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

**TL 9000
Quality Management System**

Measurements Handbook

FR Examples

R5.0 and Earlier

7 FR Examples

7.1 Basic Calculations

Example 7.1-1

Each month the reporting organization reports the FRU return measures for the month based on all returns received during the month and the field population of units at the end of the prior month. The returns and population numbers are split into three separate groups depending on the age of the units. As an example, suppose during January 2010 there were a total of 355 returns received out of a total population of 186,914 units. Of the 355 returns, 153 were shipped during the month or the prior six months. In other words, 153 of the units were shipped on or after July 1, 2009. Likewise, 163 of the returns were 7 to 18 months old having originally been shipped between July 1, 2008 and June 30, 2009. This leaves 39 units returned out of the long-term population, which are units shipped prior to July 1, 2008. Similarly the total population numbers are split into the three age groups. For purposes of this example, let us set these at 57,288, 99,626, and 30,000 units respectively for the ERI, YRR, and LTR subsets of the population. In tabular form the data for the month is:

	ERI	YRR	LTR	Total
Returns	153	163	39	355
Population	57,288	99,626	30,000	186,914

The resulting calculations for the month are

$$\begin{aligned}
 \text{Early Return Index} &= 100 \times 12 \times \frac{\text{Returns from units shipped Jul-09 through Jan-10}}{\text{Total shipments for Jul-09 through Dec-09}} \\
 &= 100 \times 12 \times \text{FRri/FRsi} \\
 &= 100 \times 12 \times 153/57288 \\
 &= 3.20\%
 \end{aligned}$$

$$\begin{aligned}
 \text{One-Year Return Rate} &= 100 \times 12 \times \frac{\text{Returns of units shipped Jul-08 through Jun-09}}{\text{Total Shipments for Jul-08 through Jun-09}} \\
 &= 100 \times 12 \times \text{FRry/FRsy} \\
 &= 100 \times 12 \times 163/99626 \\
 &= 1.96\%
 \end{aligned}$$

$$\begin{aligned}
 \text{Long-Term} & \quad \text{Returns from shipments prior to Jul-08} \\
 \text{Return} & = 100 \times 12 \times \frac{\quad}{\quad} \\
 \text{Rate} & \quad \text{Total Shipments prior to Jul-08} \\
 & = 100 \times 12 \times \text{FR}_t / \text{FR}_s \\
 & = 100 \times 12 \times 39 / 30000 \\
 & = 1.56\%
 \end{aligned}$$

More detailed examples using these same numbers are shown in 7.2 and 7.3 below.

7.2 Examples Without Normalization

1) Early Return Index, One-Year Return Rate and Long-Term Return Rate

In a given reporting month, all returns are divided into three groups according to when they were shipped. For example, for the reporting month of January 2010, returns are divided into the following groups as illustrated in Figure 7.2-1.

- Early Returns from units shipped in the period from July 1, 2009, through January 31, 2010.
- One-Year Returns from units shipped in the period from July 1, 2008 through June 30, 2009.
- Long-Term Returns from units shipped prior to July 1, 2008.

2009												2010
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
One-Year Returns						Early Returns						

2007	2008											
DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Long-Term Returns							One-Year Returns					

Figure 7.2-1 Shipping Date Groups for Computing Return Rates

Table 7.2-2 Example Returns

		Returns from Shipment Population by Month Received											
Shipment Month	Number Shipped	Jan 2010	Feb 2010	Mar 2010	Apr 2010	May 2010	Jun 2010	Jul 2010	Aug 2010	Sep 2010	Oct 2010	Nov 2010	Dec 2010
Jun-08 & before	30000	39	44	42	46	31	35	48	36	46	41	32	30
Jul-08	8253	22	9	11	12	11	10	7	10	8	15	16	5
Aug-08	9243	11	11	14	12	19	15	13	1	16	10	13	21
Sep-08	9261	17	16	17	12	16	16	17	7	16	11	12	17
Oct-08	9721	19	13	21	15	17	11	14	19	16	18	17	13
Nov-08	10131	16	8	15	14	21	28	17	17	19	13	14	20
Dec-08	10140	24	16	17	22	12	19	17	15	24	14	15	14
Jan-09	6263	11	11	7	9	9	9	9	13	6	3	6	3
Feb-09	6436	7	9	8	11	10	8	5	5	3	14	7	9
Mar-09	7244	14	15	12	8	10	15	4	12	7	9	5	12
Apr-09	7275	10	9	14	10	9	8	10	6	12	11	11	10
May-09	7396	6	11	12	11	16	9	13	16	8	13	10	3
Jun-09	8263	6	13	12	16	11	7	9	12	14	13	7	13
Jul-09	8833	14	12	14	12	12	14	14	15	11	10	11	8
Aug-09	8954	16	6	14	17	14	14	11	14	12	12	8	13
Sep-09	9368	20	18	15	18	16	6	12	19	12	6	16	11
Oct-09	9818	39	24	18	7	15	15	17	16	13	6	19	9
Nov-09	9787	36	26	24	23	12	13	6	13	9	9	20	12
Dec-09	10528	23	30	20	22	25	15	15	15	16	12	16	11
Jan-10	10644	5	33	23	25	22	30	18	15	14	19	14	19
Feb-10	11321		1	31	23	27	24	24	11	13	22	11	16
Mar-10	11332			5	27	26	20	29	38	17	14	19	12
Apr-10	11674				2	33	28	26	26	16	19	19	12
May-10	12151					4	27	27	28	31	18	13	24
Jun-10	12460						1	31	26	28	26	22	15
Jul-10	13494							1	35	25	32	35	16
Aug-10	13670								5	33	25	28	21
Sep-10	13933									4	30	23	32
Oct-10	13725										4	34	22
Nov-10	14467											3	36
Dec-10	14905												4
Total Returns Received In Month:		355	335	366	374	398	397	414	445	449	449	476	463

Table 7.2-2 shows shipments for July 2008 through December 2010, plus all shipments prior to July 2008. In addition, it shows returns for January 2010 through December 2010, by month of shipment as determined by shipping records. The highlighted first column of data in Table 7.2-2 shows the month of shipment for the 355 returns received during January 2010. For example, in January 2010, 22 returns were received from the 8253 units shipped in July 2008 and 11 returns were received from the 9243 units shipped in August 2008.

The Early Return Index, ERI, for the month of January 2010, is calculated as follows. The field population is determined by adding the shipment quantities shown on the left side of Table 7.2-2 for the months of July 2009 through December 2009. Therefore the total shipments are

$$FR_{si} = 8833+8954+9368+9818+9787+10528 = 57,288.$$

The number of returned units is the total returned from July 2009 through January 2010. Therefore

$$FR_{ri} = 14+16+20+39+36+23+5 = 153.$$

$$\begin{aligned} \text{Early Return Index} &= 100 \times 12 \times \frac{\text{Returns of units shipped Jul-09 through Jan-10}}{\text{Total Shipments for Jul-09 through Dec-09}} \\ &= 100 \times 12 \times \frac{FR_{ri}}{FR_{si}} \\ &= 100 \times 12 \times \frac{153}{57288} \\ &= 3.20\% \end{aligned}$$

Note that the returns of units shipped in January are included to count all returns during the month and to be alerted to any developing problems. However, shipments during January are excluded because the majority of units shipped in January will not have been placed in operation.

The One-Year Return Rate, YRR, for January 2010, is calculated as follows. The field population is determined by adding the shipment quantities shown on the left side of Table 7.2-2 for the months of July 2008 through June 2009. Therefore the total shipments are

$$\begin{aligned} FR_{sy} &= 8253+9243+9261+9721+10131+10140+ \\ &6263+6436+7244+7275+7396+8263 = 99626. \end{aligned}$$

The number of returned units is the total returned from units shipped in July 2008 through June 2009. Therefore

$$FR_{ry} = 22+11+17+19+16+24+11+7+14+10+6+6 = 163.$$

$$\begin{aligned}
 \text{One-Year} & \quad \text{Returns of units shipped Jul-08 through Jun-09} \\
 \text{Return} & = 100 \times 12 \times \frac{\quad}{\quad} \\
 \text{Rate} & \quad \text{Total Shipments for Jul-08 through Jun-09} \\
 & = 100 \times 12 \times \text{FR}_{ry}/\text{FR}_{sy} \\
 & = 100 \times 12 \times 163/99626 \\
 & = 1.96\%
 \end{aligned}$$

The Long Term Return Rate, LTR, for January 2010, is calculated as follows. The field population is determined by summing the shipment quantities shown on the left side of Table 7.2-2 for the months prior to July 2008. Therefore the total shipments are

$$\text{FR}_{st} = 30,000.$$

The number of returned units is the total returned from units shipped prior to July 2008. Therefore

$$\text{FR}_{rt} = 39.$$

$$\begin{aligned}
 \text{Long-Term} & \quad \text{Returns from shipments prior to Jul-08} \\
 \text{Return} & = 100 \times 12 \times \frac{\quad}{\quad} \\
 \text{Rate} & \quad \text{Total Shipments prior to Jul-08} \\
 & = 100 \times 12 \times \text{FR}_{rt}/\text{FR}_{st} \\
 & = 100 \times 12 \times 39/30000 \\
 & = 1.56\%
 \end{aligned}$$

Calculating the return rates for all months in 2010 gives

Month in 2010	Early Return Index	One-Year Return Rate	Long-Term Return Rate
January	3.20%	1.96%	1.56%
February	2.80%	1.72%	1.66%
March	2.66%	1.96%	1.69%
April	2.44%	1.96%	1.73%
May	2.74%	1.86%	1.70%
June	2.57%	1.65%	1.80%
July	2.69%	1.50%	1.84%
August	2.80%	1.81%	1.52%
September	2.47%	1.55%	1.86%
October	2.39%	1.55%	1.66%
November	2.39%	1.73%	1.56%
December	2.14%	1.57%	1.55%

2) Field Replaceable Unit (FRU) Returns Data Table

The data reported to the TL 9000 Administrator are shown in Table 7.2-3.

Table 7.2-3 Example 1 – FR Data Table Report

Identifier	Value
Year	2010
Month	01
Product Category	1.1
MeasurementID	FR
FRa	12
FRs	99626
FRri	153
FRry	163
FRrt	39
FRsi	57288
FRsy	99626
FRst	30000

7.3 Examples With Normalization

Example 7.3-1 – Normalized One-Year Return Rate – DSL

An organization makes an HDSL transmission system consisting of the following products:

- i) HDSL Central Office Transceiver Unit (HTU-C) – One HTU-C is required per HDSL line deployed.
- ii) HDSL Remote Transceiver Unit (HTU-R) – One HTU-R is required per HDSL line deployed.
- iii) HDSL Range Extender (HRE) – Zero to two HREs may be used per HDSL line deployed.
- iv) HDSL Fuse / Alarm Controller (HFAC) – One HFAC is required per HDSL shelf, which may be used to deploy up to 13 HDSL lines.
- v) HDSL Central Office Terminal Controller (HCOT-CTL) – One HCOT-CTL can control up to 100 shelves.
- vi) HDSL E220 Shelf – One shelf can accommodate up to 13 HDSL transceiver units.

Only products i) through v) are field replaceable units.

To calculate the NYR, returns are aggregated for the entire HDSL product category and the normalizing factor is applied to the category as a whole:

- i) HDSL Central Office Transceiver Unit (HTU-C)

Returns in the reporting period (one month):	50
Shipments in the basis period (one year):	100,000
- ii) HDSL Remote Transceiver Unit (HTU-R)

Returns in the reporting period:	40
Shipments in the basis period:	100,000
- iii) HDSL Range Extender

Returns in the reporting period:	5
Shipments in the basis period:	50,000
- iv) HDSL Fuse/Alarm Controller

Returns in the reporting period:	3
Shipments in the basis period:	10,000

- v) HDSL Central Office Terminal Controller
- | | |
|----------------------------------|-----|
| Returns in the reporting period: | 0 |
| Shipments in the basis period: | 500 |

The normalizing factor for xDSL products is the number of DSL lines deployed. Since one HTU-C and one HTU-R are required to deploy a single HDSL line, the total number of lines deployed in the basis period is

$$FRs = 100,000.$$

The number of returns from the units shipped in the One-Year basis-shipping period is

$$FR_{ry} = 50 + 40 + 5 + 3 + 0 = 98.$$

The normalized One-Year Return Rate is

$$\begin{aligned} NYR &= 12 \times FR_{ry} / FRs = 12 \times 98 / 100,000 \\ &= 0.012 \text{ returns / year / DSL line.} \end{aligned}$$

Example 7.3-2 – Normalized One-Year Return Rate Terminations

An organization makes a local switch consisting of the following products:

- i) POTS line card – Each POTS line card has 16 POTS lines.
- ii) Trunk line card – Each trunk line card has four trunk lines.
- iii) ISDN line card – Each ISDN line card has eight basic rate ISDN lines, each of which has two terminations. Each ISDN line card has an identical card providing protection for the first card.
- iv) Miscellaneous circuit packs – Besides the previous three circuit packs there are 30 other pack codes. They do not supply termination service, but are needed to support the office.

During the basis period for the YRR and NYR, this organization installed one switch with the line cards and other circuit packs listed below. To calculate the YRR and NYR, returns are aggregated for the entire switch and the normalizing factor is applied to the category as a whole.

- i) POTS Line Card

Returns in the reporting period (one month):	10
Shipments in the basis period (one year):	1,000

- ii) Trunk Line Card

Returns in the reporting period:	5
Shipments in the basis period:	500

iii) ISDN Line Card	
Returns in the reporting period:	2
Shipments in the basis period:	500
Active cards with 1:1 protection:	250
iv) Miscellaneous Circuit Packs	
Returns in the reporting period:	2
Shipments in the basis period:	500

The normalizing factor for Switching and Routing System Elements is one termination. The total of all terminations for this switch is

$$\text{FRs} = (1,000 \times 16) + (500 \times 4) + (250 \times 8 \times 2) = 22,000.$$

The number for FRUs shipped in the NYR basis-shipping period is

$$\text{FRsy} = 1,000 + 500 + 500 + 500 = 2,500$$

The number of returns is

$$\text{FRry} = 10 + 5 + 2 + 2 = 19$$

The Normalized One-Year Return Rate for the switch circuit pack shipments is

$$\begin{aligned}\text{NYR} &= 12 \times \text{FRry}/\text{FRs} = 12 \times 19/22,000 \\ &= 0.010364 \text{ returns / year / termination.}\end{aligned}$$

The One-Year Return Rate for the switch is

$$\begin{aligned}\text{YRR} &= 100 \times 12 \times \text{FRry}/\text{FRsy} = 100 \times 12 \times 19/2500 \\ &= 9.12\%.\end{aligned}$$

The data reported to the TL 9000 Administrator are shown in Table 7.3-1. For completeness, the report includes examples of ERI and LTR data, which were not discussed in the example.

Table 7.3-1 FR Data Table Report

Identifier	Value
Year	2010
Month	01
Product Category	1.1
MeasurementID	FR
FRa	12
FRs	22000
FRri	14
FRry	19
FRrt	30
FRsi	1200
FRsy	2250
FRst	4500

Example 7.3-3 – Normalized One-Year Return Rate DS1

The following example demonstrates the calculation of NPRs for Product Category 3.2.1.2 Digital Cross Connects where the normalization factor is DS1s.

Definitions

Please refer to the Glossary for definitions for **NYR**, **Afactor**, **FRry**, **FRS**, and **NU**.

Example

An organization provides a digital cross connect system consisting of the following:

1. 28 DS1 Ports
2. 256 DS3 Ports

During the basis period for the Normalized One-Year Return Rate (NYR) this organization installed twenty systems. To calculate the NYR, returns are aggregated for the entire system and the normalizing factor is applied to the overall usable port connections as a whole.

- Normalization units (NUs) per system = $28 + 256 * 28 = 7,196$
Note: This calculation determines the normalization units for the total number of DS1 Ports
- Total NUs = $20 * 7,196 = 143,920$
- FRU returns in the reporting calendar month = 22

NYR Calculation:

- Afactor = 12
- FRry = 22
- FRS = 143,920

$$\text{NYR} = 12 \times \text{FR}_{\text{ry}}/\text{FRS} = 12 \times (22/143,920) = 12 \times 0.000152863 = \mathbf{0.00183435}$$

returns/ DS1/ Year

7.4 Estimation of Equivalent Number of Normalization Units

a) Problem

The normalization factor for the Normalized One-Year Return Rate (NYR) is the number of normalization units that fall within the One-Year Return Rate (YRR) shipment period. This can lead to a problem for mature products. At some point in the life cycle of many products, the new hardware being shipped is used to fill out or expand existing systems and not to create new systems or capacity growth. This can lead to a situation where the product has a substantial YRR Field Replaceable Unit (FRU) population, but few or even no new systems or capacity shipped in the YRR period. This then leads to a greatly distorted normalization factor. It could even become non-reportable if it was zero. The following provides a method to estimate an equivalent FRs for Network Elements of capacity-based normalization using the YRR FRU population. This in turn allows the calculation of a reasonable and comparable NYR figure.

b) Solution

This method yields an estimated “equivalent” number of Normalization Units for reporting as the NYR normalization factor (FRs) for products subject to the problem described above. The estimate is based on other TL 9000 data elements. These elements are the number of FRU’s in the Early Return Index (ERI), YRR and Long Term Return (LTR) populations and the total number of NEs that make up this overall population. The TL 9000 identifier terms for these values are FR_{si} (ERI FRUs), FR_{sy} (YRR FRUs), FR_{st} (LTR FRUs), and NPRs (Normalization Units used for NPR Measurement). The estimate itself is straight forward. Examples of its use for two cases, network element based normalization and capacity based normalization, follow.

For products where the normalization unit is network elements, first the average number of FRUs per network element is calculated. Then this average is applied to just the YRR FRU population to come up with the equivalent number of YRR network elements that quantity of FRUs represents. The equations for this are:

$$\# \text{ of FRU's per NE} = (\text{FR}_{\text{si}} + \text{FR}_{\text{sy}} + \text{FR}_{\text{st}}) / \text{NPRs}$$

$$\text{Equivalent NEs} = (\text{FR}_{\text{sy}}) / (\# \text{ of FRU's per NE}) = \text{FRs}$$

If the population of network elements being tracked in the NPR measurement is different than the population being tracked by the FRU Return measures, then NPRs will need to be adjusted to account for the total number of network

elements included in the overall FR population. One example of this would be where a customer does not return units to the organization for repair, but does send in problem reports.

This technique can also be applied when the NYR normalization unit is “system”. It can be used for those product categories where the NYR normalization unit is “network element” or “system”. It can only be used on mature products where new units being shipped are primarily going into existing systems.

Example 7.4-1

ERI, YRR, and LTR FRU populations are 5,000 (FR_{si}), 10,000 (FR_{sy}) and 185,000 (FR_{st}) units respectively. The total count for the network elements included in the FR population is 500 (NPRs). The number of FRUs per NE is therefore

$$\# \text{ of FRUs per NE} = (5000+10000+185000)/500 = 400 \text{ FRUs/NE}$$

The equivalent number of NEs that may be used for FRs is:

$$\text{Equivalent NEs} = 10000/400 = 25 \text{ NEs (FRs)}$$

To get the average number of FRUs per NU for products that use capacity-based normalization units (e.g., terminations, OC-1, DSL), the total number of FRUs is calculated as before and divided by the sum of the rated capacities of each FRU shipped over the life of the product. This number when divided into the number of FRUs shipped over the basis shipping period for the reporting month (FR_{sy}) results in an estimated value of FRs for use in the NYR calculation. The Organization should already know the capacities of each FRU to perform the FRs calculation for those product categories.

$$\# \text{ of FRUs Per NU} = (\text{FR}_{si} + \text{FR}_{sy} + \text{FR}_{st}) / (\text{Total NU Capacity of Shipped FRUs})$$

$$\text{Estimated FRs} = (\text{FR}_{sy}) / (\# \text{ of FRUs Per NU})$$

Example 7.4-2

ERI, YRR, and LTR FRU populations are 500 (FR_{si}), 2,500 (FR_{sy}) and 297,000 (FR_{st}) units respectively. The total count for the capacity based normalization units included in the FR population is 3,000,000 (use either the sum of the rated capacities of each FRU shipped over the life of the product or SOs for that month). The number of FRUs per NU is therefore

$$\# \text{ of FRUs per NU} = (500+2500+297000)/3000000 = 0.10 \text{ FRUs/NU}$$

The equivalent number of NUs that may be used for FRs is:

$$\text{Equivalent NEs} = 2500/0.10 = 25000 \text{ NEs (FRs)}$$

7.5 Accounting for Decommissioned Units

As noted in rule 7.1.4 c) 6), the organization is required to exclude from the FR measurement units that have been taken out of service. This is important to keep the FR calculations as accurate as possible. Since decommissioned products most often occur in the LTR segment of the populations, the following example shows how to account for the impact on LTR. The same methodology would apply to any of the FR measures.

Using the data from the earlier LTR example, let's suppose that a customer has notified the organization that it is replacing an older product with the latest generation equipment. As of January 2010, 3000 units shipped prior to eighteen months ago have been removed from the field and decommissioned. In January 2010 there were also three earlier returns from this population that had been received in the month. The LTR data for the month would then need to be adjusted to reflect these quantities as shown in the table and calculation below.

Table 7.5-1 LTR Data for January 2010

	LTR – Shipped	LTR – Decommissioned	Total – In Field
Returns	39	3	36
Population	30,000	3,000	27,000

$$\begin{aligned}
 \text{Long-Term} & \quad \text{Returns from shipments prior to Jul-08} \\
 \text{Return} & = 100 \times 12 \times \frac{\text{Returns from shipments prior to Jul-08}}{\text{Total Shipments prior to Jul-08}} \\
 \text{Rate} & \\
 & = 100 \times 12 \times \text{FR}_{rt}/\text{FR}_{st} \\
 & = 100 \times 12 \times 36/27000 \\
 & = 1.33\%
 \end{aligned}$$