

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

**TL 9000
Quality Management System
Measurements Handbook**

Release 5.5

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Throughout this document the term 'Measurements Handbook' refers to *TL 9000 Quality Management System Measurements Handbook, Release 5.5*, namely this volume. The term 'Requirements Handbook' refers to the latest version of the *TL 9000 Quality Management System Requirements Handbook*. The term 'ISO 9001' refers to ISO 9001:2015.

Any errors identified after printing will be posted to the TL 9000 website. See the Measurements Handbook Errata link at tl9000.org/links.html

This handbook is dedicated to Jennifer Simcox, in recognition of her many years of service both as an individual contributor and as a dedicated leader of the IGQ workgroup.

This material replaces Sections 7.1 and 8.1 in the R5.0 TL 9000 Quality Management System Measurements Handbook. It also adds Section 9.3. The combination of the existing unchanged material in the R5.0 Handbook along with the material herein constitutes the full R5.5 Handbook.

Approved and Adopted
by the
QuEST Forum
Effective

30 June 2017

Section 7 Hardware Measurements

7.0 Return Rates

7.0.1 Purpose

This section contains return rate measurements for two types of products:

- 1) products whose reliability is tracked throughout their life cycle.
- 2) products where returns or requests for replacements can only be tracked during the initial usage of the product.

7.1 Field Replaceable Unit Returns (FR)

7.1.1 General Description and Title

FR is comprised of three return rate measurements that cover the full life cycle of a product. These are:

- 1) Early Return Index (ERI) – a measure of the returns of units during the first six months after initial shipment. This is not a true return rate; see note in 7.1.3 below.
- 2) One-Year Return Rate (YRR) – return rate of units shipped seven to eighteen months prior to the reporting month.
- 3) Long-Term Return Rate (LTR) – return rate of units shipped nineteen or more months prior to the reporting month.

7.1.2 Purpose

The measurement

- provides a quantification of the quality of the product as initially received by all customers including equipment manufacturers and/or end-customers, and during subsequent in-service operations,
- determines areas needing corrective action or most likely benefiting from continual improvement activity, and
- provides input data needed to calculate equipment life cycle costs.

7.1.3 Applicable Product Categories

This measurement applies to product categories as shown in the Measurement Applicability Table (Normalization Units), Appendix A, Table A-2. In general, these measurements apply to

- any system comprised of field replaceable units (FRUs),
- a system which is a FRU, or
- the individual FRUs.

The FR measurements apply to equipment whose reliability needs to be tracked throughout its entire life cycle. These measurements apply equally to any FRU shipped either in a system or separately. These measurements are not intended for items shipped in bulk such as

- cable and optical fiber, or
- mechanical hardware such as metallic connectors, optical connectors, conduit, mounting hardware, labels, etc.

NOTE: The Early Return Index is used as a surrogate for the installation reject rate, including Dead On Arrivals (DOAs), because the quantity of units shipped is known whereas the number of units actually installed is not readily determined. The Early Return Index measurement for items warehoused outside of the organization's control for an extended period before placement in service may not accurately reflect the actual returns for product in service. This may also be true of items sold through distributors.

NOTE: Early in a product's life, when shipments are low, the ERI may be unstable month-to-month and higher due to any returns against small volumes. This may also occur as the product matures and shipments begin to decline.

NOTE: Long-Term Return Rates may become inaccurate for older products as units are taken out of service without the knowledge of the organization.

NOTE: The return rate for low cost items after the expiration of any warranty period is likely to be inaccurate if purchasing a new item is no more expensive than repairing the failed one.

7.1.4 Detailed Descriptions

a) Terminology

The Glossary includes definitions for

- Afactor (Annualization Factor)
- Basis Shipping Period
- Field Replaceable Unit
- Return

b) Counting Rules

The following rules shall apply when counting returns and shipments for the return rate measurements:

- 1) All returns except as noted in 7.1.4 c), Counting Rule Exclusions, are counted.
- 2) Only returns from the basis shipping period corresponding to the specific measurement shall be counted.
- 3) Customer returns are counted when received by the selling organization or third-party repair/logistics agency.
- 4) The organization shall document the method of determining which of the returns are from which of the corresponding original basis shipping period. This determination shall be based on the initial shipment to the field of the individual returned unit. This may be determined by
 - serialized shipment records of the returned unit,
 - shipment or warranty start date code marked on the unit,
 - shipment date associated with a customer order, or
 - manufactured date associated with a lot number.

NOTE: The last method requires the determination of an accounting for a standard time delay between the date of manufacture and shipment.

- 5) Units that fail due to a problem corrected by a recall before they can be rotated are counted as returns.

- 6) Units damaged during normal shipping or handling where the container is not damaged due to abnormal shipping conditions are counted as returns.
 - 7) No trouble found units, that is, returned units determined by the organization to meet its specifications, are counted as returns.
 - 8) The date of original shipment to the end customer shall be used for determining the basis shipping period.
 - 9) Returns and shipments should only be reported once when submitting data to the TL 9000 Administrator. When a unit is used in more than one product and those products span multiple product categories, it may not be practical or possible to identify with which product, and therefore which product category, a return or shipment is associated. In such cases, the organization should, if possible, apportion the returns and shipments appropriately among all product categories in which the unit is used. If accurate apportioning is not possible, the organization may apply all the data for that unit to the most appropriate product category.
 - 10) If a returned product contains multiple FRUs, each individual FRU shall be counted separately.
- c) Counting Rule Exclusions
- Exclude from the return and shipment counts:
- 1) working or untested units returned as part of a formal rotation or recall program,
 - 2) units damaged during shipping or while in service due to vehicular accidents, water leakage, electrical spikes outside of specified limits, misuse by the end user, or other environmental factors outside those conditions for which the equipment was designed,
 - 3) items that were ordered in error, ordered in excess, consignment items, or canceled orders,
 - 4) returns from laboratory systems or First Office Application (FOA) systems,
 - 5) units returned voluntarily by the customer to install modifications to obtain optional features or functionality or to reconfigure the unit for another use, such as a change in operating frequency,
 - 6) units that have been permanently removed from service by the customer, and
 - 7) shipments to customers for products where
 - defective units are not returned for repair by the customer or
 - units are repaired by a third party or the customer and the return data is not made available after solicitation by the organization.
- d) Calculations and Formulas
- 1) The FR measurements are annualized and shall be calculated monthly as shown in Table 7.1-2.
 - 2) Early Return Index (ERI) – The ERI in month n measures the rate of return of product during months n-6 through n-1. In addition to returns from months n-6 through n-1, returns from units shipped during the current month (n) are also included. This basis shipping period is assumed to represent the rate of return of the product during installation, turn-up, and testing. Any shipments in the month are deliberately

excluded as only a few units are actually put into use during the month they are shipped.

- 3) One-Year Return Rate (YRR) – The YRR measures the rate of return of product shipped seven to eighteen months prior to the reporting month. It is based on the number of returns during the month from the population of units shipped seven to eighteen months prior to the month. This basis shipping period is assumed to represent the operation during the early life period.
- 4) Long-Term Return Rate (LTR) – The LTR measures the rate of return of product shipped nineteen or more months prior to the reporting month. It is based on the number of returns during the month from the population of units shipped more than eighteen months prior to the month. This rate represents the mature return rate of the product.

Table 7.1-1 FR Notation

Identifier	Definition
NU	Normalization Unit (NU) from the Measurement Applicability Table (Normalization Units), Appendix A, Table A-2
Afactor	Number of calculation periods in a year
FRri	Number of returns from the ERI basis shipping period
FRry	Number of returns from the YRR basis shipping period
FRrt	Number of returns from the LTR basis shipping period
FRsi	Number of FRUs shipped during the ERI basis shipping period
FRsy	Number of FRUs shipped during the YRR basis shipping period
FRst	Number of FRUs shipped during the LTR basis shipping period

Table 7.1-2 FR Measurement Identifiers and Formulas

Identifier	Title	Formula	Note
ERI	Early return index	$100 \times \text{Afactor} \times (\text{FRri} / \text{FRsi})$	% per year
YRR	One-year return rate	$100 \times \text{Afactor} \times (\text{FRry} / \text{FRsy})$	% per year
LTR	Long-term return rate	$100 \times \text{Afactor} \times (\text{FRrt} / \text{FRst})$	% per year

- e) Reported Data and Format
 - 1) Monthly data shall be reported per the frequency and method noted in Sections 3.5.2 and 4.2.2 of this document.
 - 2) The FR measurement shall be reported for each month and each product category with data elements, or equivalent as defined by the TL 9000 Administrator, shown in Table 7.1-3.

Table 7.1-3 FR Data Table

Identifier	Value
MeasurementID	FR
Fra	Afactor
FRri	Number of returns from the ERI basis shipping period
FRry	Number of returns from the YRR basis shipping period
FRrt	Number of returns from the LTR basis shipping period
FRsi	Number of FRUs shipped during the ERI basis shipping period

FRsy	Number of FRUs shipped during the YRR basis shipping period
FRst	Number of FRUs shipped during the LTR basis shipping period

7.1.5 Sources of Data

As a part of its data systems, the organization should have available the information listed above needed to calculate these measurements. This includes:

- a) FRU shipping records – These are required to determine which units received for repair are early returns, one-year returns, or long-term returns and to determine the respective populations.
- b) FRU return records – The organization's return records shall include the identifiers necessary to match returns with shipment records.
- c) Third-party return records – Units returned to a third-party repair agency by the customer or repaired by the customer itself shall be included in the return counts when available. To have accurate measurements, it is necessary for the customer to include a contractual requirement of their third-party repair agencies to supply this data to the original equipment manufacturers.

7.1.6 Examples

Examples for applying the FR measurement are located on the TL 9000 website (tl9000.org/links.html).

Section 8 **Software Measurements**

8.0.1 Purpose

Software measurements track

- the effectiveness of an organization’s software fix process by measuring the ratio of defective fixes to the number of fixes delivered, and
- the maintenance effort associated with the deployed software by measuring the incidence of customer found software problems associated with the products developed by the organization.

The measurements in this section are provided to aid the customer and the organization in understanding the quality of software releases, the quality of software fixes, the efforts involved in the installation and maintenance of the software release, and the risk of introducing a software fault, for example, a defective fix, into their network. For the purpose of these measurements, maintenance covers the activities to correct defects to the generally available release.

The treatment of firmware for use in software measurements is based on how the firmware is maintained in the field. If the firmware can be changed by means of a download, and without returning to the factory/repair facility for such download, then the firmware is to be treated as software and all applicable software measurements apply. If changes require rotation/replacement of hardware, specialized equipment for field installation of the new firmware, or a return to factory/supplier/repair facility, the firmware is treated as hardware for the purposes of software measurements and the software measurements do not apply. Please note the above has no bearing on the applicability of any requirement in the *TL 9000 Quality Management System Requirements Handbook* ^[5] applicable to the process used to develop the firmware.

8.1 Software Fix Quality Measurement (SFQ)

8.1.1 General Description and Title

The Software Fix Quality (SFQ) measurement is used to assess the effectiveness of an organization’s software fix processes.

This measurement is used to evaluate the defective fix percentage with a goal of minimizing customer risk of failure when introducing fixes to an in-service software release.

8.1.2 Purpose

Software Fix Quality is the percentage of software fixes that are determined to be defective. Customers are concerned with the quality of the software fixes and the number of changes the organization makes during the product lifecycle. Software Fix Quality quantifies the rate at which fixes are found defective during their initial 12 months of deployment.

8.1.3 Applicable Product Categories

This measurement applies to product categories as indicated in Measurement Applicability Table (Normalization Units), Appendix A, Table A-2.

8.1.4 Detailed Description

a) Terminology

The Glossary includes definitions for

- Afactor (Annualization Factor)
- General Availability Phase
- Official Fix
- Retirement Phase
- Software Fix

b) Counting Rules

- 1) Each individual fix delivered through software shall be counted whether delivered individually or in a package.
- 2) Fixes to correct defects found in any generally available software release, whether found internally or externally in a production or test environment, are counted.
- 3) When fixes are packaged together, only the fixes that are identified as defective shall be counted as defective.
- 4) Each individual fix is counted once regardless of the number of times that fix is replicated across machines/processors at customer site(s).
- 5) If several separate fixes are provided to affect a single change, such as covering different parts of the code, and these fixes are separately identifiable to the customer, they shall each be counted separately.
- 6) Fixes addressing the same or similar defects across multiple releases are counted separately.
- 7) A fix is counted on General Availability of the fix. For example, fixes are counted when
 - on-site and ready for system installation,
 - available for downloading by the customer to the site, or
 - shipped to the customer.
- 8) A defective fix meets one or more of the following criteria:
 - Within the first 12 months of the fix release date:
 - the fix cannot be installed or
 - the fix does not correct the intended problem or
 - the fix is withdrawn because of a potential or actual problem with the intended fix.
 - Within the first 6 months of fix release date, there is a critical or major problem that is a side effect found to be attributable to the fix.
- 9) A defective fix shall be counted in the month during which the fix was found defective by the organization.

c) Counting Rule Exclusions

- 1) Fixes associated with problems found in software that is not yet available in any generally available release are not counted.
- 2) If a fix is found to be defective later than 12 months after its release date then it shall not be counted as a defective fix.

d) Calculations and Formulas

- 1) The SFQ measurement is calculated monthly as shown in Table 8.1-2.

- 2) The SFQ measurement measures the rate at which fixes are found defective during their initial 12 months of deployment. The numerator shall be the number of fixes that were found defective during the reporting month. The denominator shall be the sum of the number of fixes released during the reporting month and the preceding 11 months.

Table 8.1-1 SFQ Notation

Identifier	Definition
Afactor	Number of calculation periods in a year
DFc	Number of software fixes found defective during the month
Fc	Total number of software fixes that became available for general release during the 12 month period leading up to and including the report month

Table 8.1-2 SFQ Measurement Identifiers and Formulas

Identifier	Title	Formula	Note
SFQ	Software fix quality	$100 \times \text{Afactor} \times (\text{DFc} / \text{Fc})$	% defective per year

- e) Reported Data and Format
- 1) Monthly data shall be reported per the frequency and method noted in Sections 3.5.2 and 4.2.2 of this document.
 - 2) The SFQ measurements shall be reported for each month and each product category with data elements, or equivalent as defined by the TL 9000 Administrator, shown in Table 8.1-3.

Table 8.1-3 SFQ Data Table

Identifier	Value
MeasurementID	SFQ
Fa	Afactor
DFc	Number of software fixes found defective during the month
Fc	Total number of software fixes that became available for general release during the 12 month period leading up to and including the report month.

- 3) The organization shall have the capability to provide the cumulative number of software fixes by release. These data are not reported to the MRS.
- 4) The SFQ measurement shall be reported by counting the defective software fixes and the total available software fixes of all in-service software releases.
- 5) The SFQ measurement is unique because when fixes are declared generally available, it is up to the customer to choose whether or not to install the fix. Therefore, there is no customer specific reporting required due to the complexity of the SFQ measurement.

8.1.5 Sources of Data

Customers shall provide feedback to the organization on unsuccessful results of any customer installed software fixes. Organizations shall collect all data necessary to report these measurements to the TL 9000 Administrator.

8.1.6 Examples

Examples for applying the SFQ measurement are located on the TL 9000 website (<http://tl9000.org/links.html>).

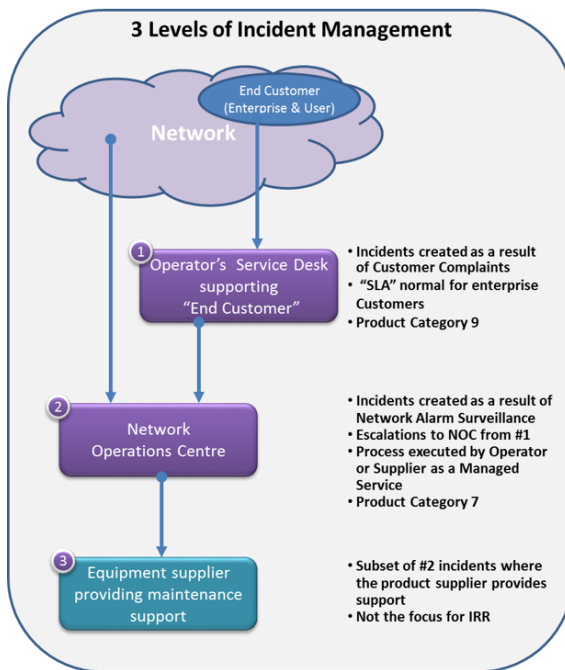
9.3 Incident Restore Rate (IRR)

9.3.1 Description and Title

Incident Restore Rate measures the organization’s overall responsiveness to incidents. The Incident Restore Rate applies to the restoration to normal service operation and its normal functionality as quickly as possible in response to incidents. As part of normal network and service operations management, incidents can be classified as required and agreed between the customer and the organization, normally with a formal agreement (Contract, Underpinning Contract Terms, Operating Level Agreement (OLA), Service Level Agreement (SLA)) because the focus is on measuring the response performance to different agreements or internal target thresholds or the default targets where no formal target exists.

IRR is a different measurement to FRT in that not all incidents will be problem reports and restoration can be effected by temporary fixes (see counting rules below). Incident restoration is normally measured in timescales of hours.

Problem reporting is often measured in days and weeks timescales.



The goal of the Incident Restore Rate measurement is to support the improvement of the Incident Management process which restores normal service operation as quickly as possible and minimizes the impact on business operations, thus ensuring that the best possible levels of service quality and availability are maintained for normal service operation. The measurement reflects restored performance to agreed Service Levels or Targets. It is focused on the Operator’s Customer Support Desk and Network Operations Centre (NOC) managed by an Operator or a Supplier performing a Managed Service as per Figure 9.3-1.

Figure 9.3-1: Levels of Incident Management

Based on the measurement taken and the teams involved in restoration of service, it is possible to measure the end-to-end (E2E) IRR. The focus of this measurement is from the Operator’s Customer Service desk or NOC perspective. The E2E time to restore the service includes any time interval associated with the time spent by a supplier to support the restoration as defined within the contractual agreement e.g. Network Operations Centre, Field Operations, Third Party Technical Support or Suppliers.

9.3.2 Purpose

This measurement is used to quantify the responsiveness to incidents and to facilitate prompt restoration of normal service operation.

9.3.3 Applicable Product Categories

This measurement applies to product categories indicated in Measurement Applicability Table (Normalized Units), Appendix A, Table A-2.

NOTE: IRR is a required measurement for the categories for which it is applicable. It cannot be declared exempt for those categories.

9.3.4 Detailed Description

a) Terminology

The Glossary includes definitions for

- Restore Time
- Incident Classification

b) Counting Rules

- 1) Incidents which are worked through an Incident Management process that are originated by a customer or notified via network surveillance processes shall be included.
- 2) The start of the interval for calculating Incident Restore Rate shall be the date and time when reported by a customer or when an incident is notified via network surveillance processes, whichever comes first. Within the organization, the start time of the incident remains unchanged regardless of any subsequent change in severity.
- 3) The end of the interval for calculating Incident Restore Rate shall be the date and time when service or functionality has been returned to normal service operation as agreed or specified by the SLA / contract. Restoration does not necessarily include resolution of the underlying problem.

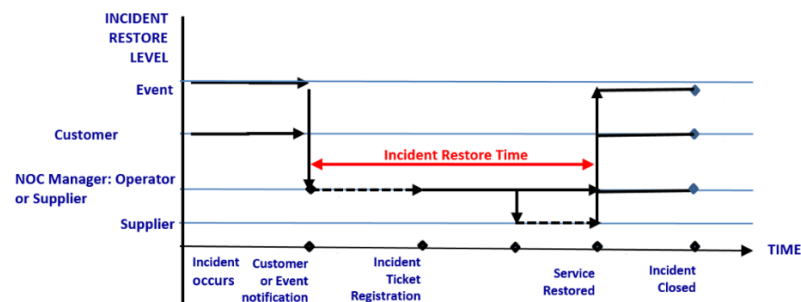


Figure 9.3-2: Timestamps of Incident Restore Time

- 4) If the customer later rejects the return to standard quality operation as incomplete or causing side effects, the incident report shall be re-classified as open and all times are aggregated as part of the original incident. All intervening time shall be included in determining on-time incident closure.

- 5) For Incident Restore Rate, incidents are counted once, ONLY in the month they are due to be restored and not in the month they are fixed or restored.
- 6) All times will be counted unless there is an agreement or contract where specific areas of excessive delay may be discounted. By the nature of an incident restore, there is a need for the supplier and/or operator to work together with the customer to meet the necessary deadlines.

NOTE: Any agreement or contract should outline areas where excessive delays should be discounted from the IRR measure, e.g. where a third party causes a delay outside the control of the supplier, or in the case of events where the customer specifically requests a delay or reschedule of incident restore action, such as periods (weekend or holidays) when access to premises cannot be given.

- 7) If an incident misses its restore due date and time when required by an agreement, it is not counted in Incident Restore Rate again – even if a new due date is negotiated.
- c) Counting Rule Exclusions
- 1) The IRR measurement shall exclude the following because they do not meet the definition of TL 9000 incidents:
 - a) an incident report determined to represent an Information Request (IR), which need not be documented by the customer to the organization;
 - b) an incident report determined to be a feature request by agreement between the organization and customer;
 - c) an incident report related to use of the product in a manner not defined in the specification of the product by agreement between the organization and customer;
 - 2) Incidents which are closed out through the initial operator contact center without the need for any escalation to the Incident Management Process are not included in this measurement.
 - 3) The Incident Restore Rate measurement is intended to quantify the organisation's performance in restoring normal service operations per the agreement specified in the SLA. By default, all delays are included in the Incident Restore Rate, however specific causes of delays which are outside the control of the organization are excluded if documented in the SLA. The organization shall keep records of such delays with specific start and stop times as determined by the organization. Examples of these types of excessive delays are:
 - a) Inevitable, unpredictable, and unreasonably severe event caused by natural forces without any human interference, and over which an insured party has no control, such as an earthquake, flood, hurricane, lightning, and snowstorm.
 - b) Some components of the measurement may be excluded based on contractual definitions (agreements) or dependent on scope accountability, if they exist, e.g. incidents triggered by planned work may be excluded, if agreed in the contract or agreement, if restored within the planned work activity time window. If an incident is active upon completion of the planned work activity time window, then the

incident becomes unplanned and becomes part of the standard incident management process as well as the IRR measure.

- c) In certain cases, restoration of normal service is dependent on another organization or third party where a pre-existing SLA has or has not been defined. The time associated with the work carried out by the other organization / third party is included in IRR unless the agreement specifies how these cases are handled.
- d) Calculations and Formulas
 - 1) The Incident Restore Rate measurement is calculated monthly as shown in Table 9.3-2. Incidents that were restored on time are those that were restored by the due restore target reference time as defined in the SLA.
 - 2) The Incident Restore Target will normally be specified in the SLA. If no formal SLA exists then internal targets may be used. If no internal targets are used, then a default shall be used of 2 hours for a central office or 4 hours for a remote office.
 - 3) In cases where there are no incidents due to be closed during the monthly calculation period, the Incident Restore value is 100%.

Table 9.3-1 IRR Notation

Identifier	Definition
Irc	Number of incidents restored on time
Ird	Number of incidents due to be restored

Table 9.3-2 Restore Measurement Identifiers and Formulas

Identifier	Title	Formula	Note
IRR	Incident Restore Rate	$100 \times (Irc / Ird)$	% closed on time

- e) Reported Data and Format
 - 1) Monthly data shall be reported per the frequency and method noted in Sections 3.5.2 and 4.2.2 of this document.
 - 2) The IRR measurement shall be reported for each month and each product category with data elements, or equivalent as defined by the TL 9000 Administrator, shown in Table 9.3-3.
 - 3) The organization shall keep track of known errors.

Table 9.3-3 IRR Data Table

Identifier	Value
MeasurementID	Incident Restore Rate (IRR)
Irc	Number of incidents restored on time
Ird	Number of incidents due to be restored

9.3.5 Sources of Data

Data for the Incident Restore Rate measurement are derived from information provided by customers and from analysis by the organization's ticket management system and the following:

- a) Customers
 - 1) confer with the organization to establish a due threshold time for incident report restoration, and
 - 2) agree with incident report restoration decisions.
- b) Organizations
 - 1) track incidents, their severity, the due threshold time, and actual restoration time, and
 - 2) count on-time restoration of incidents, and compute the measurements per the stated rules.

9.3.6 Examples

Examples for applying the IRR measurement are located on the TL 9000 website (tl9000.org).

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