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SERIES M: TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

International data transmission systems

Performance objectives, allocations and limits for international PDH leased circuits and supporting data transmission links and systems

ITU-T Recommendation M.1340

(Formerly CCITT Recommendation)

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ITU-T RECOMMENDATION M.1340

PERFORMANCE OBJECTIVES, ALLOCATIONS AND LIMITS FOR INTERNATIONAL PDH LEASED CIRCUITS AND SUPPORTING DATA TRANSMISSION LINKS AND SYSTEMS

Summary

This Recommendation is only applicable to international data transmission links and systems for PDH applications. The requirements described in this Recommendation should form the basis for all digital test measurements associated with these types of applications. The performance limits are also applicable to the international portions of international leased circuits that are supported by an international data transmission system and that have a PDH digital interface at the Customer's premises. Allocations of performance between international and national portions are covered, but those between Network Operators within the national portion require further study.

Recommendations M.1370 and M.1375 describe the Bringing-Into-Service and Maintenance procedures respectively for international data transmission links and systems, while Recommendations M.1380 and M.1385 describe similar procedures for international PDH leased circuits supported by those systems. These Recommendations are to be applied in conjunction with the performance objectives, allocations and limits described in this Recommendation.

This Recommendation addresses the performance of leased circuits with a PDH digital presentation at the Customer's premises. Another Recommendation is being developed for performance of SDH leased circuits. For leased circuits with an analogue presentation, the performance limits of Recommendations M.1020, M.1025 or M.1040 are applied as appropriate.

Source

ITU-T Recommendation M.1340 was revised by ITU-T Study Group 4 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 4 February 2000.

Keywords

In-service monitoring, international data transmission system, international leased circuit, international section, national section, performance objective, performance allocation, performance limits, performance parameters, test duration.

FOREWORD

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The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Recommendation M.1340

PERFORMANCE OBJECTIVES, ALLOCATIONS AND LIMITS FOR INTERNATIONAL PDH LEASED CIRCUITS AND SUPPORTING DATA TRANSMISSION LINKS AND SYSTEMS

(Published 1993, revised in 1996 and 2000)

1 Scope

This Recommendation is only applicable to international data transmission links and systems for PDH applications. The requirements described in this Recommendation should form the basis for all digital test measurements associated with these types of applications. The performance limits are also applicable to the international portions of international leased circuits that are supported by an international data transmission system and that have a PDH digital interface at the Customer's premises. Allocations of performance between international and national portions are covered, but those between Network Operators/Service Providers within the national portion require further study.

This Recommendation addresses the performance of leased circuits with a PDH digital presentation at the Customer's premises. Another Recommendation is being developed for performance of SDH leased circuits. For leased circuits with an analogue presentation, the procedures described in Recommendation M.1060 [11] and performance limits of Recommendations M.1020 [7], M.1025 [8] or M.1040 [9] are applied as appropriate.

The limits described in this Recommendation represent a typical minimum level of performance and Network Operators/Service Providers should apply practical experience and negotiation to mutually agree more stringent limits whenever feasible. However, it should be recognized that the performance limits described may not be achieved by certain existing transmission equipment technologies.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation G.701 (1993), *Vocabulary of digital transmission and multiplexing, and pulse code modulation (PCM) terms.*

[2] ITU-T Recommendation G.821 (1996), *Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network.*

[3] ITU-T Recommendation G.826 (1999) *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate*.

[4] CCITT Recommendation M.20 (1992), *Maintenance philosophy for telecommunication networks.*

[5] CCITT Recommendation M.34 (1988), *Performance monitoring on international transmission systems and equipment.*

[6] ITU-T Recommendation M.60 (1993), *Maintenance terminology and definitions.*

[7] ITU-T Recommendation M.1020 (1993), *Characteristics of special quality international leased circuits with special bandwidth conditioning*.

[8] ITU-T Recommendation M.1025 (1993), *Characteristics of special quality international leased circuits with basic bandwidth conditioning*.

[9] CCITT Recommendation M.1040 (1988), *Characteristics of ordinary quality international leased circuits*.

[10] ITU-T Recommendation M.1045 (1996), *Preliminary exchange of information for the provision of international leased circuits and international data transmission systems*.

[11] CCITT Recommendation M.1060 (1988), *Maintenance of international leased circuits*.

[12] ITU-T Recommendation M.1300 (1997), *Maintenance of international data transmission systems operating in the range 2.4 kbit/s to 140 Mbit/s.*

[13] ITU-T Recommendation M.1370 (1998), *Bringing-into-service of international data transmission systems*.

[14] ITU-T Recommendation M.1375 (1998), *Maintenance of international data transmission systems*.

[15] ITU-T Recommendation M.1380 (2000), *Bringing-into-service of international leased circuits that are supported by international data transmission systems.*

[16] ITU-T Recommendation M.1385 (2000), *Maintenance of international leased circuits that are supported by international data transmission systems*.

[17] ITU-T Recommendation M.1400 (2000), *Designations for inter operator networks*.

[18] CCITT Recommendation M.1510 (1992), *Exchange of contact point information for the maintenance of international services and the international network.*

[19] ITU-T Recommendation M.1530 (1999), *Network maintenance information*.

[20] ITU-T Recommendation M.1535 (1996), *Principles for maintenance information to be exchanged at the customer contact point (MICC)*.

[21] ITU-T Recommendation M.1537 (1997), *Definition of maintenance information to be exchanged at customer contact point (MICC).*

[22] ITU-T Recommendation M.1539 (1999), *Management of the grade of network maintenance services at the maintenance service customer contact point (MSCC)*.

[23] ITU-T Recommendation M.1540 (1994), *Exchange of information for planned outages of transmission systems.*

[24] CCITT Recommendation M.1560 (1992), *Escalation procedure for international leased circuits*.

[25] ITU-T Recommendation M.2100 (1995), *Performance limits for bringing-into-service and maintenance of international PDH paths, sections and transmission systems*.

3 Terms and definitions

Recommendation M.1300 [12] provides general descriptions of international data transmission systems. Terminology and definitions relating to this Recommendation are provided in Recommendations G.701 [1] and M.60 [6]. For the purposes of this Recommendation, the following definitions of an international digital leased circuit and Service Level Agreement (SLA)/Contract apply:

3.1 international digital leased circuit: The digital path between two Network Terminating Equipments (NTEs). The digital leased circuit may be bidirectional or unidirectional and its end points are at the boundaries between the Network Operator/Service Provider and the Customer. The NTEs may be owned by the Network Operator/Service Provider or owned by the Customer.

3.2 SLA/Contract: A set of appropriate procedures and targets formally or informally agreed between Network Operators/Service Providers or between Network Operators/Service Providers and Customers, in order to achieve and maintain specified Quality of Service (QoS) in accordance with ITU (ITU-T and ITU-R) Recommendations. The SLA may be an integral part of the Contract. These procedures and targets are related to specific circuit/service availability, error performance, Ready For Service (RFS) date, Mean Time Between Failures (MTBF), Mean Time to Restore Service (MTRS), Mean Time To Repair (MTTR).

4 Abbreviations

This Recommendation uses the following abbreviations:

BIS Bringing-Into-Service

CSES Consecutive Severely Errored Second

ES Errored Second

FS Frontier Station

HRX Hypothetical Reference Connection

ISM In-Service Monitoring

LTP Link Terminating Point

MP Measurement Point

MTBF Mean Time Between Failures

MTRS Mean Time to Restore Service

MTTR Mean Time To Repair

NTE Network Terminating Equipment

OOS Out-Of-Service

PCM Pulse Code Modulation

PDH Plesiochronous Digital Hierarchy

QoS Quality of Service

RFS Ready For Service

RPO Reference Performance Objective

SDH Synchronous Digital Hierarchy

SEP Severely Errored Period

SES Severely Errored Second

SLA Service Level Agreement

TIC Terminal International Centre

TMN Telecommunications Management Network

TNC Terminal National Centre

UTC Coordinated Universal Time

5 Basic principles

5.1 Operational procedures

Recommendation M.1370 [13] covers the setting up and Bringing-Into-Service (BIS) of international data transmission systems, while Maintenance procedures are covered by Recommendation M.1375 [14]. The BIS and Maintenance procedures relating to international leased circuits with a PDH digital presentation at the Customer's premises and that are supported by international data transmission systems are covered by Recommendations M.1380 [15] and M.1385 [16] respectively. International data transmission systems and leased circuits shall use M.1400 [17] designations.

5.2 Performance events and parameters

Error performance limits provided in this Recommendation are based on error performance events of Errored Seconds (ESs) and Severely Errored Seconds (SESs) and the corresponding parameters as defined in Recommendations G.821 [2], G.826 [3] and M.2100 [25]. Performance limits for timing and delay performance parameters are for further study. With developments in network technology, delay may be a problem for some user applications.

Network Operators/Service Providers should be aware that periods of Consecutive Severely Errored Seconds (CSES) of between 3 and 9 seconds, known as a Severely Errored Period (SEP), can have a severe impact on some Customers' leased circuit applications. CSESs are critical for some Customers' leased circuit applications because they require the application to be completely restarted, since the installation's own recovery system is no longer sufficient to cover the circuit interruption time.

Performance limits and objectives for SEPs are for further study. It should be recognized, however, that current PDH and some SDH transmission equipment designed to Recommendations G.821 [2] and G.826 [3] does not monitor and record these "short break" events.

5.3 Derivation of performance objectives, allocation and limits

The performance limit allocation principles described in this Recommendation are compatible with those presented in Recommendation M.2100 [25]. Table 2b/M.2100 [25] is used as the basis for deriving overall error performance allocations for this Recommendation.

For greatly simplified operational performance measurements, this Recommendation uses the same ES and SES limits to cover all 24-hour Out-Of-Service (OOS) test requirements (e.g. BIS, maintenance intervention and returning to service after repair). These limits are given in Table 1. In addition, dual limits associated with a confidence window, as described in Recommendations M.34 [5] and M.2100 [25] are not used. While this overall approach is not directly compatible with Recommendation M.2100 [25], an international digital path set up in accordance with the performance requirements of Recommendation M.2100 [25] should be able to support an international data transmission link set up in accordance with the performance requirements of this Recommendation.

5.3.1 Data rates below primary rate

The same performance limits will be applicable for all data rates below the primary rate (for the purpose of this Recommendation, this will include data rates from 600 bit/s).

The ES performance limits used in this Recommendation have a mathematical basis and are derived from a 40% allowance of an end-to-end ES objective as described in Recommendation G.821 [2]. However, taking account of practical experience, the 8% ES objective proposed in Recommendation G.821 [2] is reduced to 4% (see Table 1a/M.2100 [25]).

The SES performance limits used in this Recommendation are not directly related to the SES objectives described in Recommendation G.821 [2]. The limits have a mathematical basis, but have been modified significantly to reflect practical experience.

5.3.2 Data rates at primary rate and above

The end-to-end error performance objectives at or above the primary rate are based on those given in Table 1b/M.2100 [25]. The Reference Performance Objectives (RPOs) for ES used in this Recommendation are based on a maximum of 63% of a 2% (for primary rate), 2.5% (for secondary rate), 3.75% (for tertiary rate) and 8% (for quaternary rate) end-to-end RPO as derived from Recommendation G.826 [3], where 63% is the overall international portion error performance allocation.

Recommendation G.826 [3] allocates a block allowance of 17.5% of the overall performance objectives to one national portion of a path. In addition, a length-dependent allowance of 1% per 500 km is allocated to this portion. Considering that a path comprises two national portions and assuming a maximum length of 2×500 km, the total allocation assigned to the national portion is:

$$2 \times 17.5\% + 2 \times 1\% = 37\%$$

Because this part of the Recommendation only deals with the **international portion**, only

$$100\% - 37\% = 63\%$$

can be assigned to this **international** portion.

The SES performance limits used in this Recommendation are identical to those for data rates below primary rate.

5.4 Test duration and error phenomena

To reflect operational requirements for OOS testing, test durations of 24 hours, 2 hours, 1 hour, and 15 minutes are used in this Recommendation. While the one-month test duration suggested in Recommendations G.821 [2] and G.826 [3] is not realistic for most practical test requirements, it must be recognized that 24-hour (or less) test results are inherently less reliable, since the statistics of transmission media can have little significance over such short periods. The 2-hour, 1-hour, and 15-minute test objectives specified in this Recommendation are used to provide a basic check of operability and are not intended to give a reliable indication of transmission error performance.

The performance limits used during BIS and Maintenance tests should be consistent. For short duration tests, the limits given in clause 6 and its associated tables are appropriate. For all performance tests described in this Recommendation, the ES and SES limits should be met simultaneously for the test result to be considered acceptable.

5.5 Action on test failure

A 24-hour test duration cannot be expected to give a particularly reliable indication of transmission error performance (a test duration of one month is suggested in Recommendations G.821 [2] and G.826 [3]), since the statistics of transmission media can have little significance over such short periods. When a performance limit is not met, Network Operators/Service Providers should use

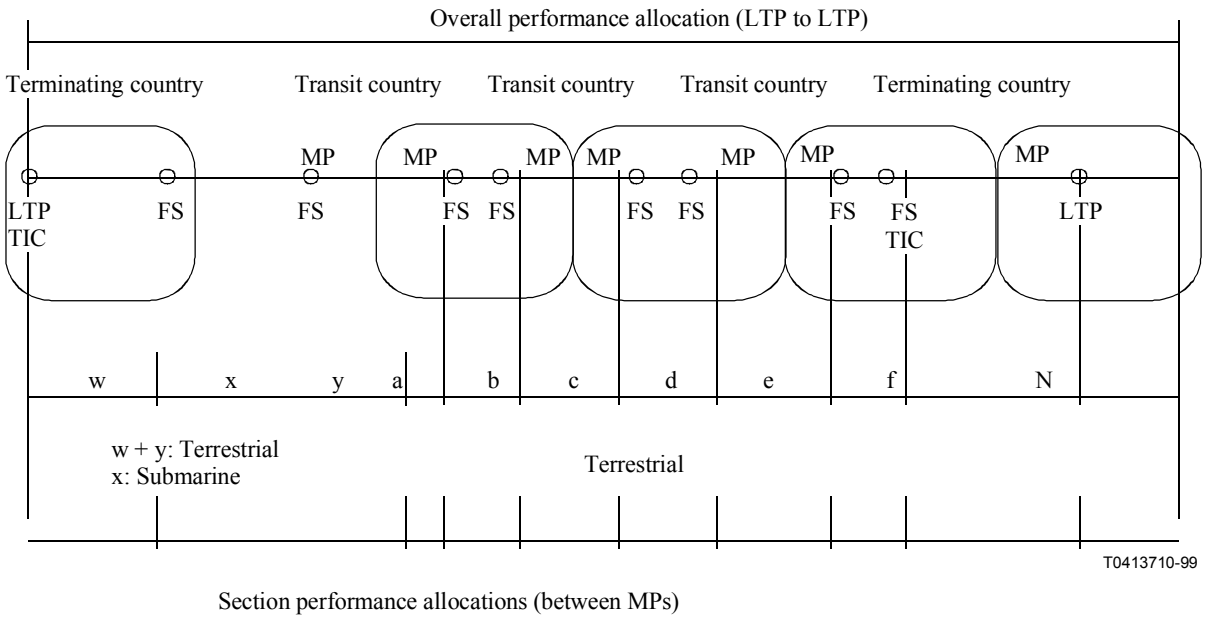
practical judgement to determine an agreed course of action. Except where performance is catastrophically bad and a fault is obviously present, it will often be advantageous to continue testing to increase the level of confidence in the result. However, to avoid unnecessary testing where a limit is exceeded by only a very small margin, following agreement between Network Operators/Service Providers involved, it may be appropriate to consider the result acceptable. See Recommendations M.1370 [13], M.1375 [14], M.1380 [15] and M.1385 [16] for further guidance.

In addition, reference should be made to any particular maintenance agreement with the Customer, including for example, a Service Level Agreement (SLA)/Contract. This should have been included in the preliminary exchange of information for the provision of international leased circuits and international data transmission systems, defined in Recommendation M.1045 [10]. See also Recommendations M.1510 [18], M.1530 [19], M.1535 [20], M.1537 [21], M.1539 [22] and M.1540 [23] for further information. Maintenance staff should refer to such agreements when dealing with a fault reported by the Customer, and should follow the escalation procedures defined in Recommendation M.1560 [24] where necessary.

6 Error performance allocation principles and test limits

6.1 Overall performance allocation (link terminating point-to-link terminating point)

Prior to attempting to determine an overall performance allocation, Network Operators/Service Providers should construct an agreed schematic routing diagram for the international data transmission link or system or international leased circuit under consideration. The diagram should locate Link Terminating Points (LTPs), earth stations, terrestrial Frontier Stations (FSs) and Terminal International Centres (TICs), showing distances in kilometres (except for any satellite sections). Figure 1 is a typical schematic diagram (see also Figures 2a/M.2100 [25] and 3/M.2100 [25]). A suitable routing diagram may have been agreed at the initial planning stage prior to BIS. This routing diagram is used to calculate the error performance block allowances for the overall transmission link or circuit and its constituent portions. The inclusion of intermediate Measurement Points (MPs) as shown in Figure 1 is not necessary for the derivation of overall performance limits.



FS Frontier Station
LTP Link Terminating Point
MP Measurement Point
TIC Terminal International Centre

NOTE 1 – An overall performance allocation is derived using Table 2/M.2100 [25] and Table 1 and taking account of allocations for national portions, e.g. N.

NOTE 2 – Individual international portion performance allocations are derived using Tables 1 and 2.

NOTE 3 – Where an LTP is located at a TIC, there will be no national portion.

Figure 1/M.1340 – Performance allocation for international data transmission links and systems

Within international portions, percentage performance allocations attributable to terminating countries, transit countries, submarine cable systems, satellite systems and terrestrial border crossings are determined by reference to Tables 2a/M.2100 [25] and 2b/M.2100 [25] as appropriate. The percentage allocations are described as "% of end-to-end RPO" (Reference Performance Objectives) in these tables.

Percentage performance allocations attributable to national portion components are the responsibility of the Network Operators/Service Providers concerned and are for further study. Where a national portion is provided over a high grade transmission path, an allocation consistent with the terrestrial components given in Table 2 is recommended. Appendix I gives guidelines for performance limits for the national portion of an international leased circuit routed via medium and/or local grade transmission paths.

6.2 Calculation of overall performance limits

The calculation of overall performance limits from a single overall percentage allocation is preferred. An overall allocation is derived by simple addition of the individual portion allocations. The overall percentage allocation should then be applied to the appropriate data rate in Table 1 to determine single 24-hour test limits for ES and SES. Where an overall percentage performance allocation of greater than 40% for data rates below primary rate and 63% for data rates at the primary rate and above is derived, Network Operators/Service Providers should determine suitable limits for ES and SES by bilateral agreement, taking account of the limits in Table 1. The linear addition of portion performance limits to derive overall performance limits is not recommended. The 24-hour performance limits derived are applicable to all OOS tests (e.g. BIS, maintenance

intervention and returning to service after repair) of the overall international data transmission link (LTP-to-LTP) or system or international leased circuit.

6.3 Portion performance allocation (between MPs)

For certain operational test requirements (e.g. during maintenance investigation and re-routing), it will be necessary to perform 24-hour tests of portion components of an international data transmission link or international leased circuit. Prior to attempting to determine performance allocations, Network Operators/Service Providers should construct an agreed schematic routing diagram for the international data transmission link or system or international leased circuit as described in 6.1 above. A suitable routing diagram may have been agreed at the planning stage prior to BIS. The air-route distance between link portion end points, as described in Recommendation M.2100 [25] as Path Core Elements (PCEs) should be multiplied by an appropriate routing factor. This routing factor is specified as follows:

- If the air route distance is < 1000 km, the routing factor is 1.5.
- If the air route distance is ≥ 1000 km and < 1200 km, the calculated route length is taken to be 1500 km.
- If the air route distance is ≥ 1200 km, the routing factor is 1.25.

The modified air route distance is compared with the actual route length, where this is known, and the smaller of these distances is then applied to Table 2 for the calculation of percentage performance allocation between points of interest.

6.4 Calculation of portion performance limits

The portion components from the schematic routing diagram should be applied to Table 2 (this is a simplified version of Table 2b/M.2100 [25]) for the calculation of percentage performance allocations between points of interest. Network Operators/Service Providers must ensure that the sum total of performance allocations for individual portion components is consistent with the overall performance allocation described in 6.1 above. Where the overall performance allocation is exceeded, Network Operators/Service Providers should agree proportional reductions to portion performance allocations by negotiation. Agreed portion performance allocations should then be applied to the appropriate data rate in Table 1 to determine the single 24-hour test limits for ES and SES. These test limits may be used for all OOS test requirements between agreed MPs.

7 Short duration test objectives

The application of short duration test limits to BIS and maintenance operations on international data transmission links and systems is described in Recommendations M.1370 [13] and M.1375 [14] respectively, and similarly for international leased circuits in Recommendations M.1380 [15] and M.1385 [16].

It must be recognized that short duration tests do not give a reliable indication of overall transmission error performance for the reasons stated earlier. Failure to meet a short duration test objective by a small margin (see Note 3 to Table 4) may not necessarily be indicative of a performance problem and Network Operators/Service Providers should use their practical judgement to determine an agreed course of action, taking account of operational requirements. Where a short duration test objective is not met by a significant margin, corrective action should be taken in accordance with Recommendations M.1370 [13], M.1375 [14], M.1380 [15] or M.1385 [16] as appropriate.

7.1 Maintenance test limits

It is recognized that 24-hour test limits are not appropriate for all OOS test requirements, especially those associated with maintenance operations. Proposed 15-minute and 1-hour test limits for international data transmission links and systems are given in Table 4. These error performance limits are independent of the routing configuration that is used. If there is any doubt about the validity of a 15-minute or 1-hour test result, a longer duration test may be appropriate.

7.2 BIS test limits

International leased circuits are often carried on higher speed data transmission systems and links, and are provisioned at a later date than the supporting transport network. Table 2 gives 2-hour error performance test limits that can be used for BIS tests, when the circuit is provided over a data transmission system that has already been tested over a 24-hour period and is in service.

8 In-Service Monitoring (ISM) of performance

On some international data transmission systems, it may be possible to assess overall performance by using built-in In-Service Monitoring (ISM) facilities e.g. CRC within the frame alignment signal or by monitoring a dedicated service channel. Performance limits are defined for ES and SES resulting from ISM errors and each performance limit will have its own threshold. The general strategy for the use of performance monitoring information and thresholds is described in Recommendations M.20 [4] and M.34 [5]. Specific information is also given in Recommendation M.1375 [14] for international data transmission systems and Recommendation M.1385 [16] for international leased circuits.

Unacceptable Performance Limit (UPL) threshold values for a 15-minute period and. Degraded Performance Limit (DPL) threshold values for a 24-hour period are for further study. When UPL or DPL thresholds are exceeded, maintenance action should be initiated including escalation procedures if necessary (see Recommendation M.1560 [24]). Threshold violations may automatically generate alerts to a TMN management system if implemented.

Table 1/M.1340 – 24-hour Out-Of-Service test limits

Allocation %	Event	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
< Primary rate	ES		9	16	23	30	37	45	52	60	68	76	83	91	99	107	115	123	131	139	147	155	163	171	179	187	195
	SES		1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8
Primary rate	ES		3	6	9	12	16	19	23	26	30	34	37	41	45	49	52	56	60	64	68	72	76	79	83	87	91
	SES		1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8
Secondary rate	ES		4	8	12	17	21	26	30	35	39	44	49	53	58	63	68	73	77	82	87	92	97	102	107	112	117
	SES		1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8
Tertiary rate	ES		8	14	21	28	35	42	49	56	63	70	77	85	92	99	107	114	122	129	137	144	152	159	167	174	182
	SES		1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8
Quaternary rate	ES		23	37	52	68	83	99	115	131	147	163	179	195	211	227	243	259	276	292	308	325	341	358	374	390	407
	SES		1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8

Allocation %	Event	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0
< Primary Rate	ES	203	211	219	227	235	243	251	259	268	276	284	292	300	308	317	325	333	341	349	358	366	374	382	390	399	407
	SES	8	8	8	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	15	15	15
Primary Rate	ES	95	99	103	107	111	115	119	123	127	131	135	139	143	147	151	155	159	163	167	171	175	179	183	187	191	195
	SES	8	8	8	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	15	15	15
Secondary Rate	ES	122	127	132	137	142	147	152	157	162	167	172	177	182	187	192	197	202	207	212	217	222	227	232	237	242	247
	SES	8	8	8	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	15	15	15
Tertiary Rate	ES	189	197	204	212	219	227	235	242	250	257	265	273	280	288	296	303	311	319	326	334	342	349	357	365	372	380
	SES	8	8	8	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	15	15	15
Quaternary rate	ES	423	440	456	473	489	506	522	539	556	572	589	605	622	639	655	672	689	705	722	738	755	772	789	805	822	839
	SES	8	8	8	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	15	15	15

Table 1/M.1340 – 24-hour Out-Of-Service test limits *(continued)*

Allocation %	Event	26.5	27.0	27.0	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0
< Primary Rate	ES	415	423	432	440	448	456	465	473	481	489	498	506	514	522	531	539	547	556	564	572	580	589	597	605	614	622
	SES	16	16	16	16	17	17	17	18	18	18	18	19	19	19	20	20	20	21	21	21	21	22	22	22	23	23
Primary Rate	ES	199	203	207	211	215	219	223	227	231	235	239	243	247	251	255	259	264	268	272	276	280	284	288	292	296	300
	SES	16	16	16	16	17	17	17	18	18	18	18	19	19	19	20	20	20	21	21	21	21	22	22	22	23	23
Secondary Rate	ES	252	257	263	268	273	278	283	288	293	298	303	308	314	319	324	329	334	339	344	349	354	360	365	370	375	380
	SES	16	16	16	16	17	17	17	18	18	18	18	19	19	19	20	20	20	21	21	21	21	22	22	22	23	23
Tertiary Rate	ES	388	396	403	411	419	426	434	442	450	457	465	473	481	488	496	504	512	519	527	535	543	550	558	566	574	582
	SES	16	16	16	16	17	17	17	18	18	18	18	19	19	19	20	20	20	21	21	21	21	22	22	22	23	23
QuaternaryRate	ES	855	872	889	905	922	939	956	972	989	1006	1023	1039	1056	1073	1090	1106	1123	1140	1157	1174	1190	1207	1224	1241	1258	1274
	SES	16	16	16	16	17	17	17	18	18	18	18	19	19	19	20	20	20	21	21	21	21	22	22	22	23	23

Allocation %	Event	39.5	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	51.5	52.0
< Primary Rate	ES	630	639																								
	SES	23	24																								
Primary Rate	ES	304	308	313	317	321	325	329	333	337	341	345	349	353	358	362	366	370	374	378	382	386	390	395	399	403	407
	SES	23	24	24	24	24	25	25	25	26	26	26	26	27	27	27	28	28	28	29	29	29	29	30	30	30	31
Secondary Rate	ES	385	390	396	401	406	411	416	421	426	432	437	442	447	452	457	463	468	473	478	483	488	494	499	504	509	514
	SES	23	24	24	24	24	25	25	25	26	26	26	26	27	27	27	28	28	28	29	29	29	29	30	30	30	31
Tertiary Rate	ES	589	597	605	613	620	628	636	644	652	659	667	675	683	691	698	706	714	722	730	737	745	753	761	769	777	784
	SES	23	24	24	24	24	25	25	25	26	26	26	26	27	27	27	28	28	28	29	29	29	29	30	30	30	31
Quaternary Rate	ES	1291	1308	1325	1342	1358	1375	1392	1409	1426	1443	1459	1476	1493	1510	1527	1544	1561	1577	1594	1611	1628	1645	1662	1679	1695	1712
	SES	23	24	24	24	24	25	25	25	26	26	26	26	27	27	27	28	28	28	29	29	29	29	30	30	30	31

Table 1/M.1340 – 24-hour Out-Of-Service test limits *(concluded)*

Allocation %	Event	52.5	53.0	53.5	54.0	54.5	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5	60.0	60.5	61.0	61.5	62.0	62.5	63.0
< Primary Rate	ES																						
	SES																						
Primary Rate	ES	411	415	419	423	427	432	436	440	444	448	452	456	460	465	469	473	477	481	485	489	494	498
	SES	31	31	32	32	32	32	33	33	33	34	34	34	34	35	35	35	36	36	36	37	37	37
Secondary Rate	ES	519	525	530	535	540	545	550	556	561	566	571	576	582	587	592	597	602	607	613	618	623	628
	SES	31	31	32	32	32	32	33	33	33	34	34	34	34	35	35	35	36	36	36	37	37	37
Tertiary Rate	ES	792	800	808	816	823	831	839	847	855	863	870	878	886	894	902	910	917	925	933	941	949	957
	SES	31	31	32	32	32	32	33	33	33	34	34	34	34	35	35	35	36	36	36	37	37	37
Quaternary Rate	ES	1729	1746	1763	1780	1797	1814	1830	1847	1864	1881	1898	1915	1932	1949	1966	1983	1999	2016	2033	2050	2067	2084
	SES	31	31	32	32	32	32	33	33	33	34	34	34	34	35	35	35	36	36	36	37	37	37

ES Errored Seconds

SES Severely Errored Seconds

NOTE 1 – The % allocation relates to the proportion of the overall reference performance objective that is attributable to a particular routing configuration.

NOTE 2 – The limits are applicable to discrete measurement periods of 24 hours.

NOTE 3 – Where a test has a discrete period of more than 24 hours, it is recommended that the limits be applied to each discrete period without averaging.

NOTE 4 – The maximum % allocation of 40% in this table is consistent with the allowance for the high-grade quality classification given in Recommendation G.821 [2].

NOTE 5 – The ES and SES performance limits relate to the maximum number of errored seconds or severely errored seconds that would be acceptable in the measurement period.

NOTE 6 – Performance limits for unavailable time are left for negotiation between Network Operators/Service Providers. However, it should be appreciated that an availability of 100% would normally be achieved during a typical 24-hour period and that a transition to unavailable state would be inconsistent with SES limits for allocations below 16.5%.

Table 2/M.1340 – 2-hour BIS limits for circuits carried on a data transmission system which has already been tested over 24 hours and is in service

Allocation %	Event	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
< Primary rate	ES		0	0	0	0	0	1	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	10	10
	SES		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
< Primary rate	ES		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	2	3	3	3	3
	SES		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secondary rate	ES		0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5
	SES		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tertiary rate	ES		0	0	0	0	0	0	1	1	2	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9
	SES		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quaternary rat	ES		0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	22	23	24	25
	SES		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Allocation %	Event	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0
< Primary rate	ES	11	11	12	12	13	13	14	15	15	16	16	17	17	18	19	19	20	20	21	22	22	23	23	24	25	25
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Primary rate	ES	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	10	10	10
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secondary rate	ES	5	6	6	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tertiary rate	ES	10	10	11	11	12	12	13	13	14	14	15	16	16	17	17	18	18	19	19	20	20	21	22	22	23	23
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quaternary rate	ES	26	28	29	30	31	33	34	35	36	37	39	40	41	42	44	45	46	47	49	50	51	52	54	55	56	58
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2/M.1340 – 2-hour BIS limits for circuits carried on a data transmission system which has already been tested over 24 hours and is in service *(continued)*

Allocation %	Event	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0
< Primary rate	ES	26	26	27	28	28	29	29	30	31	31	32	33	33	34	34	35	36	36	37	37	38	39	39	40	41	41
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Primary rate	ES	10	11	11	11	11	12	12	12	13	13	13	13	14	14	14	15	15	15	15	16	16	16	17	17	17	17
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secondary rate	ES	14	14	15	15	16	16	16	17	17	17	18	18	18	19	19	20	20	20	21	21	21	22	22	23	23	23
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tertiary rate	ES	24	24	25	26	26	27	27	28	28	29	29	30	31	31	32	32	33	34	34	35	35	36	36	37	38	38
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quaternary rate	ES	59	60	61	63	64	65	67	68	69	70	72	73	74	76	77	78	79	81	82	83	85	86	87	89	90	91
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Allocation %	Event	39.5	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	51.5	52.0
< Primary rate	ES	42	42																								
	SES	0	0																								
Primary rate	ES	18	18	18	19	19	19	20	20	20	20	21	21	21	22	22	22	23	23	23	23	24	24	24	25	25	25
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secondary rate	ES	24	24	24	25	25	26	26	26	27	27	27	28	28	29	29	29	30	30	30	31	31	32	32	32	33	33
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tertiary rate	ES	39	39	40	40	41	42	42	43	43	44	45	45	46	46	47	48	48	49	49	50	50	51	52	52	53	53
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quaternary rate	ES	92	94	95	96	98	99	100	102	103	104	106	107	108	109	111	112	113	115	116	117	119	120	121	123	124	125
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2/M.1340 – 2-hour BIS limits for circuits carried on a data transmission system which has already been tested over 24 hours and is in service *(concluded)*

Allocation %	Event	52.5	53.0	53.5	54.0	54.5	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5	60.0	60.5	61.0	61.5	62.0	62.5	63.0
Primary rate	ES	26	26	26	26	27	27	27	28	28	28	29	29	29	29	30	30	30	31	31	31	32	32
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secondary rate	ES	34	34	34	35	35	35	36	36	37	37	37	38	38	39	39	39	40	40	40	41	41	42
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tertiary rate	ES	54	55	55	56	56	57	58	58	59	59	60	61	61	62	62	63	64	64	65	65	66	67
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quaternary rate	ES	127	128	129	131	132	133	135	136	137	139	140	141	143	144	145	147	148	149	151	152	153	155
	SES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ES Errored Seconds

SES Severely Errored Seconds

NOTE 1 – The % allocation relates to the proportion of the overall reference performance objective that is attributable to a particular routing configuration.

NOTE 2 – The limits are applicable to discrete measurement periods of 2 hours. The 2-hour limits are derived from Table C/M.2100 [25].

NOTE 3 – Where a test has a discrete period of more than 2 hours, it is recommended that the limits be applied to each discrete period without averaging.

NOTE 4 – The maximum % allocation of 40% in this table is consistent with the allowance for the high-grade quality classification given in Recommendation G.821 [2].

NOTE 5 – The ES and SES performance limits relate to the maximum number of errored seconds or severely errored seconds that would be acceptable in the measurement period.

NOTE 6 – Performance limits for unavailable time are left for negotiation between Network Operators/Service Provider. However, it should be appreciated that an availability of 100% would normally be achieved during a typical 24-hour period and that a transition to unavailable state would be inconsistent with SES limits for allocations below 16.5%.

Table 3/M.1340 – Performance allocations for the derivation of performance limits for the international portion routed via a high grade transmission path

International link portion component	Distance "d" (km)	Allocation % per 100 km
Terrestrial (including transit and non-optical undersea cable)	$d \leq 500$ $500 < d \leq 1000$ $1000 < d \leq 2500$ $2500 < d \leq 5000$ $5000 < d \leq 7500$ $d > 7500$	0.4 3 4 6 8 10
Optical undersea cable	$d \leq 500$ $d > 500$	1 2.5
Satellite	–	20
NOTE 1 – By negotiation, where sectional testing incorporates a terrestrial border crossing, it may be acceptable to incorporate an additional performance allocation (see Notes 3 and 4 in Table 2b/M.2100 [25]); an allocation of 0.5% is suggested. NOTE 2 – The allocations given in this table are maximum values and may be reduced by agreement between Network Operators/Service Providers.		

Table 4/M.1340 – Short duration out-of-service test limits

Dest duration	Objectives	
	ES	SES
15 minutes	0	0
1 hour	5	0
NOTE 1 – The ES and SES performance limits relate to the maximum number of errored seconds or severely errored seconds that would be acceptable in the test period specified. NOTE 2 – Where a 15-minute limit is exceeded, it may be useful to reference Annex D/M.2100 [25] and Table D.1/M.2100 [25] for guidance. NOTE 3 – The acceptable tolerance applicable to the limits of this table is dependent upon the overall allocation as defined in 3.1.		

9 Tables under study

Tables 4 and 5 of the 1996 version of this Recommendation dealing with "24-hour in-service degraded performance limit thresholds" and "15-minute in-service unacceptable performance limit thresholds" require further study and are not contained in this edition.

APPENDIX I

Guidelines for performance allocations of the national circuit portions of an international leased circuit

I.1 Scope

This appendix gives some examples to produce the performance limits for all digital test measurements associated with national circuit portions of PDH international leased circuits that are supported by an international data transmission system and that have a PDH digital interface at the Customer's premises.

Terminology, operational procedures, performance parameters and derivation of performance limits in this appendix are identical to those described in this Recommendation.

I.2 Basic principles

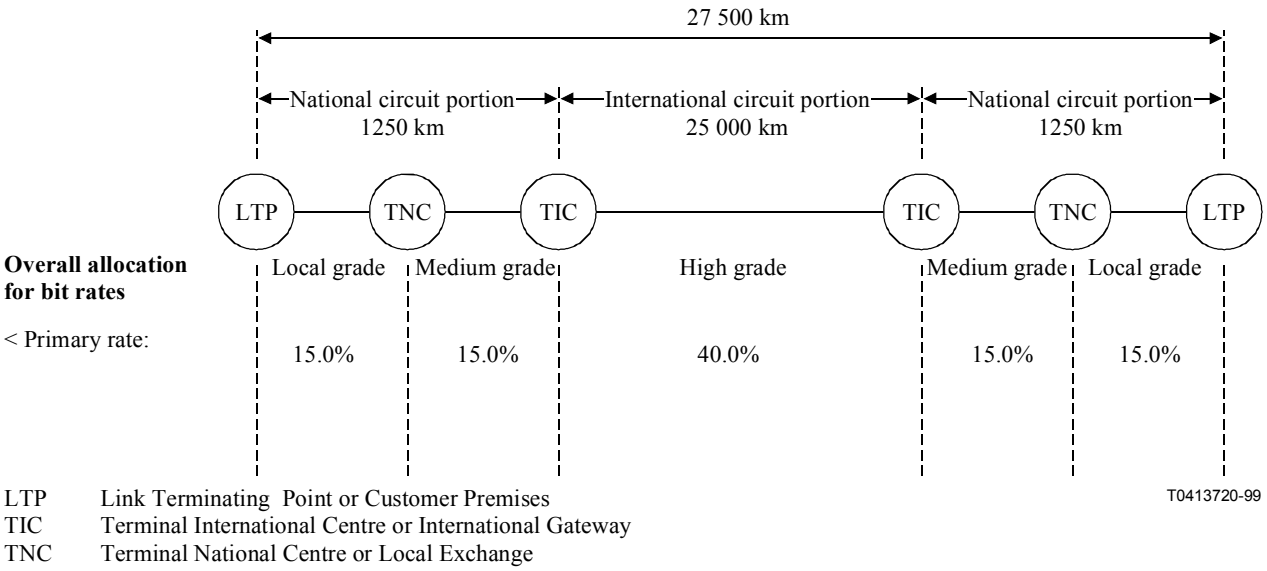
I.2.1 Data rates below primary rate

The ES performance limits used in this appendix have a mathematical basis and are derived from 15% for local grade and 15% for medium grade as a maximum allowance of the ES objective for terminal national portions of an international leased circuit inside a national territory as described in Recommendation G.821 [2]; see Figure I.1. However, taking account of practical experience, the 8% ES objective proposed in Recommendation G.821 [2] is reduced to 4% (see Table 1a/M.2100 [25]).

I.2.2 Data rate at the primary rate and higher rates

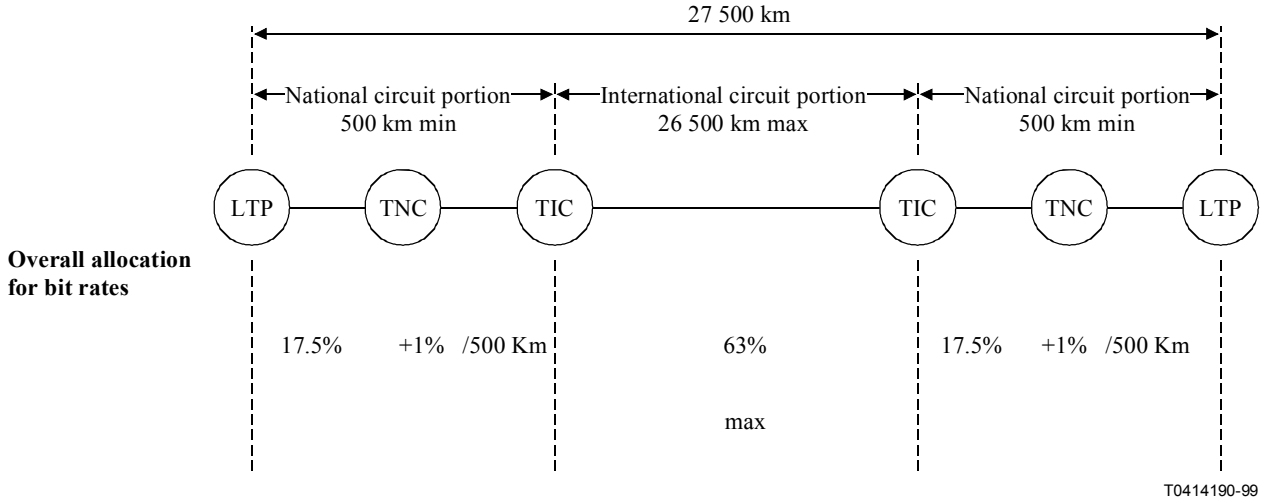
The end-to-end error reference performance objectives at or above the primary rate are those given in Table 1b/M.2100 [25]. The reference performance objective for ES used in this appendix is based on a maximum of 2% (primary rate), 2.5% (secondary rate), 3.75% (tertiary rate) and 8% (quaternary rate) end-to-end reference performance objective as derived from Recommendation G.826 [3], where 18.5% (comprised of 17.5 block allowance plus 1% per 500 km) is the performance allocation for one terminal national portion of an international leased circuit, where the maximum allocation is 9.5% for the local grade and 9% for the medium grade inside national territory (see Figure I.1).

The SES performance limits are identical to those for data rates below the primary rate.



LTP Link Terminating Point or Customer Premises
TIC Terminal International Centre or International Gateway
TNC Terminal National Centre or Local Exchange

Figure I.1/M.1340 – Example of a model for a transmission system based on the Hypothetical Reference Connection (HRX) with the location of the boundary between the medium and the high grade portions of the HRX on TIC



LTP Link Terminating Point or Customer Premises
TIC Terminal International Centre or International Gateway
TNC Terminal National Centre or Local Exchange

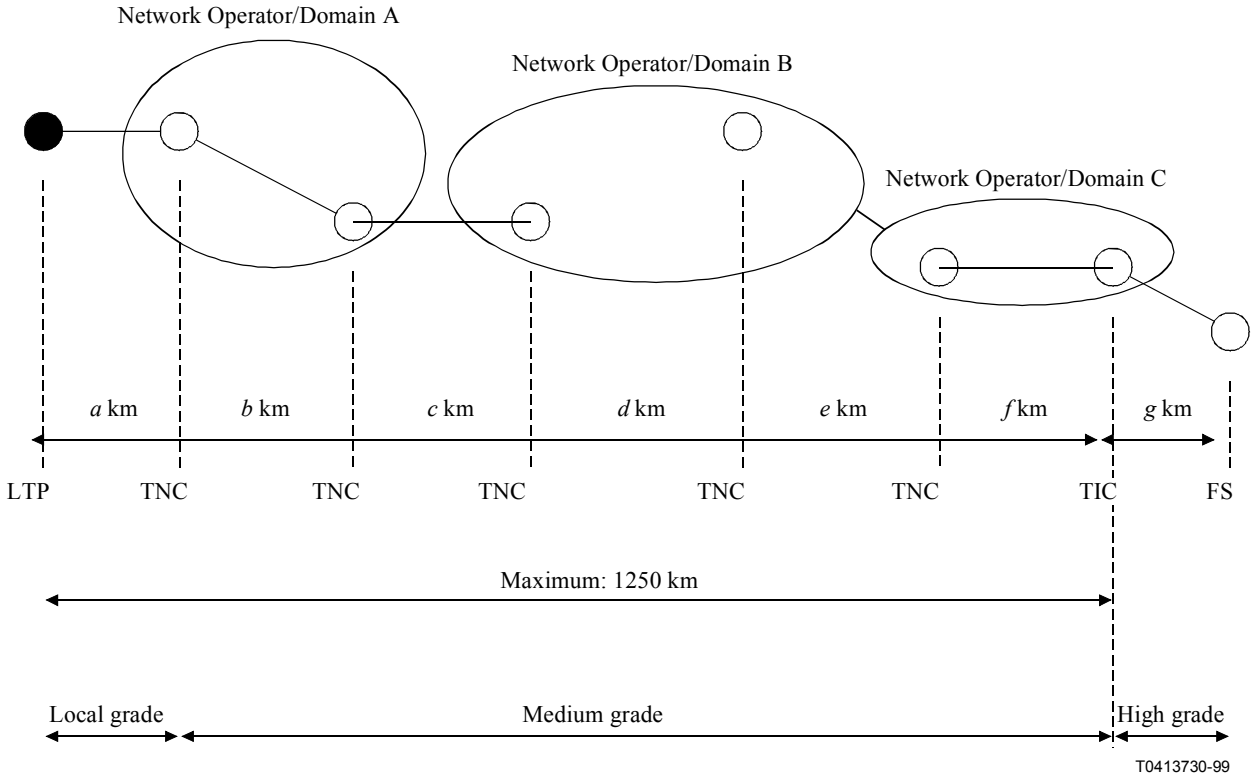
Figure I.2/M.1340 – Example of a model for a transmission system based on the Hypothetical Reference Path

The definition of "local grade" is the classification for transmission path between LTP or Customer Premises and the nearest TNC or local exchange. The definition of "medium grade" is the classification for transmission path between nearest TNC to LTP or Customer Premises and TIC or IG where the maximum distance is 1250 km. When the distance is greater than 1250 km, a part of the national circuit portion should be routed over a high-grade transmission path.

I.3 Error performance allocation principles

I.3.1 Performance allocation

Figure I.3 is a schematic diagram example of the possible regional networks within one national territory showing the LTPs, FSs, TNCs and TICs (see also Figures 2a/M.2100 [25] and 3/M.2100 [25]). For the national circuit portions, the percentage performance allocations attributable to terminating TNCs and TIC are determined by reference to Table 1. Where a national circuit portion is provided over a high grade transmission path, an allocation consistent with the terrestrial components given in Table 2 is recommended.



FS Frontier Station
LTP Link Terminating Point or Customer Premises
TIC Terminal International Centre or International Gateway
TNC Terminal National Centre or Local Exchange

Figure I.3/M.1340 – Performance allocation for the national circuit portion of an international leased circuit

The 24-hour performance limits derived are applicable to all out-of-service tests (e.g. BIS, maintenance intervention and return to service after repair) of the overall national data transmission link (LTP-to-TIC) or system.

I.3.2 Portion performance allocation

For certain operational test requirements (e.g. during maintenance investigation and routing re-arrangements), it could be necessary to perform 24-hour tests of component portions of a national data transmission link. The component portions should be measured according to Table 2.

To evaluate the allocation in the national portion of a leased circuit operating at the primary rate or above in a multi-operator environment, the following model in Figure I.4 is proposed:

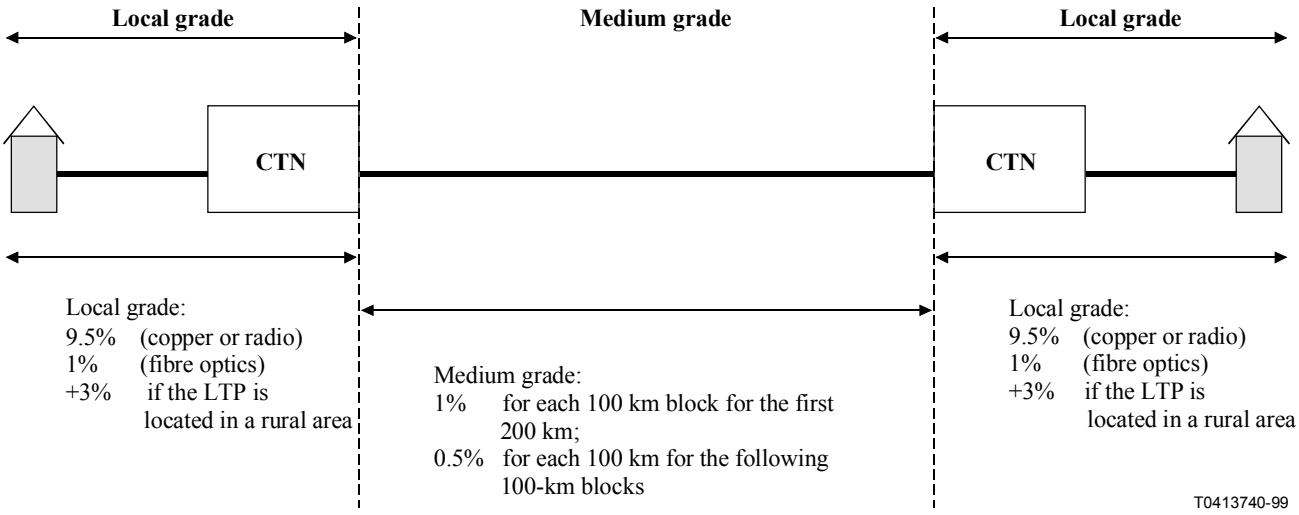
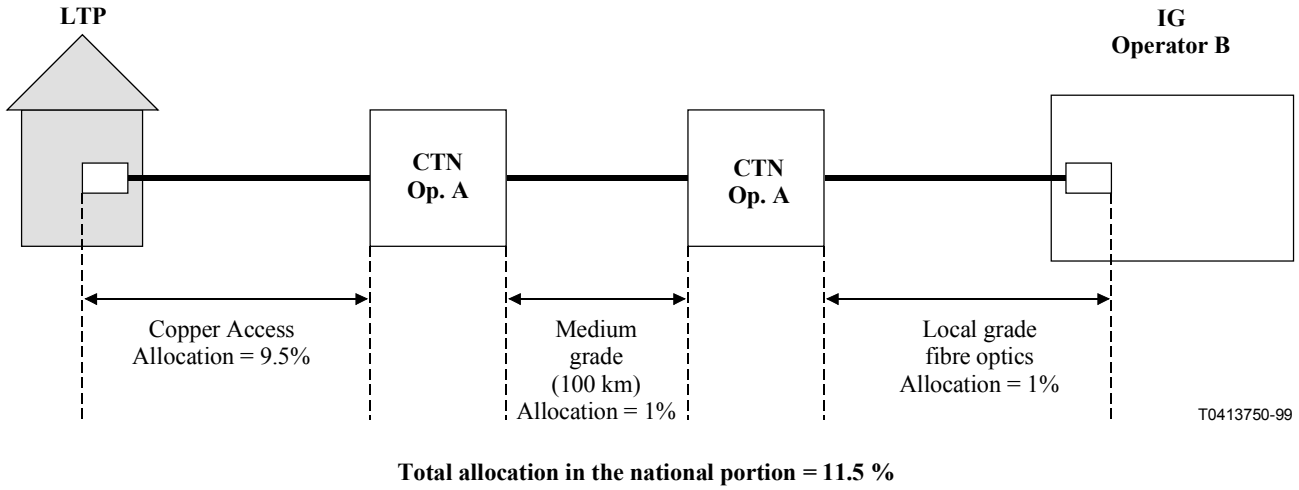


Figure I.4/M.1340 – Model for performance allocation in a multi-operator environment

This model is recursively applied to each interconnection between Network Operators/Service Providers.

Figure I.5 is an example of the national portion of an international circuit carried by a National Operator (A) and an International Operator [owner of the International Gateway (IG)].



Total allocation in the national portion = 11.5 %

Figure I.5/M.1340 – Example of performance allocation in a multi-operator environment

Network Operators/Service Providers must ensure that the sum total of allocations for individual component portions is consistent with the allocation principles described above. Where the overall allocation is exceeded, Network Operators/Service Providers should agree on proportional reductions to portion allocations by negotiation.

Agreed portion allocations should be applied to the appropriate part of Table 1 for the determination of single 24-hour test limits for ES and SES. These test limits may be used for all out-of-service test requirements between agreed MPs.

I.4 Short duration test objectives

See clause 7.

I.5 In-service performance monitoring

See clause 8.

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