

- Steps towards Optimisation:
  - Original High Carbon High Chromium knives regrind interval was low
  - HCHCr knives were changed to Carbide Tipped knives
  - Production achieved:
    - HCHCr knives = 800 Tons
    - Carbide Tipped = 1900 Tons
  - Knive angle optimised after trials:
    - Top knife angle = 24° ipo 19°
    - Bottom knifeo angle= 21° ipo 16°



Cutter Knive Angles Optimisation …

- Phenomenal increase in knives regrind interval



Re-engineering 6 : Modification for Ease of Maintenance

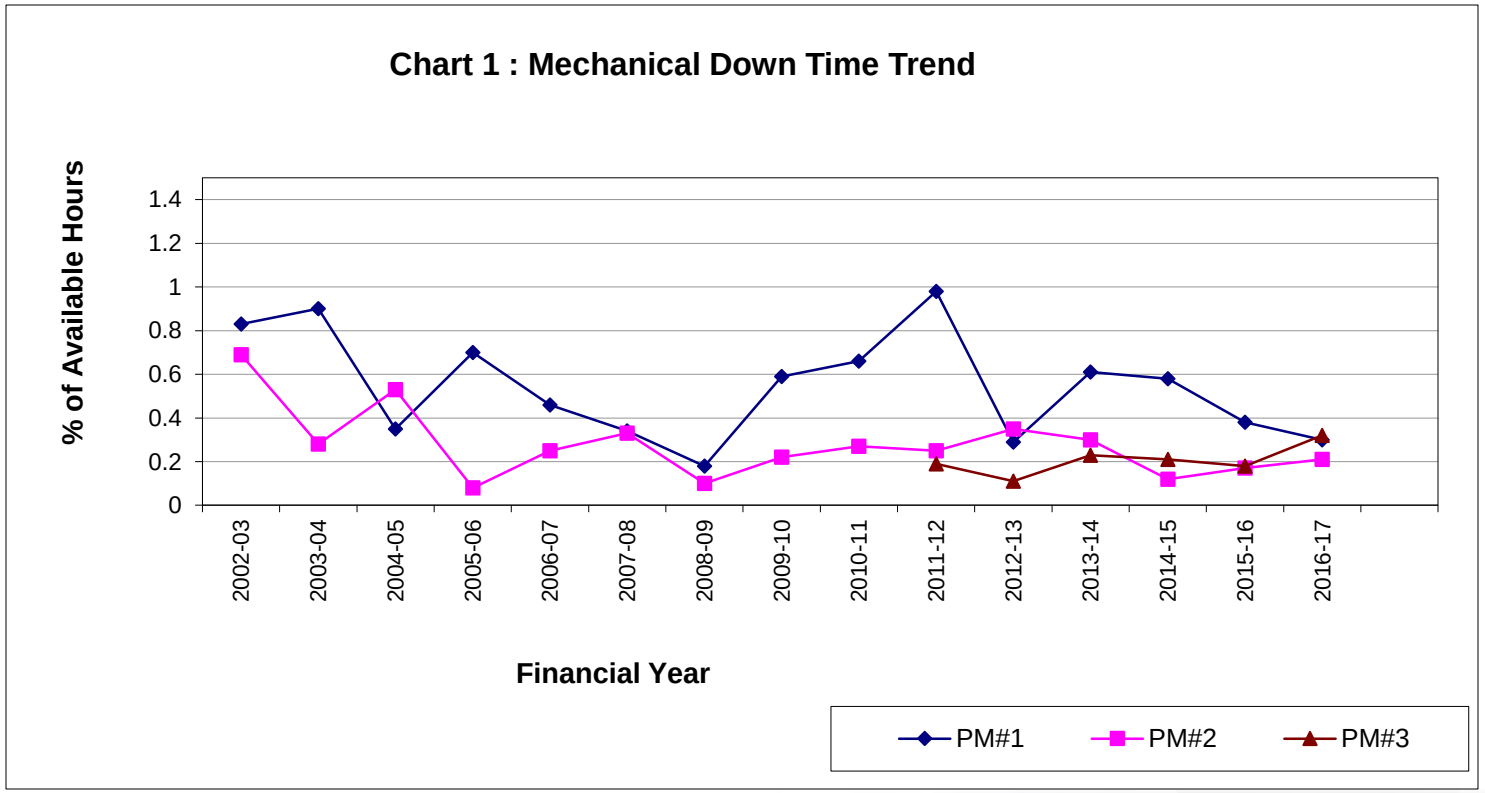
- Issues Encountered:
  - 4 vibrating screens in a confined area
  - Restricted work space and difficult to approach
  - Due to want of space valves in wrong positions
  - Dry run of Speed Flow rolls
  - Frequent damages to vibrating screen mesh

Modification for Ease of Maintenance …

- Modifications done:
  - All 4 vibrating screens shifted to a new are with ample workspace
  - Valve positions shifted near the roll by rerouting pipes
- Benefits obtained:
  - Dry run of rolls avoided
  - Life of vibrating screen mesh increased

Fin.Year	No. of Year	No. of mesh changes	Average Mesh Change Frequency (days)
2009-2011	2	120	24
2011-2016	5	142	52

Results of Maintenance Best Practices and Re-engineering



Results …

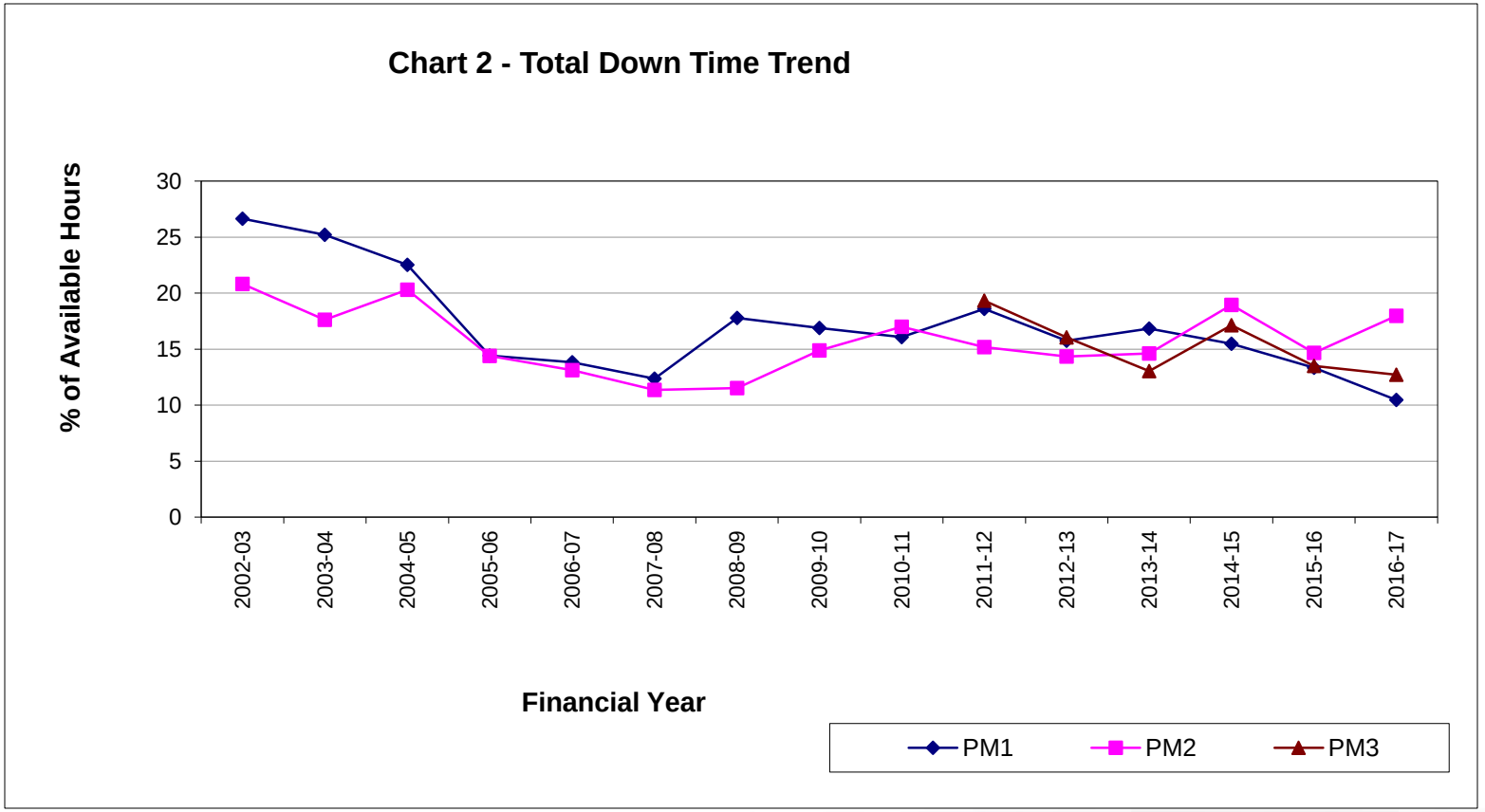


Chart 2 - Total Down Time Trend
% of Available Hours
30
25
20
15
10
5
0
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
Financial Year
PM1
PM2
PM3

Results …

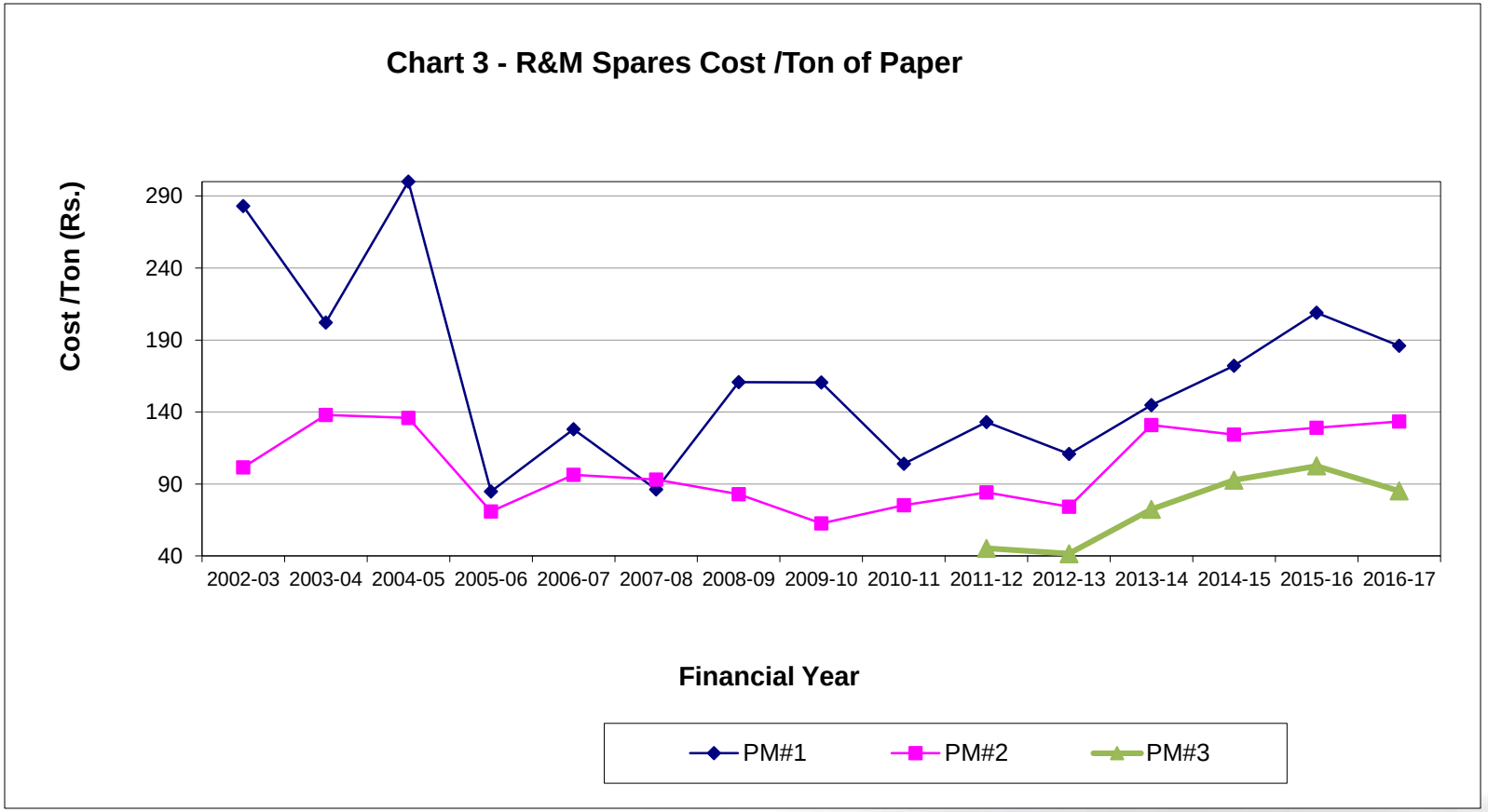


Chart 3 - R&M Spares Cost /Ton of Paper
Cost /Ton (Rs.)
290
240
190
140
90
40
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
Financial Year
PM#1
PM#2
PM#3

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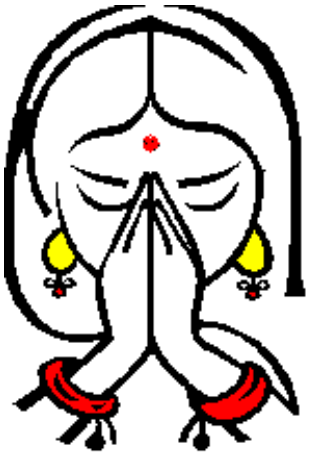
Thank  You