MAINTENANCE AND RELIABILITY BODY OF KNOWLEDGE

MANUFACTURING PROCESS RELIABILITY GUIDELINE

2.0 Understanding OEE

The Society for Maintenance and Reliability Professionals (SMRP) has developed standard definitions for metrics used in the industry. These metrics were created by SMRP's Best Practices Committee using a rigorous development process that included an initial draft, project manager review and edit, subcommittee review and edit, Web review (public review and comment), harmonization (with other global metrics), validation (pilot implementation and verification), full committee review and edit, and final edit and format prior to publication.

For further information about SMRP and the Best Practices Committee, please visit www.smrp.org or contact Al Poling, SMRP Technical Director at apoling@smrp.org.

2.0 Understanding OEE

Guidelines provide additional information or further clarification on component terms used in SMRP Best Practice Metrics. This guideline is for Overall Equipment Effectiveness (OEE). This guideline is not intended to be a thorough review of OEE but rather an explanation on how OEE is defined as a SMRP best practice metric.

A. DEFINITION

Overall Equipment Effectiveness (OEE) is a metric for measuring how well a process is operating by evaluating the three major process components; availability, performance efficiency (rate/speed) and quality. The process can be a single piece of equipment, a manufacturing cell, a production line or a plant.

OEE takes into account equipment availability, how efficiently the equipment performs and the quality of the products produced.

OEE = Availability × Performance Efficiency × Quality

B. PURPOSE

The purpose of OEE is to identify sources of waste and inefficiencies or process losses that reduce availability (downtime), performance efficiency (rate/speed) and quality (defects) so corrective action can be taken to improve the process.

C. OEE COMPONENTS:

Figure 1 below is provided as an aid to help understand the various components used to calculate OEE.

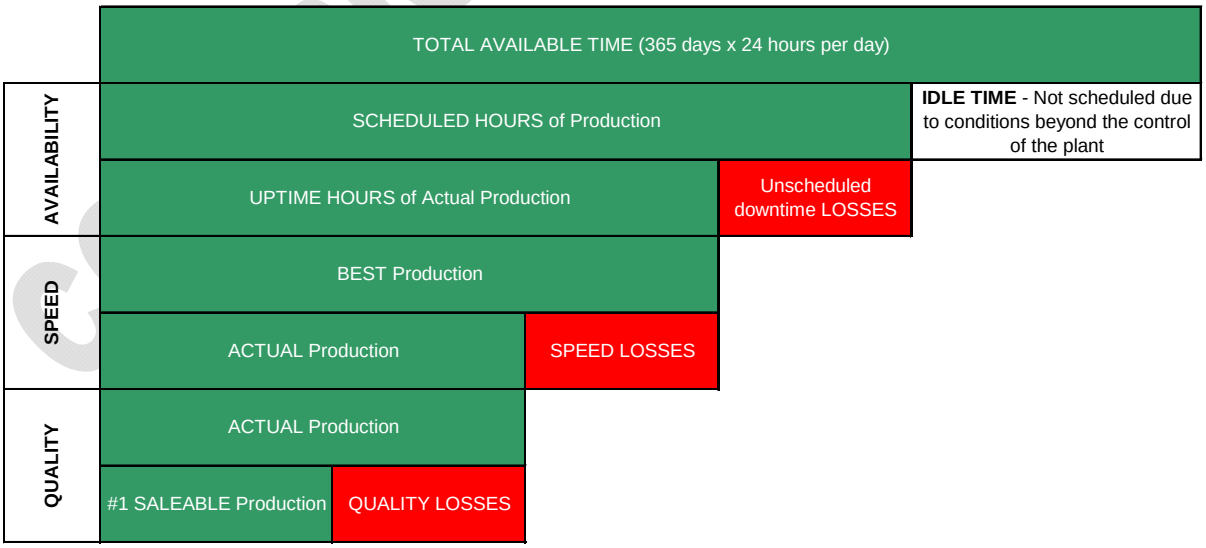

Figure 1 – OEE Components

AVAILABILITY

Availability is defined as the percentage of time that the process is actually operating (uptime) compared to when it is scheduled to operate and is calculated as follows:

Availability (%) = {Uptime (hrs) ÷ [Total Available Time (hrs) – Idle Time (hrs)]} × 100

Scheduled Hours:

Production can occur every day of the year. Total Available Time in Figure 1 above is calculated as 365 days per year, 24 hours per day, and 7 days per week. However, equipment may not be scheduled to operate at all times due to business conditions (no demand, seasonal weather conditions, holidays, test runs, etc.) which are beyond the control of the plant.

Scheduled hours are calculated by deducting these non-scheduled operating hours or Idle Time from the Total Available Time. This is done so that the plant is not penalized by conditions which it cannot control. However, if planned/scheduled maintenance is performed during time not scheduled for business reasons these planned/scheduled maintenance hours should be included in the scheduled hours.

Uptime Hours:

Uptime hours are calculated by determining the total duration of the downtime events that stopped scheduled production and subtracting this from the calculated Scheduled Hours. Typical sources of downtime losses include equipment failures, changeover/set-up time, planned/scheduled maintenance, operator shortages and related conditions.

PERFORMANCE EFFICIENCY (RATE/SPEED)

Performance efficiency (rate/speed) is defined as the percentage of Actual Run Rate/Cycle Time to the Best Run Rate/Cycle Time and can be calculated by either of the methods below.

Performance Efficiency (rate/speed) (%) = (Actual Run Rate ÷ Best Run Rate) × 100

Performance Efficiency (rate/speed) (%) = (Best Cycle Time ÷ Actual Cycle Time) × 100

Run rate is expressed in units produced per operating time and cycle time is expressed as time per unit of output. The Performance Efficiency (rate/speed) calculation considers all units produced and includes good and defective product.

The ideal run rate and ideal cycle time should be based on the equipment, cell, production line, or plant capacity as designed, and represents the maximum production rate at which the equipment can consistently and reliably operate.

The Best Run Rate and Best Cycle Time should be based on the equipment, cell, production line, or plant capacity as designed or the historic best rate (whichever is higher), and represents the maximum production rate at which the equipment can consistently and reliably operate.

The differences between the best and actual run rates or cycle times are losses due to the performance efficiency (rate/speed) of operation. These take into account all instances when the equipment, cell, production line, or plant is not operating at its best performance efficiency (rate/speed), e.g. reduced speeds, as well as idling and minor stoppages not included in the availability delays.

The Performance Efficiency (rate/speed) value cannot exceed 100% to ensure that if the best performance efficiency (rate/speed) is incorrectly specified; the impact on the OEE will be minimized.

QUALITY

Quality is defined as the percentage of "First Pass, First Time" Saleable Production to the Actual Production and can be calculated by either of the methods below.

Quality (%) = ("First Pass, First Time" Saleable Production ÷ Actual Production) × 100

Quality (%) = (Good Pieces ÷ Total Pieces) × 100

"First Pass, First Time" Saleable Production is all production that meets all customer (or internal customer) quality specifications on the first attempt, without the need for reprocessing or rework.

Actual Production is the total quantity of production produced in the given time period, regardless of its quality.

Quality losses include losses due to the product not meeting all specified quality standards as well as scrapped product and product requiring rework. Product that must be reworked is included as a loss because the goal is zero defects by making the product right the first time.

D. INTERPRETATION OF OEE

The OEE metric is open to various interpretations. When comparing and benchmarking OEE, it is important that the basis for each component is fully understood and calculated the same way. Availability is the most subjective component. The hours used or excluded for availability can have a significant effect on the value of the availability component.

A literature review and discussions with experts indicates that some definitions of OEE use total time to calculate availability. In addition, some availability calculations excluded planned maintenance downtime from the scheduled hours of production. In this guideline for OEE, SMRP has placed value on what is controllable at the plant level and only includes these controllable production times.

Equally important is the comparison of the various OEE components. The classic example in literature is improving OEE through higher availability or increased performance efficiency (rate/speed) but at the expense of quality. OEE must be evaluated in the context of the entire operation with other metrics and plant comment. OEE must be part of the plant's overall improvement process.

Lastly, OEE does not provide information on the cost benefits of maximizing the OEE components. OEE is a starting point for understanding sources of plant losses and the beginning the improvement process.

E. OTHER METRICS

The following SMRP metrics are similar in scope:

1. 2.5 Utilization Rate
2. 2.1.2 TEEP (Total Effective Equipment Performance)

F. REFERENCES

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