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SDH INTERCONNECT BETWEEN UK LICENSED OPERATORS INTEROPERABILITY COMMISSIONING RECOMMENDATION

Issue 8

Network Interoperability Consultative Committee
Ofcom
Riverside House,
2a Southwark Bridge Road,
London
SE1 9HA
UK
http://www.nicc.org.uk

Normative Information

If you have any comments concerning the accuracy of the contents of this document, please write to:

The Technical Secretary,
Network Interoperability Consultative Committee,
Ofcom,
Riverside House,
2a Southwark Bridge Road,
London,
SE1 9HA,
UK.

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1. INTRODUCTION

1.1 Document History

Release 3.0 June 95

First formal release of the recommendation, covering 2Mbit/s only, carried in VC12 format, over STM-1 (155Mbit/s) interconnects.

Release 4.0 May 97

This release addresses interconnection at additional line rates, namely STM-4 (622Mbit/s) and STM-16 (2488Mbit/s), together with tributaries at 2Mbit/s (VC12), 34Mbit/s (VC3), 140Mbit/s (VC4) and STM-1 (electrical and optical). Not formally issued by PNOIG.

Release 4.1 July 97

Addition of note to paragraph 3.3.

Release 5 March 99

To bring in line with G707 (1996).

Release 6 June 2000

This release adds STM-64,256 and VC concatenation,
(to bring in line with G.707(2000)

Release 7 July 2001
Change of document title and amendment of Section 3.2 for optional end to end tributary testing.

Release 8 March 2002

New sections 3.2.6 and 3.2.7 for support of MSP In Span Connections with supporting Test 14 & 15 records in Appendix A & B.

Normative References

Reference 1: SDH Interconnect between UK Licensed Operators – Overview. Release 6
Reference 2: SDH Interconnect between UK Licensed Operators – Technical Release 6.
Reference 3: BS EN 60825: Radiation Safety of Laser Products
Part 1:Equipment Classification , Requirements and User Guide (1994).
Part 2: Safety of Optical Fibre Communications Systems (1995).
Reference 4: ITU(T) Recommendation G.958.
Reference 5: ITU(T) Recommendation G707 (2000).
Reference 6: BS EN 100015-1:1992.
Reference 7: ITU(T) Recommendations M.2100/2101.1
Reference 8: ITU(T) Recommendation O.151
Reference 9: ITU(T) Recommendation G.703

1.3 Definitions and Abbreviations

1.3.1 Interconnection Types

For the purposes of this Recommendation the terminology used in Reference 1 shall be used, as follows:

In Span Interconnection - Optical, ISI-O.

In Span Interconnection - Optical occurs when the point of interconnection is located in the optical fibre, or optical fibre connectors, between the two Network Elements forming the interconnect circuit, as shown below:

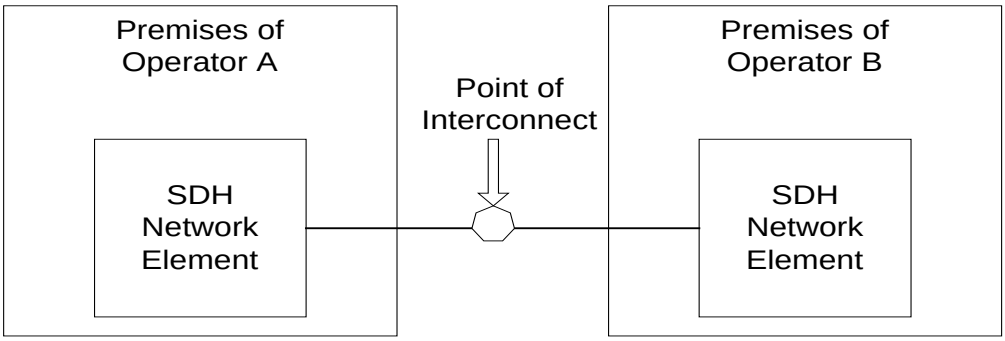


Figure 1

In Building Interconnection - Optical, IBI-O, and
In Building Interconnection - Electrical, IBI-E

In Building Interconnection - Optical/Electrical occurs at an optical/electrical interface, as appropriate, between two network elements within one operators premises, as below;

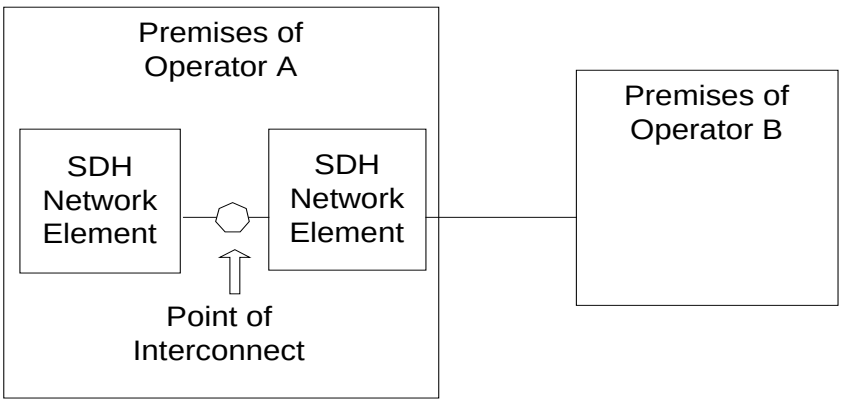


Figure 2

1.3.2 Automatic Laser Shutdown, ALS

Automatic Laser Shutdown is a mechanism which ensures that a laser transmitter is automatically turned off when a break occurs in the optical fibre into which it is transmitting.

ALS is detailed in reference 4.

The implementation of ALS is optional.

1.4 Scope

This test specification encompasses the following:

- Essential safety information.
- The entry criteria for the testing to commence.
- The order in which testing shall be carried out.
- The configuration and test method for each test.
- The mechanism for collection of results.
- The mechanism for reporting problems.
- The exit criteria for completion of testing.

Configurations of interconnect covered are STM-N(N=1,4,16,64,256) carrying single containers VC-n or concatenated containers VC-n-Xc or Xv (where n=1,2,3,4 and X=4,16,64). Payloads supported include 1.5/2/34/45/Mbit/s, ATM, IP and other clients, which may be mapped into single or concatenated containers. Interfaces may be electrical or optical depending on bit rate.It is assumed that interconnecting elements may comprise SDH line systems, SDH multiplexers, SDH cross-connects or any combination of the above. The following shall not be covered by this document.

- Path protection switching based on BER thresholds.
- Measurement of path protection switching times.
- Optional features (eg User Channel, Engineering Order Wire)

This recommendation may need future updating to take account of international standards revisions.

The combination of tests carried out will depend on the configuration of interconnect used. In general however, testing will follow the sequence below.

1. Receive optical power measurements, with ALS testing if implemented, or
2. Receive optical power measurements, with distant link alarm tests if ALS not implemented.
3. Error free operation at each site.
4. Path / sub-network protection.
5. Operation of synchronisation across a link.
6. Percussion test
7. Stability test

During testing, the synchronisation arrangements for the link should be set up as they will be in final operation unless the test specifies an alternative arrangement.

If Automatic Laser Shutdown is operational, it will have to be disabled during those tests that involve breaking a fibre link.

Some of the tests described in this recommendation may have to be modified or omitted if they are likely to have an adverse effect on live network traffic. Any changes to the testing program should be agreed between the two operators.

When carrying out bit error rate tests, recognition should be given to the principles outlined in ITU(T) M.2100/M.2101.1 in relation to acceptable errors and length of circuits.

1.5 Purpose

This document specifies a commissioning procedure for establishing the correct operation of an SDH interconnect between two independent synchronous networks, and the operation of circuits carried across that interconnect. The document assumes that the two networks are linked via one or more In Span Interconnections – Optical, ISI-O, but a subset of the tests in this document may also be used for testing In Building Interconnections, both Optical and Electrical, IBI-O and IBI-E respectively, (the principles of In Building and In Span SDH interconnection may be found in Reference 1).

The recommendation is applicable both to SDH interconnects using equipment supplied by a single vendor, and also to SDH interconnects involving equipment supplied by several different vendors.

This recommendation does not address the issue of equipment conformance testing. Operators are expected to demonstrate that their equipment is capable of meeting the requirements of the Technical Recommendation (Reference 2) before undertaking the tests described in this document. Where the interconnect is being implemented using equipment supplied by more than one vendor, operators should carry out compatibility testing before undertaking the tests described in this document. Compatibility testing will subsequently be required after hardware, firmware or software upgrades.

Some combinations of vendor equipment are known to result in problems with channel numbering. Where this occurs, procedures will be required to handle the change in channel numbering as a circuit passes from one side of the interconnect to the other.

2 PRE-REQUISITES

2.1 Test Entry Criteria

- Equipments shall have successfully completed conformance testing.
- Interworking between the two network element types providing the interconnect, at the relevant build levels, shall have been proven.
- The network elements at each end of the link must have been commissioned in standalone mode in accordance with the respective operator's internal test procedures.
- The equipment should be set to a known state, and any active alarms should be noted.
- All necessary fibres and other connections shall have been provided and commissioned in accordance with the respective operators internal procedures.
- A means of detecting alarm signals shall be available at both ends of the interconnection.
- A synchronisation strategy for the interconnect as per Reference 2 shall have been implemented.
- Appropriate company documentation shall be available as described in Section 2.6.
- All staff involved in testing shall be trained in accordance with the respective company procedures.
- Staff involved in testing shall have access to the appropriate Equipment User Manual(s).
- Optical line losses to be agreed and verified.
- For in building electrical interconnect the maximum line reach of G.703 should be considered.

2.2 Test equipment

The following test equipment will be required to enable the tests described in this recommendation to be performed.

- Bit error rate tester (BERT). The tester used must be appropriate for the type of tests being conducted. For example if the interconnect is at the STM-N tributary level then an STM-N tester is required. If the interconnect is at the 2Mbit/s, 34Mbit/s,45 Mbit/s or 140Mbit/s tributary level then a tester(s) capable of testing at these levels is sufficient. Test patterns shall conform to ITU-T Recommendation O.151.

- Optical Power Meter.

- Variable Optical Attenuator

- Local Terminal with software and appropriate cables.

- Clock synthesiser.

- Frequency counter.

- Appropriate electrical and optical patch cords.

2.3 Optical Safety

All work on network elements employing lasers shall be conducted in accordance with the respective operators Optical Safety procedures. The following minimum requirements shall apply;

BEFORE POWER IS APPLIED TO ANY OPTICAL EQUIPMENT AT EITHER END, PERSONNEL AT EACH END OF THE LINK SHALL CONFIRM TO PERSONNEL AT THE OTHER END THAT THEY ARE READY TO BEGIN TESTING, AND THAT THEY HAVE TAKEN THE NECESSARY PRECAUTIONS.

ALL STAFF WORKING ON OPTICAL SYSTEMS MUST BE ADEQUATELY TRAINED.

Under normal operating conditions, the optical fibre equipment forms part of a closed system, i.e., the invisible radiation produced is contained within closed paths. However, when the path is broken, (e.g., during testing) exposure to the radiation is possible.

The focusing ability of the eye makes it susceptible to damage, and safe working practice must be adopted to minimise the risk of exposure.

All optical interconnections should be designed, installed and operated in accordance with the safety requirements detailed in Reference 3 (BS EN 60825 Parts 1 and 2). It is theoretically possible under fault conditions that the level of power emitted by the equipment could exceed the class limit for a brief period. The owner of the transmission equipment who has exclusive access to that equipment should use internal company safety procedures appropriate to the classification of the laser sources.

See also Reference 3.

2.4 Precautions against Electrostatic Discharge (ESP)

Precautions shall be taken in accordance with respective operators procedures. The following minimum requirements shall apply;

i) All personnel shall wear conductive and bonded wrist straps (which conform to reference 6) and be connected to an electrostatic protection bonding point or, if there is no point available, to a suitable earth point via an ESP adapter.

ii) Always connect the ESP wrist strap to the equipment rack ESP bonding point before removing covers, cards or connectors.

iii) The ESP wrist strap shall be in contact with the wearer's skin.

iv) All test equipment and trolleys should be connected to the ESP bonding point.

2.5 Inspection and Cleaning of Optical Connectors

Optical connectors shall be inspected and cleaned in accordance with respective operators procedures. As a minimum the following shall apply;

Before any inspection of an optical connector, ensure that the optical power source is removed. Confirm this by the use of an optical power meter to check that no power is present at the connector, before a microscope is used.

Note: Inspection and cleaning of optical connectors may have been performed during equipment commissioning.

2.6 Documentation

Staff involved in testing should be aware of the following documents in addition to the relevant Health and Safety procedures required by the circumstances:

Procedure	Necessary Documentation
Ensuring Optical Safety	BS EN 60825 Parts 1,2 and 4 Internal Company Procedures (see also Section 2.3)
Protection Against Electrostatic Discharge (ESP)	Internal Company Procedures (see also Section 2.4)
Inspection and Cleaning of Optical Connectors	Internal Company Procedures (see also Section 2.5)

3. FEATURES TO BE TESTED

3.1 Testing of the interconnect link.

3.1.1 Test options.

This test sequence confirms the operation of the link between the Network Elements at each end. Where the interconnection is over optical fibre, and Automatic Laser Shutdown, ALS, is implemented, test sequence 3.1.2, and 3.1.4 should be used. Where the interconnection is over optical fibre and ALS is not implemented, test sequence 3.1.2 and 3.1.3 should be used. If the interconnect is an In Building Interconnection - Electrical, test sequence 3.1.3 only should be used.

The test sequences below should be repeated for each interconnect transmit/receive pair in the interconnect network. (Except for previously tested links carrying live traffic).Options could include -

- Point to point interconnect using one receive and one transmit fibre only.
- 1+1 dual fibre pairs to provide protected interconnect.
- Two separate fibre pairs, forming two sections of an interconnect ring or other network.
- A second interconnect pair to provide diversity to an existing interconnect carrying live traffic

The tests will -

- Give confidence in the end-to-end continuity, quality of fibre if appropriate (particularly at joints) and desired signal strength through the fibre.

- Ensure distant alarms are reported correctly.

- Allow all other tests to be carried out.

3.1.2 Optical Received power and path continuity test.

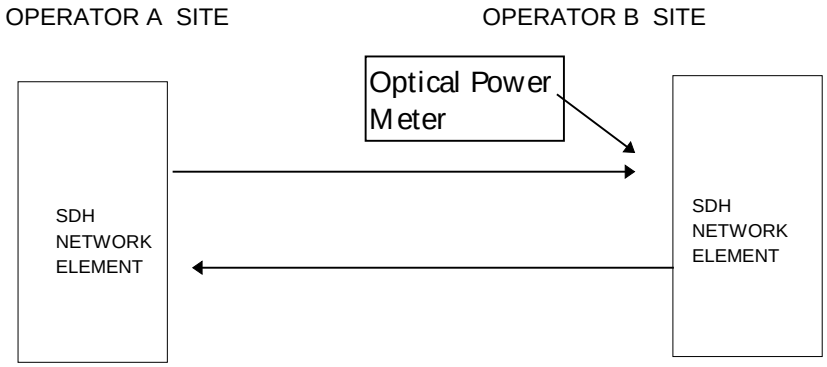


Figure 3

3.1.2.1 Test Objectives

a) To check end to end continuity

b) To measure received optical power

Note: Before conducting this test details of the correct optical operating range for the receive network elements should be determined from the appropriate equipment handbooks and/or other locally held information.

3.1.2.2 Test Summary

Optical line continuity is checked by measuring the optical power received. For test purposes the laser power should only be connected to the fibre when the receive end is connected to either the Optical Power Meter or to the SDH equipment. The test will be conducted for both directions of transmission.
The test procedure should be repeated for each optical path when a main and standby interconnect route are implemented.
Note: Transmitted optical power will have already been confirmed during equipment stand alone commissioning.

3.1.2.3 Test Procedure

Note: ALS should be disabled whilst conducting this test.

Steps	Actions	Measurement/Pass Criteria
Operator A to Operator B direction.		
1.	Operator A measures and records local transmit power.	A Tx Power…….dBm
2.	Operator B measures and records local transmit power.	B Tx Power …….dBm
3	Operator A disables it's laser source.	
4	Operator B connects its Optical Power Meter.	
5	Operator A enables it's laser and Operator B measures and notes the received power at the connector used for connection to the SDH equipment.	B Rx Power.....dBm
6	Operator A disables it's laser source.	
7	Operator B reconnects it's receive fibre to the SDH equipment.	
8	Operator A enables it's laser. Both operators check that the link is established.	Link is operational in both directions.
Operator B to Operator A direction.		
9	Operator B disables it's laser source.	
10	Operator A connects its Optical Power Meter.	

11	Operator B enables it's laser and Operator A measures and notes the received power at the connector used for connection to the SDH equipment.	A Rx Power.....dBm
12	Operator B disables it's laser source.	
13	Operator A reconnects it's receive fibre to the SDH equipment.	
14	Operator B enables it's laser. Both operators check that the link is established.	Link is operational in both directions.

Note: blanked out box indicates an instruction to enable the test to be conducted

3.1.3 Distant Alarm Tests at Operator A and Operator B Sites

3.1.3.1 Test Objective

This test confirms end to end alarm signalling between network elements and is applicable to all interconnection types as described in Section 1.3.1. For optical interconnections the test is only required if ALS is not used.

3.1.3.2 Test Summary

The output at each end of the link is interrupted and the far end alarm indications noted.

3.1.3.3 Test Procedure

Steps	Actions	Measurements/Pass Criteria
1	Disable the network element output at the Operator A end and check that the network element terminating the Operator B end of the interconnecting section reports "Loss of Signal" alarm.	LOS alarm present at B end.
2	Restore the network element A output connection and establish error free traffic.	No System Alarms reported.
3	Disable the network element output at the Operator B end and check that the network element terminating the Operator A end of the interconnecting section reports "Loss of Signal" alarm.	LOS alarm present at A end.
4	Restore the network element B output connection and establish error free traffic.	No System Alarms reported.

3.1.4 Automatic Laser Shutdown Test

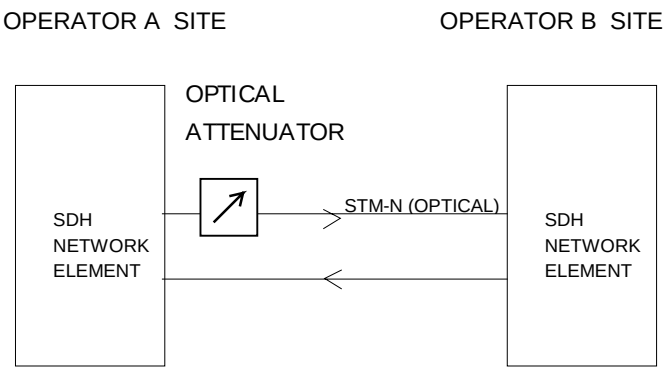


Figure 4

3.1.4.1 Test Objective

To demonstrate the correct operation of Automatic Laser Shutdown (ALS).

This test is only applicable to optical interconnections on which ALS to Recommendation G.958 has been implemented. This test is not applicable to SDH In Building Interconnections - Electrical.

3.1.4.2 Test Summary

The optical output in one direction of transmission is broken and correct operation of ALS in the opposite direction monitored. The failed direction is then reactivated and correct recovery from ALS monitored. The test is repeated for both directions of transmission.

3.1.4.3 Test Procedure

Steps	Actions	Measurements/Pass Criteria
Operator B to A direction.		
1	Using the test configuration in Figure 4 set the optical attenuation to 0 dB and check that the interconnect is operating normally and that no alarms are raised.	Normal operation. No alarms.
2	Increase the optical attenuation to infinity. Check that an STM-N Loss of Signal alarm is raised immediately at *both* network elements.	LOS alarm at both ends.
3	Remove the fibre input to Operator A's network element and connect to an optical power meter. Check to ensure that there is no optical power except for bursts of approximately 2 seconds duration at intervals no less than 60 seconds apart (the automatic restart pulses). Reconnect the fibre input to Operator A's network element.	No optical power except for restart pulses.

4	(Test for automatic restart.) Decrease the optical attenuation to 0 dB. Check that the interconnect recovers to normal operation within a period not greater than 300 seconds.	Normal operation and no alarms within 300 seconds.
5	Increase the optical attenuation to infinity again. Check that an STM-N Loss of Signal alarm is raised at *both* network elements.	LOS alarm at both ends.
6	(Test for manual restart.) Decrease the optical attenuation to 0 dB. Immediately restart the laser at Operator B's network element using the manual restart command. Check that the interconnect immediately recovers to normal operation. (Note: This test may need to be repeated if automatic restart occurs before the manual restart command is sent.)	Normal operation and no alarms immediately after manual restart.
Operator A to B direction.		
7	Using appropriate safety precautions remove the optical attenuator from the Operator A to Operator B transmit direction and fit an optical attenuator in the Operator B to Operator A transmit direction.	
8	With the optical attenuation set to 0 dB, check that the interconnect is operating normally and that no alarms are raised.	Normal operation. No alarms.
9	Increase the optical attenuation to infinity. Check that an STM-N Loss of Signal alarm is raised immediately at *both* network elements.	LOS alarm at both ends.
10	Remove the fibre input to Operator B's network element and connect to an optical power meter. Check to ensure that there is no optical power except for bursts of approximately 2 seconds duration at intervals no less than 60 seconds apart (the automatic restart pulses). Reconnect the fibre input to Operator B's network element.	No optical power except for restart pulses.
11	(Test for automatic restart.) Decrease the optical attenuation to 0 dB. Check that the interconnect recovers to normal operation within a period not greater than 300 seconds.	Normal operation and no alarms within 300 seconds.
12	Increase the optical attenuation to infinity again. Check that an STM-N Loss of Signal alarm is raised at *both* network elements.	LOS alarm at both ends.

13	(Test for manual restart.) Decrease the optical attenuation to 0 dB. Immediately restart the laser at Operator A's network element using the manual restart command. Check that the interconnect immediately recovers to normal operation. (Note: This test may need to be repeated if automatic restart occurs before the manual restart command is sent.)	Normal operation and no alarms immediately after manual restart.

Note: Test Process 3.1.2, 3.1.3 and 3.1.4 should be repeated for standby interconnect path if implemented.

3.2 Testing of traffic paths

3.2.1 Test options

The objective of these tests is to gain confidence in the stability of the set-up including the test equipment by verifying error free traffic flow when transmitting between Operator A and Operator B.

The interconnect may be carrying a variety of payloads and hence equipment may contain a variety of tributary types including 1.5/2/34/45/140, STM-N (1<N<64). In addition, the interconnecting network element may utilise STM-N electrical or optical tributaries to link to another SDH network element, forming a contiguous SDH network within an operators domain. In such cases, the STM-N tributaries from the interconnect element should be tested as below, when agreed as necessary by both operators, whether onward linked to other SDH network elements, or left spare for future expansion.

The continued evolution of SDH and the growth in traffic has meant that SDH multiplexors can now provide a very large number of tributaries and an end-to-end daisy chain of every tributary has become impractical in many cases. Operational experience has therefore dictated that some of this testing will be optional to reflect the increasing reliability of SDH equipment such that a single end-to-end test now provides greater confidence that the system is working.

Operators or contracted installers should carry out stand-alone tests of the SDH multiplexor (including checking the tributaries where agreed) during or after equipment installation. A single end-end tributary test is the recommended requirement when commissioning an interconnect link between operators. Any additional testing must be agreed in advance between operators, but should be no more than one tributary per tributary card so as to provide confidence that the interconnect link and operator systems are inter-working correctly.

This does not affect any decision for further testing that may be carried out by bilateral agreement between operators, for example in the event of faults/testing problems, techniques such as daisy chaining may be applicable.

The test is applicable to all SDH interconnection types described in Section 1.3.1.

3.2.2 Error free traffic on STM-1 tributaries

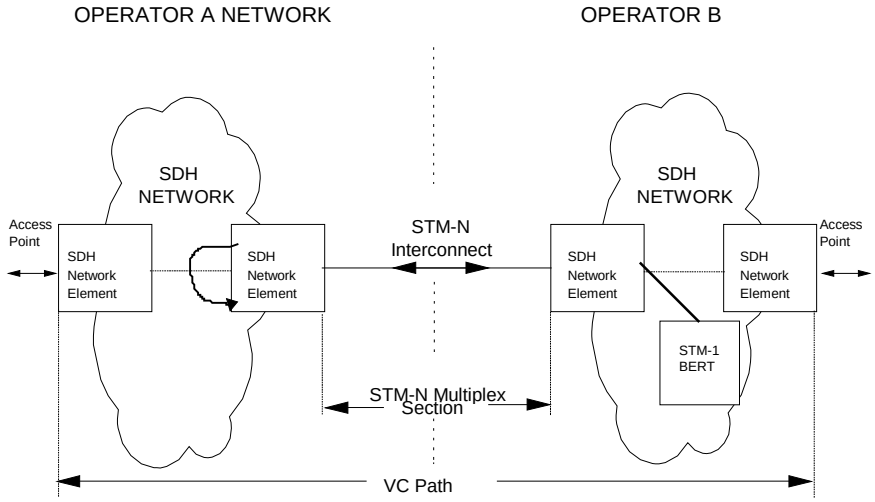


Figure 5

3.2.2.1 Test Objectives

This test is designed to give progressive path confidence where subsidiary SDH elements are connected via SDH tributaries to the interconnecting element. This test should be carried out prior to testing of end to end VC paths.

3.2.2.2 Test Summary

Test traffic is monitored for error free transmission across the interconnect link using a Bit Error Rate Tester (BERT) set to 2^{23}-1 PRBS CMI or NRZ.

3.2.2.3 Test Procedure

Steps	Actions	Measurements/Pass Criteria
1.	Internal Test For each operator or contracted installer to internally check/commission the tributaries of their SDH multiplexor.	
2	Start of end-to end Testing With the testing arrangement as in Figure 5, set the A end tributary to loopback,	
3	Apply the BER tester to the send and receive of the B end tributary.	
4	Generate outgoing and monitor incoming traffic.	
5	Monitor the system for a period of 30 minutes, checking that there are no errors recorded on the Bit Error Rate Tester and that no alarms are reported by the network elements.	No errors. No alarms.

Note: blanked out box indicates an instruction to enable the test to be conducted

3.2.3 Error free traffic on VC path.

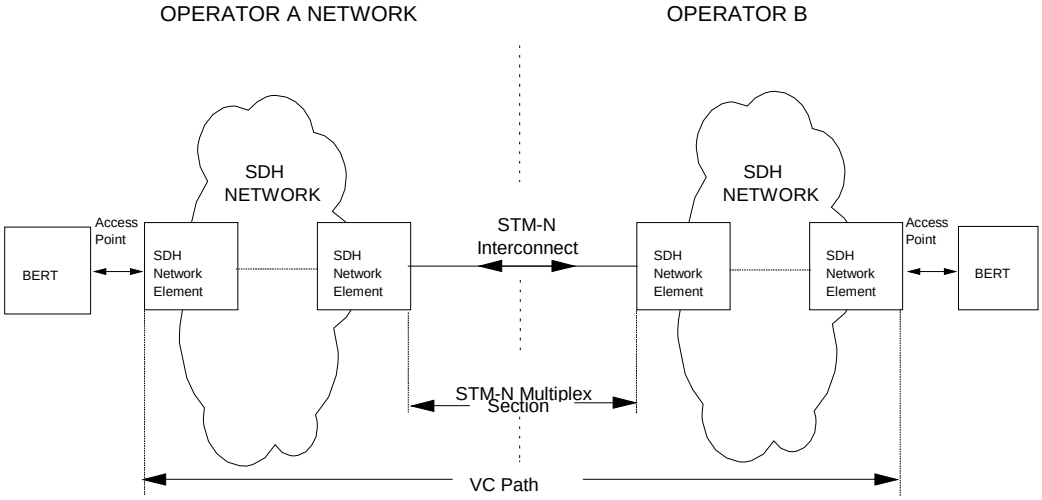


Figure 6

3.2.3.1 Test Objective

This test proves correct end to end transmission.

3.2.3.2 Test Summary

Bit error rate testers are again used to generate and monitor test traffic across the end to end path. The following settings are used:

Bit Rate	PRBS Setting	line code
2.048Mbit/s	2^{15}-1	HDB3
34.368Mbit/s	2^{15}-1	HDB3
44.768Mbit/s	2^{15}-1	B3ZS
139.264Mbit/s	2^{23}-1	CMI

Note: It is acceptable to replace the Bit Error Rate Tester at one end with a loopback, either at the tributary ports.

3.2.3.3 Test Procedure

Notes: This test may require the co-operation of each operators Fault Reporting Point (FRP) to monitor alarms in network elements along the route.

This test may be conducted independently of the sequence of tests defined in the remainder of this recommendation.

Steps	Actions	Measurements/Pass Criteria
1.	Both operators should agree which traffic path(s) is/are to be tested and then implement the appropriate mapping.	
2	With the testing arrangement as in Figure 6, set the Bit Error Rate Tester to transmit the appropriate pattern as detailed above, using internally generated timing. (This may generate alarms on some manufacturers' equipment.)	
3	Generate outgoing and monitor incoming (error free) traffic.	
4	Monitor the system for a period of 30 minutes, checking that there are no errors recorded on the Bit Error Rate Tester and that no alarms are reported by any network element along the VC path.	No errors. No additional alarms.

Note: blanked out box indicates an instruction to enable the test to be conducted

3.2.4 Revertive Path Protection / Sub-Network Connection Protection

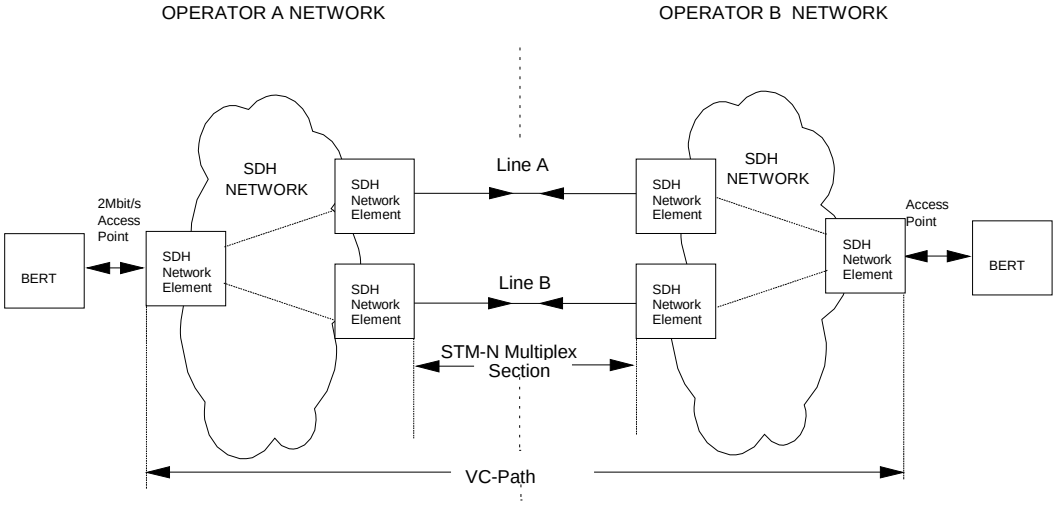


Figure 7

3.2.4.1 Test Objective

The primary objective of this test is to gain confidence in Revertive path protection where this protection mechanism is used to protect traffic crossing the SDH interconnect. However, the situation where one or both networks are using sub-network connection protection could also be tested in this way, since the two protection mechanisms have the same characteristics at the points of interconnect.

This test is only applicable to SDH In Span Interconnections - Optical where two or more paths exist between the two networks.
Note: this test is also applicable to the arrangement illustrated in Figure 4 of Reference 1.

3.2.4.2 Test Summary

The main interconnect path is failed and automatic switch over to the protection path is monitored. Reversion of traffic to the main path on its recovery is also tested.

3.2.4.3 Test Procedure

Note: The specific interconnecting network design employed between operators will affect the detail of the test. Unless otherwise agreed unidirectional 1+1 path protection shall be assumed.

Steps	Actions	Measurements/Pass Criteria
1	With the test configuration of Figure 7, modified in accordance with the actual interconnecting network design, set-up the Bit Error Rate Testers and establish error free traffic. Note: It is acceptable to replace the Bit Error Rate Tester at one end with a tributary loopback.	
2	Configure the two network elements at the circuit termination's for Revertive path protection, with Line A as the MAIN and Line B the PROTECTION path.	
3	Fail the MAIN path at any convenient point in either operator's network. Ensure that error free traffic is re-established via the PROTECTION path.	Errors on MAIN Error free on PROTECTION path
4	Restore the MAIN path, and ensure that error free traffic is re-established via the MAIN path.	Errors on PROTECTION path Error free on MAIN path

Note: blanked out box indicates an instruction to enable the test to be conducted

3.2.5 Non-Revertive Path Protection / Sub-Network Connection Protection

3.2.5.1 Test Objective

The primary objective of this test is to gain confidence in non-Revertive path protection where this protection mechanism is used to protect traffic crossing the SDH interconnect. However, the situation where one or both networks are using sub-network connection protection could also be tested in this way, since the two protection mechanisms have the same characteristics at the points of interconnect.

This test is only applicable to SDH In Span Interconnections - Optical where two or more paths exist between the two networks.

Note: this test is also applicable to the arrangement illustrated in Figure 4 of Reference 1.

3.2.5.2 Test Summary

The main interconnect path is failed and automatic switch over to the protection path is monitored. Continued delivery of traffic over the protection path on recovery of the main path is also tested.

3.2.5.3 Test Procedure

Note: The specific interconnecting network design employed between operators will affect the detail of the test. Unless otherwise agreed unidirectional 1+1 path protection shall be assumed.

Steps	Actions	Measurements/Pass Criteria
1	With the test configuration of Figure 7, modified in accordance with the actual interconnecting network design, set-up the Bit Error Rate Testers and establish error free traffic. Note: It is acceptable to replace the Bit Error Rate Tester at one end with a tributary loopback.	
2	Configure the two network element at the circuit termination's for Non-Revertive path protection, with Line A as the MAIN and Line B as the PROTECTION path.	
3	Fail the MAIN path at any convenient point in either operator's network. Ensure that error free traffic is re-established via the PROTECTION path.	Errors on MAIN Error free on PROTECTION path
4	Restore the MAIN path and ensure that error free traffic is maintained over the PROTECTION path.	Error free on PROTECTION path
5	Fail the PROTECTION path by removing at any convenient point in either operator's network. Ensure that error free traffic is established over the MAIN path.	Errors on PROTECTION path Error free on MAIN path

Note: blanked out box indicates an instruction to enable the test to be conducted

3.2.6 Commissioning of Mutliplexor Section Protected In Span Connections

3.2.6.1 Test Objective

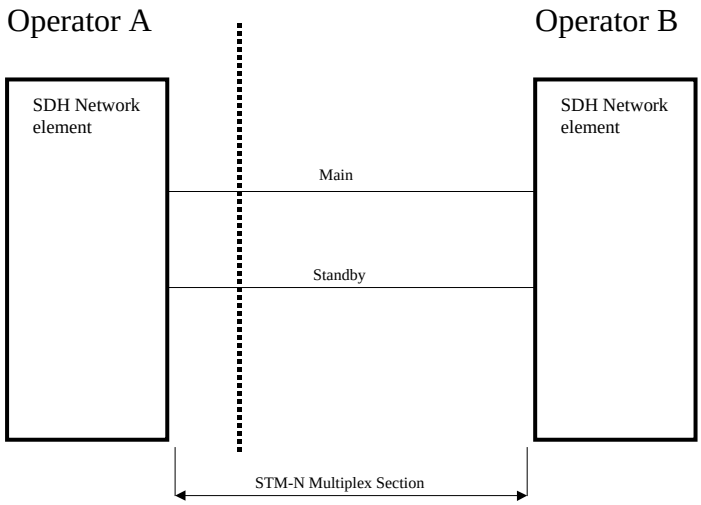
The primary objective of this test is to gain confidence in the Section Layer connectivity as it is provided between two Operators. This test does not relate to the Traffic Path layer but is aimed at Networks where testing of circuits will take place within the discreet operator domains and will not require collaborative testing across the Point of Connection (e.g. including but not limited to Partial Private Circuits and ATM In Span). Reference SDH Overview NICC 00/093 Section 3.2 Figure 2.

3.2.6.2 Configuration

The interfaces shall be configured in agreement with SDH Overview (NICC DOC 00/093). MSP shall be operated in Unidirectional, non revertive mode as defined in ITU-T G.841 section 7.1.4.4.

3.2.6.3 Test Procedure

In Span Connections



POC is co-located with Operator A site

Operator A installs and commissions the In Span ADM. Note, synchronisation may be set to Internal Clock at this stage if connectivity is not in place to other network elements. The LOS alarms from Line Interfaces shall be acknowledged. Multiplexor Section Protection operation is included in the commissioning of the stand alone element.

When Operator B Fibres are available, Operator A shall initiate work for fibres to be extended to the ISH ADM with pig-tails and left looped back towards Operator B from the

ADM by the use of 2 couplers. Operator A then invites Operator B to test their fibres to the loops on the pig tails. This tests the fibres up to, but not touching the ISH ADM.

When both parties are ready, The loops are removed and Operator A arranges with Operator B to check the transmit and incoming light levels and fit an attenuator on the receive side if required. On completion of this test, Operator A connects the pig tails to the ISH ADM. No cross connection mapping or MSP tests are carried out between operators. The Line Sections shall be self testing, and Signal Degrade settings are enabled on Line Interfaces as part of Multiplex Section Protection operation.

A check is made for stable alarm state on the Line Section interfaces of the In Span ADMs. The connection is declared available for service and recorded in Appendix A under Test 14.

3.2.7 Commissioning of Paths which cross a MSP Point of Connection

3.2.7.1 Test Objective

The primary objective of this test is to gain confidence in the Path provision within each perators domain. It shall not incorporate path layer testing across the Point of Connection.
3.2.7.2 Test Procedure

Circuit shall be provisioned within each operators domain. Circuit commissioning and testing activities within each operators network are carried out in accordance with the operators normal procedures. All SDH Sections within the circuit path, up to the Point of Connection are monitored for correct operation. The final cross connection is made within the In Span ADM to the Point of Connection. In this way, the Point of Connection is treated as a network boundary, up to which provisioning takes place. The Multiplex Sections which span the Point of Connection are self monitoring at the Section Layer and any test performed can be recorded in Appendix A under Test 15.

This method of establishing circuit provision across the Point of Connection does not preclude any testing requirements at the service layer.

3.3 Synchronisation Test

(Note: This test to be conducted with bilateral agreement)

3.3.1 Both Network Elements not in service.

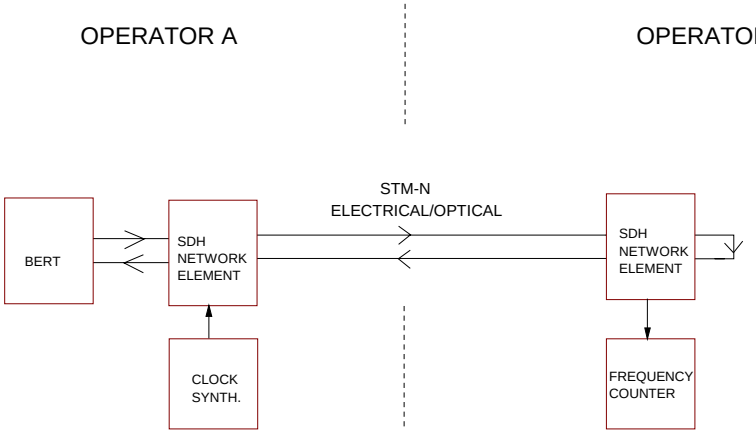


Figure 8

3.3.1.1 Test Objective

The objective of this test is to verify that Operator B's network element is sourcing synchronisation from Operator A's network element and not from its internal free running clock. Where each operator is supplying their own synchronisation (ie neither network is deriving synchronisation from the interconnect), then this test can be ignored.

3.3.1.2 Test Summary

The test shall be performed by varying the frequency (by approximately 2.5 ppm from nominal) of the synchronisation source of Operator A's network element and noting the corresponding variation at Operator B's network element. If Operator A's network element is already in service, then it will not be possible to vary its clock frequency; in this situation, the Alternative Synchronisation Test in section 3.3.2 should be used instead.

This test is applicable to all SDH interconnection types described in Section 1.3.1.

3.3.1.3 Test Procedure

Step	Action	Measurements/Pass Criteria
1	Use a clock synthesiser as the synchronisation source for Operator A's network element and set to 2048kHz.	
2	With the testing arrangement as in Figure 8, set the Bit Error Rate Tester to transmit the appropriate pattern for a chosen tributary, and monitor error free operation.	Error free operation.
3	At the Operator B site monitor the sync by the use of a frequency counter.	Record nominal frequency value.

4	Increase the frequency of the sync source of Operator A's network element to 2.5 ppm above nominal.	Increase of 2.5 ppm in frequency at Operator B's network element. Record frequency.
5	Decrease the frequency of the sync source of Operator A's network element to 2.5 ppm below nominal.	Decrease of 2.5 ppm in frequency at Operator B's network element. Record frequency.

Note: blanked out box indicates an instruction to enable the test to be conducted

3.3.2 One Network Element in service

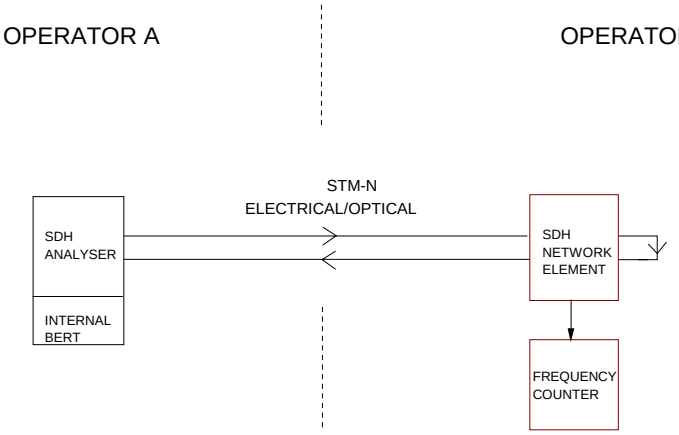


Figure 9

3.3.2.1 Test Objective

The objective of this test is to verify that Operator B's network element is sourcing synchronisation from Operator A's network element and not from its internal free running clock. Where each operator is supplying their own synchronisation (ie neither network is deriving synchronisation from the interconnect), then this test can be ignored.

3.3.2.3 Test Summary

The test shall be performed by replacing Operator A's network element with an SDH analyser. The frequency of the synchronisation supplied to Operator B's network is varied by 2.5 ppm from nominal, and the corresponding variation at Operator B's network element is noted. This test is an alternative to the test in the previous section, and is intended to be used when Operator A's network element is already in service.

This test is applicable to all SDH interconnection types described in Section 1.3.1.

3.3.2.3 Test Procedure

Step	Action	Measurements/Pass Criteria
1	Use an SDH analyser to replace Operator A's network element for the purposes of this test.	
2	With the testing arrangement as in Figure 9, set the Bit Error Rate Tester contained within the SDH Analyser to transmit the appropriate pattern for a chosen trib, and monitor error free operation.	Error free operation.
3	At the Operator B site monitor the sync by the use of a frequency counter.	Record nominal frequency value.
4	Increase the frequency of the sync source within the SDH Analyser by 2.5 ppm above nominal.	Increase in frequency of 2.5 ppm at Operator B's network element. Record frequency.
5	Decrease the frequency of the sync source within the SDH Analyser by 2.5 ppm below nominal.	Decrease in frequency of 2.5 ppm at Operator B's network element. Record frequency.

Note: blanked out box indicates an instruction to enable the test to be conducted

3.4 Stability

3.4.1 Test Objective

The objective of these tests is to ensure that the interconnection path is stable under normal operating conditions.

3.4.2 Test Summary

Stability of the optical connectors is tested by percussion testing and overall path stability by means of a period of error free operation. Where protection is employed error free operation of both main and protection paths is monitored.

3.4.3 Test Procedure

Step	Action	Measurements/Pass Criteria.
1	With the testing arrangement as in Figure 6, set the Bit Error Rate Tester to transmit the appropriate pattern for a chosen trib. See Section 3.2.3.2.	
2	Carry out a percussion test by gently tapping all fibre connectors at both A & B ends. Check that no alarms are reported, or errors generated.	No alarms. No errors.
3a	If no protection is employed carry out a 2 hour stability run on the system. Check that there are no alarms reported on the system and that no errors occur in the 24 hours.	No alarms. No errors.
OR 3b	If protection is employed carry out a stability run of approximately 12 hours with traffic configured on the main path and then not less than 3 hours with traffic configured on the protection path. Check that there are no alarms reported on the system and that no errors occur in the total test period Note: The detailed arrangements for performing this test will need to be agreed between the two operators.	No alarms. No errors.

Note: blanked out box indicates an instruction to enable the test to be conducted

4 TEST EXIT CRITERIA

The test exit criteria are as follows:

i) All relevant tests have been carried out.
ii) All results have been gathered.
iii) All problems have been documented and resolved.

As each test in this document is performed, the test case on the Test Results Sheet (see Appendix B) must be completed to indicate pass or fail. Deviations from the anticipated results should be noted in the Test Results Comments section for each test on the sheet.

A specific test will be deemed to have failed if the result does not comply with the requirements stated in this test specification. A pass may be recorded if after corrective action the result is compliant. Where corrective action is necessary the test shall be repeated and the results noted on a new Test Results Sheet. The details of the corrective action must be recorded on the new Test Results Sheet. Care must be taken to ensure that the corrective action remains valid after any regular maintenance activity, eg replacement of a faulty card.

6. APPENDICES

6.1 Appendix A - Test Check List

The following lists the series of test described in this Recommendation and provides a means of recording the progress of the interoperability commissioning procedure.
The following tests should be carried out:-

Inter-connect type	**Automatic Laser shut-down implemented**	**Standby path implemented**	**Test number to be implemented**														
Test No			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Optical			**X**	**X**					**X**	**X**			**A**	**A**	**X**	**X**	**A**
Optical	**X**		**X**		**X**				**X**	**X**			**A**	**A**	**X**	**X**	**A**
Optical		**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**	**A**	**A**	**X**	**X**	**A**
Optical	**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**	**X**	**A**	**A**	**X**	**X**	**A**
Electrical				**X**					**X**	**X**			**A**	**A**	**X**	**X**	**A**
Electrical		**X**		**X**			**X**		**X**	**X**	**X**	**X**	**A**	**A**	**X**	**X**	**A**

X Test to be implemented
A Test implemented by mutual agreement if required.

Test No	Section No	Title	Relevant	Pass/Fail
1	3.1.2	Optical Received Power and Path Continuity on main path	Yes ❑ No ❑	Pass ❑ Fail ❑
2	3.1.3	Distant Alarm Test on main path	Yes ❑ No ❑	Pass ❑ Fail ❑
3	3.1.4	Automatic Laser Shutdown on main path	Yes ❑ No ❑	Pass ❑ Fail ❑
4	3.1.2	Optical Received Power and Path continuity on standby path	Yes ❑ No ❑	Pass ❑ Fail ❑

5	3.1.3	Distant Alarm Test on standby path	Yes ❑ No ❑	Pass ❑ Fail ❑
6	3.1.4	Automatic Laser Shutdown on standby path	Yes ❑ No ❑	Pass ❑ Fail ❑
7	3.2.2	Error Free Traffic on STM-1 tributaries	Yes ❑ No ❑	Pass ❑ Fail ❑
8	3.2.3	Error Free Traffic on VC Path	Yes ❑ No ❑	Pass ❑ Fail ❑
9	3.2.4	Revertive Path Protection/SNC Protection	Yes ❑ No ❑	Pass ❑ Fail ❑
10	3.2.5	Non-Revertive Path Protection/SNC Protection	Yes ❑ No ❑	Pass ❑ Fail ❑

11	3.3.1	Synchronisation Test - both NE's not in service	Yes ❑ No ❑	Pass ❑ Fail ❑
12	3.3.2	Synchronisation Test - One NE in service	Yes ❑ No ❑	Pass ❑ Fail ❑
13	3.4	Stability	Yes ❑ No ❑	Pass ❑ Fail ❑
14	3.2.6	MSP In Span Connection	Yes ❑ No ❑	Pass ❑ Fail ❑
15	3.2.7	Commissioning of paths which cross a MSP	Yes ❑ No ❑	Pass ❑ Fail ❑

The relevance of each test will depend upon the interconnect configuration. Details are associated with the test descriptions.

6.2 Appendix B - Test Results Sheets

The following test results sheets refer to the test cases contained within this document. They can be used to record the results of the tests conducted in accordance with this recommendation.

In cases where the procedure is not a measurement, a tick in the Pass/Fail column shall be used to indicate that the activity has been successfully or unsuccessfully carried out.

Where tests are conducted from more than one location in each operators network separate Test Results Sheets shall be completed for each site.

Test Information

Operator A: Operator B:

Site A Address: Site B Address:

Site A Test Equipment

	Manufacturer	Type	Serial Number
STM-1 Bit Error Rate Tester (note 1)			
2, 34, and 140Mbit/s Bit Error Rate Tester (note 1)			
Optical Power Meter			
Variable Optical Attenuator			
Clock synthesiser (optional)			
Frequency counter (optional)			
Local Terminal and software			

note 1: As appropriate. See Section 2.2. Use blank entry for any other BERT type.

Site B Test Equipment

	Manufacturer	Type	Serial Number
STM-1 Bit Error Rate Tester (note 1)			
2, 34 and 140Mbit/s Bit Error Rate Tester (note 1)			
Optical Power Meter			
Variable Optical Attenuator			
Clock synthesiser (optional)			
Frequency counter (optional)			
Local Terminal and software			

note 1: As appropriate. See Section 2.2. Use blank entry for any other BERT type.

	Network Element at Site A	Network Element at Site B
ADM / DXC etc		
Manufacturer		
Type		
Serial Number		
Software Version No.		
Hardware Version No.		

Test Results Sheet

Test 1 (Described in section 3.1.2) - Optical Received Power and Path Continuity on main path.

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Measurement	Pass/Fail	Comments
1	dBm		
2	dBm		
5	dBm	Pass ❑ Fail❑	
8		Pass ❑ Fail❑	
11	dBm	Pass ❑ Fail❑	
14		Pass ❑ Fail❑	

Test Result: Pass ❑ Fail❑

Corrective Action:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 2 (Described in section 3.1.3) - Distant Alarm Tests at Operator A and Operator B Sites on main path

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
1	Pass ❑ Fail ❑	
2	Pass ❑ Fail ❑	
3	Pass ❑ Fail ❑	
4	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 3 (Described in section 3.1.4) - Automatic Laser Shutdown Test on main path

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
1	Pass ❑ Fail ❑	
2	Pass ❑ Fail ❑	
3	Pass ❑ Fail ❑	
4	Pass ❑ Fail ❑	
5	Pass ❑ Fail ❑	
6	Pass ❑ Fail ❑	
8	Pass ❑ Fail ❑	
9	Pass ❑ Fail ❑	
10	Pass ❑ Fail ❑	
11	Pass ❑ Fail ❑	
12	Pass ❑ Fail ❑	
13	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 4 (Described in section 3.1.2) - Optical Received Power and Path Continuity on standby path.

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Measurement	Pass/Fail	Comments
1	dBm		
2	dBm		
5	dBm	Pass ❑ Fail❑	
8		Pass ❑ Fail❑	
11	dBm	Pass ❑ Fail❑	
14		Pass ❑ Fail❑	

Test Result: Pass ❑ Fail❑

Corrective Action:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 5 (Described in section 3.1.3) - Distant Alarm Tests at Operator A and Operator B Sites on standby path

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
1	Pass ❑ Fail ❑	
2	Pass ❑ Fail ❑	
3	Pass ❑ Fail ❑	
4	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 6 (Described in section 3.1.4 - Automatic Laser Shutdown Test on standby path

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
1	Pass ❑ Fail ❑	
2	Pass ❑ Fail ❑	
3	Pass ❑ Fail ❑	
4	Pass ❑ Fail ❑	
5	Pass ❑ Fail ❑	
6	Pass ❑ Fail ❑	
8	Pass ❑ Fail ❑	
9	Pass ❑ Fail ❑	
10	Pass ❑ Fail ❑	
11	Pass ❑ Fail ❑	
12	Pass ❑ Fail ❑	
13	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 7 (Described in section 3.2.2) **Error Free Traffic on STM-1 Tributaries**

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
5	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 8 (Described in section 3.2.3) **Error Free Traffic on VC Path**

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
4	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 9 (Described in section 3.2.4) **Revertive Path Protection/SNC Protection**

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
3	Pass ❑ Fail ❑	
4	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 10 (Described in section 3.2.5) Non-Revertive Path Protection/SNC Protection

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
3	Pass ❑ Fail ❑	
4	Pass ❑ Fail ❑	
5	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 11 (Described in section 3.3.1) Synchronisation Test (Both NE's not in service)

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Measurement	Pass/Fail	Comments
2		Pass ❑ Fail ❑	
3	MHz	Pass ❑ Fail ❑	
4	MHz	Pass ❑ Fail ❑	
5	MHz	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 12 (Described in section 3.3.2) Synchronisation Test (One NE in service)

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Measurement	Pass/Fail	Comments
2		Pass ❑ Fail ❑	
3	MHz	Pass ❑ Fail ❑	
4	MHz	Pass ❑ Fail ❑	
5	MHz	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 13 (Described in section 3.4) Stability

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
2	Pass ❑ Fail ❑	
3a	Pass ❑ Fail ❑	
OR		
3b	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 14 (Described in section 3.2.6) **MSP In Span Connection**

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
14	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative:

Test Results Sheet

Test 15 (Described in section 3.2.7) Commissioning of paths which cross a MSP

Operator: Test Engineer:

Test Conducted: Yes ❑ No ❑

Step	Pass/Fail	Comments
15	Pass ❑ Fail ❑	

Test Result: Pass ❑ Fail❑

Corrective Actions:

Test Engineer Signature:

Date:

Operator A Representative:

Operator B Representative: