Chapter 13

Total Productive Maintenance

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13.1 INTRODUCTION

During the early days of the industrial working scenario, the routine maintenance of machines was carried out by the operator himself, while major repairs were done by the supervisor, or an external specialist. As we have seen in Chapter 5, the development of Taylors' principle of specialization resulted in the creation of a separate specially trained maintenance team to do all maintenance work, including lubrication by the patrol maintenance gang, together with all minor repairs, such as screw tightening. The industry did benefit a lot by such specialization in light of the centralized maintenance planning and control, the benefits of which we had seen in the previous chapters.

However, it turned out that whenever small machine hold-ups need minor works, such as lubrication or screw tightening, the operator simply waits for the maintenance man to come and do that job, thereby losing production time. Hence, the logical outcome is the idea that the operator himself can trained to do such minor adjustments. This thinking lead to the development of the TPM philosophy, which has become a part and parcele of Total Quality Management (TQM) philosophy.

Total Quality Management: Key Concepts and Case Studies. http://dx.doi.org/10.1016/B978-0-12-811035-5.00013-1

In other words, TPM philosophy emphasizes auto-maintenance, meaning every worker is responsible for the proper working of his machine, apart from being responsible for the quality. The production operators share the preventive maintenance efforts, assist the mechanics with repairs when the equipment is down, and together they work on equipment and process improvements on a team activity basis. TPM aims to use all equipment at its maximum effectiveness by eliminating waste and loss incurred by failure of the equipment, increased set-up time, reduced speeds, and processed effects, etc., which finally lead to reduced output.

The objective of TPM is to maintain the plant or equipment in good condition without interfering in the daily process. To achieve this objective, preventive and predictive maintenance is required. By following the philosophy of TPM, we can minimize the unexpected failure of the equipment.

To distinguish TPM from the quality circles, we can say that quality circles are formed by the workmen of a particular activity location, while TPM is formed by senior managers, supervisors, and workmen who carry out similar exercises on a company-wide basis.

13.2 THE MEANING OF TPM

T represents *Total* employee involvement, indicating the teamwork with well-coordinated work between the production and maintenance workers. This term “Total” also means total equipment effectiveness.

P represents *Productive*, indicating the production of goods and services that meet the customers' expectation by maintaining the reliability of the outputs, which would only be possible if the reliability of the respective machines is kept at a high level.

M represents *Maintenance*, keeping the equipment and plant in good working condition at all times.

13.3 EVOLUTION OF TPM

TPM is an evolving process, starting from a Japanese idea that can be traced back to 1951, when preventive maintenance was introduced into Japan from the United States (Deming). Nippondenso, an ancillary unit of Toyota, was the first company in Japan to introduce plant-wide preventive maintenance in 1960. While, as stated above, the main principle behind TPM, that is, the production operator taking care of routine maintenance of his machine is traced back to the prewar industrial scenario, the development of present TPM philosophy is traced back to the early 1950s, when the Toyota group of companies in Japan made headway introducing this practice. Because of the high level of automation, the equipment maintenance became complex, needing more specialized maintenance personnel that the management lead by Seiichi Nakajima, aptly called the father of TPM, and decided to pass on the routine maintenance jobs to the production operator, focusing the maintenance department's attention more towards the major maintenance jobs. This practice refined the concept of TPM.

The evolution of TPM is summarized as:

• Pre-Industrial Revolution	Operator is responsible for operation and maintenance
• Pre-1950s	Maintenance department's gang for cleaning and lubricating all machines, plus specialized preventive maintenance, etc
• 1960s	Productive maintenance
• 1970s	TPM
• 1980s	Predicative maintenance by operatives and foremen
• 1990s	Maintenance preventive design— Design out maintenance
• 2000s	TPM— the concept of the factory of the future

13.4 DEFINITIONS OF TPM

- TPM is a proactive approach that essentially aims to identify issues as soon as possible, and plan to prevent any issues before occurrence. One motto is "zero error, zero work-related accident, and zero loss."
- Seiichi Nakajima, the Japanese originator of the TPM concept, had defined it as a process to continuously improve all operational conditions within a production system, by stimulating the daily awareness.
- Business Dictionary defines TPM as a methodology designed to ensure that every machine in a production process always performs its required task and its output rate is never disrupted.
- QCFI gives an explanatory definition to TPM as a manufacturing philosophy that pursues production efficiency to its ultimate limits of comprehensive efficiency by,
  - Putting together a practical shop floor system to prevent losses before they occur throughout the entire production system's life cycle,
  - Involving all functions like production, development, sales, and management,
  - Having employee participation from top executives to front line workers,
  - Achieving zero losses through overlapping small groups.

There are several other definitions of TPM and most of them imply the following:

1. TPM aims to maximize the equipment effectiveness.
2. TPM establishes a thorough system of preventive maintenance for the equipments' entire life span.
3. TPM is implemented by various departments, such as line operations, maintenance, engineering, etc.
4. TPM involves every single employee from the top management to the shop floor workers.
5. TPM is based on the promotion of preventive maintenance through motivation.

13.5 TPM IS AN EXTENSION OF TQM

In manufacturing and service industries, improved quality of products and services depend very much on the features and conditions of the company's equipment and facilities. TPM is a maintenance process developed for improving productivity by making processes more reliable and less wasteful. This is where TPM plays a major supplementary role for TQM.

TPM focuses primarily on manufacturing and is the first methodology Toyota used to improve its global position during the 1950s. After integrating TPM with it, the focus was stretched to include various other aspects of TQM, like Supply Chain involving suppliers and customers. The next methodology was called lean manufacturing, where TPM plays a critical role. If machine uptime is not predictable and if process capability is not sustained, the process must keep extra stocks to buffer against this uncertainty and flow through the process will be interrupted. This would deteriorate the product quality, and also delay the delivery to the customer. In this context, TPM contributes a lot to TQM and hence, we can say TPM is an extension of TQM.

While we have stated above that TPM is an extension of TQM, the following distinguishing features of TQM and TPM would enable us to understand the statement better.

1. TPM focuses on the reliability of the equipment, whereas TQM focuses on the reliability and quality of the products and services, which, however, cannot be achieved without achieving TPM's focus on equipment.
2. TPM focuses on improvement of the performance of the equipment, that is, the hardware, while TQM focuses on the improvement of systems and standards that is the software.
3. In TPM, personnel training centers on maintenance technology and skills specific to maintenance, whereas TQM centers on the personnel training in management technologies, such as SC, Kaizan, quality circles, etc.
4. Like quality circles popular with TQM, TPM also advises weekly meetings among small groups of production and maintenance operators, which some companies prefer to call "productivity circles."

13.6 TPM STARTS WITH CLEANING

Fig. 13.1 illustrates how the simple job of cleaning transforms into high quality standards of a company.

Operation and maintenance are like the wheels on the both sides of a car. If one is turned, the other turns, too.

TPM starts with cleaning

- *Cleaning* gives the opportunity for *inspection* of the machine
- *Inspection* reveals *abnormalities*
- *Abnormality* identification enables *rectification* steps
- *Rectification* steps result in *improvement*
- *Improvement* brings *positive results*
- *Positive results* increase *high quality standards*
- High quality standards give *PRIDE* to the work environment.

FIG. 13.1 Metamorphosis of cleaning to high quality standards.

Another allusion is how we take daily care of our body by brushing, cleaning ourselves. We go to the doctor only in case of major illnesses. Like the machine cleaning, lubrication, etc. should be done by the operator himself. Only the major preventive or breakdown maintenance should be assigned to specialists, or the maintenance department.

13.7 THE SEVEN TYPES OF ABNORMALITIES

We can categorize the abnormalities as follows:

1. *Minor Flaws*	
(a) Contamination	dust, dirt, oil, grease, and rust
(b) Damages	cracking, crushing, chipping, bending, and deformation
(c) Play	shaking, falling out, run out, eccentricity, and wear
(d) Slackness	in belts and chains
(e) Abnormal phenomena	unusual noise, overheating, vibration smell, and discoloration
(f) Adhesion	hardening, obstructing, accumulation of debris, and malfunction
2. *Unfulfilled basic condition such as*	
(a) Poor lubrication	insufficient, dirty, and leaking lubricant
(b) Lubricant supply	dirty, unsuitable deformed oil inlets, faulty lubricant channels
(c) Tightening	nuts and bolts being loose, cross-threaded, and unsuitable washers
3. *Inaccessible places*	
(a) Cleaning	covers, plant and machine layout, lack of design out maintenance, and available space
(b) Checking	instrument position and orientation
(c) Lubricating	position of lubricant inlets, height, levers
(d) Tightening	covers, layout, and leverages
(e) Operation	like machine layout, valve position, switches and levers
(f) Adjustment	the position of the pressure and other gages, adjusting instructions
4. *Contamination sources*	
(a) Product	leaks spills and scatter
(b) Raw materials	leaks scatter, overflow
(c) Lubricant	leaking, wet, and contaminated with fuels and other fluids
(d) Gases	leaking compressed air, vapors, and exhaust fumes
(e) Liquids	leakages, half-finished products, and wastewater
(f) Scrap	flashes, packaging, and nonconforming products
5. *Defective sources*	
(a) Foreign matter	inclusions, insects, and rust
(b) Shock	jolting, collision, and vibration
(c) Moisture	infiltration and wetness
(d) Grain size	punctured mesh-screen, separators, unwanted grain sizes

(e) Concentration	inadequate warming, mixing, and evaporation
(f) Viscosity	on-homogeneous mixture, evaporation, and presence of water droplets
6. *Unnecessary and nonperforming items*	
(a) Machinery	pumps, fans, and tanks
(b) Piping equipment	unwanted pipe connections, dampers, and valves
(c) Measuring equipment	pyrometers and gages that are not referred to
(d) Electrical equipment	wiring, switches plugs, and power leads
(e) Jigs and tools	general fixtures, cutting tools, molds, and frames
(f) Spare parts	standby equipment, and auxiliary materials
(g) Makeshift	tapes, wire, and metal plates repair items
7. *Unsafe places*	
(a) Floors	uneven, slippery, projections, and cracking floors
(b) Steps	irregular, too steep, and missing handrails
(c) Lights	dim, dirty, fused, and with broken covers
(d) Rotating machinery	displaced covers, unguarded, and without emergency stops
(e) Lifting gear	cables, hooks, and other parts of cranes
(f) Others	special substances, toxic gases, and lack of protective clothing

13.8 THE EIGHT PILLARS OF TPM

The eight pillars of TPM as emphasized by the Japanese are:

1. *Focused improvement* (Kobetsu Kaizen)—Continuous improvement, even though small steps.
2. *Planned Maintenance*—It focuses on increasing availability of equipment and reducing breakdown of machines.
3. *Initial Control*—To establish the system to launch the production of a new product and new equipment in a minimum run-up time.
4. *Education and Training*—Formation of autonomous workers who have skill and techniques for autonomous maintenance.
5. *Autonomous Maintenance* (Jishu Hozen)—meaning “Maintaining one's equipment by oneself.”
6. *Quality Maintenance* (Hinshitsu Hozen)—Quality Maintenance is establishment of machine conditions that will not allow the occurrence of defects, and control of such conditions is required to sustain Zero Defect.
7. *Office TPM*—To make an efficient working office that eliminates losses.
8. *Safety, Hygiene, and Environment (SHE)*—The main role of SHE is to create a safe and healthy workplace where accidents do not occur, uncover and improve hazardous areas, and do activities that preserve the environment.

Fig. 13.2 illustrates the pillars that support the structure of TPM, each pillar representing each of the above concepts.

13.9 THE FIVE ZEROS OF TPM

In any industrial situation, the major effort of the management is to minimize the factors that increase production hold ups and cause losses to the profitability of the company. To create the awareness and commitment among all employees, companies successful in TQM practices publicize the following through posters, etc., so as to create a mindset among employees.

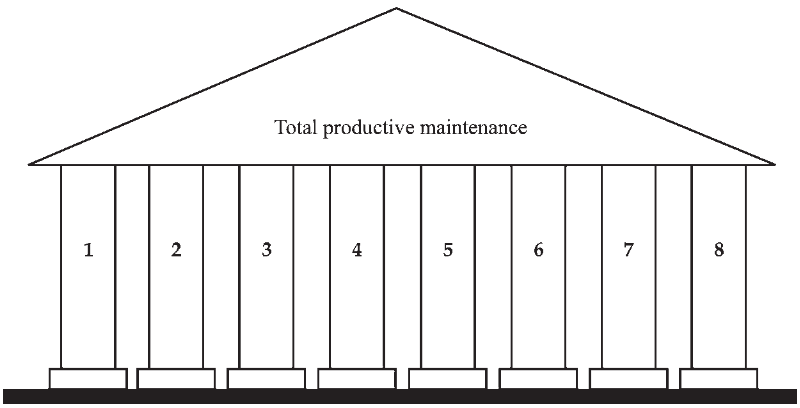

FIG. 13.2 TPM structure.

- Zero breakdowns
- Zero defects
- Zero accidents
- Zero pollution
- Zero inventory

Actually, the last one, viz. zero inventory, is applied in general to the production situation wherein the inventory plays a major cost-adding factor, more than for the maintenance function, whose inventory requirements are different. Normally TPM books cite four zeroes. Nevertheless, since some of the syllabi specify five zero's for Maintenance Management, this concept is explained as above, together with the last one.

13.10 WHY OPERATIVES FAIL TO ADAPT TPM AS A WAY OF LIFE?

- They do not know what and where regular checks are to be made on the equipment
- When equipment is to be lubricated and the lubricating points are not relayed to him

- When an abnormality is routinely found and the operative is not trained to address it
- The operative himself is not very conscious of the losses created by the machine downtime

13.11 WHAT CAN TPM ACHIEVE?

Wikipedia emphasizes that an accurate and practical implementation of TPM will increase productivity within the total organization, where:

1. A clear business culture has been developed to continuously improve the efficiency of the organization.
2. There is a standardized approach for preventing known or unknown losses.
3. All employees and departments could be involved to form a transparent multidisciplinary organization to reach zero losses.
4. Steps are taken on the whole road map, and not as a quick menu.
5. Finally, TPM will provide practical and transparent ingredients to reach operational excellence.

Whereas in most production settings the operator is not viewed as a member of the maintenance team, in TPM the machine operator is trained to perform many of the day-to-day tasks of simple maintenance and fault-location. Teams are created that include a technical expert (often an engineer or maintenance technician) as well as operators. In this setting, the operator is enabled to understand the machinery and identify potential problems, righting them before they can impact production and by so doing, decrease downtime, and reduce costs of production. He attends to the daily cleaning of the machine bed and slide ways, and lubricates the lubrication points, including the work surfaces. Where an oil well is provided, he checks the oil level, starts the machine and then checks the oil flow, etc., before commencing the production work. Any defect is reported to the supervisor to ensure his immediate attention. To assist the operative lubrication, points should be painted in distinctive colors. These maintenance jobs should be incorporated as suitable allowances in the standard output rates.

13.12 OVERALL EQUIPMENT EFFECTIVENESS (OEE)

Overall equipment effectiveness quantifies how well a manufacturing unit performs relative to its designed capacity, during the periods when it is scheduled to run. OEE breaks the performance of a manufacturing unit into three separate, but measurable components: Availability, Performance, and Quality.

Availability is	Operating time/planned production time
Performance is	Net operating time/operating time
Quality is	Rate or percentage of good parts out of total production

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$$

13.13 THE SIX LOSSES FROM POOR OEE

The website of Optimum FX Consulting lists six major losses that result from poor OEE

- PDT or external unplanned event
- Breakdowns (>5 min)
- Minor stops (<5 min)
- Speed loss
- Production rejects
- Start-up rejects

These losses are explained in Table 13.1 and further illustrated in Fig. 13.3

13.14 THE THREE LEVELS OF AUTONOMOUS MAINTENANCE IN TPM

1. Routine lubrication and minor repairs, such as screw tightening or belt tightening, if necessary under instructions from the supervisor. This is called the *repair level of TPM*.
2. In case of any abnormal sound, like vibration or bearing notice, identify the root cause or notify the supervisor, as a part of the condition monitoring. This is called the *prevention level of TPM*.
3. Not only taking corrective action as above, but also take it up during quality circle meetings, departmental meetings, etc., and discuss improvements. This is called *improvement level of TPM*.

13.15 THE FIVE GOALS OF TPM

1. TPM's chief goal is to *improve system effectiveness*. It identifies and examines all losses that occur, whether it is downtime losses or speed losses or defect losses.
2. TPM achieves *autonomous maintenance* by motivating the operators to take responsibility for routine maintenance tasks as explained in the previous paragraph.
3. TPM adopts a *systematic approach* to all the maintenance activities. The level and nature of preventive maintenance for machine and equipment is identified and standards developed for condition monitoring. While operators are considered as owners of the machines taking their general care, the maintenance staff is considered as specialists providing supportive role for preventive and corrective maintenance activities.
4. TPM defines the *responsibilities* of the operators and maintenance staff, and that each has all the needed skills to carry out their roles. TPM emphasizes appropriate and continuous training and the maintenance department is given the responsibility of training the operators in routine and minor maintenance.

TABLE 13.1 The Six Losses due to Poor OEE

No.	OEE Measure	Six Loss Category	Reason for Loss	Countermeasures
1	Availability	Planned downtime or external unplanned event	1. Changeovers 2. Planned maintenance 3. Material shortage 4. Labor shortages	• Planned Downtime Management • 5S Workplace Organization • ABC Planning
2	Availability	Breakdowns	1. Equipment failure 2. Major component failure 3. Unplanned maintenance	• Kaizen Blitz • ProACT • Root cause analysis • Asset Care
3	Performance	Minor stops	1. Fallen product 2. Obstruction 3. Blockage 4. Misalignment	• Opportunity Analysis • 5S Workplace Organization • Management Routines • Line Minor stop audits
4	Performance	Speed loss	1. Running lower than rated speed 2. Untrained operator not able to run at nominal speed 3. Misalignment	• IFA Opportunity Analysis • Line Balance Optimization • Management Routines
5	Quality	Production rejects	1. Product out of specification 2. Damaged product 3. Scrap	• IFA Opportunity Analysis • Six Sigma • Error proofing
6	Quality	Rejects on startup	1. Product out of specification at start of run 2. Scrap created before nominal running after changeover 3. Damaged product after planned maintenance activity	• Planned Downtime Management • 5S Workplace Organization • Standard Operating Procedures • Precision settings

5. TPM strives to *attain the early design out maintenance* aspects for equipment. Its aim is to move towards zero maintenance through a maintenance prevention program (MP). This involves considering and analyzing failure causes and maintainability of the equipment during every stage, whether during design, manufacture, installation, or commissioning of the equipment.

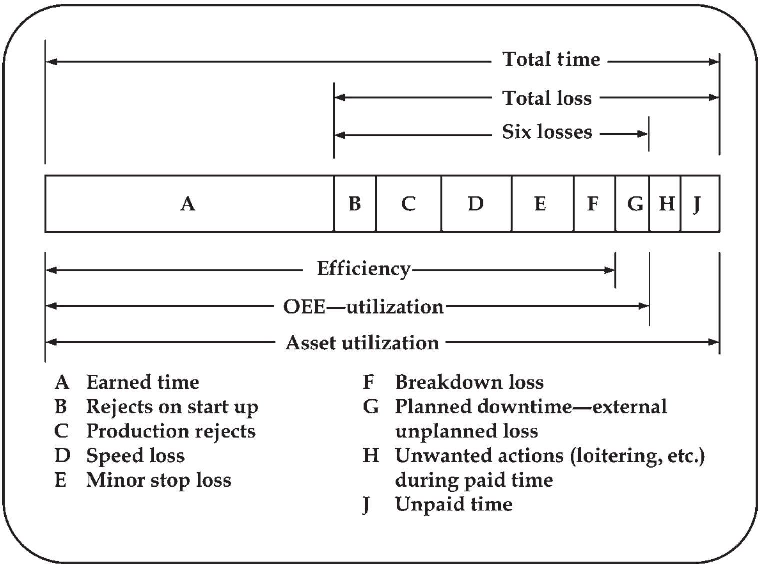

FIG. 13.3 Illustration of the six OEE losses.

13.16 PROCEDURE FOR THE IMPLEMENTATION OF TPM

1. Study the existing equipment history, maintenance records, etc., for all equipment and make a preliminary report of the need for TPM.
2. Obtain the consent of top management for the introduction of TPM in the organization.
3. Discuss with the concerned department heads, supervisors, and the unions.
4. Set goals and norms for TPM parameters such as the equipment's effectiveness and availability standards.
5. Segregate the maintenance jobs into three classes
   (a) *Routine maintenance jobs that could be done by the operator*:
      (i) Machine lubrication and oil levels monitoring.
      (ii) Cleaning and upkeep of the equipment.
      (iii) Adjustments, set up, and minor repairs like screw tightening.
      (iv) On-line condition monitoring with the help of production supervisor

   (b) *Jobs essentially to be done by the maintenance staff*:
      (i) Major breakdown jobs.
      (ii) Related works, like work order, material indents.

   (iii) Plant shutdowns for preventive maintenance.
   (iv) Major checking and off-line condition monitoring.
   (v) Major shutdowns and capital repair jobs.

(c) *Jobs that are to be done by the planning and technical service groups*:
   (i) Overall planning of the preventive maintenance e-schedules.
   (ii) Simple design alteration in the equipment to suit maintenance.
   (iii) Preparation and issue of periodic checklists.
   (iv) Specialized inspection and condition monitoring.
   (v) Spare part inventory control, salvaging, etc.
   (vi) Subcontracting of maintenance jobs.
   (vii) Design of forms and documentation for the maintenance department.

6. Make necessary reorganization of operation, maintenance, and planning groups to suit above segregation and earmark specific persons where necessary and possible.
7. Introduce autonomous maintenance concept for production group.
8. Seek the assistance and cooperation of the production personnel for major shutdown and breakdown jobs, along with the maintenance staff. This would not only induce a sense of belonging to the production staff, but would train them on various aspects of the machine structure and its maintenance.
9. Initiate maintenance prevention measures.
10. Evaluate the effect of TPM with respect to the set goals.
11. Ensure that the implemented system is maintained for at least 1 year. Be present to answer and solve any queries from the concerned staff about the system.

13.17 MAINTENANCE WORK SAMPLING

Work sampling is a proven measurement technique of industrial engineering, based on a random sampling of the workforce to determine what types of activities they are performing over the course of the day. It identifies and quantifies maintenance workforce efficiency opportunities. World-class maintenance operations can potentially perform the same amount of work with half as many workers. By identifying and eliminating barriers to productivity, the value-added contribution of existing maintenance resources can be significantly increased.

13.18 CONCLUSION

As we had seen, preventing equipment breakdowns and standardizing the equipment result in less variance and the quality of the products increases. Thus, as explained in Section 13.4, TPM is, and continues to be, one of the cornerstones in the quality movement and forms an extension of TQM.

APPENDIX *(SOURCE: TOTAL QUALITY MANAGEMENT BY SAMUEL K. HO)*

CHECKLIST FOR JIPE'S PRODUCTIVE MAINTENANCE EXCELLENCE AWARD

Japan Institute of Plant Engineers (JIPE) sponsored the *Productive Maintenance Excellence Award* recognizing outstanding achievements in TPM field for Japanese industries as indicated earlier. JIPE developed a checklist as indicated below, to decide on the award. This checklist also gives the full insight into the salient aspects of TPM and helps us better understand the several factors that contribute for the success of TPM.

1. *Policy and objectives*
- **1.1** How is equipment management integrated into company policy?
- **1.2** Are equipment management policy and objectives set and prioritized correctly?
- **1.3** Are the management guidelines and evaluation criteria good?
- **1.4** Are long-term and annual plans integrated?
- **1.5** Are policy and objectives thoroughly understood and implemented?
- **1.6** Are accurate checks done to make sure objectives are being met?
- **1.7** Are the year's results considered in formulating goals, objectives, and plans for the next year?

2. *Organization and operation*
- **2.1** Are the organization and personnel assignments right for managing the equipment?
- **2.2** Is a good organization in place for promoting TPM?
- **2.3** Is the TPM promotion organization in close contact with production lines?
- **2.4** Are all the necessary departments participating fully in TPM?
- **2.5** Is effective coordination being done between the head office and the factories?
- **2.6** Are there any impediments to the exchange and use of information?
- **2.7** Are relations good with any subcontractors responsible for equipment, dies, tools, and maintenance work?

3. *Small-group activities and autonomous maintenance*
- **3.1** Is the organization of the small groups done right?
- **3.2** How are small-group activity objectives set?
- **3.3** Do the groups meet frequently and are their meetings lively?
- **3.4** Are there lots of good suggestions, and are they handled properly?
- **3.5** How is goal-attainment ascertained?
- **3.6** Do operators take the initiative in maintaining their equipment?

4. *Training*
- **4.1** Do the different departments understand TPM?
- **4.2** Are the training programs broad enough and their curricula right?

- **4.3** Do the training programs follow the curricula?
- **4.4** Do people take part in outside training programs?
- **4.5** How many people have technical or expert certifications?
- **4.6** How knowledgeable and skilled are people in maintenance techniques?
- **4.7** How is skill-assessment done?
- **4.8** Is there any way to make sure the training is having an effect?

5. *Equipment maintenance*

- **5.1** Are the 5-S being implemented?
  - Is the machinery clean and free of dust, filings, oil, and other waste material?
  - Have policies been instituted to deal with dirt, places that cause foiling, and places that are difficult to clean, inspect, and lubricate?
  - Are lubrication labels, gauge limitations, bolt tighten-to-her marks, and other visible indicators used?
  - Are all of the tools, materials, gauges, and other things stored neatly and kept clean?
- **5.2** Are equipment diagnosis techniques used in these cases?
  - Cracking, corrosion, and loosening?
  - Abnormal vibration, heating, and noise?
  - Water, oil gas, and air leakage?
- **5.3** Are power lines, water lines, hydraulic lines, and other lines neatly and properly handled?
- **5.4** Are oils properly selected and properly replaced or filtered at the appropriate intervals?

6. *Planning and management*

- **6.1** Are the appropriate efforts being made to improve maintenance techniques and efficiently?
- **6.2** Are equipment standards properly set and enforced in a planned manner?
- **6.3** Are monthly and annual maintenance plans drawn up and implemented properly?
- **6.4** Are the purchasing plans for spare parts and other maintenance equipment properly drawn up (eg, how much of what to buy from where) and are such things cared for?
- **6.5** Are equipment blueprints well cared for?
- **6.6** Are the dies, tools, and gauges properly cared for?
- **6.7** Are good records being kept on equipment wear and equipment failures that mandate stoppages or other maintenance efforts?
- **6.8** Are maintenance records used to improved processes?
- **6.9** Are the right maintenance techniques properly applied?

7. *Equipment investment plans and maintenance planning*

- **7.1** Is equipment investment coordinated with the development of new products and new processes?

- **7.2** Is equipment investment cost-effective?
- **7.3** How is the plant investment budget drawn up and controlled?
- **7.4** Are maintenance planning suggestions duly reflected in equipment investment standards?
- **7.5** Are reliability and maintenance duly considered in selecting, designing, and placing equipment?
- **7.6** Is equipment closely monitored in the start-up stages?
- **7.7** Is the company good at developing its own dies, tools, and equipment?
- **7.8** Are policies promptly instituted to keep major problems from recurring?
- **7.9** Are plant assets properly managed?

8. *Production volume, scheduling, quality, and cost*

- **8.1** Is equipment control closely integrated with production volume and scheduling?
- **8.2** Is equipment control closely integrated with quality control?
- **8.3** Are maintenance budgets drawn up and managed properly?
- **8.4** Is energy and other resource conservation practice?

9. *Safety, sanitation, and environmental conservation*

- **9.1** Are sound policies in place for safety, sanitation, and environmental conservation?
- **9.2** Are the right organizations in place for safety, sanitation, and environmental conservation?
- **9.3** Are safety, sanitation, and environmental conservation methods known and practiced?
- **9.4** Is equipment investment integrated with safety, sanitation, and environmental conservation considerations?
- **9.5** Are safety and sanitation polices paying off?
- **9.6** Do environmental policies meet all of the legal requirements?

10. *Results and assessments*

- **10.1** Are results properly measured?
- **10.2** Are policies being implemented and objectives met?
- **10.3** Is maintenance paying off in terms of enhanced productivity and other management aims?
- **10.4** Does the company make an effort to publicize its activities and its successes?
- **10.5** Does the company know where the problems are?
- **10.6** Have plans been drawn up for future progress?

On the Lighter Side

The secret of managing is to keep the guys who hate you away from those who are undecided

–Casey Stengel

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