CQE EXAM

Overall Equipment Effectiveness

CQE Academy

OEE Field Guide

OEE Template

OEE Practice Exams

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Click Here For the OEE Template

Machine Speed: 24 Parts per Minutes
Machine Cycle Time: 2.5 seconds

Date	Total Production	Shift	Shift Duration	Planned Downtime			Planned Runtime	Breakdowns (Downtime)			Change-Overs (Downtime)	
				Breaks	Lunches	Other		Failure A	Failure B	Failure C	Material CO	Line Clearance
8/1/2022	12,234	A	12	45	45	0	10.5	30	10	5	10	31
8/1/2022	9,587	B	10	30	30	0	9.0	45	10	5	10	23
8/2/2022	10,864	A	12	45	45	0	10.5	35	15	10	60	37
8/2/2022	9,725	B	10	30	30	0	9.0	40	5	10	10	34
8/3/2022	12,234	A	12	45	45	0	10.5	45	10	5	10	26
8/3/2022	10,234	B	10	30	30	0	9.0	30	5	10	10	35
8/4/2022	12,167	A	12	45	45	0	10.5	45	5	10	10	33
8/4/2022	9,435	B	10	30	30	0	9.0	40	15	15	35	28
8/5/2022												
	86,480							310	75	70	155	247

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Date	Total Production	OEE Components			
		Availability	Performance	Yield	OEE
8/1/2022	12,234	86%	94%	95%	77%
8/1/2022	9,587	83%	89%	95%	71%
8/2/2022	10,864	75%	96%	96%	69%
8/2/2022	9,725	82%	92%	95%	71%
8/3/2022	12,234	85%	95%	96%	77%
8/3/2022	10,234	83%	95%	95%	75%
8/4/2022	12,167	84%	96%	96%	77%
8/4/2022	9,435	75%	97%	96%	70%
8/5/2022					

Overall Equipment Effectiveness (OEE)

One of the most important metrics in Lean Manufacturing is Overall Equipment Effectiveness (OEE), which is calculated as a percentage value that is function of *Performance, Availability and Yield.*

$$OEE = P \times A \times Y$$

Performance   Availability   Yield

Performance – Is the machine performing at the right speed?

Availability – Is the machine available to produce parts?
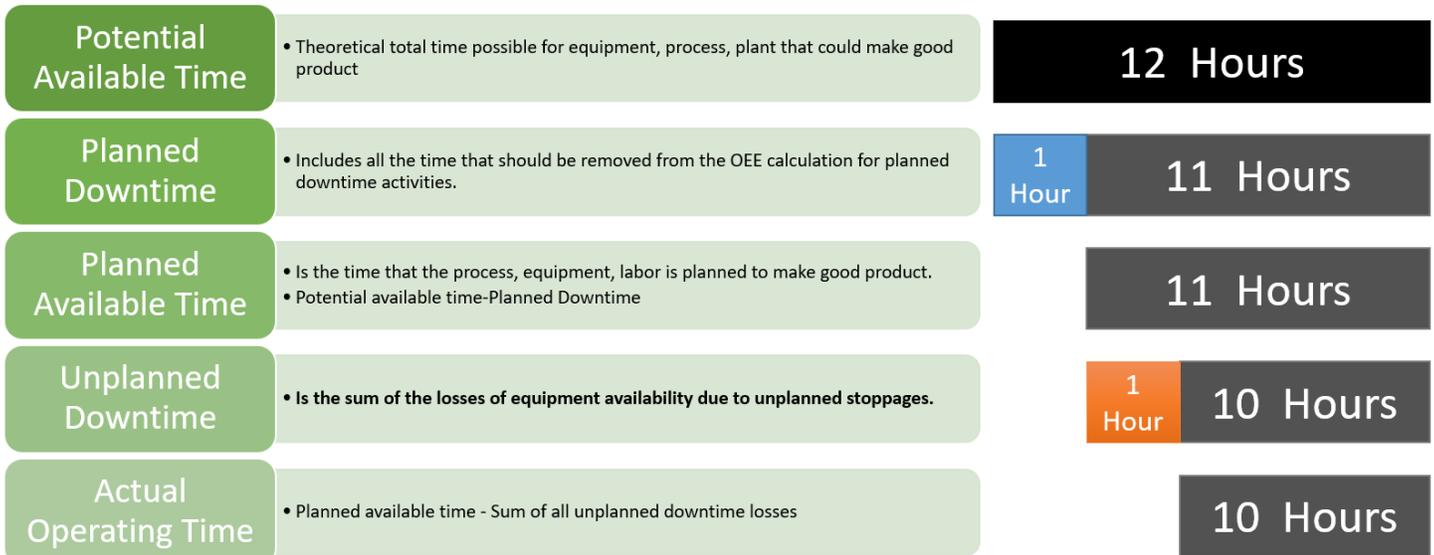
Yield – Is the machine producing good parts?

To calculate the overall effectiveness of your equipment you must calculate the performance, availability and yield of your equipment. Let's start with Availability first.

Availability

Availability Reflects capacity (and effectiveness) losses due to equipment failures, setup and adjustments. To calculate availability, you must be familiar with different time elements associated with your equipment.

Remember, **the planned downtime** is not included in the availability calculation.

Potential Available Time	• Theoretical total time possible for equipment, process, plant that could make good product	**12 Hours**
Planned Downtime	• Includes all the time that should be removed from the OEE calculation for planned downtime activities.	1 Hour **11 Hours**
Planned Available Time	• Is the time that the process, equipment, labor is planned to make good product. • Potential available time-Planned Downtime	**11 Hours**
Unplanned Downtime	• **Is the sum of the losses of equipment availability due to unplanned stoppages.**	1 Hour **10 Hours**
Actual Operating Time	• Planned available time - Sum of all unplanned downtime losses	**10 Hours**

$$Availiability = \frac{Actual\ Run\ Time\ (Actual\ Operating\ Time)}{Planned\ Run\ Time\ (Planned\ Available\ Time)}$$

$$Availiability = \frac{Actual\ Run\ Time}{Planned\ Run\ Time} = \frac{10\ Hours}{11\ Hours} = 90.9\%$$

The interpretation for this result is that, over the course of this shift, the equipment was available 91% of the time. The other 9% of the time the equipment was down or unavailable.

In terms of continuous improvement, it's important to collect data on why the equipment was not available, so that you can investigate the root cause and improve the process.

Performance

Performance reflects losses due to idling, stoppages and slower machine pace.

The two main components in Performance include your **actual output**, in comparison to your **theoretical output**.

$$Performance = \frac{Actual\ Output}{Theoretical\ Output}$$

Actual output is easy, the operations team simply reports the total quantity of units produced.

For example, let's say operations reports 11,000 units produced.

The **theoretical calculation** requires some calculation.

This is a function of the cycle time associated with the equipment, and the planned run time.

$$Theoretical\ Output = Equipment\ Speed * Planned\ Run\ Time$$

To calculate the equipment hourly capacity, we must know the equipment's cycle time. For example, if an equipment has a cycle time of 3 seconds per part, that means that the equipment should product 20 parts per minute.

3 seconds per part → 20 parts per minute → 1,200 parts per hour

Then, if the equipment runs for 10 hours, the theoretical output would be 12,000 parts.

$$Performance = \frac{Actual\ Output}{Theoretical\ Output} = \frac{11,000}{12,000} = 91.7\%$$

Yield

Yield reflects **losses due to process defects and reduced product yield.**

- Can be calculated as the ratio of **good parts/total parts built.**

This obviously requires some inspection to count the good parts, and the total parts.

$$Yield = \frac{Good\ Parts\ Produced}{Total\ Parts\ Produced}$$

Let's say that we produced a total of 11,000 parts, and only 10,000 of them are good parts.

$$Yield = \frac{Good\ Parts\ Produced}{Total\ Parts\ Produced} = \frac{10,000}{11,000} = 91\%$$

Final OEE Calculations

All of these metrics (Yield, Performance and Availability) are calculated a decimal value or a percentage, and are combined to calculate the OEE of a piece of equipment.

$$OEE = P * A * Y$$

$$OEE = 91\% * 92\% * 91\%$$

$$OEE = 76\%$$

Below you can visualize how each of the elements of loss (availability/performance and yield) contribute to the overall lost capacity of the equipment.

In terms of evaluating these results, world class OEE is generally considered to be 85%.

To improve your OEE, you should look at each component (Performance, Availability or Yield), to determine which element is contributing to the losses.

Then you can go through the DMAIC process to improve either the performance, availability or yield of the equipment.

Nowadays, several automated manufacturing pieces of equipment can be programmed to calculate OEE and track Performance, Availability and Yield.

This is data that sets the ground for a controllable environment such as Visual Factory.

Data Collection for OEE

A critical element of OEE is data collection. We must start with data to calculate availability, performance and yield.

This data collection should capture any downtime associated with breakdowns, change-overs, minor stoppages along with quality losses due to defects.

With this information, you can calculate the OEE for your equipment, which in turn should highlight opportunities for improvement.

Practice Exam for Overall Equipment Effectiveness

QUESTIONS

1. **In OEE, we calculate the performance of the equipment by comparing?**
    - Actual Run Time versus Planned Run Time
    - Good Parts versus Total Parts Produced
    - Actual production output against the theoretical production output
    - Actual Run Time versus the theoretical run time

2. **What is the OEE value for process that has a Performance, Availability and Yield of 92%, 88% and 96%, respectively?**
    - 82.3%
    - 77.7%
    - 75.5%
    - 72.4%

3. **You've been tasked with calculating the OEE of your production equipment and you want to calculate the availability of that equipment, what data must you collect to complete this calculation??**
    - Good Parts versus Total Parts Produced
    - Actual Run Time versus Planned Run Time
    - Actual production output against the theoretical production output
    - Actual Run Time versus the theoretical run time

4. **What does TPM stands for?**
    - Total Preventive Maintenance
    - Total Productive Maintenance
    - Total Priority Maintenance
    - Total Primary Maintenance

5. **What is the performance of a process that has a cycle time of 10 seconds per part and was able to produce 3800 parts after 11 hours of actual production run time?**
    - 91%
    - 92%
    - 93%
    - 96%

6. **You run a 12-hour shift, with 1 hour of planned downtime for breaks and lunches. You record 60 minutes of downtime due to a lack of material and equipment maintenance. What is the availability for this process?**
   - 87%
   - 89%
   - 91%
   - 93%

7. **What are the 3 elements of OEE?**
   - Performance, Availability, Yield
   - Performance, Availability, Downtime
   - Cycle time, Downtime, Uptime
   - Process time, Uptime, Downtime

8. **What is the yield for a process that produces 3500 good parts out of 3800 total built?**
   - 95%
   - 91%
   - 89%
   - 92%

9. **What is the availability for a process that had a scheduled planned time of 12.5 hours and 1.5 hours of unscheduled downtime?**
   - 87%
   - 88%
   - 89%
   - 90%

10. **You run a 10-hour shift, with 90 minutes of planned downtime for breaks and lunches. You record 30 minutes of downtime due to a lack of material and equipment maintenance. What is the availability for this process?**
    - 91%
    - 94%
    - 97%
    - 99%

11. **What does OEE stands for?**
- Overall Equipment Efficiency
- Optimal Employee Effectiveness
- Overall Equipment Effectiveness
- Optimal Equipment Efficiency

12. **You've been tasked with calculating the OEE of your production equipment and you want to calculate the yield of that equipment, what data must you collect to complete this calculation??**
- Good Parts versus Total Parts Produced
- Actual run time versus planned run time
- Total parts compared to the planned run time
- Good parts compared to customer demand

13. **When thinking about the three elements of OEE, which one of them most closely aligns with one seven forms of waste:**
- Performance
- Availability
- Yield
- Output

14. **What is the performance of a process that has a cycle time of 5 seconds per part and was able to produce 7000 parts after 10 hours of actual production run time?**
- 91%
- 97%
- 93%
- 99%

15. **What is the yield for a process that produces 5,500 good parts out of 7,000 total built?**
- 63%
- 71%
- 78%
- 68%

SOLUTIONS

1. **In OEE, we calculate the performance of the equipment by comparing?**
   - Actual Run Time versus Planned Run Time
   - Good Parts versus Total Parts Produced
   - **Actual production output against the theoretical production output**
   - Actual Run Time versus the theoretical run time

$$Performance = \frac{Actual\ Output}{Theoretical\ Output}$$

2. **What is the OEE value for process that has a Performance, Availability and Yield of 92%, 88% and 96%, respectively?**
   - 82.3%
   - **77.7%**
   - 75.5%
   - 72.4%

$$Overall\ Equipment\ Effectiveness\ (OEE) = Performance * Availability * Yield = 92\% * 88\% * 96\% = 77.7\%$$

3. **You've been tasked with calculating the OEE of your production equipment and you want to calculate the availability of that equipment, what data must you collect to complete this calculation??**
   - Good Parts versus Total Parts Produced
   - **Actual Run Time versus Planned Run Time**
   - Actual production output against the theoretical production output
   - Actual Run Time versus the theoretical run time

$$Availiability = \frac{Actual\ Run\ Time}{Planning\ Run\ Time}$$

4. **What does TPM stands for?**
   - Total Preventive Maintenance
   - **Total Productive Maintenance**
   - Total Priority Maintenance
   - Total Primary Maintenance

5. **What is the performance of a process that has a cycle time of 10 seconds per part and was able to produce 3800 parts after 11 hours of actual production run time?**
   - 91%
   - 92%
   - 93%
   - **96%**

$$10\ seconds\ per\ part = 6\ parts\ per\ minute = 360\ parts\ per\ hour\ (Theoretical\ Output)$$

$$Performance = \frac{Actual\ Output}{Theoretical\ Output} = \frac{3800}{11\ hours * 360\ parts\ per\ hour} = \frac{3800\ parts}{3960\ parts} = 95.9\%\ or\ 96\%$$

6. You run a 12-hour shift, with 1 hour of planned downtime for breaks and lunches. You record 60 minutes of downtime due to a lack of material and equipment maintenance. What is the availability for this process?
   - 87%
   - 89%
   - **91%**
   - 93%

$$Availiability = \frac{Actual\ Run\ Time}{Planning\ Run\ Time} = \frac{10\ Hours}{11\ Hours} = 91\%$$

7. What are the 3 elements of OEE?
   - **Performance, Availability, Yield**
   - Performance, Availability, Downtime
   - Cycle time, Downtime, Uptime
   - Process time, Uptime, Downtime

$$Overall\ Equipment\ Effectiveness\ (OEE) = Performance * Availability * Yield$$

8. What is the yield for a process that produces 3500 good parts out of 3800 total built?
   - 95%
   - 91%
   - 89%
   - **92%**

$$Yield = \frac{Good\ Parts\ Produced}{Total\ Parts\ Produced} = \frac{1850}{2000} = 92\%$$

9. What is the availability for a process that had a scheduled planned time of 12.5 hours and 1.5 hours of unscheduled downtime?
   - 87%
   - **88%**
   - 89%
   - 90%

$$Availiability = \frac{Actual\ Run\ Time}{Planning\ Run\ Time} = \frac{12.5 - 1.5}{12.5} = \frac{11}{12.5} = 88\%$$

10. You run a 10-hour shift, with 90 minutes of planned downtime for breaks and lunches. You record 30 minutes of downtime due to a lack of material and equipment maintenance. What is the availability for this process?
    - 91%
    - **94%**
    - 97%
    - 99%

$$Availiability = \frac{Actual\ Run\ Time}{Planning\ Run\ Time} = \frac{Planned\ Run\ Time\ (8.5) - Actual\ Downtime\ (0.5)}{Total\ Time\ (10) - Planned\ Downtime\ (1.5)} = \frac{8\ Hours}{8.5\ Hours} = 94\%$$

11. What does OEE stands for?

- Overall Equipment Efficiency
- Optimal Employee Effectiveness
- **Overall Equipment Effectiveness**
- Optimal Equipment Efficiency

12. You've been tasked with calculating the OEE of your production equipment and you want to calculate the yield of that equipment, what data must you collect to complete this calculation??

- **Good Parts versus Total Parts Produced**
- Actual run time versus planned run time
- Total parts compared to the planned run time
- Good parts compared to customer demand

$$Yield = \frac{Good\ Parts\ Produced}{Total\ Parts\ Produced}$$

13. When thinking about the three elements of OEE, which one of them most closely aligns with one seven forms of waste:

- Performance
- Availability
- **Yield**
- Output

The **yield** of your equipment directly aligns with the **"Defects"** form of waste.

14. What is the performance of a process that has a cycle time of 5 seconds per part and was able to produce 7000 parts after 10 hours of actual production run time?

- 91%
- **97%**
- 93%
- 99%

$$5\ seconds\ per\ part = 12\ parts\ per\ minute = 720\ parts\ per\ hour\ (Theoretical\ Output)$$

$$Performance = \frac{Actual\ Output}{Theoretical\ Output} = \frac{7,000}{10\ hours * 720\ parts\ per\ hour} = \frac{7,000\ parts}{7,200\ parts} = 97.2\%\ or\ 97\%$$

15. What is the yield for a process that produces 5,500 good parts out of 7,000 total built?

- 63%
- **71%**
- 78%
- 68%

$$Yield = \frac{Good\ Parts\ Produced}{Total\ Parts\ Produced} = \frac{5000}{7000} = 71\%$$