OEE loss waterfall with denominator discipline

Reconcile OEE factors and equivalent-time losses, retain first-pass quality accounting and choose a loss investigation without mistaking the percentage for a cause.

One percentage, three different loss questions

Fictional machine-shift record: 450 minutes were planned for production, the machine ran 360 minutes and made 600 units, of which 570 were first-pass good. The approved ideal cycle for this exercise is 0.5 minute per unit. Analyst Tessa must explain the loss picture before recommending improvement work.

Your role and the reference condition

Production analyst with operator, quality and maintenance representatives.
Normal: Time scope, count definitions and ideal cycle are explicit and consistent; the factors reconcile to good ideal time divided by planned time.
Gap: The dashboard shows a low result but the team is treating all lost time as downtime and counting reworked units as first-pass good.

Work within these conditions

1. Planned-production time and ideal cycle are supplied teaching inputs; real use requires a controlled definition.

2. Quality and performance losses below are ideal-time equivalents, not necessarily separately observed clock intervals.

Fictional teaching case. Supplied observations support the exercise; proposed actions are not verified customer results.

See how the method works

Declare the planned production time before calculating equipment effectiveness. In this exercise, 360 run minutes from 450 planned minutes gives 80% availability. Six hundred units at an ideal half-minute each represent 300 ideal minutes, giving 83.33% performance during run time. Of those units, 570 are good first time, giving 95% quality. Multiplying the three factors yields 63.33% OEE, equivalent to 285 good ideal minutes out of 450. Investigate the underlying loss rather than chasing the score. Reworked output is not first-pass good, and making unwanted inventory cannot establish better customer flow.

Time retained and loss, on one minute scale

Keep the denominators visible

A = 360 / 450 = 80%
P = (600 x 0.5) / 360 = 83.33%
Q = 570 / 600 = 95%
OEE = 285 / 450 = 63.33%

Method exhibit: Planned time, Run time, Ideal total time, Good ideal time.

Follow the evidence and decisions

Inspect the supplied case inputs

Input	Supplied value
Planned production time	450 min
Run time	360 min
Total units	600
First-pass good units	570
Ideal cycle	0.5 min/unit
Non-first-pass units	30; disposition does not change first-pass history

01 / Calculate availability

Divide 360 run minutes by 450 planned minutes to obtain 80%. The difference is 90 minutes of availability loss under the supplied time definition.

Why: The denominator must remain the agreed planned scope; removing a loss from the denominator would improve the number without improving the work.

Evidence / check: 450 = 360 + 90 minutes.

02 / Calculate performance

600 total units at 0.5 ideal minute require 300 ideal minutes. Divide 300 by 360 run minutes to obtain 83.33% performance.

Why: Performance compares ideal output time with run time; it is not another downtime subtraction.

Evidence / check: 360 minus 300 = 60 minutes performance loss equivalent.

03 / Keep first-pass quality intact

Divide 570 first-pass good units by 600 total units to obtain 95% quality. Good ideal time is 570 x 0.5 = 285 minutes.

Why: Later rework may recover product but does not undo the original failure to be good first pass.

Evidence / check: 300 minus 285 = 15 minutes quality loss at ideal time.

04 / Reconcile and route learning

Multiply 0.80 x 0.833333… x 0.95 = 0.633333…, or 63.33%. Check 285 / 450 gives the same result. Review loss events with the responsible teams before selecting an investigation.

Why: OEE locates loss categories but does not identify a failed component, prove a cause or justify maximizing every machine's output.

Evidence / check: 90 + 60 + 15 + 285 = 450 minutes; actual causes require event evidence.

Completed loss reconciliation - fictional shift

Stage / factor	Calculation	Result / loss
Availability	360 / 450	80%; 90 min loss
Performance	600 x 0.5 / 360	83.33%; 60 min equivalent
Quality	570 / 600	95%; 15 min ideal equivalent
OEE	285 / 450	63.33%
Reconcile	90 + 60 + 15 + 285	450 min total

Twenty rejected units are recovered later

The 30 non-first-pass units include 20 subsequently reworked and accepted. A colleague proposes changing first-pass good from 570 to 590.

Decision

Keep first-pass quality at 570 / 600 = 95% for this defined original pass and record rework/recovery separately. Clarify how any rework resource/time enters the relevant reporting scope.

Reasoning

Recovery changes disposition, not first-pass history. Mixing scopes can count output or time twice.

What would change the decision?

Retain the original counts, rework identities, subsequent disposition and approved time-accounting rule.

Practise with a changed case

Reconcile a different shift

New fictional record: 480 planned minutes, 400 run minutes, 800 total units, 750 first-pass good and an approved ideal cycle of 0.4 min/unit. Twenty failed units are later recovered; do not change the original first-pass count.

Input	Value
Planned / run	480 / 400 min
Total / first-pass good	800 / 750 units
Ideal cycle	0.4 min/unit
Later recovered	20; separate disposition

Your task

1. Calculate availability, performance, quality and OEE.
2. Calculate all three equivalent-time losses and reconcile to planned time.
3. Explain the effect of later recovery and one limit of the OEE interpretation.

Use the next page to record your reasoning before reading the answer.

Your practice worksheet

Reconcile a different shift

Defined time/count scope

Factors with numerator and denominator

Time waterfall and units

First-pass versus recovery record

Next loss evidence / investigation owner

Complete your reasoning before turning to the answer. Use the separate learner workbook for group practice.

Check your reasoning and transfer it

1. Availability is 400 / 480 = 83.33%; performance is 800 x 0.4 / 400 = 80%; quality is 750 / 800 = 93.75%. OEE is 62.5%, also 300 good ideal minutes /480.

2. Availability loss is 80 minutes; performance loss is 400 minus 320 = 80 minutes; quality ideal loss is 320 minus 300 = 20 minutes. These plus 300 good ideal minutes total 480.

3. The 20 later recovered units do not change 750 first-pass good. The loss categories suggest questions, not a diagnosis or proof of customer throughput improvement.

Suggested completed record

Measure	Worked result
Availability / performance / quality	83.33% / 80% / 93.75%
OEE	62.5%; 300 / 480
Losses	80 + 80 + 20 = 180 min
Reconcile	180 + 300 = 480 min
Recovery	20 separate; first-pass good remains 750

Plausible wrong turns

1. Do not add the three percentage factors or average them.

2. Equivalent quality-loss minutes are not necessarily actual rework clock minutes.

Evidence of a sound answer

1. Reconcile both OEE calculation paths.

2. Preserve first-pass definition and units.

3. Choose a specific event-data question rather than asserting a cause from the percentage.

Take the learning back to work

Commitment	Agreed follow-through
Owner	Performance-data owner with production, quality and maintenance
Record	Controlled shift loss record linked to time and unit events
Review	At loss review and after a targeted countermeasure trial
Verification evidence	Consistent definitions, reconciled counts/time and observed loss mechanisms
If unresolved	Repair data scope or investigate event records before changing targets or attributing causes.

Help someone else apply the method

Prepare

1. Native 450 > 360 > 300 > 285 waterfall
2. Blank calculation sheet
3. Calculator; first-pass/rework tokens

Minutes	Activity and coaching prompt
5	Define denominators Which time is planned, run and ideal?
8	Reconcile the worked shift Where do the 15 quality-loss minutes come from?
10	Calculate changed shift Can both OEE paths agree?
5	Debrief recovery and action What event evidence is needed before choosing a repair?

Debrief

1. Check scope before correcting a formula.
2. Make the learner label equivalent time versus observed clock time.

Individual or remote practice

Calculate factors and direct good-ideal-time ratio independently, then use their agreement as a reconciliation check.

Connect the method and check its boundaries

Before application

1. Valid ideal cycle time
2. No double-counted losses

Outside this lesson

1. High OEE is not proof of customer flow
2. Reworked units are not first-pass good

LEI: Overall Equipment Effectiveness

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Availability x performance x quality and loss categories

Method reference; original OPEX scenario and diagram are synthetic teaching content, not source case results.

Open this lesson and its visual aids