A Maintenance Philosophy

Asset Management: Phase II

Total Productive Maintenance

1. TPM definition

- **A company-wide team-based effort to build quality into systems and to improve overall asset effectiveness**
- **Total**
  - **all employees are involved**
  - **it aims to eliminate all accidents, defects and system problems**
- **Productive**
  - **actions are performed while maintaining system integrity**
  - **troubles for system are minimized**
- **Maintenance**
  - **keep in good condition**
  - **repair, clean, clear, lubricate**

1. TPM definition

- TPM combines the traditionally American practice of preventive maintenance with Total Quality Control and Total Employee Involvement to create a culture where all employees develop ownership of their equipment and operating systems and become full partners with Engineering and Management to assure equipment and systems operate properly and effectively everyday.

2. Origins of TPM

- Dr. Deming introduced statistical analysis and used the resulting data to control quality during manufacturing (TQM)
- Some general concepts of TQM did not work well in the maintenance environment
- The need to go further than preventive maintenance was quickly recognized by those companies who were committed to TQM
- Maintenance became an integral part of TQM in the early 90's

3. TPM principles

- Increase Overall Asset Effectiveness (OAE) - Increase asset utilization
- Improve existing planned maintenance systems
- The employee who uses the equipment most is the best condition monitor
- Provide training to upgrade operations and maintenance skills
- Involve everyone and utilize cross-functional teamwork

3. TPM principles

- Major Equipment and Tools
  - LNG and Propane Plant Equipment and Systems
  - Distribution and Transmission Lines
  - SCADA Systems
  - Services
  - Meters and Regulators
  - City Gates
  - District Regulator Stations
  - Rectifiers and Corrosion Control Equipment

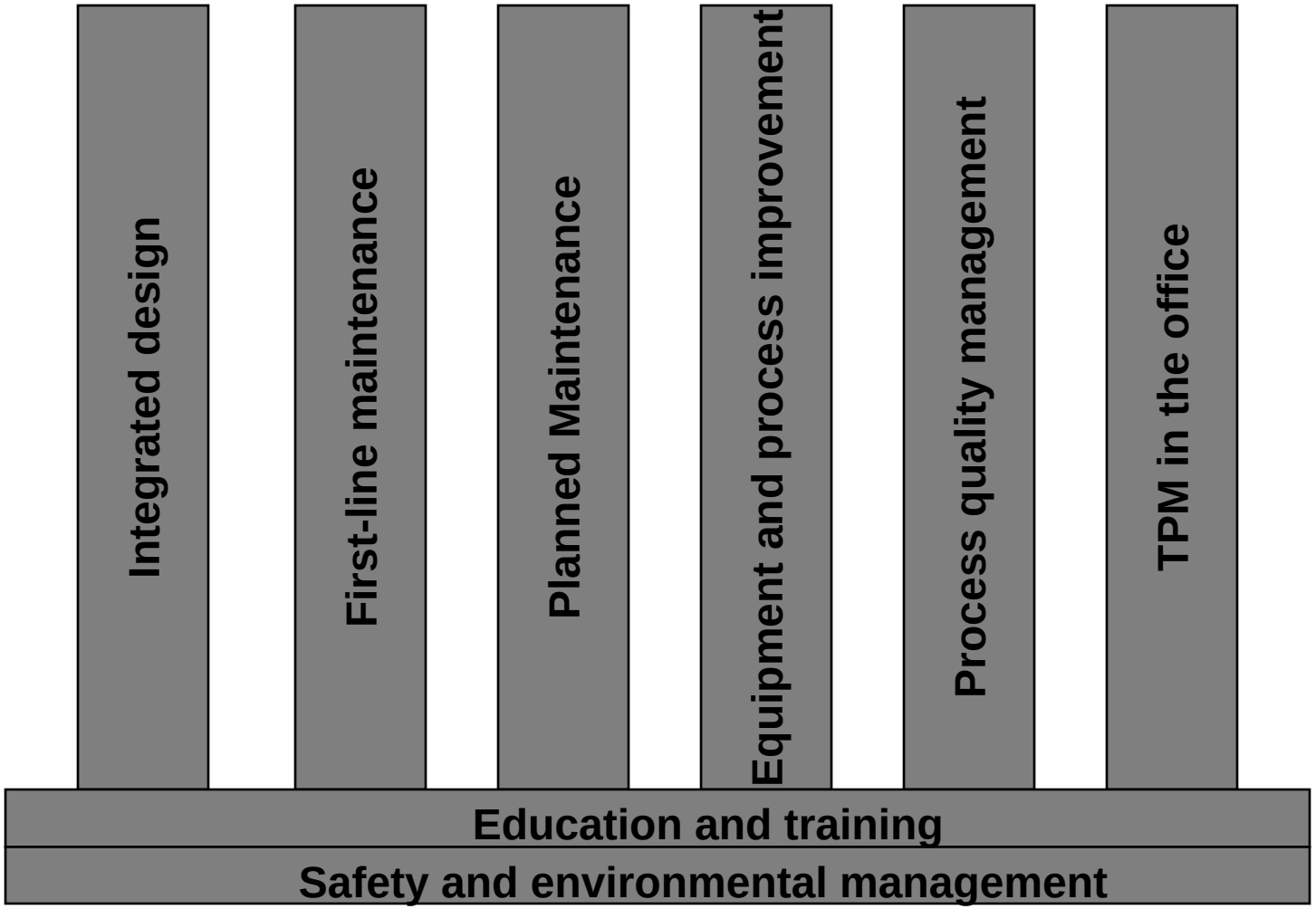
3. TPM principles

- Major Equipment and Tools
  - Vehicles
  - Backhoes
  - Lifting Equipment
  - Tapping and Stopping Equipment
  - Shoring Equipment
  - Pipe Horns
  - Gas Detectors
  - Squeezers

3. TPM principles

- Major Equipment and Tools
  - Diaphragm Pumps
  - Arc Welder(s)
  - Electrofusion Machines
  - Light Sets
  - SCBAs
  - Fire Extinguishers

4. Eight major pillars of TPM



4. Eight major pillars of TPM

4.1. Integrated Design

- **Objective: establish systems to shorten cycle time for:**
  - **new product or equipment development**
  - **system adds**
  - **start-up and commissioning time**
- **New equipment and system adds needs to be:**
  - **easy to operate**
  - **easy to clean**
  - **easy to maintain and reliable**
  - **have quick set-up times**
  - **operate at the lowest life cycle cost**

4. Eight major pillars of TPM

4.1. First-line Maintenance

- Train all employees to close the gap between them and all maintenance functions, making it easier to work as one team
- Change the equipment and systems so that the employees who utilize and operate it can identify any abnormal conditions and measure deterioration before it affects the system or leads to a failure

4. Eight major pillars of TPM

4.1. First-line Maintenance (2)

- 7 steps are implemented to progressively increase employee knowledge, participation and responsibility for their equipment
  - **1. Perform initial cleaning and inspection**
  - **2. Countermeasures for the causes and effects of dirt and dust**
  - **3. Establish cleaning and lubrication standards**
  - **4. Conduct general inspection training**
  - **5. Establish visual control systems**
  - **6. Carry out equipment inspection checks**
  - **7. Workplace management and control**
  - **8. Continuous improvement**

4. Eight major pillars of TPM

4.3. Planned maintenance

- **Objective: establish Preventative and Predictive Maintenance systems for equipment and tooling**
- **Natural life cycle of equipment and individual system elements must be achieved**
  - **Correct operation**
  - **Correct set-up**
  - **Cleaning**
  - **Lubrication**
  - **Retightening**
  - **Feedback and repair of minor defects**
  - **Quality spare parts**

4. Eight major pillars of TPM

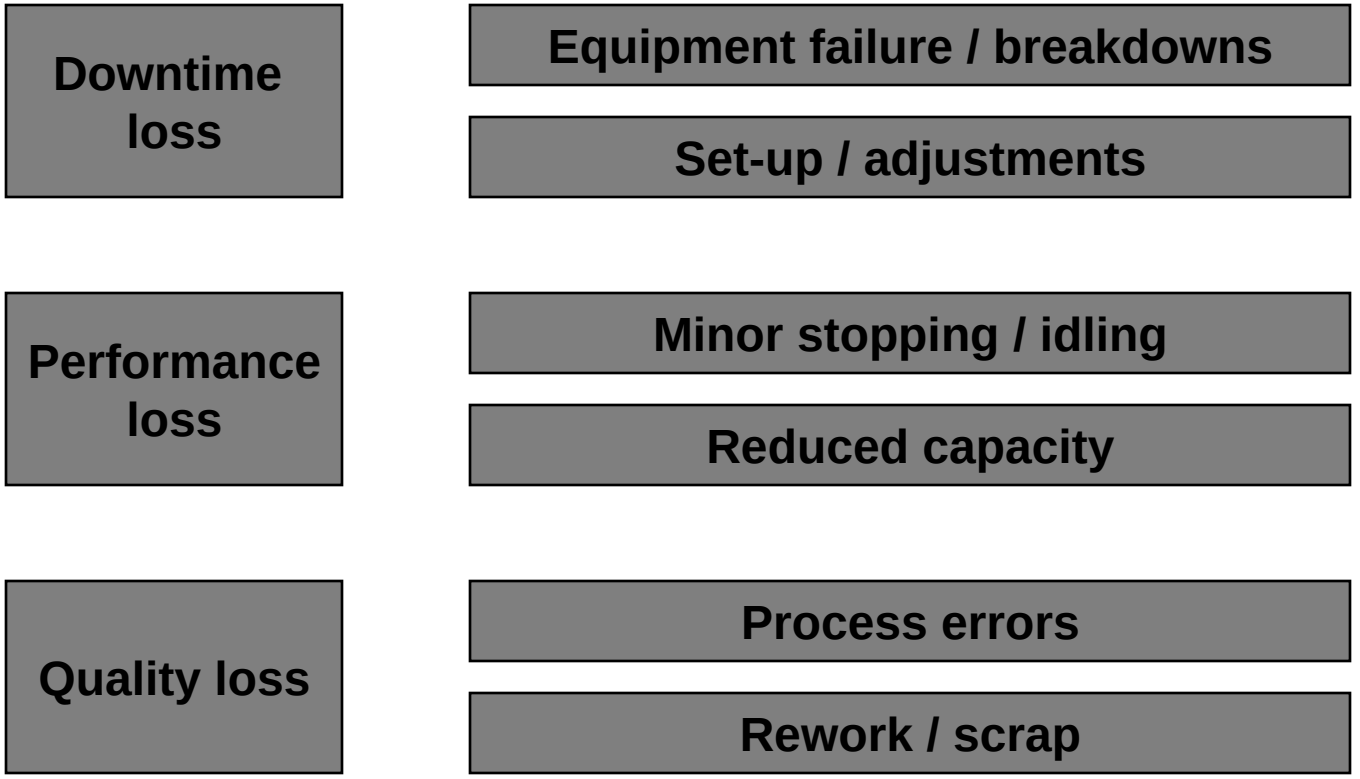
4.2. Equipment and process improvement

- **Objective: maximize efficiency by eliminating waste and losses**
- **Losses are categorized into three areas (the 16 big losses):**
  - **Equipment losses (6)**
  - **Manpower losses (4)**
  - **Material losses (3)**

4. Eight major pillars of TPM

4.2. Equipment and process improvement

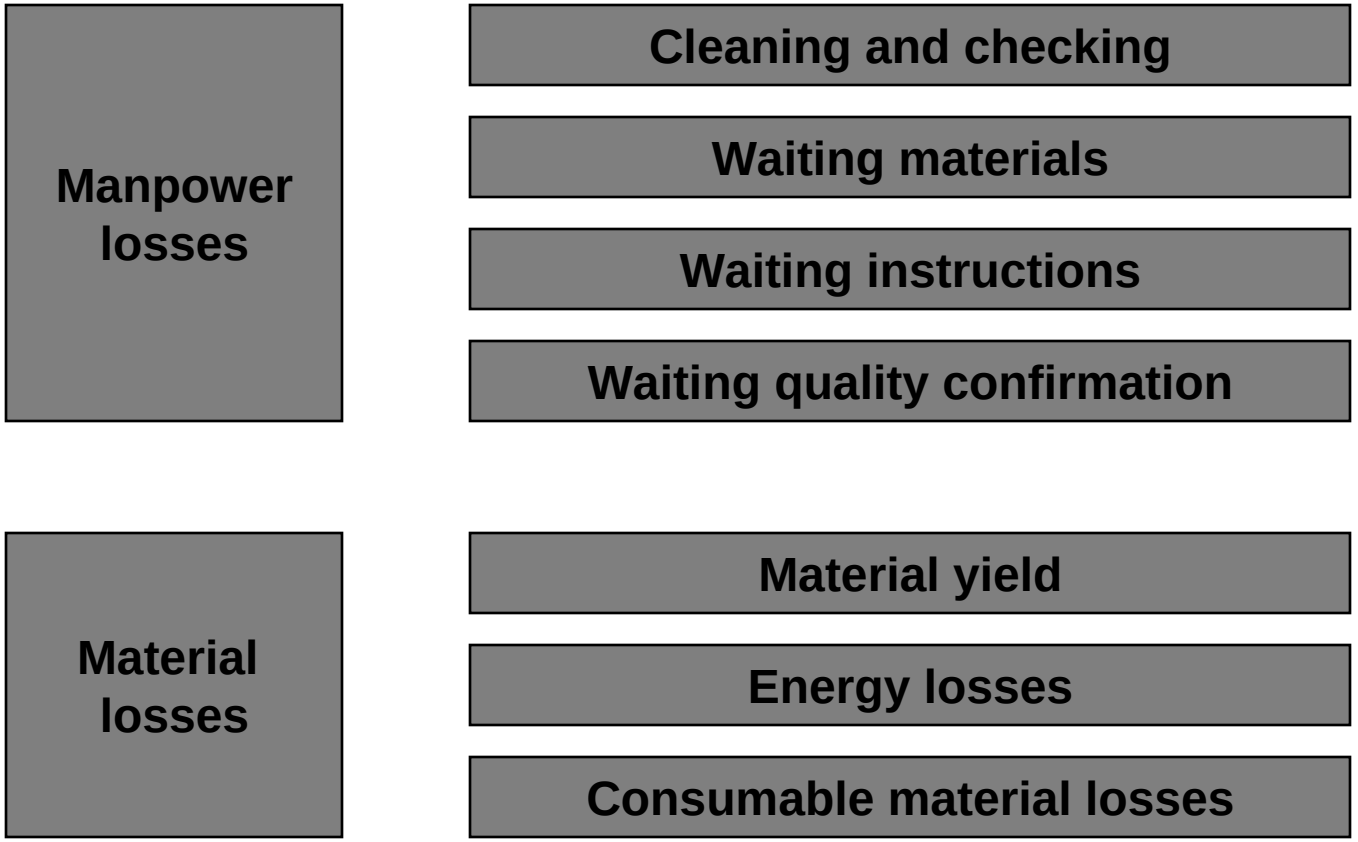
4.2.1. Equipment losses



4. Eight major pillars of TPM

4.2. Equipment and process improvement

4.2.2. Manpower and material losses



4. Eight major pillars of TPM

4.2. Equipment and process improvement

4.2.3 Overall Asset Effectiveness (OAE)

- OAE figures are determined by combining the availability, utility, and performance of your equipment with the quality of output
- OAE measures the efficiency of the machine during its planned loading time. Planned downtime does not effect the OAE figure.

4. Eight major pillars of TPM

4.2. Equipment and process improvement

4.2.3 Overall Asset Effectiveness (OAE)

Overall Equipment Effectiveness = Availability x Performance x Quality Yield

Availability	**Downtime loss**
Performance	**Performance loss**
Quality Yield	**Quality loss**

4. Eight major pillars of TPM

4.2. Equipment and process improvement

4.2.3 Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness = Availability x Performance x Quality Yield

$$\text{Availability} = \frac{\text{time available for production - downtime}}{\text{time available for production}}$$

$$\text{Performance} = \frac{\text{actual production or capacity (performance testing)}}{\text{ideal production or capacity (engineering)}}$$

$$\text{Quality Yield} = \frac{\text{total quantity produced – quantity out of spec}}{\text{total quantity produced}}$$

4. Eight major pillars of TPM

4.5. Process Quality Management

- **Definition: a process for controlling the condition of equipment components that affect variability in product quality**
- **Objective: to set and maintain conditions to accomplish zero defects**
- **Quality rate has a direct correlation with**
  - **material conditions**
  - **equipment precision**
  - **production methods**
  - **process parameters**

4. Eight major pillars of TPM

4.6. TPM in administrative and support departments

- Administrative and support departments can be seen as process plants whose principal tasks are to collect, process, and distribute information
- Process analysis should be applied to streamline information flow

4. Eight major pillars of TPM

4.7. Education and training

- **TPM is a continuous learning process.**

- **2 major components**
  - **soft skills training: how to work as teams, diversity training and communication skills**
  - **technical training: upgrading problem-solving and equipment- related skills**

4. Eight major pillars of TPM

4.8. Safety and environmental management

- Assuring safety and preventing adverse environmental impacts are important priorities in any TPM effort

5. TPM Implementation

6. TPM Benefits

- Increased equipment and personnel productivity
- Increased asset utilization
- Lower maintenance and system costs
- Approaching zero equipment-caused defects or reliability issues
- Enhanced job satisfaction
- Increased Return On Investment

The end