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CODE OF PRACTICE FOR THE INSTALLATION OF FIBRE OPTIC CABLING

GUIDANCE NOTES

A complete guide to BS7718 and FIA-CCP-1/91

CONTENTS

1.0 Introduction

The FIA Code of Practice for the Installation of Fibre Optic Cabling (FIA-CCP-1/91) has sold over 1250 copies (as of March 1994) and is being published by BSI as BS7718 (1994).

This document has been produced by the Fibreoptic Industry Association in response to users and installers who:

- wish to have a more global view of what the Code of Practice contains
- require added clarification with regard to some of the points raised or
- would like to gain an understanding of the thought processes involved in the production of the Code of Practice.

The format of this document will be based jointly on the itemised sections within the FIA-CCP-1/91 version of the Code of Practice together with the amended clause numbering system to be found in the BS7718 publication of the Code of Practice.

These Guidance Notes cover the all sections of the Code of Practice with the exception of the introductory sections (1.3) and the Guidance section (Annex B) which will be the subject of other FIA publications in due course.

The Guidance Notes aim to clarify each section/clause of the Code of Practice by dealing with the issues raised from three viewpoints; design and technical guidance, implementation guidance and contractual guidance.

This document is not a replacement for the Code of Practice but can be a useful interpretative tool and must be read in conjunction with the relevant sections of the Code of Practice.

2.0 The Scope of a Code of Practice

The nature of the Code of Practice prevents the allocation of MANDATORY labelling on relevant sections as there is no legislative procedure to enforce compliance.

The basis of the Code of Practice is to offer a standard design and planning template allowing both user and installer to reach a common and accurate understanding of requirements, specification and implementation.

Implicit in the Code of Practice is the provision of a quality assured installation based on correct design, component selection and installation practices.

The Installation Specification is the mechanism by which mandatory requirements may be specified and implemented as per the CONTRACT TERMS & CONDITIONS which will have a legal standing dependent upon “Conditions Precedent” and the law and statutes of the nominated country in which the contract is let and signed.

3.0 Section-by-Section Guidance

The section numbers from the FIA Code of Practice are shown in bold type throughout whereas the clause numbers from the BSI document BS7718 (1994) are shown in bold italics.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 4: **Optical Fibre Safety** ***Clause 4:*** ***Optical Fibre Safety***		
Cabling should be designed with safety in mind taking into account the requirements of the Health and Safety at Work, relevant workplace acts and the specific dangers associated with optical fibre technology. The installed cabling should be designed and installed to protect the user during operation over its defined lifetime provided that the user takes all precautions with equipment subsequently connected to the installed cabling. Products and components used within the installation must not deteriorate over its defined lifetime in a manner that may endanger users, maintainers etc.	It is the legal responsibility for the installer to ensure that safe working practices are adopted during installation, termination and testing of the optical system. This responsibility extends beyond the installation phase and may be defined further in the defects liability period of the system and the relevant Health and Safety legislation. The Health and Safety responsibility requires that the supplier has sufficient public liability cover requiring that all reasonable actions are taken to comply with safety standards during and following installation and post contract works. In addition to the general requirements for Health and Safety practices, the installation of certain components may require the use of substances which require careful handling under the COSHH regulations. Also, the control of optical power during the testing of the installed cabling represents a major safety issue. Good housekeeping and Health and Safety compliance is the responsibility of the individual installer once he/she has been specifically issued with necessary work instructions and safety equipment and given on site training & work permits as defined in the Specification Agreement.	The Installation Specification (5:5) should specify safety procedures and local regulations. These are further supported by the Health and Safety Executive legislative position. The installer MUST COMPLY with • Public Liability & Indemnity • Defect Liability • Material deterioration • Chemical protection • Eye protection • Safety notices and guarding where relevant • Safe use of the installed cabling over its defined lifetime • Product suitability, unless specifically waived in the Installation Specification, in which case responsibility passes to the user. Remedial works based on subsequent changes in legislation may not be the responsibility of the installer and may require the issue of additional work instructions and moneys from the user to upgrade the system.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5: **Definition of a Specification Agreement** ***Clause 5.1:*** ***Installation Specification***		
The Installation Specification should be agreed between the user and the installer which clearly details the: • OPERATIONAL REQUIREMENT • TECHNICAL SPECIFICATION • SCOPE OF WORKS The Installation Specification is not necessarily the basic statement of requirements as defined by the content of the Invitation to Tender(ITT) for the installation. Rather it is the refined agreement between the user and installer in response to the original ITT. It is supported by the Quality Plan produced by the installer which defines how compliance with the Installation Specification will be demonstrated.	The Installation Specification should clearly define the physical aspects of the installation leading to a common understanding of the Scope of Works specifying: • Bills of Material, Labour and Testing • Route serving and civil works • Material issue and handling • Installation Plan • Acceptance Criteria • Documentation • Project Management The Installation Specification is not necessarily the basic statement of requirements as defined by the content of the Invitation to Tender(ITT) for the installation. Rather it is the refined agreement between the user and installer in response to the original ITT. It is supported by the Quality Plan produced by the installer which defines how compliance with the Installation Specification will be demonstrated. The Installation Specification cannot require blanket compliance with the Code of Practice since the Code of Practice supports a number of options, particularly in relation to test methods. The Installation Specification should refer instead to the general workmanship requirements ***(SectionsIClauses 8 and 9***) of the Code of Practice but with specific reference to those sections, clauses or sub-clauses which are most appropriate in a particular instance.	The Installation Specification is not necessarily the basic statement of requirements as defined by the content of the Invitation to Tender(ITT) for the installation. Rather it is the refined agreement between the user and installer in response to the original ITT. It is supported by the Quality Plan produced by the installer which defines how compliance with the Installation Specification will be demonstrated. An Installation Specification translates the physical and technical requirements of the installation into a mandatory form based on a common agreement of those requirements and their implications covering: • Contract Terms and Conditions • Regulatory and legislative issues • Health and Safety • Contract Interfaces and Responsibilities • Installation Plan System Acceptance • Warranty and Liabilities • Variations and Change Control The Installation Specification cannot require blanket compliance with the Code of Practice since the Code of Practice supports a number of options, particularly in relation to test methods. The Installation Specification should refer instead to the general workmanship requirements ***(SectionsIClauses 8 and 9***) of the Code of Practice but with specific reference to those sections, clauses or sub-clauses which are most appropriate in a particular instance.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.1: **Operational Requirement** ***Clause 5.2:*** ***Operational Requirement***		
The Operational Requirement created by the user should reflect all relevant design criteria affecting the installation topology, routeing, future application and intended lifetime of the installed cabling. The Operational Requirement may cover more than one installation on a specific site. The Scope of Work ***(*****5.2*****:5.4)*** provides specific detail for the current installation.	The Operational Requirement should define the routes and installation environments highlighting all areas where the environment may impact the installation techniques used and the subsequent product selection. In addition the location of all hazards requiring special handling (including plant and additional installation equipment) should be defined.	The Operational Requirement should define global requirements which may influence the overall price of the installation contracts on the site. Further definition will be provided in the Scope of Works (**5.2*:5.4***). Final costs will be influenced by the impact of the Contract Terms and Conditions (**5.4*:5.5***).
Section 5.1.1: **Infrastructure Definition** ***Section 5.2.1:*** ***Infrastructure Definition***		
The infrastructure should be defined to reflect the following criteria: • Nodal distribution and route design ensuring that the installed cabling will support a defined set of applications in terms of distance and interconnect centres. • System topology providing the desired level of resilience, contingency through diverse cable routes, redundancy, route protection and ease of re-installation. • Cable and connectivity products will be defined by the environment and available infrastructure.	Route, environment and pathway choice (duct, tray, aerial) will influence product choice and provide the global requirements for the Bill of Materials covering the pathways, serving and civil works to facilitate the installation of the cabling and the requirements for installation plant and safety equipment.	The route and environment will determine the products which are fit for purpose and which will last for the operational lifetime of the installed cabling.
Section 5.1.2: **Operational Capability** ***Clause* 5.2.2:** ***Operational Capability***		
Where known, the operating wavelength, optical power budget and bandwidth requirements of applications to be supported should beincluded to allow verification by design iteration following the final selection of component performance values. Note that any application mapping. restrictions based on distance, topology, wavelength or product choice should be highlighted by the installer in order to allow the user to amend design as required.		Notification of performance restrictions due to route and topology is vital at this stage as failure to do so could render the installer liable for inability to meet the performance specification defined by the user. It should be established on what basis final system acceptance is to be awarded following installation

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.2: **Scope of Works** ***Clause 5.4:*** ***Scope of Works***		

The Scope of Works should define the installation required.
 	
This differs from the Operational Requirement in that the Operational Requirement is a global document valid for all installations on a particular site.
 	
The Scope of Works should contain all the requirements and responsibilities during the following phases of the current installation:
 	
• PRE INSTALLATION
• INSTALLATION
• POST INSTALLATION
	The Scope of Works should allow the installer to develop and agree with the user an Installation Plan to cover pre-installation, installation and post-installation elements which will include the following:
	
	• Programme Timescales
	  • serving and civils works
	  • installation, jointing and termination of the cabling
	  • acceptance testing
	  • documentation
	  • progress meetings
	  • user acceptance
	• Resource Planning (labour and materials)
	  • personnel clearance
	  • lead times for material and testing
	• Plant and equipment requirements
	
	Allowance should be made for access and other productivity restrictions in addition to impact of any site-specific practices resulting from the presence of hazards identified within the Operational Requirement.
	
	Assessment should be made against any working restrictions imposed by site-specific or general Health and Safety at Work, regulatory and legislative requirements.
		The Scope of Works defines complete requirement allowing terms and conditions to be applied to the provision, acceptance and payment for the completed system.
		
		The Scope of Works may feature a range of task options:
		
		• Supply and Install
		• Install only
		• Supply, Install and Terminate
		  Install and Terminate
		  Terminate Pre-installed Cabling
		• Fault and Remedial Works
		
		Damage or non-compliance which is ill-defined at the commencement of installation work results in excessive liability for the installer who will be contractually bound to comply with the Installation Specification.
		
		The Scope of Works should allow the development of a full and clear Bill of Material, Labour and Testing for all aspects of the installation which will form the basis of supply and be subject to the Contract Terms and Conditions (**5.4:*5.5***).
		
		The Scope of Works refers to completion dates within the Installation Plan which may form part of the Contract Terms and Conditions (**5.4:*5.5***) and be subject to financial incentive or penalty. The Scope of Works allows changes and variations to be agreed, costed and accepted throughout the duration of the contract.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.2.1: **Pre-installation** ***Clause 5.4.1:*** ***Pre-installation***		
The Scope of Works should specify all aspects of serving, civil works and pathways installation, The design should minimise potential damage to the installed cabling from all sources identified within the Operational Requirement.	The Scope of Works should allow the installer to develop and agree with the user an Installation Plan to cover pre-installation activities which should ensure safety of installation personnel and others and should consider; • Minimum disruption with adequate notification and liaison with affected parties. • Adequate guarding of works during construction and Installation. Route preparation will include safety tests for gas, removal of water from route and power hazards. • The provision of adequate and sufficient installation and cable protection equipment e.g. fused linkages, pulling eyes and swivels, cable stockings (cables without central strength members only), bell mouths, cable guides and turning wheels, lubrication of cable during installation into ducts. • Maintenance of bend radii restrictions within the routes.	The Scope of Works should clearly identify the transition points between one contractual responsibility and another in order that the installer may ensure that works by others are completed in accordance with programme and specification. The Scope of Works should identify the need for site survey and the validity of all route/node documentation provided to the installer by the user. The installer should ensure that all routes and route environments are consistent with the performance of the cabling components to be used and that any deviations identified are notified to the user (this is of particular importance where materials are supplied by a third party). The Scope of Works should allow the development of a full and clear Bill of Material, Labour and Testing for all aspects of the installation which will form the basis of supply and be subject to the Contract Terms and Conditions (**5.4:*5.5***). The Scope of Works refers to completion dates within the Installation Plan which may form part of the Contract Terms and Conditions (**5.4:*5.5***) and be subject to financial incentive or penalty. The Scope of Works allows changes and variations to be agreed, costed and accepted throughout the duration of the contract.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.2.2: Installation ***Clause 5.4.2: Installation***		
Task:	**Installation:**	**Installation and Test:**
The Scope of Works should specify the requirements for the marking and identification of installed cables and closures (patch panels, splitter boxes etc.) in accordance with the requirements of the Technical Specification. The Scope of Works should specify the layout of closures within each node. The Scope of Works should specify the specific connectivity requirements of each optical fibre in each closure at each node. The Scope of Works should specify the methods to be used in the earthing and bonding of all electrically conducting elements within the installed cables.	The Scope of Works should allow the installer to develop and agree with the user an Installation Plan to cover installation activities which should ensure safety of installation personnel and others and should consider: • Duct allocation • Set up positions and pull through points together with any fleeting positions • Adherence to bend and installation restrictions defined by the manufacturer • Tension control and method for attaching draw rope for installation using tensile member • Type of labelling to be used numbering scheme to be used and location of labels based upon the Technical Specification.	The Scope of Works should allow the development of a full and clear Bill of Material, Labour and Testing for all aspects of the installation which will form the basis of supply and be subject to the Contract Terms and Conditions (**5.4:*5.5***). The Scope of Works refers to completion dates within the Installation Plan which may form part of the Contract Terms and Conditions (**5.4:*5.5***) and be subject to financial incentive or penalty. The Scope of Works allows changes and variations to be agreed, costed and accepted throughout the duration of the contract.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.2.2: Installation ***Clause 5.4.2: Installation***		
Testing:	**Testing:**	**Testing:**
The Scope of Works should specify the acceptance test requirements (methods, testing volumes).	Test and inspection can be carried out at various stages of the installation. The Scope of Works should allow the installer to develop and agree with the user an Installation Plan to cover inspection and acceptance testing activities which should define the tasks to be carried out.	Although viewed as being critical to the proof of compliance with a properly written Installation Specification, testing is NOT an automatic requirement of the Code of Practice. Acceptance test criteria and the means of compliance proving MUST be defined and agreed between the user and the installer within the Installation Specification. Testing can then act as the contractual hand over and transfer of ownership and/or liability once accepted. The level of pre-installation, progress and post-installation testing will define the level of risk to be accepted by the installer. The costs of full testing must be evaluated against the Scope of Works, the extent of pre installed system components and the risk involved in underwriting untested work in the event of damage or non-compliance.
Documentation:	**Inspection:**	**Documentation:**
The Scope of Works should define the level of documentation required, the form in which it is to be supplied (paper or electronic) and the number of copies of the documentation to be supplied.	**Stage 1A:** Inspection of physical installation quality and administration. **Stage 2A:** Inspection of cable and optical fibre administration and dressing into and within closures.	Acceptance documentation must be defined in the Installation Specification contract by the user.
	Acceptance Testing:	
	Stage 1B: Testing of single optical fibres prior to jointing and termination. **Stage 2B:** Acceptance tests on terminated cables in accordance with component performance and optical loss budget acceptance criteria.	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.2.3: **Post-installation** ***Clause 5.4.3:*** ***Post-installation***		
The Scope of Works should specify all relevant post installation works to reinstate, make good and reseal in accordance with the building fabric and regulatory requirements for fire and other hazards. The Scope of Works should specify the requirements for spares materials to support operation or agreed maintenance and repair philosophies. The Scope of Works should specify any requirements for training in system operation, test and evaluation at this stage (prior to commencement of any warranty period).	The Scope of Works should allow the installer to develop and agree with the user an Installation Plan to cover post-installation activities which should ensure safety of installation personnel and others and should specify the form and nature of seals, protection, warning signs and notices to be fitted to the installed cabling and the associated pathways and infrastructure. Requirements for final reinstatement and site clearance should be specified. The Scope of Works should specify the procedures for warranty claims together with repair and maintenance philosophies.	Regulatory and local requirements for reinstatement and making good to be agreed prior to the contract being let.
Section 5.2.4: **Regulatory Issues** ***Clause 5.4.4:*** ***Regulatory Issues***		
	The Scope of Works should specify the appropriate regulatory requirements applicable to the installation. Implementation plans should reflect these requirements.	
Section 5.2.5: **Site Contacts** ***Clause 5.4.5:*** ***Site Contacts***		
	The Scope of Works should detail the site contacts in order that proper and timely reporting may be ensured.	The users nominated authorities for change control, security and safety shall be defined.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.3: **Technical Specification** ***Clause 5.3:*** ***Technical Specification***		
The Technical Specification should define an unambiguous identification scheme for all the cabling components. The Technical Specification should also include the performance and physical requirements for the components to be used in the installation. These components include: • OPTICAL FIBRES • OPTICAL CABLES • OPTICAL FIBRE CONNECTORS • JOINTS • CLOSURES • This information may be supplemented with the calculated optical loss budgets for each installed fibre optic span which may be used as acceptance criteria. Alternatively these may left implicit for calculation at a later date.	The Technical Specification contains information which has direct relevance to the implementation phase as detailed below: • Cabling component acceptance criteria • Route environment compatibility • Optical fibre and cable bend radii • Optical cable labelling, administration, looming and dressing requirements • Cable support, protection and anti-creep fittings • Node and closure identification labelling • Closure mounting, support, installation including earthing, sealing and cable protection • Cable earthing and bonding	There is no mandatory level of testing defined in the Code of Practice. Final system testing requirements are defined in the Scope of Works (**5.2:*5.4***). The Technical Specification details the performance requirements of the cabling components. The level of component and staged testing will define the level of risk to be accepted by the installer and the risk involved in underwriting untested work in the event of damage or non compliance. The costs of comprehensive testing of components must be weighed against the risk of later discovery of faults.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 5.4: **Contract Terms & Conditions** ***Clause 5.5:*** ***Contract Terms and Conditions***		
The Contract Terms and Conditions act in place of mandatory requirements. They must clearly relate to the Operational Requirement ***(5.1:5.2),*** Technical Specification (**5.3:*5.3***) and the Scope of Works **(5.2:5.4).**	The Contract Terms and Conditions must be based on agreed performance at the interfaces defined within the Scope of Works (**5.1:*5.2***). The Contract Terms and Conditions must clearly define ownership and responsibility and the stages of transfer.	The Contract Terms and Conditions should protect BOTH customer and installer by defining: • Task-based Responsibility • Health and Safety responsibility • Acceptable performance • Proof of Acceptance • Regulatory conformance • Legislative conformance • Programme milestone payments • Variations • Delays to contract • Warranty • Liabilities
Section 5.5: **Changes and Variations** ***Clause* 5.6:** ***Changes and Variations***		
A Change and Variation Control procedure must be adopted to analyse and record the agreed impact of changes and variations against the following factors: • Topology and performance • Optical loss budget • Nodal design and layout • Application support • Test methods and acceptance requirements • Documentation	A Change and Variation Control procedure must be adopted to analyse and record the agreed impact of changes and variations against the Installation Plan.	A Change and Variation Control procedure must be adopted to analyse and record the agreed impact of changes and variations against the following factors: • Cost implications • (infrastructure works/cost delays) • Warranty and support

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 6.0: **Quality Plan** ***Clause* 6:** ***Quality Plan***		
Quality statements (conformance to BS 5750 /ISO 9000 etc.) may be included in the Installation Specification and the Quality Plan. The Quality Plan provides much greater detail with regard to the activity of the installer on the specific installation underway. Inspection • Cabling Component Acceptance • Stage 1A: Inspection of physical installation quality and administration. • Stage 2A: Inspection of cable and optical fibre administration and dressing into and within closures. Acceptance Testing • Cabling Component Acceptance • Stage 1B: Testing of single optical fibres prior to jointing and termination. • Stage 2B: Acceptance tests on terminated cables in accordance with component performance and optical loss budget acceptance criteria. Test methods from Section/Annex A of the Code of Practice and the appropriate sampling levels must be agreed. Implications on interpretation, validity, calibration and repeatability must be defined. Acceptance criteria SHOULD NOT always be based on the absolute values defined in manufacturers specifications, but on the practical achievable values following consideration of: • measurement methods; • optical fibre tolerances; • wavelength correction. The Quality Plan should also include full details of all documentation to be supplied by the installer to the user.	The Quality Plan should be used throughout all stages of the installation to minimise risk and prove work in defined stages. The Quality Plan should be used to accept work, authorise commencement of the next stage of works and facilitate hand over and payment for completed works. There should be a mechanism for defect identification, resolution and acceptance. The scope and range of testing must reflect the requirements of the Installation Specification with acceptance criteria, acceptance limits and supporting documentation levels defined and agreed between both parties and reflected in the Bills of Material, Labour and Testing and associated costing.	The Quality Plan should form an integral part of the Contract Terms and Conditions in terms of definition of acceptability, proven performance and handover liabilities. The Quality Plan should be used throughout all stages of the installation to minimise risk and prove work in defined stages. The Quality Plan should be used to accept work, authorise commencement of the next stage of works and facilitate hand over and payment for completed works.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 7.0: **Cabling Component Acceptance** ***Clause 7:*** ***Cabling Component Acceptance***		
Components purchased by the installer should comply with the requirements of the Technical Specification (**5.3:*5.3***) within the Installation Specification. Components from other sources have a more complex contractual status and should be treated with caution. Free-issue components or pre-installed components should be assessed for compatibility with those components supplied by the installer. Interworking (jointing etc.) of multi-sourced components should be investigated to ensure that compliance the Technical Specification can be achieved. Existing documentation relating to free-issue components or pre-installed components should be reviewed for accuracy and relevance.	The range of tests defined in the Code of Practice is applicable to the widest possible range of installations and must be intelligently applied to a specific installation dependent upon content, cost options and installer underwritten risk. The procedures agreed between the user and the installer should be defined in the Quality Plan (6:6). The installer must qualify any modifications to the stated procedures and must agree any variation with the user. The Quality Plan (6:6) should use the information provided in this section/clause and Section/Annex A of the Code of Practice to define the inspection procedures, test types, methods and sampling levels to be applied during the cabling component acceptance process. The means by which purchased or indirectly supplied components are accepted by the installer may also be defined in the Installation Specification.	Failure of the installer to verify performance and component compatibility at each stage of the installation may make increase the liability for any remedial works to produce installed system compliance. The scope and type of component performance verification is entirely dependent upon the risk undertaken by the installer against the final system specification and contractual performance requirements. The procedures agreed between the user and the installer should be defined in the Quality Plan (**6:*6***). The installer must qualify any modifications to the stated procedures and must agree any variation with the user. The Quality Plan (**6:*6***) should use the information provided in this section/clause and Section/Annex A of the Code of Practice to define the inspection procedures, test types, methods and sampling levels to be applied during the cabling component acceptance process. The means by which purchased or indirectly supplied components are accepted by the installer may also be defined in the Installation Specification. Documentation is the key element in system conformance to defined specifications and must be used to confirm compliance with the system performance specification. Interim documentation may be used to establish damage liability in the event of dispute and contractual claims.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 8.0: **Optical Cable and Closure Installation** ***Clause 8:*** ***Optical Cable and Closure Installation***		
The requirements of this section/clause within the Code of Practice are generally applicable to all installations and represent the minimum standard of workmanship required. Cable design should be consistent with the limitations and requirements of the route environment and be physically compatible with the installation procedures. Closures should be compatible with physical and environmental requirements of the nodes.	The requirements of this section/clause within the Code of Practice are generally applicable to all installations and represent the minimum standard of workmanship required. Optical cable and closure installation should be undertaken in accordance with the Installation Plan ***(5.2:5.4).*** Stages 1A Inspection should be undertaken as defined in the Quality Plan (**6:*6***) against the requirements of the Installation Specification (**5:*5***). Stage 1B Acceptance Testing,where defined within the Installation Specification, should be undertaken by the installer using the methods and sample levels defined in the Quality Plan (**6:*6***).	The requirements of this section/clause within the Code of Practice are generally applicable to all installations and represent the minimum standard of workmanship required. It is the responsibility of the installer to work in accordance with the Installation Plan ***(5.2:5.4)*** and to notify the user of any change, delay or component acceptance issues. Liability during the installation lies with the installer unless specific waivers are defined and agreed in writing with the user. Health and safety is the responsibility of the installer as is the conformance to local and general building regulations. However the Health and Safety at Work Act may still require the ultimate responsibility for safety to rest with the owner of the site. Satisfactory Stage 1 Inspection and Testing may facilitate acceptance, handover and payment.
Section 9.0: **Jointing and Termination** ***Clause 9:*** ***Jointing and Termination***		
The requirements of this section/clause within the Code of Practice are generally applicable to all installations and represent the minimum standard of workmanship required. Joints and terminations should be compliant with both environmental and installation restrictions defined within the Installation Specification (**5:*5***). The use of joints and connectors at each closure should be as defined within the Scope of Works ***(5.2:5.4)*** and the performance of those components should be as defined within the Technical Specification ***(5.3:5.3).***	The requirements of this section/clause within the Code of Practice are generally applicable to all installations and represent the minimum standard of workmanship required. Optical fibre jointing and termination should be undertaken in accordance with the Installation Plan ***(5.2:5.4).***	The requirements of this section/clause within the Code of Practice are generally applicable to all installations and represent the minimum standard of workmanship required. It is the responsibility of the installer to work in accordance with the Installation Plan **(5.2:5.4)** and to notify the user of any change, delay or component acceptance issues. Labelling, administration and warning notices will be required for optical fibre systems.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 10.0: **Final Cabling Acceptance (Stage 2) Tests** ***Clause 10:*** ***Final Cabling Acceptance (Stage 2) Tests***		
Stage 2A Inspection is undertaken against the requirements of the Installation Specification and the general requirements of sections/clauses 8 and 9 of the Code of Practice. Stage 2B Acceptance Testing is applicable to unterminated, jointed and terminated optical fibres. The Final Cabling Acceptance Testing of unterminated optical fibres is identical to the Stage 1B acceptance testing but is undertaken following full dressing into the closures and as such is termed Stage 2B Acceptance Testing. Stage 2B tests are the definitive performance tests intended to optical loss budget and/or component compliance with the Installation Specification. The test methods applicable to each category of test are detailed in Section/Annex A of the Code of Practice. The type of test, the test method applied and the sample levels to which the test are applied are the subject of agreement between the user and the installer and are defined in the Quality Plan.	Stage 2A Inspection is undertaken against the requirements of the Installation Specification and the general requirements of sections/clauses 8 and 9 of the Code of Practice. The Quality Plan (6:6) should use the information provided in this section/clause and Section/Annex A of the Code of Practice to define the test types, methods and sampling levels to be applied during Stage 2B acceptance testing. The options are: • OTDR • Power Meter • configuration dependent • Single Wavelength • Dual Wavelength • Single Direction • Bi-directional • Sampling level Calibration, correction factors and installed statistical variations should be built into the measurement acceptance criteria. Measurements may be averaged for dual direction measurements dependent upon Installation Specification. Result interpretation should be supplied within the Final System Documentation ***(11:11).***	Stage 2A Inspection and 2B Acceptance Testing are the key mechanisms used to demonstrate compliance with the Installation Specification (**5:*5***). Satisfactory Stage 2 Inspection and Testing generally facilitates acceptance, handover and payment. Failure to comply with the Stage 2 requirements can result in contract liability requiring the installer to complete investigation and remedial works. The warranty may commence from the hand over {acceptance} date.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 11.0: Documentation ***Clause 11: Documentation***		
Documentation is the cornerstone of a supportable installation. Documentation levels should be defined within the Installation Specification (**5:*5***). Final System Documentation should completely define the system as specified within the Scope of Works (**5.2:*5.4***) comprising: • Installation Specification • Quality Plan • Installation Plan	Documentation supplied by the user for information, surveying and costing should be included in the installation documentation and marked accordingly following completion of works. Component acceptance and Stages 1 and 2 inspection and test documentation should be maintained for acceptance, handover and inclusion into the Final System Documentation. Documentation formats are changing in line with PC management systems and documentation may be supplied in disk format to support hard copy. (OTDR results may now be stored in a PC compatible format, allowing rapid access, management and assessment in the case of fault or damage). Documentation may be linked to management systems to facilitate system administration, application mapping and contingency planning. Included should be: • Route locations • Cable system as-built drawing and information • Interconnect and system records • Test results	Acceptance documentation, installation, which can relate to specific stages of the may constitute contractual compliance and hand over and form the boundary between ownership, liability, maintenance and warranty. Documentation coupled with Bills of Material, Labour and Testing and supported by the Installation Scope of Works ***(5.2:5.4)*** and Change and Variation documentation (**5.5:*5.6***) will be required for accurate cost management and related payments. Inaccurate, incomplete or incorrect documentation may delay hand over and acceptance which will impact on payment and cash flow for the installer. For systems defined by an application requirement, documentation is a fundamental requirement for proof of system compliance. The documentation platform, format and requirement must be agreed within the Installation Specification (**5:*5***) and supported by the Quality Plan (**6:*6***). Disk based systems require less storage and may be bonded and protected more easily than paper systems allowing rapid access and decision making in the event of problems.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section 12.0: **Maintenance and Repair** ***Clause 12:*** ***Maintenance and Repair***		
The requirement for preventative maintenance for the passive cable system is often overlooked, but the nature of the optical fibre presentation systems employed makes regular inspection necessary. The system specification should define procedures for inspection, fault. notification and rectification. Repair and remedial work MUST be bound by the original performance requirements defined in the Operational Requirement (**5.1:*5.2***) section of the Installation Specification. Repair and remedial work MUST be bound by the acceptance test methods and documentation systems as defined in the Quality Plan (**6:*6***) of the original installation. This ensures test result and documentation compatibility. The holding of spares to the original specification may be required as part of the contract to overcome component compatibility, delivery availability and lead times for manufacturing.	Procedures for user inspection, fault identification, first line maintenance and escalation to repair. Procedures for good housekeeping associated with system interconnection and patching assemblies. Maintenance agreements may be defined and signed to support the installation following hand over and warranty commencement. There may be a requirement to train the user in test and measurement techniques. User based testing should ONLY come into operation following installation acceptance and hand over.	Warranty should commence from the date of acceptance and hand over. Warranty and maintenance issues need to be resolved prior to commencement to remove the possibility of contractual dispute. Defect liability may be effective for several years following installation and hand over dependent upon the contract and the law of the country in which the contract was signed. The health and safety responsibility remains following hand over and any repair or maintenance must comply with the original specification and compliance requirement. The response times defined in Service Level Agreements for repair and maintenance should have a pre-defined attend and fix time which will have contractual implications if not met.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A: **Acceptance Test & Inspection Methods** ***Annex A:*** ***Acceptance Test & Inspection Methods*** ***Clause A1:*** ***Introduction***		
The test types and methods defined in this section are provided in order to ensure that the results obtained are of use and are repeatable. The actual tests to be undertaken and the sampling levels applied in a given installation should be detailed in the Quality Plan (**6:*6***), agreed between user and installer and based upon a common understanding and interpretation of the benefits of the chosen techniques against the requirements of the system operation defined in the Installation Specification.	Results are only beneficial if there is a clear interpretation against defined acceptance criteria. The test types and methods defined in this section are provided in order to ensure that the results obtained are of use and bear a direct correlation to the requirements of transmission equipment. The actual tests to be undertaken and the sampling levels applied should be detailed in the Quality Plan (**6:*6***). Repeatability is a key factor and test equipment, procedures and interface components should be under appropriate control.	Based on agreement between both parties, the adopted test procedures MUST satisfy the customer that the requirements of the Installation Specification have been met. Techniques for optical measurements require interpretation and the results must be clearly defined and understood to remove contractual dispute about installed performance. Acceptance & test criteria define the contractual boundaries for hand over and payment.
Section A1.0: **Optical Test Equipment** ***Section A2:*** ***Optical Test Equipment***		
The system design may require optical media with two operational wavelengths. Testing will have to verify performance of the INSTALLED system for each operational wavelength defined in the specification. Optical power budgets should be defined in the specification agreement based on component choice, media selection, interconnect requirements and interconnect assemblies. Launch conditions must be met by test leads.	Equipment must be calibrated, set up with correct measurement data relevant to the media being tested and the results must be interpreted in accordance with defined procedures that have been agreed between supplier and customer. Measurements must be specific about inclusions and exclusions and must be repeatable within defined tolerances. As important as the equipment are the optical fibre test leads which are used to connect the equipment to the system on test. These leads must meet the required launch conditions of the installed system.	The requirement to characterise the system and link performance at the defined operational wavelengths should be defined prior to installation. The measurements must be defined in terms of transmission direction, trace requirements and percentage of fibres to be tested in accordance with the Quality plan and the defined acceptance criteria. The acceptance levels for each system link and operational wavelength will be the contractual requirement. Rotational displacement for non- keyed connectors. Measurements will differ at each operational wavelength and transmission direction. Interpretation and clarity is vital to contract compliance and hand over.

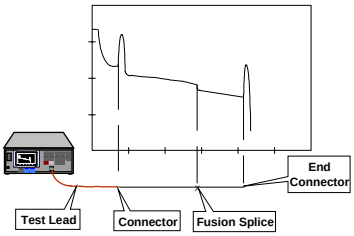
Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A1.1: **Continuity Testing** ***Clause A2.1:*** ***Continuity Testing***		
Adopted for pre installed cable, free issue cable, cable stored prior to installation.	Proving continuity of the fibres can be carried out as part of other testing, using either an OTDR or light source and power meter.	Risk assessed by installer against contract requirements and costing
Section A1.2: **Optical Time Domain Reflectometry** ***Clause A2.2:*** ***Optical Time Domain Reflectometry***		
The OTDR offers a complete system or link fingerprint while the power meter gives an single measured loss value. The OTOR trace offers the required data for system analysis, planning and fault analysis. The accuracy of the OTOR process is increasing and dependent upon resolution, calibration and interpretation of the instrument, may allow system diagnostics to 1m resolution. The characterisation of individual system components (cable, splice, connector) may be assessed with the OTDR giving a far more representative picture than the power meter reading.	An OTDR is dependant upon the calibration and operational wavelength as well as the direction of measurement, but gives more information for analysis of the installed cabling and for identification of faults. The OTDR may be used for continuity and component performance analysis. It does not easily provide the overall loss of an optical fibre link. The centre wavelength of the OTDR must be within the wavelength window defined in the specification agreement at the specified operational wavelength.	Correct analysis and result interpretation allows contractual performance issues to be resolved. The installed link fingerprint provided by OTDR methods is a key contractual tool following installation and may be used to define and limit liability in the event of subsequent, consequential or warranty damage. The OTDR trace assesses component performance and may offer the installer legal support in the event of component failure or degradation following hand over.
Section A1.3: **Attenuation Measurement** ***Clause A2.3:*** ***Attenuation Measurement***		
Single loss values obtained with the use of source and power meter calibrated to the operational wavelength. No analysis or fingerprint information on link components.	Light source and power meters give the overall attenuation of an optical fibre link dependent upon the operational wavelength, the method used and the calibration accuracy of the equipment. The centre wavelength of the light source must be within the wavelength window defined in the specification agreement. Attenuation can be measured on unterminated sections (cut back attenuation) or on terminated sections (insertion loss). Due to the variability of optical connectors, absolute measurements can only be made on unterminated sections of fibre. A light source and power meters cannot give information on individual components once they are connected into a system.	Absolute Compliance or Non Compliance. Limited use in the event of system damage, degradation or undefined component tolerances. Limited fault and warranty support.

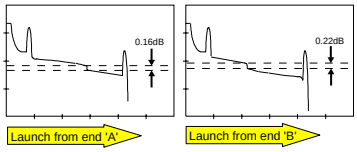
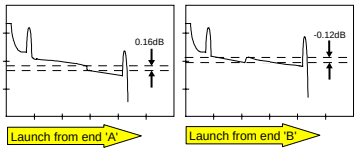
Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A1.4: **Requirements for Optical Fibre Test Leads** ***Clause A2.4:*** ***Requirements for Optical Fibre Test Leads***		
Vital in system analysis and measurement repeatability. Leads designed to ensure system stability over measured length allowing equilibrium conditions to be reached. Optical fibre compatibility with system under test.	The test leads used when carrying out optical measurements are of paramount importance as they determine the launch conditions for the measurement.	Contractual compliance and measurement verification dependent upon test leads. Leads used during Stage, Acceptance and Witness testing
Section A1.4.1: **OTDR Launch Leads** ***Clause A2.4.1:*** ***OTDR Launch Leads***		
Vital in system analysis and measurement repeatability. Leads designed to ensure system stability over measured length allowing equilibrium conditions to be reached. Geometrical compatibility with system under test	Test leads used with an OTOR should be of the same fibre type and geometry as the fibre being tested. The test lead should be sufficiently long to ensure an equilibrium launch and to enable the loss of the launch connector to be assessed. The test lead should be fitted with the same type of connector as the system being measured. To ensure this condition, a launch lead of several hundred metres should be used dependent upon link length. The length and type of the launch lead used should be recorded with the test results.	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A1.4.2: **Light Source and Power Meter Test Leads** ***Clause A2.4.2:*** ***Requirements for Optical Fibre Test Leads***		
Independent from equipment and interconnect leads	Depending on the configuration, either two or three test leads are required. All test leads should be of the same fibre type and geometry as the section being measured. They should be fitted with the same type of connector as the system being measured. It is important that a fully filled, equilibrium launch to the fibre being tested is obtained. To ensure a suitable launch, both a mode scrambler and a mode filter should be used in the launch optics. Types and lengths of all test leads used should be recorded with the test results. .	Calibrated leads ensure measurement repeatability and component compatibility to confirm contractual compliance.
Section A1.4.3: **Index Matching Materials** ***Clause A2.4.3:*** ***Index Matching Materials***		
Cabling designs should not be based on the use of Index Matching Materials. Index Matching Materials will improve optical results but can be subject to environmental conditions and variations	Index matching materials should only be used in mechanical and temporary splices which are designed to be used with such materials. Index matching materials must NEVER be used with optical connectors.	Acceptable contractual conformance based on a repeatable measurement system unreliant on matching materials to TUNE performance. Index matching materials can introduce variations into measured results and therefore jeopardise conformance to Installation Specification (**5:*5***).

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A2.0: **Inspection Equipment** ***Clause A3.0:*** ***Inspection Equipment***		
Inspection equipment should be compatible with the system components selected for termination. Care must be taken to prevent eye damage from exposure to infrared radiation from coupled transmitter devices	Illumination of the connector poses the major problem for field terminated connectors as rear illumination is not usually possible. Procedures must comply with Health and Safety requirements for component end face testing. For example, testing and visual inspection may require filters for eye protection. Connector dust caps must be fitted to ALL unused fibres.	Pre-manufactured connector assemblies and field-terminated connectors require a defined percentage inspection in order to analyse the installed quality.

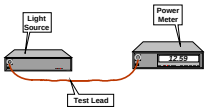
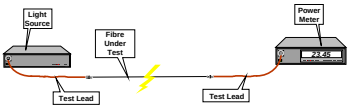
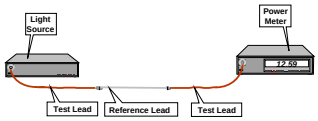
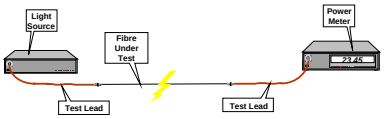
Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.0: **Optical Performance Test Methods** ***Clause A4.0:*** ***Optical Performance Test Methods***		
Define the actual measurement inclusions and exclusions for connectors and patch cords. Define the relevance and accuracy of the measurements, equipment and ancillary components used. Define the correction factors to be applied to each measurement to compensate for measurement wavelength etc. Power meter methods give a single valued loss measurement at the operational wavelength and cannot be used for installed cabling component analysis. OTDR gives link characterisation at the operational wavelength. OTDR is resolution based and can be used to analyse both component position and performance within the installed cabling. Results may be characterised and data stored in a PC compatible format for documentation compliance. Measurement anomalies may be detected by the dual direction measurements and result from the modal distribution and mixing at the interface of dissimilar optical fibre and connector end-faces. Mean values should be taken after dual directional measurements. Both OTDR and POWER meter reading may vary with direction of measurement and a mean value may be required for system characterisation and planning purposes. In the case of the power meter, measurement inaccuracies can be relatively large and can undermine the value of bi-directional measurement as a means of achieving a more accurate value.	The acceptance criteria for splices must be defined. The ability to produce repeatable, stable but high-loss splices may be a function of the fibre properties as opposed to poor jointing performance, this must be allowed for in the acceptance criteria. Measurement procedures must detail methodology, equipment, calibration levels, test leads and environmental conditions to allow repeatability. Documentation and test reports must define all relevant measurement criteria with common interpretation covered by procedures and the specification agreement. Variations due to mated connectors must be built into the measurement and acceptance criteria, and acceptable link performance budgets. Launch conditions MUST be defined and must be constant for all fibres tested. Set up measurements may be required for certain test methods prior to system testing. Results of these should be recorded with the test results.	The ability to prove that the link performance meets specification agreement definition will facilitate acceptance and payment. The use of the OTDR will allow verification of route length and conformance with section topology and survey detail. This will allow verification of the defined Bills of Quantities. The OTDR methodology may be used to confirm component compliance with the defined performance specification. The results measured by OTDR and POWER METER cannot be used to define concatenated link or system performance. Concatenated system performance must be defined by additional measurements across the constructed link with defined patch and connecting assemblies.

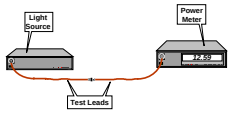
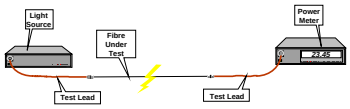
Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.3: **Assessment of Component Compliance Within Fibre Optic Spans** ***Clause A4.3:*** ***Assessment of Component Compliance Within Fibre Optic Spans***		
	An OTDR is used to assess the compliance of individual components within an installed link, and to measure the length of the link. It can also be used to measure the distance to features within the link. The OTDR operates by launching a narrow pulse of infra-red light into a fibre. Light is scattered as it propagates along the fibre and some of this light is captured by the core of the fibre and is guided back to the instrument. At the OTDR the level of light received is plotted against time and the result is displayed. As long as the refractive index of the core of the fibre is known, the time scale can be replaced by a distance scale. Different features reflect or absorb light differently, so the performance of individual components can be assessed by examining the display  	Defined interpretation and acceptance criteria should be defined within the Installation Specification (**5:*5***) and supported by the Quality Plan (**6:*6***). Compliance should be defined in terms of wavelength and directional results, mean values and component tolerances. Sufficient margin should be included in the acceptance criteria to accommodate optical effects and tolerances. For systems installed without defined transmission directions, the cable system must perform equally well in both directions.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.3 continued ***Clause A4.3 continued***		
	Measurements should always be carried out in both directions. The loss caused by a feature, such as a splice, may not appear the same in both directions. The loss can be estimated by averaging the measurements made in each direction.  Estimated loss of splice = (0.16 + 0.22)/2 = 0.19dB Measurements must be carried out at wavelengths within the windows stated in the Installation Specification (**5:*5***) and supported by the Quality Plan (**6:*6***). Great care must be taken when interpreting the results obtained from an OTDR, for example: “if the two fibres spliced together have different backscatter coefficients, then it is possible to see an apparent 'gain' at the splice when looking from one direction. When looked at from the other direction, the splice will appear to have a loss equal to the gain plus the loss of the splice itself”.  Estimated loss of splice = (0.16 - 0.12)/2 = 0.02dB	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.3 continued ***Clause A4.3 continued***		
	A similar result is observed if the two fibres have different core sizes, however in this case there will be no apparent gain, just a greater loss when the splice is looked at from the larger to the smaller cored fibre. It is also possible to have 'ghost' reflections on an OTDR trace. These ghost reflections are caused by multiple reflections within the fibre. The ghost reflection will have no loss associated with it, and will be a multiple of the distance to the cause of the original reflection.	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.4: **Loss Measurement of Fibre Optic Spans** **Section A4.4:** ***Loss Measurement of Fibre Optic Spans***		
Single valued loss measurements of fibre optic span performance at specific wavelengths are used to prove compliance against optical loss budget design calculations and to provide a YES/NO operational capability. Loss of the measured span MUST BE LESS than the optical loss budget of the constructed fibre optic span and MUST BE LESS than equipment optical power budget.	Measurements must be carried out at wavelengths within the windows stated in the specification agreement. The errors produced using these measurements are based in the terminating connectors and are “built-in” to the measurement technique and represent an unavoidable variation. This level of variation frequently undermines the value of bi-directional testing, particularly on short lengths of cable up to 500 metres in length. For longer lengths, measurements may be carried out in both directions. The Code of Practice suggests three variations on the insertion loss technique for use on different cable configuration.	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.4.1: **Testing of Fibre Optic Spans** **Configuration A** **Section A4.4.1:** ***Testing of Fibre Optic Spans Configuration A***		
Configuration A is used for the measurement of fibre optic spans terminated at fixed adapters such as a Patch Panel - Patch Panel arrangement.	**Reference Measurement:**  **Measurement:**  This configuration uses a single test lead for the reference measurement. This test lead then becomes the launch lead for the measurement, a second test lead being used as the tail lead. The result obtained includes the loss of the mated connector pairs at both ends of the fibre being measured.	
Section A3.4.2: **Testing of Fibre Optic Spans** **Configuration B** **Section A4.4.2:** ***Testing of Fibre Optic Spans Configuration B***		
Configuration B is used for the measurement of fibre optic spans terminated at free connectors.	**Reference Measurement:**  **Measurement:**  This configuration makes use of a third test lead in the reference measurement. In order to carry out the measurement, this third test lead is replaced by the fibre link to be measured. The result obtained excludes the loss of the connectors fitted to the ends of the fibre being measured.	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A3.4.3: **Testing of Fibre Optic Spans** **Configuration C** **Section A4.4.3:** ***Testing of Fibre Optic Spans*** ***Configuration C***		
Configuration C is used for the measurement of fibre optic spans terminated at a fixed adapter at one ned and a free connector at the other.	**Reference Measurement:**  **Measurement:**  This configuration uses two test leads connected together, and then comparing this value with the light received when the fibre being measured is inserted between these two test leads. The result obtained includes the loss of one mated pair of connectors (or one “connector” at each end of the fibre being measured).	

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A4.0: **Test Equipment Stability** **Section A5.0:** ***Test Equipment Stability***		
Both power meter and OTDR need to be calibrated at the operational wavelength defined in the Installation Specification (**5:*5***) and supported in the Quality Plan (**6:*6***). Ensure constant power supply to test equipment throughout measurements.	To reduce the effects of drift within the test equipment, repeated reference measurements should be made during prolonged measurement sessions. The actual centre wavelength of all test equipment should be recorded with all test results to enable wavelength correction to be carried out on the results.	Correction factors are vital to confirm result relevance and interpretation and conformance to the acceptance criteria and specification agreement.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A4.0: **Wavelength Correction** **Section A5.0:** ***Wavelength Correction***		
Wavelength correction is vital for result interpretation and acceptance. The centre wavelength of some test equipment sits outside the centre wavelength for the operational wavelength of the fibre system e.g. 850nm fibre operation 820nm test wavelength Correction factor (-0.6 dB) from measured results corrected to km figures.	The correction factor defined by the test equipment operational wavelength and must be applied to the measured length of installed cable in order to produce a “centre wavelength” value. An equivalent correction factor should be applied to transmission equipment to establish power budget compatibility.	Wavelength of test equipment MUST be defined with the implications and interpretation of results and correction factors. The compliance with the acceptance criteria may be based on the application of correction factors to both test and transmission equipment.

Design and Technical Guidance	Implementation Guidance	Contractual Guidance
Section A6.0: **Terminated Optical Fibre Inspection Methods & Criteria** ***Section A7.0:*** ***Terminated Optical Fibre Inspection Methods & Criteria***		
Inspection procedures should be based on health and safety factors. Precautions must be taken to prevent accidental eye damage from connected and operational test equipment or transmission equipment. Health and safety issues must be addressed in the use and allocation of irritant chemicals in the bonding, polishing and preparation process.	Test and inspection should examine the connector end faces for the following: • Core concentricity • Core Eccentricity • Scratches • Cracks • Chips and pits Longer term inspection may require the monitoring of grow-out and pull-in effects. Inspection and acceptance criteria should be aimed at removing all areas of immediate or long term dispute between supplier and customer. Manufacturing instructions should be carefully followed during field termination to ensure the there is no contractual dispute or liability in the event of deterioration during system operation.	Defects can result in lack of stability, operational difficulties, limited lifetime and deviation from the defined performance specifications - ALL of which lead to contractual dispute and general liability on the part of the installer. Defect reports should be completed at the time of inspection and notified to the user along with a defined plan of remedial works (or acceptance by the user.)