RECOMMENDATION ITU-R F.1330-1*

PERFORMANCE LIMITS FOR BRINGING INTO SERVICE OF THE PARTS OF INTERNATIONAL PLESIOCHRONOUS DIGITAL HIERARCHY AND SYNCHRONOUS DIGITAL HIERARCHY PATHS AND SECTIONS IMPLEMENTED BY DIGITAL RADIO-RELAY SYSTEMS

(Question ITU-R 161/9)

(1997-1999)

The ITU Radiocommunication Assembly,

considering

a) that digital radio-relay systems for use in constant bit-rate digital paths at or above the primary rate in the international portion of a 27 500 km hypothetical reference path (HRP) are being designed;

b) that performance objectives for planning of radio-relay systems are specified separately for MRP digital and real digital links;

c) that there is a need to specify "bringing into service" (BIS) performance limits for digital radio-relay systems;

d) that ITU-T has prepared performance limits for bringing-into-service and maintenance of international plesiochronous digital hierarchy (PDH) paths, sections and transmission systems in ITU-T Recommendation M.2100 and for international synchronous digital hierarchy (SDH) paths and international SDH multiplex sections in ITU-T Recommendation M.2101, both of them being based on ITU-T Recommendation G.826;

e) that ITU-T Recommendation M.2110 provides procedures for the BIS of international digital sections, paths and transmission systems with and without in-service monitoring (ISM);

f) that ITU-R has approved Recommendations ITU-R F.1092 and ITU-R F.1189 for the error performance objectives of constant bit-rate digital paths at or above the primary rate carried by radio-relay links, both in the international and the national portions of a 27 500 km HRP;

g) that propagation conditions may adversely affect the BIS procedures for digital radio-relay systems;

h) that the influence of propagation conditions on the BIS procedures for digital radio-relay systems is addressed by Question ITU-R 203/9 and is also currently under study in Radiocommunication Study Group 3;

j) that performance limits and procedures for the BIS of PDH and SDH constant bit rate paths and sections based on digital radio-relay systems should be defined;

k) that BIS performance objectives (BISPOs) should take into account a suitable margin, to minimize subsequent maintenance interventions;

l) that due consideration of propagation conditions should be taken when undertaking BIS measurements;

m) that the performance limits and procedures for maintenance activities should be the subject of a separate recommendation,

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* This Recommendation should be brought to the attention of Radiocommunication Study Groups 3 and 4, and Telecommunication Standardization Study Groups 4 and 13.

recommends

1 that for the purpose of allocating the performance objectives for the international portion of a constant bit rate path at or above the primary rate using digital radio-relay systems, an international digital path has been partitioned in geographical terms; these portions have been titled path core elements (PCE). Two types of international PCE are used:

– an international PCE (IPCE) between an international gateway and a frontier station in a terminating country, or between frontier stations in a transit country (see Note 1);

– an inter-country PCE (ICPCE) between the adjacent frontier stations of the two countries involved. The ICPCE corresponds to the highest order digital path carried on a digital transmission system linking the two countries;

2 that the limits for BIS should be based on end-to-end reference performance objectives (RPOs) shown in Table 1 as well as allocations shown in Table 2;

TABLE 1 (see Note 2)

RPO

PDH	Primary	Secondary	Tertiary	Quaternary	
SDH (Mbit/s)	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3 500
Parameter	End-to-end RPO (maximum % of time)				
Errored seconds (ES)	2	2.5	3.75	8	Not applicable
Severely errored seconds (SES)	0.1	0.1	0.1	0.1	0.1

TABLE 2

Allocation, a_n

PCE classification (see Note 3)	Allocation (% of end-to-end RPOs)
IPCE Terminating/transit national networks: $d \leq 500$ km 500 km < $d \leq 1\,000$ km 1 000 km < $d \leq 2\,500$ km 2 500 km < $d \leq 5\,000$ km 5 000 km < $d \leq 7\,500$ km $d > 7\,500$ km	 2.0 (see Note 4) 3.0 4.0 6.0 8.0 10.0
ICPCE $d \leq 300$ km	 0.3
International multiplex section	0.2

3 that the allocated performance objective (APO) and the BISPO for the BIS of a path should be calculated as follows:

$$APO = A\% \times RPO\% \times TP$$

where:

$$A\% = \sum_{1}^{N} a_n\%$$

i.e., $A\% = a_1\% + a_2\% + \ldots + a_N\%$

a_n: allocation for each IPCE and ICPCE forming the path

TP: test period (s)

$$BISPO = APO/Fm$$

where Fm is the maintenance margin;

4 that for the definition of BISPO the following maintenance margin Fm should be specified:

TABLE 3

Maintenance margins, *Fm*

	Maintenance margin, *Fm*	
	For normal propagation conditions (Note 5)	For adverse propagation conditions (Notes 5 and 6)
PDH paths and sections SDH paths	2	0.5
PDH transmission systems SDH multiplex sections	10	0.5

5 that test periods (TPs) for BIS of digital radio-relay systems have been designed as follows:

– for all radio paths and sections, a 24-h BIS test period should be used and the performance must satisfy the calculated *S*1 limit for each parameter, ES and SES (see Annex 1);

– for radio paths and sections with performance falling between the *S*1 and *S*2 performance limits during the 24-h test period and that are continuously monitored during operation (with in-service monitoring (ISM)), a further extended 7-day BIS test period should be undertaken;

– for radio paths and sections with performance falling between the *S*1 and *S*2 performance limits during the 24-h test period and that are not monitored during operation (non-ISM), provisional acceptance or BIS re-testing should be undertaken, subject to agreement between the parties;

– for new radio paths and sections over routes where no radio paths or sections are present and during periods of adverse propagation conditions, an extended 7-day BIS testing period should be used and the performance must satisfy the calculated BISPO for each parameter, ES and SES;

6 that Annex 1 contains guidance and further details on the BIS limits, test procedures and methodology for calculating the BISPOs and their limits.

NOTE 1 – The definitions of an international gateway and a frontier station can be found in ITU-T Recommendation M.2101 (Part 1).

NOTE 2 – It is the responsibility of each country to design its network in a way that is consistent with its country allocation for the international path.

NOTE 3 – The lengths *d* referred to in Table 2 are actual route lengths or air-route distances multiplied by an appropriate routing factor, *Rf*, whichever is less; for multiplex sections the length *d* refers to the actual distance only (see ITU-T Recommendation M.2100):

$Rf = 1.5$ for $d \leq 1\,000$ km,

$Rf = 1.25$ for $d > 1\,000$ km.

NOTE 4 – For an IPCE with a total length below 500 km a lower value could be used upon agreement between the interested parties.

NOTE 5 – The periods of normal and adverse propagation conditions may change from country to country and therefore it is the responsibility of the interested parties to reach agreement.

NOTE 6 – If it is defined that the BIS procedure should take place during *X* month (*X* month is up to 3 and it is under mutual agreement between the interested parties) before or after the period with adverse propagation conditions the value $Fm = 1$ may be used under mutual agreement between the interested parties.

ANNEX 1

Performance limits and methodology for BIS

1 BIS testing procedures

The BIS testing procedures for the bringing into service of international PDH paths, sections and transmission systems and SDH paths and sections, including how to deal with any period of unavailability during the test, are defined in § 4.2 of ITU-T Recommendation M.2110 and may be applied to digital radio-relay paths, sections and transmission systems during periods of normal propagation.

However, in order to take due consideration of the effects of propagation and the periods of adverse propagation that may influence the performance of radio-relay systems, the following BIS testing procedures and steps should be used. The testing procedures are divided into two discrete steps; namely:

– An initial (15-min) testing period, to provide initial proof of performance of the radio system under test.

– BIS testing for the full TP, as appropriate to the radio system under test (see *recommends* 5).

1.1 Initial testing procedure (Step 1)

Initial measurements should be performed over a 15-min period of time, using a measuring instrument with a framed pseudo-random bit sequence (PRBS).

During this 15-min period of time there should be no errors or unavailability events. If any error or unavailability event is observed, the test should be halted and repeated. The initial testing may be repeated twice. If, during the third (and the last) test, there is any error or unavailability event, the radio system should be withdrawn from testing and fault localization and correction must be performed.

It is recommended that the initial (15-min) tests are performed during a period of the day where clear-air propagation conditions exist and where the probability of adverse propagation conditions is minimal (normally this period is between 10:00 and 14:00 h local time).

1.2 Main testing procedure (Step 2)

After successfully passing Step 1 (initial testing procedure), a test over a 24-h period of time is applied. Real traffic could be carried if (ISM) is available. However, if ISM is not available, the testing is performed under the same conditions as for initial testing (i.e. using a measuring instrument).

At the end of the 24-h period of time, the results of the measurements are compared to the BIS limits *S*1 and *S*2 (see § 2 and 3).

Should an unavailability event occur at any time during the BIS testing, the cause should be investigated and a new BIS test re-scheduled. Should a further unavailability event occur in the second BIS test, then BIS testing should be suspended until the cause of the unavailability event has been resolved.

The outcome of all BIS tests should be recorded for future reference.

2 The methodology of calculation of BIS performance limits

The following steps shall be followed to obtain path performance limits:

– Identify the bit rate of the path.

– Read the RPOs for the appropriate bit rate from Table 1 for both ES and SES.

– Identify all PCEs for the entire path, and set N = the total number of PCEs.

– Identify the length, d, of each PCE.n (n = 1 to N). The length, d, is either the actual path length or can be estimated by the great circle length between its end points multiplied by the appropriate routing factor Rf (see Note 3 above).

– Take the allocation, a_n%, (as a percentage of end-to-end RPO) for PCE.n (n = 1 to N) from the Table 2. Note that the allocations in Table 2 are maximum values; more stringent values can be used by bilateral or multi-lateral agreement.

– Calculate A%, the path allocation, where:

$$A\% = \sum_{1}^{N} a_n\%$$

– Determine the required TP in accordance with *recommends* 5 (24 h or 7 days).

Express TP in seconds, e.g., TP = 86 400 s for a 24-h TP and TP = 604 800 s for a 7-day TP.

– Calculate the APOs for ES and SES required from the information already obtained:

$$APO = A\% \times RPO\% \times TP$$

– Calculate the BISPOs for the path:

$$BISPO = APO/Fm$$

where Fm is the maintenance margin (see *recommends* 4).

– For TP = 24 h, calculate $S1$ and $S2$ values for ES and SES objectives:

$$S1 = BISPO - 2 \times \sqrt{BISPO}$$

$$S2 = BISPO + 2 \times \sqrt{BISPO}$$

round all $S1$ and $S2$ values to the nearest integer value.

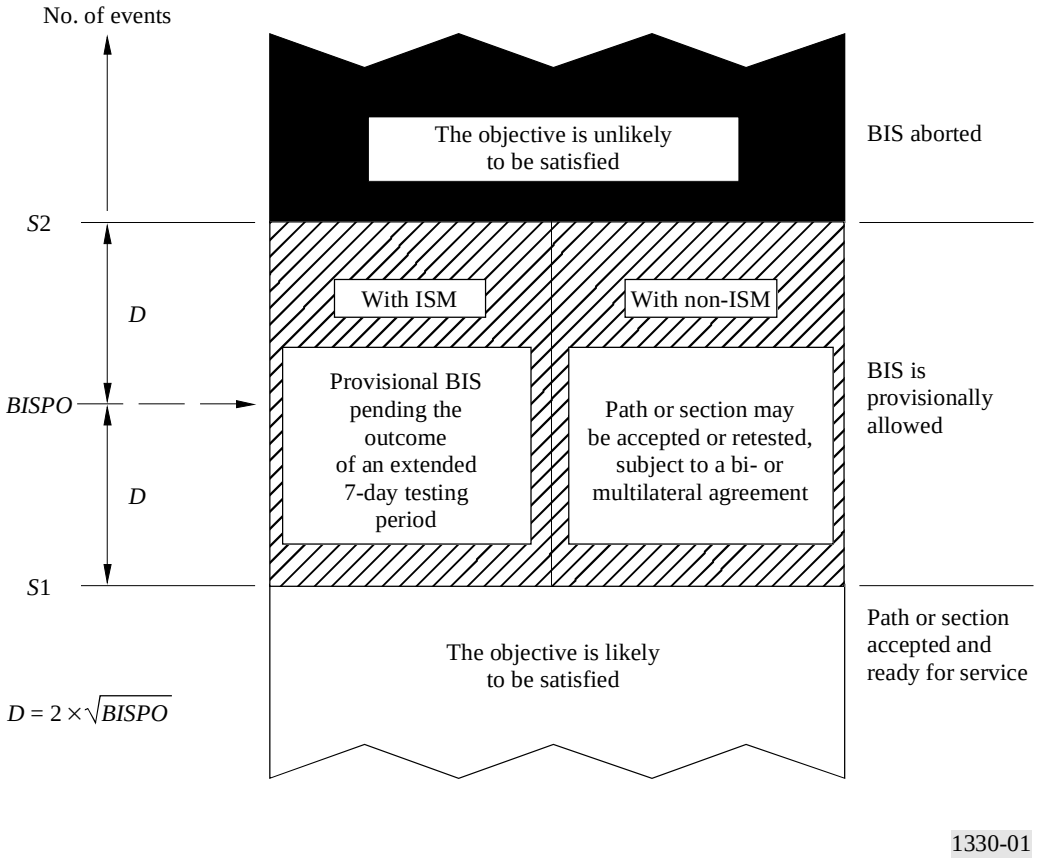
Note that if any PCE within a path is changed, then the entire calculation process must be repeated, since the $S1$ and $S2$ values are non-linear.

A similar procedure could be used for PDH transmission systems and SDH multiplex sections but Fm should be taken in accordance with *recommends* 4.

3 BIS limits and conditions

The evaluation of the BIS test results, using the $S1$ and $S2$ performance limits, as calculated using the methodology contained in § 2 are detailed below in § 3.1, 3.2, 3.3 and in Fig. 1.

FIGURE 1



3.1 BIS radio paths and sections not monitored during operation (with non-ISM)

The two steps of the BIS testing procedure, as described above, must be performed using a measuring instrument. At the end of Step 2 testing, the following scenarios are possible:

– if ES and SES are both less than or equal to their respective *S*1 values, the radio path or section is accepted and becomes ready for service;

– if ES or SES (or both) are greater than or equal to their respective *S*2 values, the radio path or section is rejected and appropriate fault localization procedures begin;

– if either ES or SES (or both) are greater than their respective *S*1 values, but both smaller than their respective *S*2 values; the radio path or section can be either provisionally accepted, or re-tested, subject to bilateral or multilateral agreement.

3.2 BIS radio paths and sections continuously monitored during operation (with ISM)

The two steps of the BIS testing procedure, as described above, in § 1.1 and 1.2, must be performed. At the end of Step 2 testing, the following scenarios are possible:

– if ES and SES are both less than or equal to their respective *S*1 values, the radio path or section is accepted and becomes ready for service;

– if ES or SES (or both) are greater than or equal to their respective *S*2 values, the radio path or section is rejected and appropriate fault localization procedures begin;

– if either ES or SES (or both) are greater than their respective *S*1 values, but both smaller than their respective *S*2 values; the radio path or section can be provisionally accepted, pending the outcome of an extended 7-day BIS testing period.

3.3 Description of the extended 7-day BIS test

Extended 7-day BIS testing is applicable to radio paths or sections:

– operating under normal propagation conditions, with ISM functions available and which has exhibited marginal performance of the 24-h test, i.e. either ES or SES (or both) are greater than their respective *S*1 values, but both are smaller than their respective *S*2 values;

– over new routes where no radio paths or sections were present and during periods of adverse propagation conditions.

When carrying out an extended 7-day BIS test, the first 24-h period of time (Step 2) should be included within the seven-day test period. For adverse propagation conditions, an extended 7-day test period should be used for all radio paths undergoing BIS testing.

At the end of this test period, the measurement should not exceed the 7-day BISPOs, as determined by the calculation method given in § 2. The following two scenarios are possible:

– if both ES and SES are less than or equal to their respective 7-day BISPOs, the radio path is accepted and becomes ready for service;

– if the 7-day ES or SES BISPOs (or both) are exceeded during normal propagation conditions, the radio path is not ready for service and the appropriate investigation and/or fault localization procedure begins.

In the case that no anomalous conditions have been detected the path is rejected.

NOTE – If the 7-day ES or SES BISPOs (or both) are exceeded but no more than twice during the period with adverse propagation conditions, the following 7-day test period could be used under mutual agreement between the interested parties for final decision if the path or section is ready for service.