Overall Equipment Effectiveness (OEE) explained

In this page I will explain OEE, the OEE calculation, OEE measurement, and how OEE can help you to maximise productivity.

In an ideal environment, all equipment would operate all the time at full capacity producing good quality product. In real life, however, this situation is almost non-existent.

Put simply overall equipment effectiveness, OEE, is a measure of what you actually made over what you could have made in theory over that timeframe. The difference between the ideal (theoretical) and actual situation is due to losses. These losses can be categorised into various metrics that provide you with excellent data to enable you to target that specific area and help you improve.

The three main categories of OEE are Availability, Performance and Quality. By measuring the performance in each of these categories and multiplying the result will give you the OEE figure. These three categories are subdivided into what is known as the ‘Six Big Losses’ to OEE.

The ‘Productivity Model’ below explains how the various OEE losses fit together.

<table>
<thead>
<tr>
<th>OEE Calculation and OEE Formula:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OEE Category</strong></td>
</tr>
<tr>
<td>Availability</td>
</tr>
<tr>
<td>Performance</td>
</tr>
<tr>
<td>Quality</td>
</tr>
</tbody>
</table>

\[
OEE = \text{Availability} \times \text{Performance} \times \text{Quality}
\]
Six Loss and counter measures
One of the major goals in TPM or OEE improvement programs is to reduce or eliminate the Six Losses. It allows us to accurately pinpoint the area of focus that will improve the efficiency of the equipment. The following table explains the Six Losses and how they can be addressed:

<table>
<thead>
<tr>
<th>Six loss category</th>
<th>OEE measure</th>
<th>Reason for Loss</th>
<th>Countermeasures</th>
</tr>
</thead>
</table>
| Planned downtime or external unplanned event | Availability | • Changeovers  
• Asset care  
• Planned Maintenance  
• Material shortages  
• Labour shortages | • SMED - quick changeover techniques  
• Benchmarking  
• Planned downtime log and matrix |
| Breakdowns                        | Availability | • Equipment failure  
>5mins  
• Major component failure  
• Unplanned maintenance | • Asset care or preventative maintenance  
• Lubrication  
• Root cause analysis  
• Electrical thermographs or vibration analysis |
| Minor stops                       | Performance | • Equipment failure  
<5mins  
• Fallen product  
• Obstruction  
• blockages | • Targeted reduction of MTBF  
• High speed cameras  
• Tick sheets for further analysis  
• OEM audit and servicing |
| Speed loss                        | Performance | • Running lower than rated speed  
• Untrained operator not able to run at nominal speed  
• Machine idling | • Optimising line control  
• Training and awareness of line balance theory |
| Production rejects                | Quality     | • Product out of specification  
• Damaged product  
• scrap | • Error proofing  
• Six Sigma  
• Targeted analysis of reject area to analyse cause |
| Rejects on start up               | Quality     | • Product out of specification at start of run | • Precision settings  
• Ensure machine availability on |
<table>
<thead>
<tr>
<th>Six loss Calculation</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned downtime or external unplanned event</td>
<td>Planned downtime / Total production time</td>
</tr>
<tr>
<td>Breakdowns (&gt;5mins)</td>
<td>Major fault time / Total production time</td>
</tr>
<tr>
<td>Minor stops (&lt;5mins)</td>
<td>Minor fault time / Total production time</td>
</tr>
<tr>
<td>Speed loss</td>
<td>(Output / Ave speed x Total production time) - (Output / Rated speed x Total production time)</td>
</tr>
<tr>
<td>Production rejects</td>
<td>Rejects in prod / (Good output + Total rejects)</td>
</tr>
<tr>
<td>Rejects on start up</td>
<td>Rejects on startup / (Good output + Total rejects)</td>
</tr>
</tbody>
</table>

**OEE and Six Loss Analysis Calculation Example**

In a 480 minute shift:-
On a machine rated at 100 products output per minute
Maximum output = 480 mins x 100 units = 48000 units

Shift info:
- Output (Good Production) = 32000 units
- Speed = 98 units per minute
- Planned downtime = 82 mins
- Bottleneck loss due to B/down = 30 mins
- Rejects (in process) = 1255 in 8 hr shift

Output (OEE) = 32000 / 48000 = 66.7%
480mins x 66.67% = 320 mins
Total Loss = 160 mins

**Six Loss Calculations:**

**Speed loss**
Max theoretical units possible at actual speed = 98 x 480 = 47040
= (32000/47040) – (32000/48000) = 68.03% - 66.67% = 1.36%
480 x 1.36% = 6.53 mins / 480 = 1.36%
Planned downtime
= 82 mins / 480 = 17.08%
Breakdown
= 30 mins / 480 = 6.25%
Rejects = 1255 / 98 (actual running speed)
= 12.81 mins / 480 = 2.67%
Minor stops = 480-320-6.53-82-30-12.81 = 28.66 mins / 480 = 5.97%

Total loss = 160 mins = (33.33%)

**OEE Calculations:**
(Time in mins)
Production time = 480
Time less availability loss = 368
Time less performance loss =...
<table>
<thead>
<tr>
<th>Availability Loss</th>
<th>Performance Loss</th>
<th>Quality Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned downtime  = 82</td>
<td>Speed loss = 6.53</td>
<td>Rejects on start up = 0</td>
</tr>
<tr>
<td>Breakdowns        = 30</td>
<td>Minor stops (&lt;5 mins) = 28.66</td>
<td>Rejects in process = 12.81</td>
</tr>
<tr>
<td><strong>Total</strong>         = 112</td>
<td><strong>Total</strong> = 35.19</td>
<td><strong>Total</strong> = 12.81</td>
</tr>
</tbody>
</table>

Availability (368/480) = 77%  Performance (333/368) = 90%  Quality (320/333) = 96%  

**OEE** = 0.77 × 0.9 × 0.96 = **66.7%**