RECOMMENDATION ITU-R F.1330-2*

Performance limits for bringing into service the parts of international plesiochronous digital hierarchy and synchronous digital hierarchy paths and sections implemented by digital fixed wireless systems

(Question ITU-R 161/9)

(1997-1999-2006)

Scope

This Recommendation provides BIS performance limits for international PDH and SDH paths and sections implemented using FWS. The approach is aligned to the ITU-T BIS approach, but some media-specific (FWS) aspects are incorporated. The Annex details the application of the performance limits for BIS.

The ITU Radiocommunication Assembly,

considering

a) that digital fixed wireless 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 there is a need to specify "bringing into service" (BIS) performance limits for digital fixed wireless systems;

c) that the performance limits and procedures for maintenance activities for digital fixed wireless systems have been defined in Recommendation ITU-R F.1668;

d) that ITU-T has prepared performance limits for bringing-into-service and maintenance of international multi-operator plesiochronous digital hierarchy (PDH) path, connections in ITU-T Recommendation M.2100 and for international multi-operator synchronous digital hierarchy (SDH) paths and international SDH multiplex sections in ITU-T Recommendation M.2101, being based on ITU-T Recommendation G.826 and G.828 respectively;

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

f) that ITU-R has approved Recommendation ITU-R F.1668 for error performance objectives for real digital fixed wireless links used in 27 500 km hypothetical reference paths and connections;

g) that propagation conditions may adversely affect the BIS procedures for digital fixed wireless systems;

h) that the influence of propagation conditions on the BIS procedures for digital fixed-wireless systems currently under study in Radiocommunication Study Group 3;

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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.

j) that performance limits and procedures for the BIS of PDH and SDH constant bit rate paths and sections based on digital fixed-wireless 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;

noting

a) 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 fixed-wireless 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;

recommends

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

TABLE 1a (See Note 2)

RPO

PDH	**Primary (Note 4)**	**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				
Errored seconds ratio (ESR) for paths designed according to G.826	0.02	0.025	0.0375	0.08	Not applicable (NA)
Errored second ratio (ESR) for paths designed according to G.828	0.005	0.005	0.01	0.02	(NA)
Background block error ratio (BBER) for SDH paths designed according to G.828	2.5 × 10–5	2.5 × 10–5	2.5 × 10–5	5 × 10–5	5 × 10–5
Severely errored seconds ratio (SESR)	0.001	0.001	0.001	0.001	0.001

TABLE 1b

RPO for end-to-end international SDH multiplex sections

Rate	STM-0	STM-1	STM-4
Blocks/second	64 000	192 000	768 000
ESR (according to G.826)	0.0375	0.08	NA
ESR (according to G.828)	0.01	0.02	NA
SESR	0.001	0.001	0.001
BBER (according to G.826)	NA	NA	NA
BBER (according to G.828)	2.5×10^{-5}	5×10^{-5}	5×10^{-5}

TABLE 2

Allocation, a_n

PCE classification (see Note 3)	Allocation (% of end-to-end RPOs)
IPCE	
Terminating/transit national networks:	
$d \leq 100$ km	1.2
100 km < $d \leq 200$ km	1.4
200 km < $d \leq 300$ km	1.6
300 km < $d \leq 400$ km	1.8
400 km < $d \leq 500$ km	2.0
500 km < $d \leq 1\,000$ km	3.0
1 000 km < $d \leq 2\,500$ km	4.0
2 500 km < $d \leq 5\,000$ km	6.0
5 000 km < $d \leq 7\,500$ km	8.0
$d > 7\,500$ km	10.0
ICPCE	
$d \leq 300$ km	0.3
International multiplex section	0.2

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

for a path

$$APO_{es} = A\% \times RPO_{es} \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

$$APO_{ses} = A\% \times RPO_{ses} \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 2\,000 \div 100 \text{ (convert } A\% \text{ to ratio – VC-1 and 2)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 8\,000 \div 100 \text{ (convert } A\% \text{ to ratio – VC-3 and 4 and VC-4-Xc)}$$

for a multiplex section

$$APO_{es} = A\% \times RPO_{es} \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

$$APO_{ses} = A\% \times RPO_{ses} \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 64\,000 \div 100 \text{ (convert } A\% \text{ to ratio – STM-0)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 192\,000 \div 100 \text{ (convert } A\% \text{ to ratio – STM-1)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 768\,000 \div 100 \text{ (convert } A\% \text{ to ratio – STM-4)}$$

where:

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

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

a_n: allocation for each IPCE and ICPCE forming the path

$A\% = a\%$ for a multiplex section

TP: test period (s)

$$BISPO = APO/Fm$$

where Fm is the maintenance margin;

3 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

4 that test periods (TPs) for BIS of digital fixed wireless 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_{24} limits for each error performance parameter (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 error performance parameter;

5 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.

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):

TABLE 4

PCE great circle length vs. routing factor

PCE great circle length	Routing factor (*Rf*)	Calculated PCE length
$d < 1\,000$ km	1.5	$1.5 \times d$ km
$1\,000 \text{ km} \le d < 1\,200$ km	$1\,500/d$	1 500 km
$d \ge 1\,200$ km	1.25	$1.25 \times d$ km

NOTE 4 – For international multi-operator connections using equipment designed according to revised ITU-T Recommendation G.826 RPO for PDH primary rate could be used.

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 ITU-T Recommendation M.2110 and may be applied to digital fixed wireless 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 fixed wireless 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* 4).

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 $S1$ and $S2$ (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 1a or 1b for each error performance parameter (ESR, SESR and BBER).

– 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:

$$APO = A\% \times RPO\% \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

– Calculate the BISPOs for the path:

$$BISPO = APO/Fm$$

where Fm is the maintenance margin (see *recommends* 3).

– For $TP = 24$ h, calculate $S1$ and $S2$ values for each error performance parameter:

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

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

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

In some cases the BBE S limits are non-zero while the ES limits are zero or invalid (i.e. do not provide 95% confidence that the BISPO will be met long term). It is generally suggested that a longer test be used where the ES limits are invalid. In either case, the BBE test cannot be accepted if there is more than 1 ES.

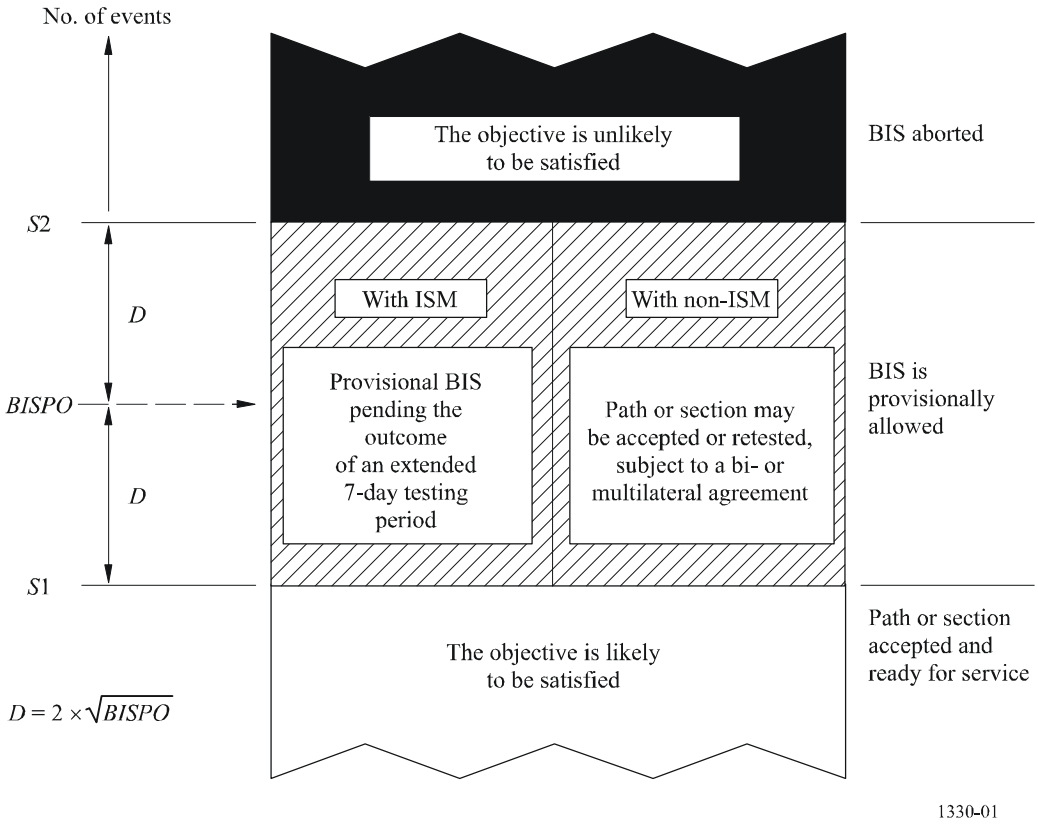
Note that if any PCE within a path is changed, then the entire calculation process must be repeated, since the $S1$ and $S2$ values are non-linear.

A similar procedure could be used for PDH transmission systems and SDH multiplex sections but Fm should be taken in accordance with *recommends* 3.

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 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 all error performance parameters are less than or equal to their respective *S*1 values, the radio path or section is accepted and becomes ready for service;

– if any error performance parameters (or all) 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 any error performance parameters (or all) are greater than their respective *S*1 values, but all are 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 all error performance parameters are less than or equal to their respective *S*1 values, the radio path or section is accepted and becomes ready for service;

– if any error performance parameters (or all) 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 any error performance parameter (or all) are greater than their respective *S*1 values, but all are 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 any error performance parameters (or all) are greater than their respective *S*1 values, but all 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 all error performance parameters are less than or equal to their respective 7-day BISPOs, the radio path is accepted and becomes ready for service;

– if during the 7-day test period any error performance parameter (or all) 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 1 – If during the 7-day test period any error performance parameter (or all) 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.