

**Quality Excellence for Suppliers of
Telecommunications Forum
(QuEST Forum)**

**TL 9000
Quality Management System
Measurements Handbook
Availability Calculation Examples**

Reliability Conversions

Conversion of the TL 9000 outage frequency and downtime measurements to other reliability measurements is as follows.

Equation 1 provides conversion from downtime (DT) expressed in minutes to system availability.

Equation 2 provides conversion from outage frequency (OF) to mean time between outages (MTBO). System availability / unavailability and MTBO are alternative expressions of system reliability found in some requirement specifications.

Equation 1

A = Availability

A = Probability that the system is operational when required

A = Up time / Total time required to be operational

$$A = (365 * 24 * 60 - DT) / (365 * 24 * 60)^1$$

$$A = (525600 - DT) / 525600$$

Using the TL 9000 Service Impact Outage Measure, where SO2 is the annual downtime due to all causes, the system availability for end user service would be:

$$A = (525600 - SO2) / 525600$$

Using the TL 9000 Network Element Impact Outage Measures, where NEO2 is the annual downtime for customer attributable outages and NEO4 is the annual downtime for product attributable events, the availability of the Network Element would be:

$$A = (525600 - (NEO2 + NEO4)) / 525600$$

U = Unavailability

U = Probability that the system is not operational when required

$$U = 1 - A$$

For five minutes per system per year of downtime, availability is 0.9999905, or "five nines," and unavailability is $1 - A = 9.5 \times 10^{-6}$. For 50 minutes of downtime, $A = 0.999905$, or "four nines," and unavailability is $1 - A = 9.5 \times 10^{-5}$.

NOTE: Availability may also be expressed as a percentage such as 99.999%

Equation 2

MTBO = Mean Time Between Outages

MTBO = Operation Time / Number of Outages

$$MTBO = (365 * 24 * 60 - DT) / (OF * 60) = \text{mean hours between outages}^1$$

$$MTBO = (525,600 - DT) / (OF * 60)$$

This calculation represents the mean (average) number of hours between system outages. Using the TL 9000 Service Impact Outage Measure, where SO1 is the annual outage frequency due to all causes, the system mean time between outages would be:

$$MTBO = (525600 - SO2) / (SO1 * 60)$$

Similarly, using the TL 9000 SONE measures,

$$MTBO = (525,600 - (NEO2 + NEO4)) / ((NEO1 + NEO3) * 60)$$

¹ The above calculations assume 24x7 system availability required.