

Planned Maintenance Implementation Manual

Qs. 1 How does PM team support and train JH teams?

Ans:

Step 1:

- ❑ To explain machine function and mechanical functions and define basic conditions – normal and abnormal
- ❑ Maintenance function should get involved in the electrical JH activities
- ❑ Identification of cleaning, inspection and lubrication items
- ❑ Cleaning tools management
- ❑ Abnormality identification training – and teach about red/white tags
- ❑ Teach how to develop One Point lessons
- ❑ Help to dis-cover difficult to access areas
- ❑ Inspection while cleaning –teaching this to operators.
- ❑ Training the operators on moving parts, functional inspection of the rotating mechanisms, to find out abnormalities and making operators judge pass-fail criteria.
- ❑ Quick response to tags – urgency explain

Step 2

Assist and implement countermeasures for sources of contamination by fabricating carrying out trials, installing and improving guards etc. This will include activities such as:

- ❑ Make machine easy to clean, lubricate and tighten – by operator with their involvement.
- ❑ Conducting WHY-WHY analysis of breakdown and if the reason being lack of Jishu Hozen activities then fill the skill gap.
- ❑ Prepare localized guards
- ❑ Arrest leakages
- ❑ Removal of red/pink tags – explain and do.
- ❑ Rectifying the major abnormalities, which cannot be done by operators.
- ❑ To train the operators for developing, with one point lessons.
- ❑ To train operators to conduct daily autonomous maintenance activities safely.
- ❑ .Attend to suggestions made by operators in form of countermeasures by JH team that they couldn't implement themselves.

Step 3

- Preparation of visual control - to make the changes in equipment including auxiliary units so that they are easy to clean, access, inspect and lubricate.(Re-tighten) make the equipment 'visually controllable' by operators
- Decide frequency for Cleaning, lubricating, tightening, making the method to do it and decide who will do what. Then teach that person 'How' to do.

- Provide the right kind of tools near the machine for operator to use. Similarly provide appropriate tools to maintenance for their work
- Prepare Breakdown sheet on which all breakdowns will be recorded and analysed
- Correct abnormalities that are identified through inspection.
- Demonstrate and explain how to implement and execute the JH and PM activities to concerned operators and maintenance people.
- Establish standards for lubrication and monitoring pressure/temperatures etc.
- Establish standards for cleaning

Qs. 2 How much time should be dedicated for PM activity ?

Ans:

Each company has to make their own plan – but some examples are:

- Depending on condition of machine, time should be decided for PM activity. Companies spend anything between 1.5 hour to 60 hours out of 100 hours operating hours per week. In some cases, PM activities are scheduled for the weekend stoppages for a period of 24 hours. However, for emergency situations, the work shall be planned immediately.
- Put into place TBM, CBM as a part of the preventive maintenance.
- MTBM/MTTR Kaizen as a part of corrective maintenance.
- MP design

For this above mentioned activity a full time PM team in place continuously. This team would support JH activities.

After step II of JH breakdowns are going to reduce as fixed deterioration will be arrested. PM is then needed only for TBM/CBM or replacement against natural deterioration.

Qs.3 How to identify the activities/jobs to be done during plant operation and shut down?

The circle committee will identify the problems, which they encounter during daily production. Depending upon the severity, the activities are scheduled whether to be done immediately stopping the machine or during the weekly shutdown maintenance.

Activities identified during plant operation

- spares planning
- planning for skilled people
- history card preparation
- replacement of movable parts
- why-why analysis
- overhauling of sub-assemblies to keep them ready
- oiling and servicing of equipment as per plan

- inspection of some particular components including spindle movement, alignments, pre-load of spindles, slide align/adjust, oil level – check and top-up, oil condition check, oil filtration system working or not. Electrical wiring clean or not, connectors clean or not, any discoloration etc.
- adjustment of shafts/lead screws etc.
- support JH
- CBM activities
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- Improve skill through training

Activities done during shutdown

- Work on Kaizen projects implementation during shutdown or JH activity time.
- replacement as per TBM calendar
- Motor currents
- Vibrations
- Abnormal noise
- Leaks, lubricant flow – speeds, sir pressure etc.

Qs. 4 How to prepare PMschedule ?

Ans :

- ❑ PM schedules are prepared studying the previous history cards of the machine that indicate the breakdown hours with frequency. and the manufacturers' recommendations.
- ❑ Criticality of machine depending on P, Q, C, D, S, M. is drawn up. Based on the criticality, these machines are ranked into ABC ranks(see point no.13)
- ❑ Replacement of parts and adjustments is planned for a calendar and spares availability is confirmed

They are prepared at the year beginning itself. These cover schedules for

- Preventive maintenance
- TMB: the schedule is prepared based on the manufacturers' recommendations and our previous experience.
- CBM: The schedule is prepared based on the history cards.
- Training
- Preventive maintenance.
- Machine improvement
- Spares planning

Qs. 5 How to achieve zero failure ?

Ans:

Ensure JH activities are done daily. Provide basic conditions – easy to clean, lubricate and re-tighten.

Carry out root-cause analysis by using why-why analysis and PM analysis for taking countermeasures.

Eliminate forced deterioration (contain the contamination)

Improve weaker points of design by making latent points visible.

Follow JH schedule religiously.

Planned Maintenance (TBM/CBM) schedule is strictly adhered to .

Training the operators to strictly follow operating procedures.

Evolve maintenance standards and inspection of Kaizens for their continued effectiveness.

Conduct Why-Why analysis for breakdown and PM analysis for chronic failures and arriving at the counter-measures/Kaizens. Extend the same to the similar places.

Standardise the above countermeasures through checklists.

Qs. 6 How to reduce maintenance costs ?

Ans :

- ❑ By increasing the life of the equipment through JH activities (Cleaning, lubricating, inspecting) that leads in reducing the consumption of the spares.
- ❑ Devising visual controls that will give early warning signal about deterioration (use of sensory organs).
- ❑ Enhancing skills of maintenance people by education and training and create awareness of cost.
- ❑ Introduction of modular system – so repairs can be done off-line.
- ❑ Increase service life of component through Kaizen
- ❑ Improve MTTR through Kaizen
- ❑ Use value engineering techniques for alternate material design
- ❑ Standardisation of spares, indigenisation, repairs of high value items – to control inventory – Office TPM.
- ❑ Reducing sub-contracting and increasing indigenisation
- ❑ Recycling oil, water
- ❑ Stocking policies and special part planning
- ❑ Effective use of unused machines parts
- ❑ Power factor improvement
- ❑ Improve cycle time
- ❑ Energy conservation
- ❑ Design change to correct the weakness or improve the conditions by Kaizens.

By establishing a spare parts and maintenance planning management system, including:

- inspection of the quality of the incoming spares
- Educating the personnel in the cost control activities.

Qs. 7 How to prepare maintenance budget ?

Ans :

- Previous data of last year
- Spare parts budget
- Sub-contractor budget
- Consumables budget
- Hand tool budget
- Consultancy budget
- Current activity level and future requirements
- Power and fuel cost
- Inflation and currency rates
- Inventory carrying cost
- Level of machines for TBM calendar
- AMC charges
- Improvement projects
- Cost of manpower
- The budget is prepared and presented during the beginning of the financial year and Actual cost vs. budget shall be monitored through a computerized system on a monthly basis.

Qs. 8 How to reduce time for doing PM activities ?

Ans :

- It is done during the JH time
- To arrange for all the materials, tools necessary for doing the tasks well in advance. Do 1S, 2S for tools and spares.
- Plan the sequence of the work and accomplish parallel activities wherever possible
- Improve the service life of the components by value engineering or Kaizen
- Improve MTTR through Kaizen
- Adequate spare parts supply
- Quality of spares assured
- Local procurement of spares – which have short lead time for purchase
- Education and training to the maintenance operators.- what dies he know, he doesn't know, he can do, he cannot do
- For all maintenance employees – categorise them based on skills – fitters, electricians, electronic experts and mechanical technicians

- ❑ Fabrication of special tools, Kaizens for quick lock/unlocking mechanisms, techniques to avoid usage of lifting tackles, by introducing pushing-pulling mechanisms.
- ❑ Implementation of horizontal deployment
- ❑ Improvement in maintenance skill through OPL & class room training
- ❑ Making special tools for diagnosis
- ❑ IT support
- ❑ Thrust on CBM activities
- ❑ Improving design through life enhancement of spares(MTBF).

Qs. 9 How to improve the skill of doing PM activities ?

Ans :

- ❑ Skill is improved through classroom training, which includes imparting knowledge on general and specific areas such as fasteners, bearings, lubrication, hydraulics, pneumatics, and power transmissions, electrical and electronic components.
- ❑ Use of five sensory organs – made aware of.
- ❑ Explanations through important cut-section models and on-the-job training, explaining function of parts and machines through cut-outs
- ❑ Developing one-point lessons and skill improvement through videographs to analyse and minimize the delaying activities and developing Kaizens.
- ❑ On the job training by the senior maintenance staff by relay teaching methodology.
- ❑ Demonstrate achievements of people in a timely way
- ❑ Teach them why-why analysis
- ❑ Use of PM and give feedback on its effectiveness
- ❑ Use of photography as a tool

Qs. 10 How to select equipment for TBM & CBM ?

Ans:

- ❑ By looking at the level of JH activity
- ❑ Monitoring condition of components is not effective – this realisation to people helps
- ❑ In a foundry, all the equipments were selected for TBM.
- ❑ Cost of CBM instruments
- ❑ Completion of step II of JH
- ❑ Condition based maintenance is practiced on rotary equipments of ‘A’ Rank category for vibration analysis and temperature monitoring.
- ❑ Furnaces/boiler shells are checked using ultrasonic methods for measuring the thickness to determine the degree of corrossions/erosions.
- ❑ For CBM if component is very costly and replacement TBM way is not cost effective then we take it up for CBM
- ❑ Life can be monitored and lengthened.

Qs. 11 How to disseminate knowledge on PM ?

Ans :

- ❑ By relay teaching methodology starting from senior maintenance manager to the maintenance staff then to the operators.
- ❑ Develop one-point lessons and visual aids to impart PM skills.
- ❑ Training by the machine manufacturers in-house and abroad.
- ❑ Training through inter and intra-net on today's topics
- ❑ Analysing Kaizens and horizontal deployments
- ❑ Experience sharing
- ❑ Lectures, seminars including TPM instructor doing in-house training to pillar chairmen, and through them to managers, supervisors, engineers, fitters and operators.
- ❑ Why-why analysis
- ❑ PM secretariat meetings
- ❑ Newsletters/magazines
- ❑ Case study presentations
- ❑ Communication boards
- ❑ Regular review meetings

Qs. 12 How to decide machine structure for PM ?

Ans :

Divide machine into main body and auxiliary units like:

- hydraulics
- electrical/electronic
- pneumatic
- power transmissions
- lubrication
- other important parts

Prepare a basic structural manual comprising of major elements, viz hydraulics, pneumatics, power transmission, electrical/electronic components, special equipments etc.

Divide these auxiliary units into sub-assemblies and identify daily and weekly checking activities

Analyse the failures of the individual equipments through history cards and evaluate the weakest links for the failure.

Apply the structural manual for the above failure and make the necessary corrective and preventive actions.

Rank the activities for replacement:

- a. TBM periodic
- b. CBM
- c. Breakdown maintenance
- as per importance.

Qs. 13 How to rank the machines ?

Ans :

Machines are ranked according to their influence on P, Q, C, D, S and M. Also at times machines that suffer from chronic problems and are unique may also get categorized as A rank machines.

Category	Criteria	Rank
P	If the production gets stopped due to breakdown	A
	Can be repaired immediately	B
	No influence	C
Q	If the breakdown results in outright rejection of the products	A
	Can be reworked and salvaged	B
	Does not affect quality or yield	C
C	Frequent stoppages of the machine leading to expensive spare parts replacement	A
	Repair cost very less and non-trouble some machineries	B
D	If the breakdown adversely affects the dispatch of products	A
	Can be taken care by alternate methods	B
S	If the failures lead to major safety and environmental problems/accidents	A
	Failure would cause no safety or environmental problems in the surrounding areas.	C

Qs. 14 How to link PM with other pillar activities ?

Ans :

Pillar	Link
PM-JH	Supporting function elaborated in answer – 1.
PM-QM	Listing out the parts, which affect quality of the products. Concentrate on them to maintain an ideal state.
PM-DM	Listing out the design weaknesses and the Kaizens done to overcome them can be applied horizontally to the newly bought out machineries.
PM-KK	Kaizens to minimize failure losses, energy losses, MTTR, improve equipment reliability.
PM-E&T	Relay teaching methodology. One point lessons/on the job training. Cut out section models.
PM-SHE	<ul style="list-style-type: none"> - To explore the possibilities of getting injured due to the individual machines and Kaizens for their rectification. - Periodical inspection of the condition of pressure vessels, lifting tackles, dust collectors and general electrical inspection. - To monitor and control the ambient air quality inside and outside the factory premises. - To monitor and control the water, noise pollutions and stack emissions.
PM-OTPM	<ul style="list-style-type: none"> - Control of maintenance spares inventory - Computerised maintenance management system for recording maintenance activities. - Feedback to OTPM for converting the losses into cost. - Maintenance back on expenses. - Budget forecast, monitor and control. Feedback on expenses. - To avoid management losses, procure spare parts and consumables in time. Transport arrangements in time.

Qs. 15 How much time is spent in time based maintenance activity and breakdown in a factory(percentage) ?

Ans:

It depends how long is TPM in place after kick-off.

- TBM : (14% (We stop for one day every week) to 60%
- Breakdown : 2.0 % (Average B/D @ 3 hours per week to 40%..

Qs. 16 What kinds of instruments are to be used for CBM activity ?

The instruments being used are :

- Vibration analyzer – IRD 350 to detect condition of bearings
- C R oscilloscope
- Pyrometer
- EMTAK IRD
- BETRO scanner
- Thermography
- Rein Shaw for CNC machine
- Infrared monitor to monitor temperature (non-contact type) used in bus-bars
- Weld checker to check spot welding cable
- Temp. Sticks (Digital temperature measurement equipment)
- Ultrasonic testing equipment
- Manometers
- Anemometers for velocity of air.
- Vayubooth: ambient air quality monitoring device.
- Endoscopes
- Digital tachometer.
- Tong tester – to measure current for finding out mechanical jamming
- Thermometer – measure oil temp to detect potential leakages
- Electrostatic filter to find out contamination to know quality of oil and aid in taking decision on replacement
- Multimeter

Qs. 17 What kind of documents are required for PM ?

Ans:

- History cards for all machines
- PM schedule for the year.
- Periodic parts replacement schedule
- Structural manual
- Computerised maintenance management system documents
- Machine structure study
- Drawings and circuit diagrams for all machines
- Utility requirements and their flow systems
- Equipment maintenance records
- Spare parts requirement and their consumption trends
- MP sheet
- One point lessons
- Breakdown occurrence trend
- Physical phenomenon of the breakdown
- Why-Why analysis documents
- PM analysis documents

- Maintenance through machine structural manual.
- Radar charts
- Calibration certificate
- Manufacturer's guideline
- TBM calendar

Manual No.2 : PLANNED MAINTENANCE IMPLEMENTATION

The TPM Club India, CII acknowledges the contribution of all the following 41 companies who added great value in sharing their experience of TPM Implementation. This manual is the second in the sequence of others to come , covering

- Quality Maintenance
 - Office TPM, and
 - Safety
- in this year

1	Aditya Cement	21	Lucas TVS - FIE Division
2	Bajaj Auto Limited	22	Mahindra & Mahindra Limited - Auto
3	Bharat Seats Limited	23	MM Forgings Limited
4	Birla Tyres	24	Mother Dairy
5	BPL Limited PTI	25	QH Talbros Limited
6	Brakes India Limited, Brakes Div.	26	Shriram Pistons & Rings Limited
7	Brakes India Limited, Foundry Division	27	Sona Koyo Steering Systems Limited
8	Brakes India Limited, Padi	28	Sundaram Brakelinings Limited
9	Brakes India Limited, Pollambakam	29	Sundaram-Clayton Limited
10	Clutch Auto Limited	30	Tata Cummins Limited
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12	Heavy Alloy Penetrator Project	32	The Tata Iron & Steel Co. Limited - Steel
13	Hindustan Lever Limited	33	The Tata Iron & Steel Co. Ltd. - Bearings
14	Hi-Tech Carbon	34	Thirumalai Chemicals Limited
15	Indian Oil Corporation Limited	35	TTK-LIG Limited
16	Indo Gulf Corporation Limited (Fertilisers)	36	Tube Products of India
17	Jay Yuhshin Limited	37	Usha Beltron Limited - Cable Division
18	Jindal Strips Limited	38	Usha Beltron Limited - Alloys & Steel
19	Lakshmi Auto Components	39	Usha Martin Industries
20	Lakshmi Machine Works Limited	40	Vikram Cement
21	Lucas TVS - FIE Division	41	Vikram Ispat, Salow

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