

Specification of Fusion Splice Loss

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FIA TSD-2000-4-1-1

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Standards Activities



Member:

ISO/IEC JTC1 SC25 WG3: Generic Cabling
ISO/IEC JTC1 SC25 Project Team: SOHO

Convenor:

ISO/IEC JTC1 SC25 WG3 IPTG: Industrial Premises Cabling



Convenor:

CENELEC TC215 WG1: IT Cabling
CENELEC TC215 WG1 PT Industrial Premises Cabling

Secretary:

CENELEC TC215 WG1 PT Data Centre Cabling



Chairman:


BSI TCT7/-/1: IT Cabling
BSI TCT7/-/3: IT Cabling Support Group


Technical and Standards Director:
Fibreoptic Industry Association


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Existing Standards for OF Cabling Components

 ISO/IEC 11801 Ed. 2 (2002) AND (BS) EN 50173-1 (2002)							
CABLED OPTICAL FIBRE	Wavelength	50/125 or 62.5/125		50/125	Wavelength	OS1	OS2*
		OM1	OM2	OM3			
Attenuation coefficient (dBkm ⁻¹ max)	850nm	3,5			1310nm	1,0	0,4
	1300nm	1,5			1550nm	1,0	0,4
MMF				SMF			

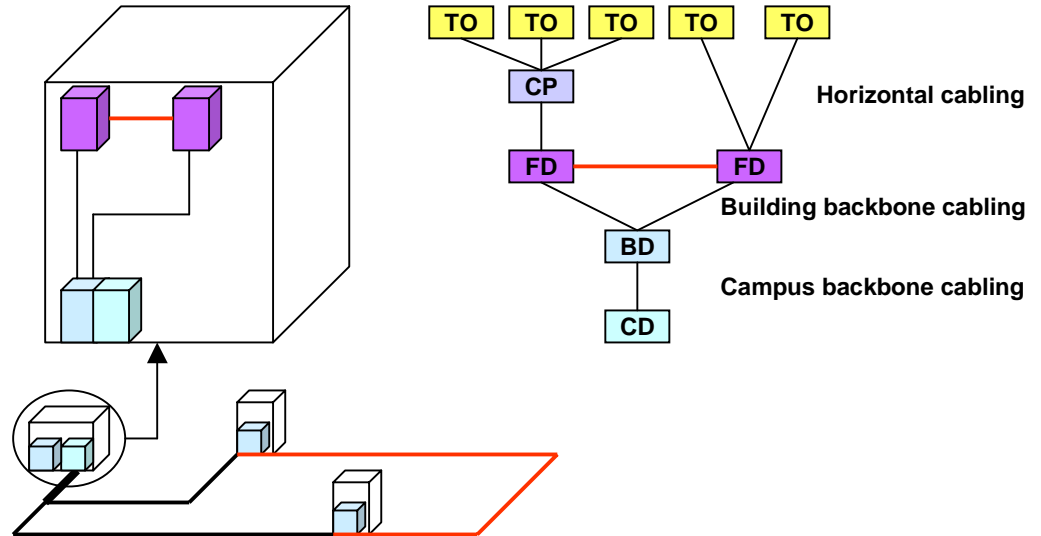
 ISO/IEC 11801 Ed. 2 (2002) AND (BS) EN 50173-1 (2002)							
CONNECTING HARDWARE	Wavelength	OM1, OM2, OM3			Wavelength	OS1, OS2*	
		Connection	Splice			Connection	Splice
Attenuation (dB max)	All	95%<0,5	100%<0,3		All	95%<0,5	100%<0,3
		100%<0,75				100%<0,75	

 ANSI/TIA/EIA-568-B.3							
CONNECTING HARDWARE	Wavelength	Connection	Splice		Wavelength	Connection	Splice

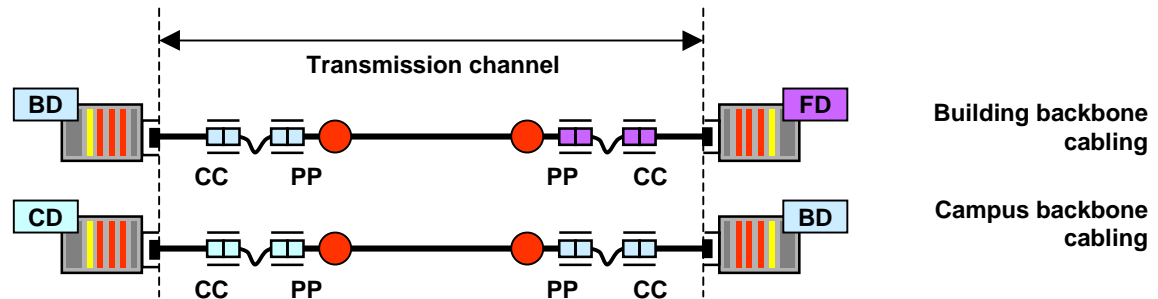
* standard in development

Premises Cabling

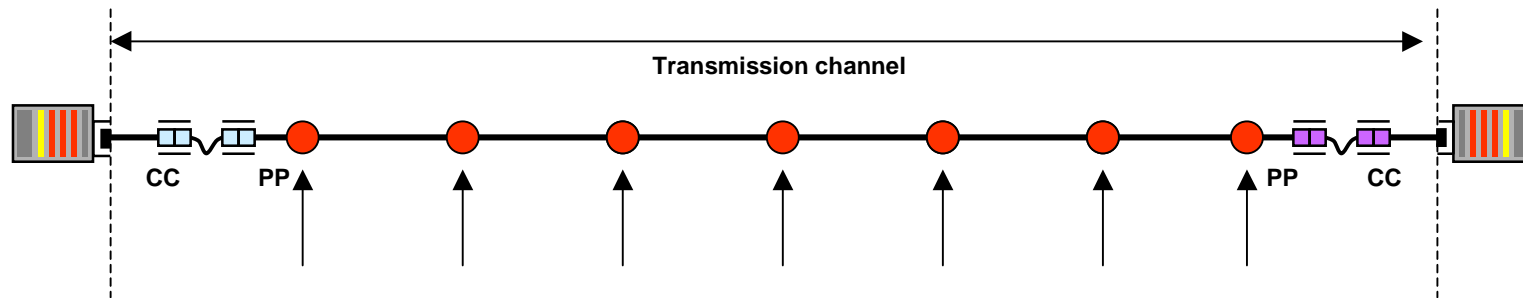
PREMISES CABLING	
ISO/IEC 11801 (BS) EN 50173-1	
TO	Telecommunications Outlet
CP	Consolidation Point
FD	Floor Distributor
BD	Building Distributor
CD	Campus Distributor



CC = Crossconnect Panel
PP= Patch Panel



WAN Cabling - Singlemode Technology

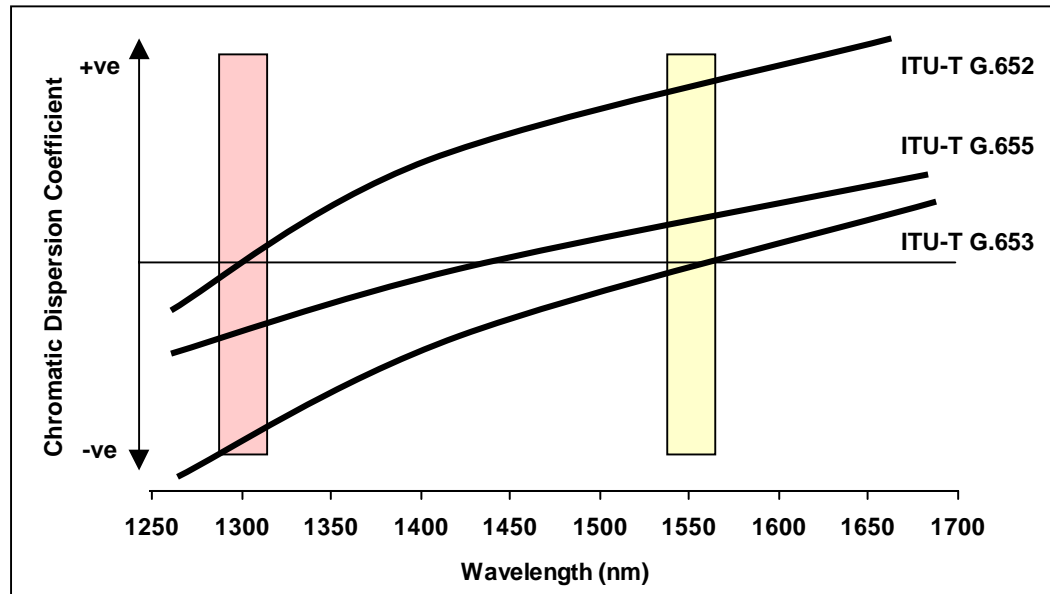


Wavelength	Attenuation	
	OS2*	Splice
1310nm	0,4 dBkm ⁻¹	0,3 dB
1550nm	0,4 dBkm ⁻¹	

Based on a splice every 1000 metres then
75% of loss comes from splices

UNACCEPTABLE

“Which singlemode would you like, Sir?”



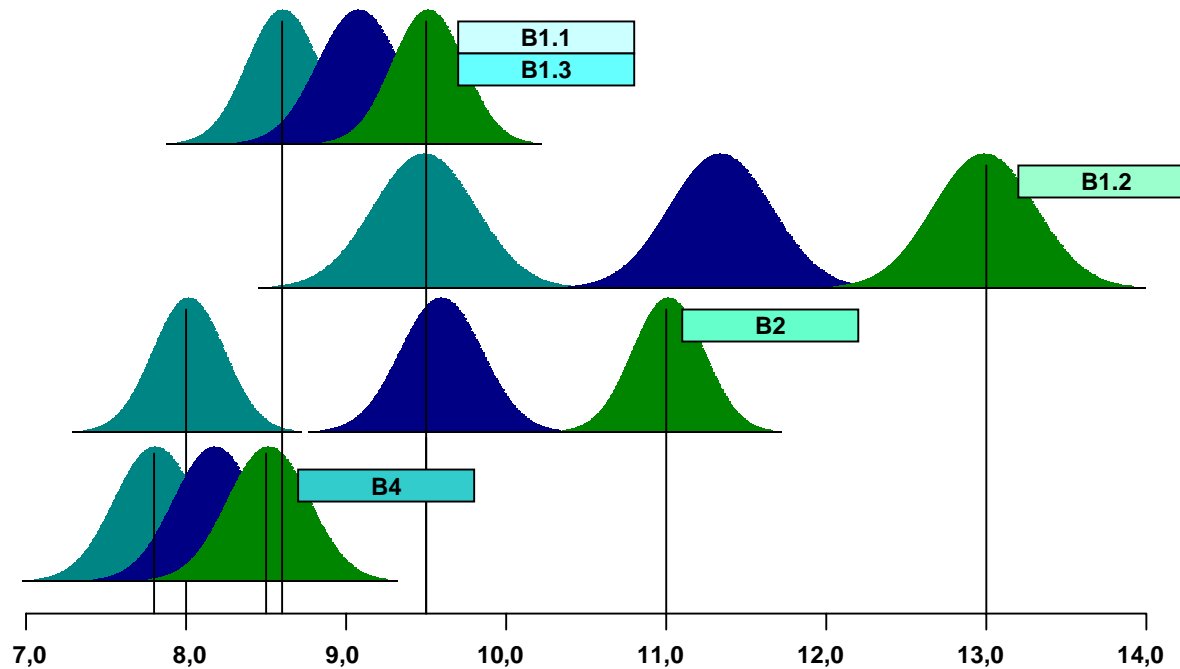
- G.652 - Characteristics of a single-mode optical fibre cable
- G.653 - Characteristics of a dispersion-shifted single-mode optical fibre cable
- G.654 - Characteristics of a cut-off shifted single-mode optical fibre cable
- G.655 - Characteristics of a non-zero dispersion shifted single-mode optical fibre cable

IEC 60793-2-50

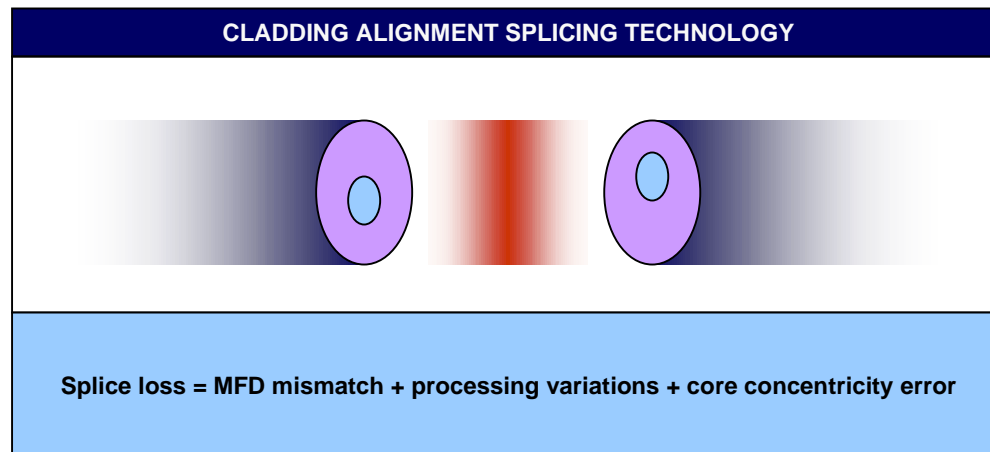
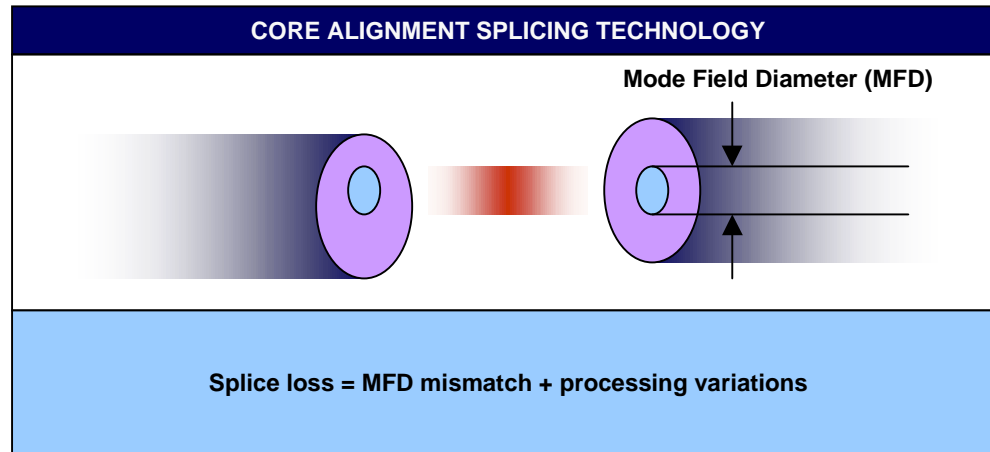
TYPE B1.1	equivalent to	G652a	G652b	
TYPE B1.2		G654a	G654b	G654c
TYPE B1.3		G652c	G652d	
TYPE B2		G653a	G653b	
TYPE B4		G655a	G655b	G655c
		G656		

Mode Field Diameter

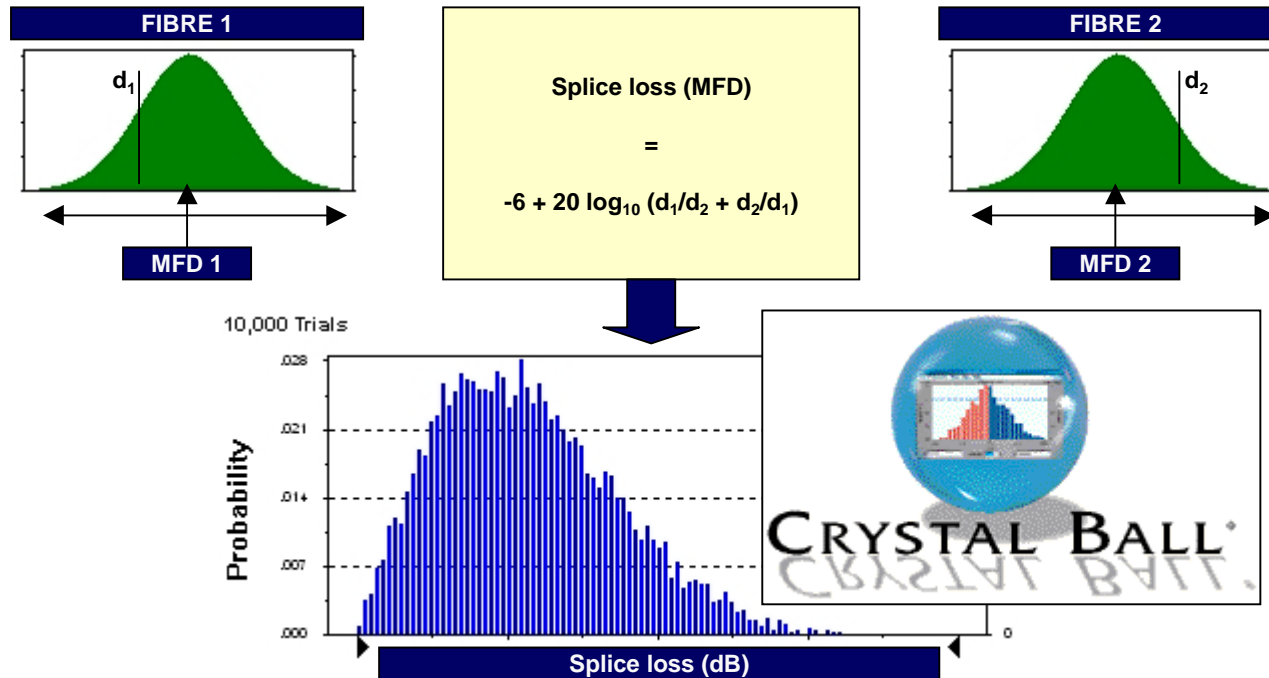
MODE FIELD DIAMETER (μm)					
Limit +/- tolerance				Extreme limits	
	Wavelength	Minimum	Maximum	Minimum	Maximum
B1.1	1310nm	8,6 +/- 0,7	9,5 +/- 0,7	7,9	10,2
B1.3	1310nm	8,6 +/- 0,7	9,5 +/- 0,7	7,9	10,2
	Wavelength	Minimum	Maximum	Minimum	Maximum
B1.2	1550nm	9,5 +/- 1,0	13,0 +/- 1,0	8,5	14,0
B2	1550nm	7,8 +/- 0,8	8,5 +/- 0,8	7,0	9,3
B4	1550nm	8,0 +/- 0,7	11,0 +/- 0,7	7,3	11,7



Splicing Technology Options



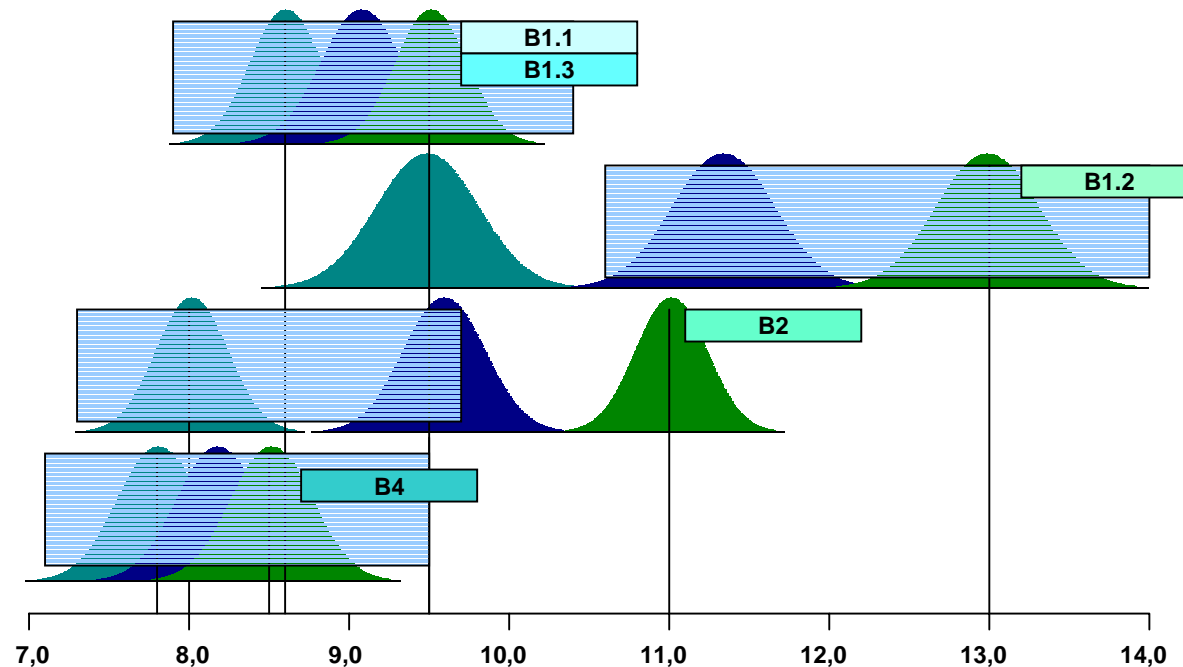
Mode Field Diameter Mismatch



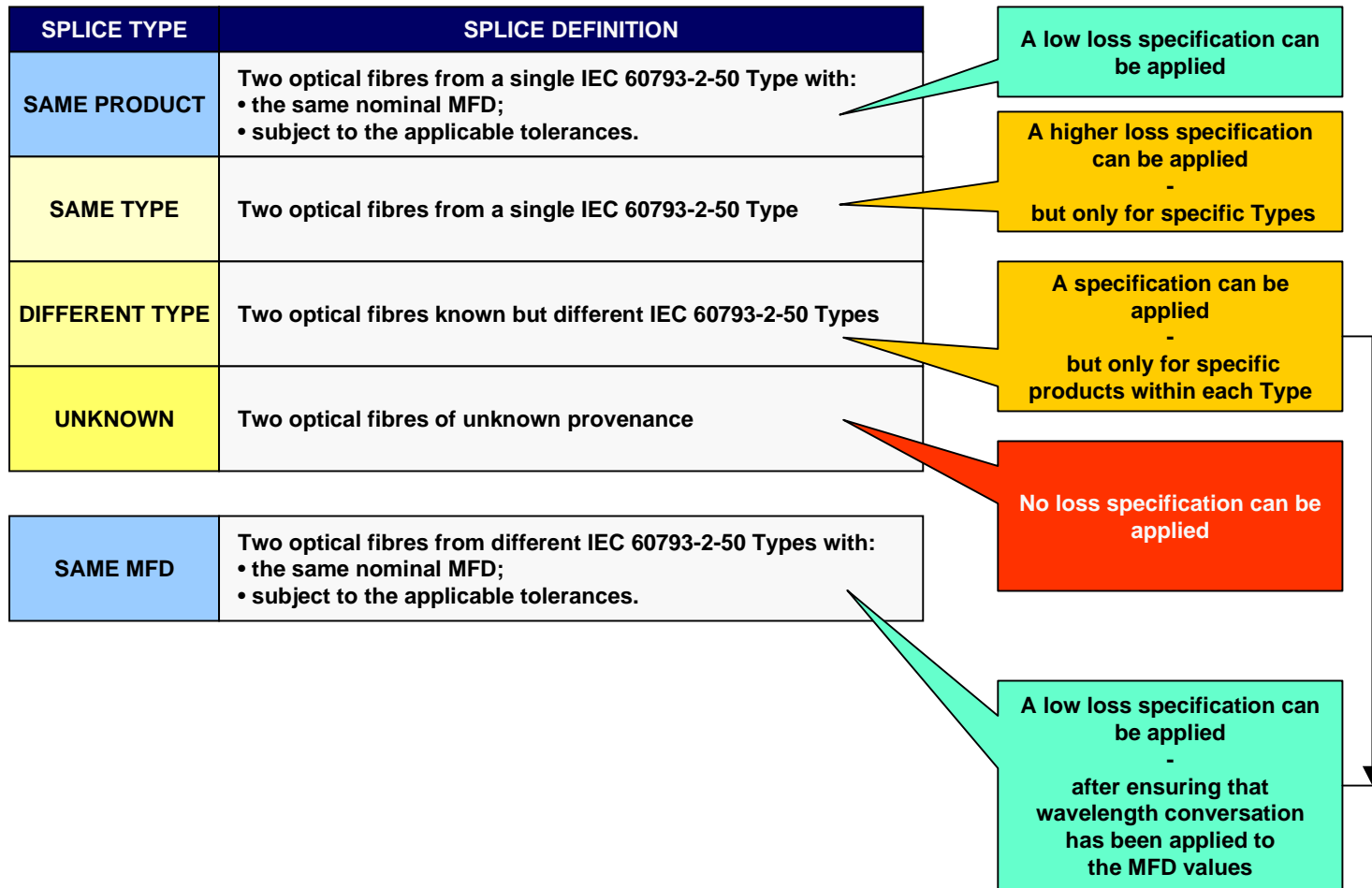
MFD 1	8,0 +/- 0,7	9,0 +/- 0,7	10,0 +/- 0,7	11,0 +/- 0,7	12,0 +/- 0,7	13,0 +/- 0,7	14,0 +/- 0,7
MFD 2	RESULTING INDIVIDUAL SPLICE LOSS (dB max.)						
8,0 +/- 0,7	0,14	0,28	> 0,3				
9,0 +/- 0,7		0,11					
10,0 +/- 0,7			0,08	0,19	> 0,3		
11,0 +/- 0,7				0,08			
12,0 +/- 0,7					0,08	0,15	0,25
13,0 +/- 0,7						0,08	0,13
14,0 +/- 0,7							0,07

Incompatibility

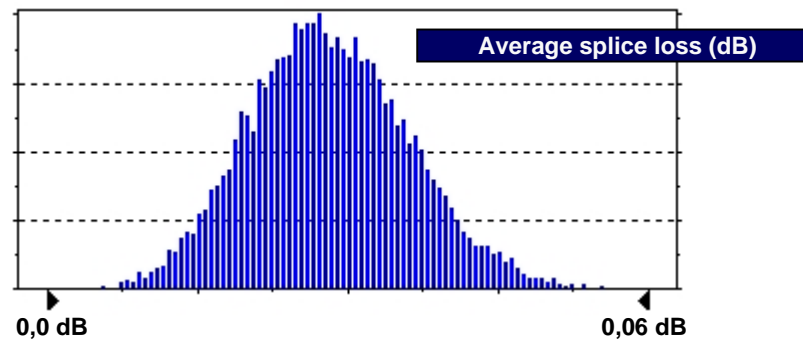
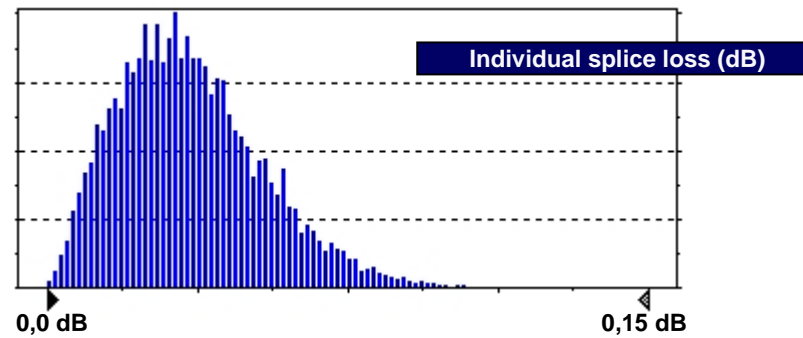
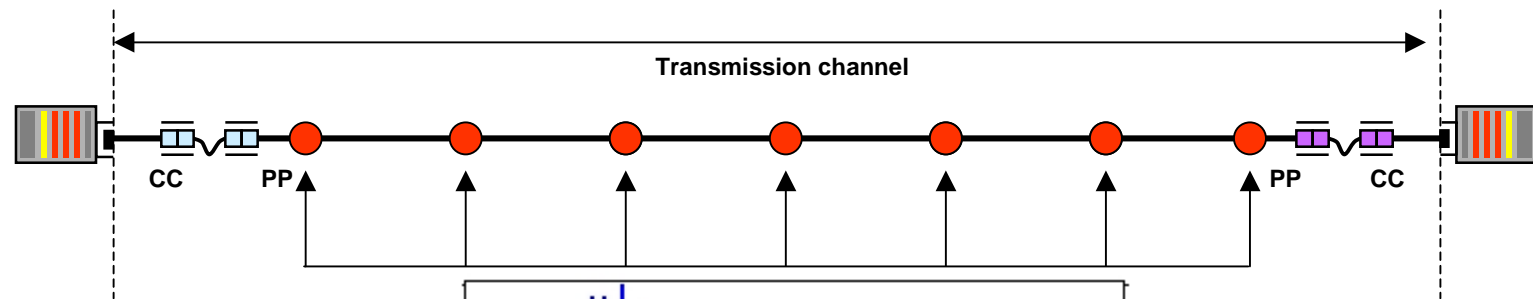
		MODE FIELD DIAMETER (μm)			
		Limit +/- tolerance		Extreme limits	
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	Wavelength	Minimum	Maximum	Minimum	Maximum
B1.2	1550nm	9,5 +/- 1,0	13,0 +/- 1,0	8,5	14,0
B2	1550nm	7,8 +/- 0,8	8,5 +/- 0,8	7,0	9,3
B4	1550nm	8,0 +/- 0,7	11,0 +/- 0,7	7,3	11,7



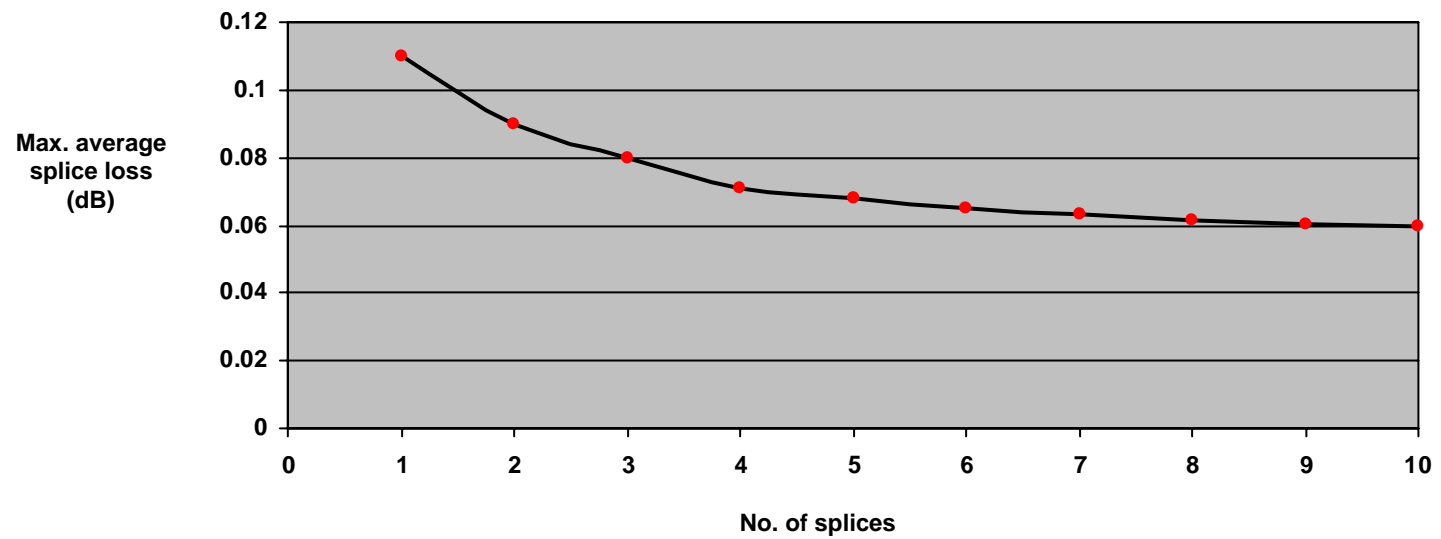
A Specification Minefield



Specification of Average Splice Loss



Behaviour of Average Splice Loss

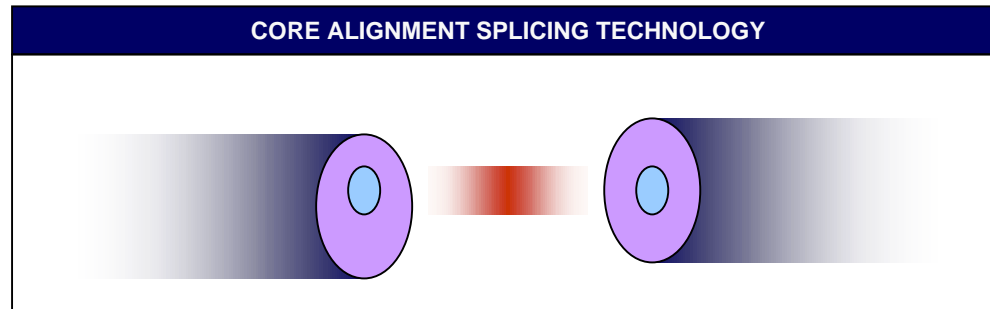



FIA Technical Support Documents

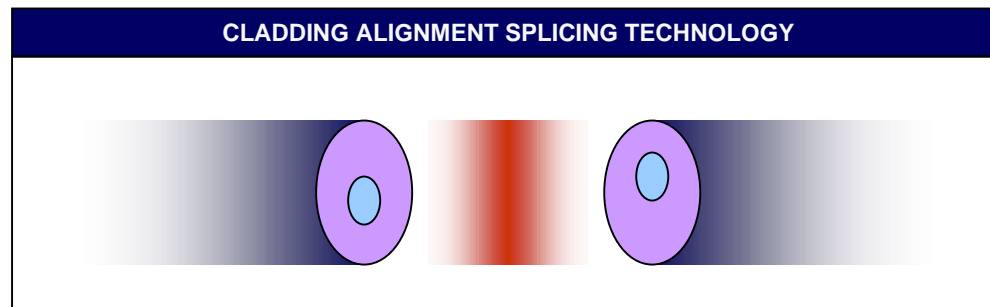


	TSD	
DESIGN	2000-1-1	OPTICAL FIBRE CABLING: LAN APPLICATION SUPPORT GUIDE
OPERATION	2000-3-3	POLARITY MAINTENANCE
INSTALLATION	2000-4-1-1	INSTALLATION PRACTICE: SPLICING
	2000-4-2-1	TESTING OF INSTALLED CABLING: ATTENUATION USING LSPM EQUIPMENT
	2000-4-2-2	TESTING OF INSTALLED CABLING: ATTENUATION USING OTDR EQUIPMENT
SAFETY	2000-5-1	OPTICAL POWER: SAFETY LEVELS
	2000-5-2	OPTICAL FIBRE: HANDLING OF PROCESSING CHEMICALS
	2000-5-3	OPTICAL FIBRE: DISPOSAL OF WASTE

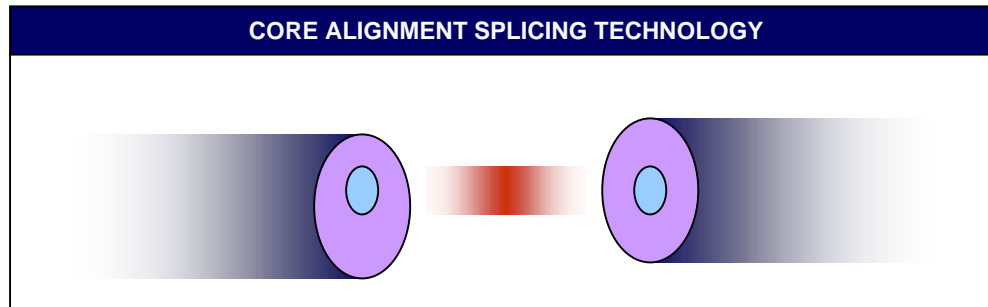
FIA Recommended Limits - Single Splices



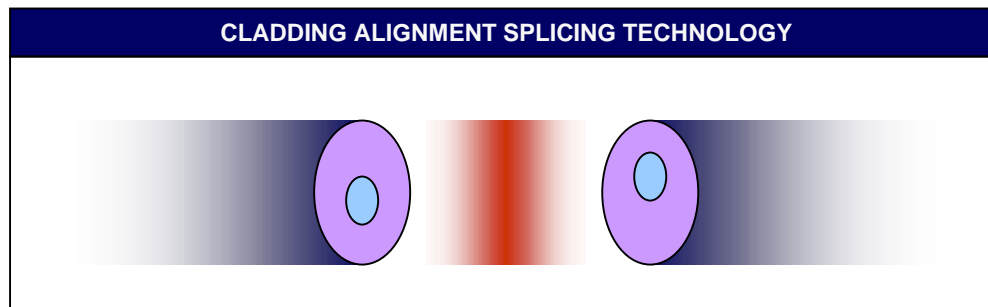
	MMF		SMF	
 ISO/IEC 11801 Ed. 2 (2002), (BS) EN 50173-1 (2002) and ANSI/TIA/EIA-568-B.3				
Attenuation (dB max)	Wavelength	Splice	Wavelength	Splice
	All	100% < 0,3	All	100% < 0,3



FIA Recommended Limits - Multiple Splices



			G652 a, b, c, d	G655 a, b and c	ITU-T
			B1.1	B4	IEC
			B1.3		60793-2-50
			1310nm	1550nm	Wavelength
Single splice (dB max.)			0,3	0,3	
Average for	2	splices (dB max.)	0,09	0,12	
Average for	3	splices (dB max.)	0,08	0,10	
Average for	4	splices (dB max.)	0,08	0,09	
Average for	5	splices (dB max.)	0,07	0,08	
Average for	10	splices (dB max.)	0,06	0,08	

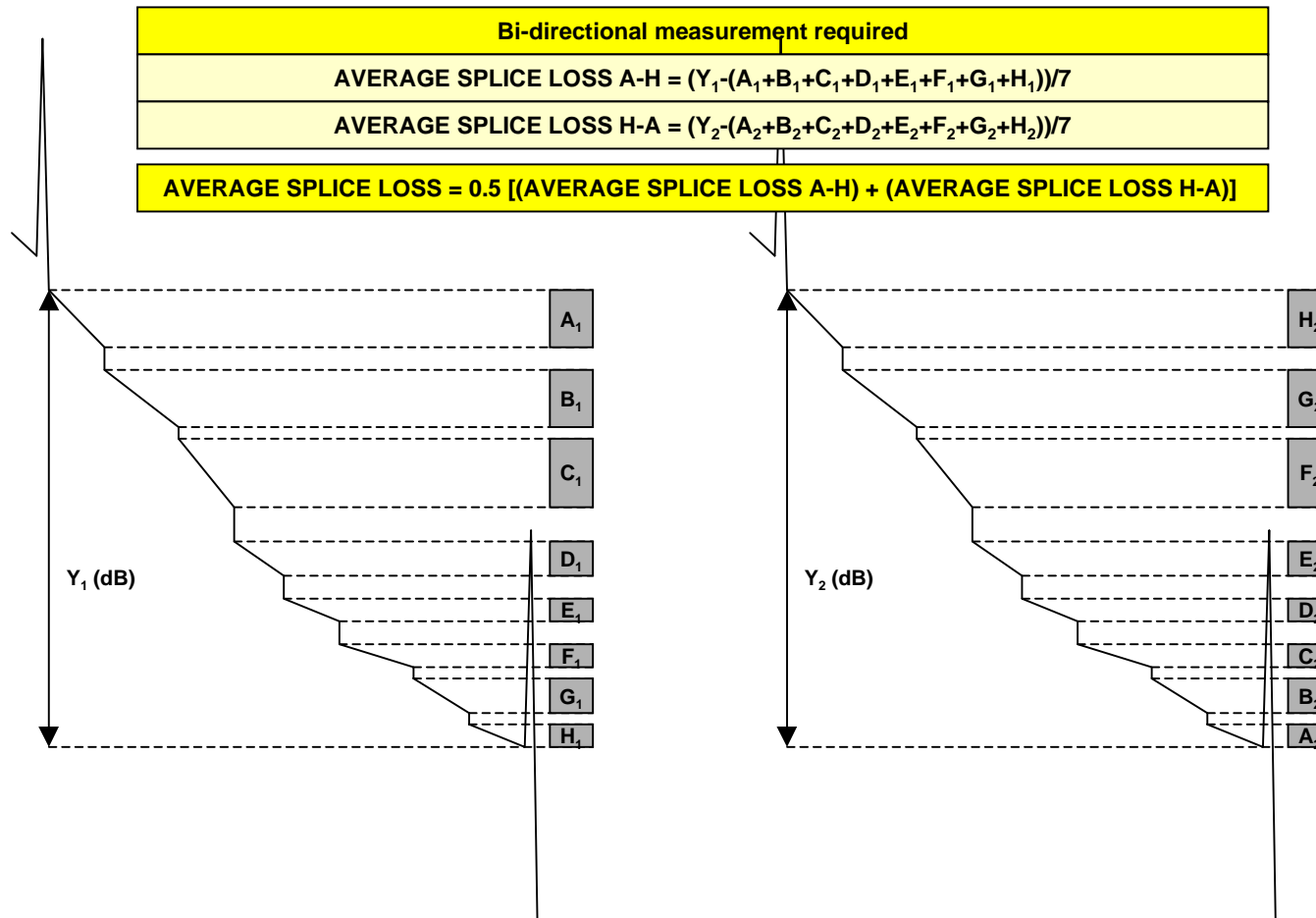


A Question of Measurement

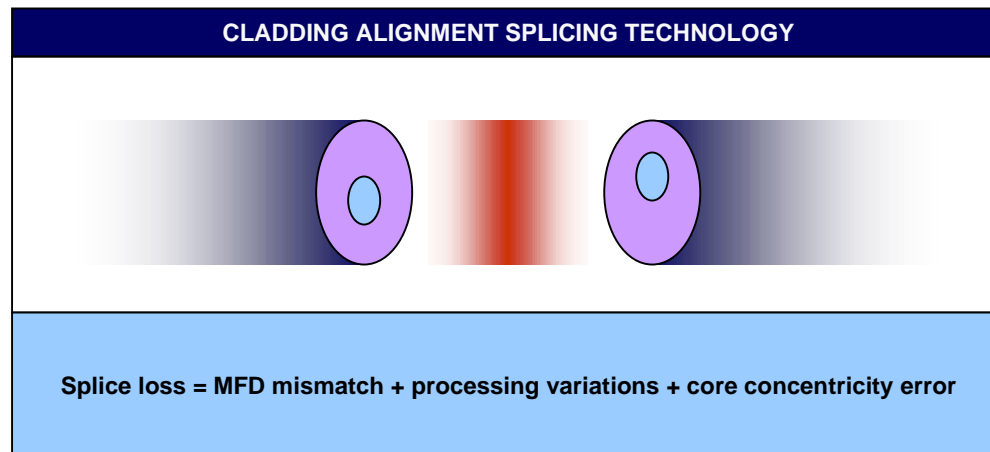
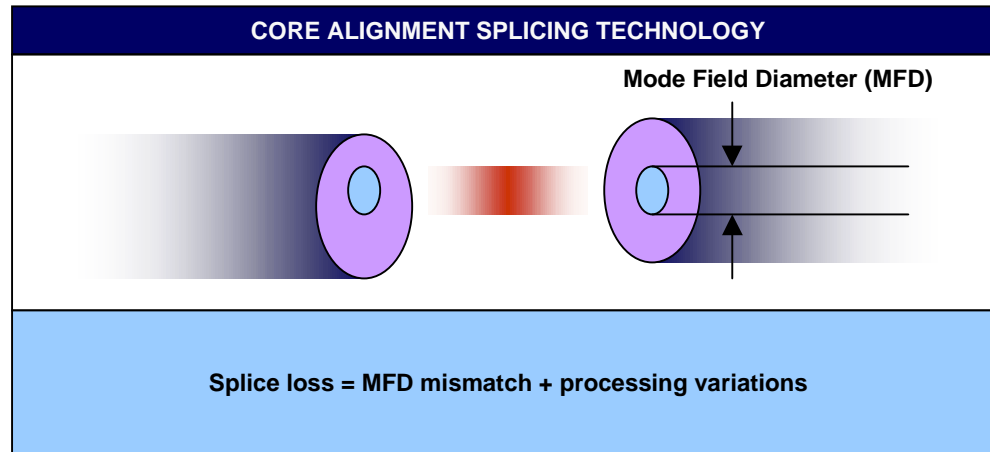


FIA

IEC 61280-4-2 and FIA-TSD-2000-4-2-2



Splicing Technology Options



Commercial Viability

THE CLIENTS PERSPECTIVE

Excessively low splice loss specifications can result in:

- delays to project completion;
- additional costs (labour resource) in meetings, re-negotiation or arbitration of outcomes;
- additional costs associated with attenuation of system components.

Unclear splice loss specifications can result in:

- delays to project completion;
- additional costs (labour resource) in meetings, re-negotiation or arbitration of outcomes.

THE INSTALLERS PERSPECTIVE

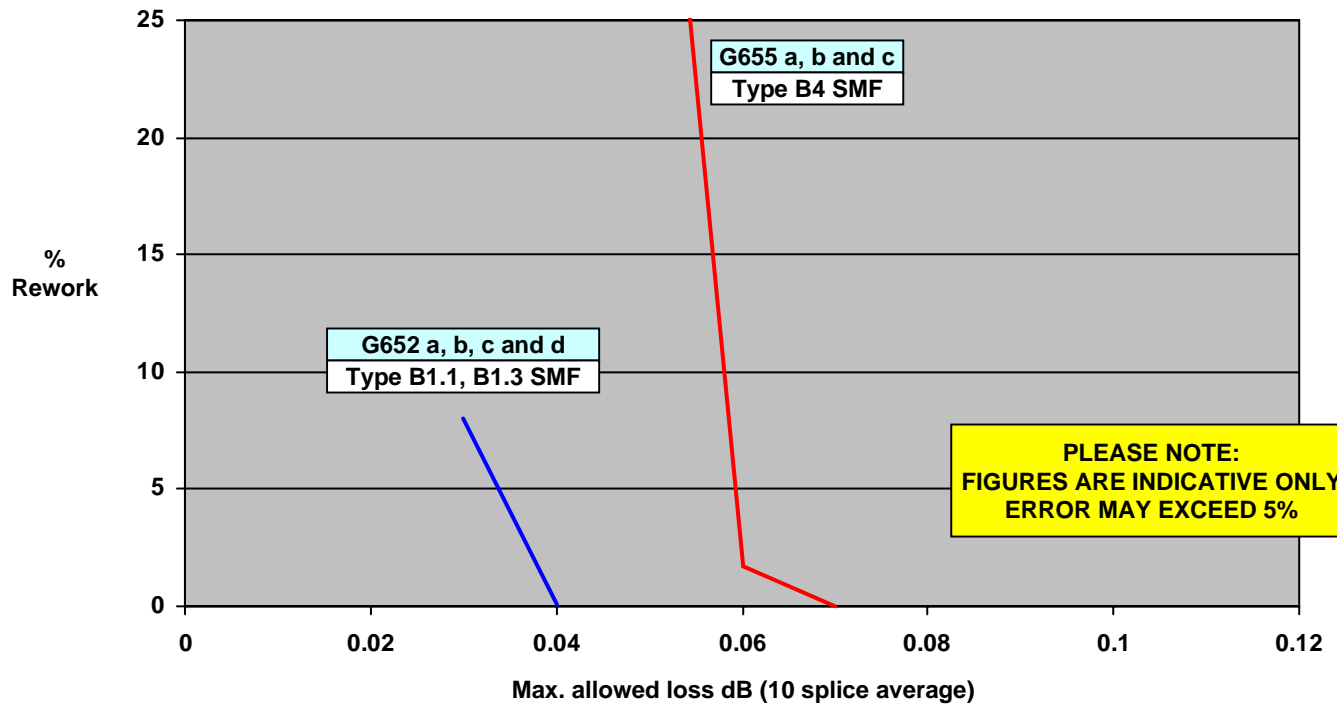
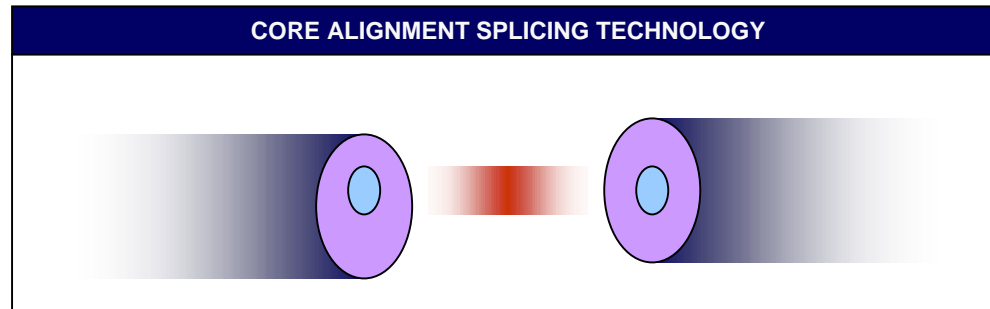
Excessively low and/or unclear splice loss specifications can result in:

- delays to project completion;
- additional costs (labour resource) in rework of completed splice closures;
- additional costs (labour resource) in meetings, re-negotiation or arbitration of outcomes;
- reduction in profit due to late payment;
- delayed onset of other work;
- damage to reputation.

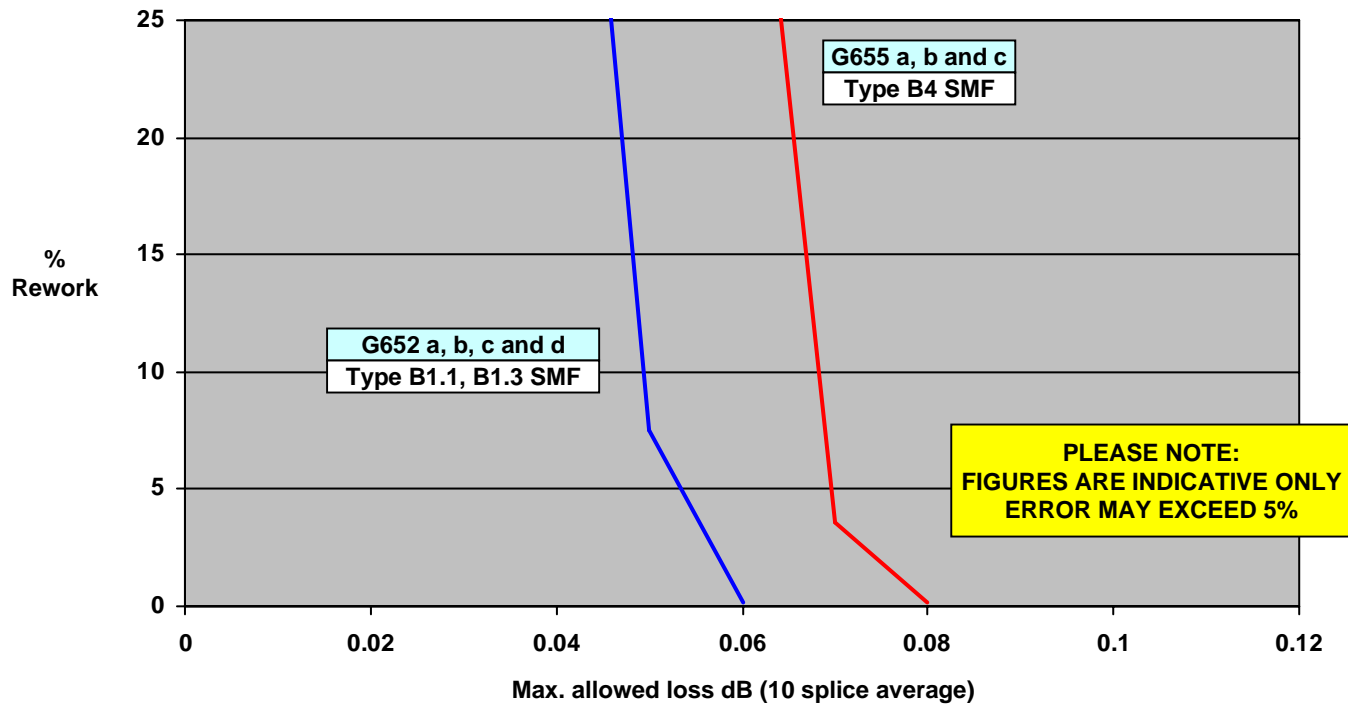
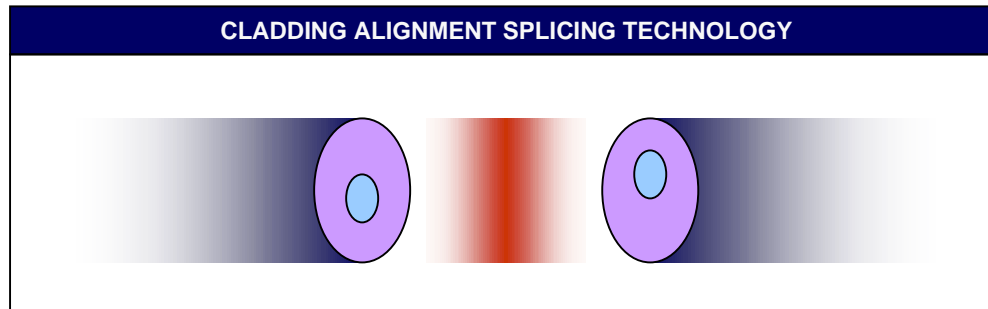
EVERYONE'S PERSPECTIVE

It is in everyone's interest to agree a clear, technically feasible and commercially viable set of limits

Rework Levels



Rework Levels



Cost of Rework

SYSTEM TOPOLOGY	<p>Example of 8% rework</p> <ul style="list-style-type: none">• a 12-element cable might require every splice closure to be reworked• a 4-element cable might only could require every third splice closure to be reworked
RESOURCE ALLOCATION	<p>Rework requires continuous presence of both splicing and testing team</p>
COST PER SPLICE	<p>Can easily exceed original installation cost</p>

Technical Checklist

INSTALLERS

DO	PREPARE THE WORK AREA
	PREPARE THE FUSION SPLICING EQUIPMENT
	PREPARE AND CLEAN CABLE ELEMENTS
	APPLY THE SPLICE PROTECTION SLEEVE
	PREPARE THE PRIMARY COATING STRIPPING TOOL
DO	REMOVE OPTICAL FIBRE PRIMARY COATING
	CLEAN THE FIBRE TO REMOVE REMAINING COATING DEBRIS, CABLE GEL RESIDUE ETC.
	CLEAVE THE FIBRE
DO	SPLICE THE FIBRE <ul style="list-style-type: none">• cleave angle:• cracks:• roll-off or lip:• dust contamination:• splice programme:
	PROTECT THE SPLICE

Conclusions



INSTALLATION	2000-4-1-1	INSTALLATION PRACTICE: SPLICING
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GUIDELINES TO SPECIFIERS	
DON'T	specify incompatible fibres!
	specify maximum individual splice losses of less than 0,3dB
	set unrealistic average splice loss requirements - design systems with realistic power budgets
DO	include specifications for the MFD of the fibre to be used as well as the generic type.
	use the FIA guidelines to set maximum average splice losses
	be clear about the meaning of average splice loss - only specify average losses for splices in the same segment or channel (i.e. do not specify an average splice loss per joint closure)

GUIDELINES TO INSTALLERS	
DON'T	quote for contracts where the optical fibres involved are not fully specified
DO	<ul style="list-style-type: none"> • consider the system topology • calculate the amount of rework and its cost before quoting for a contract.
	adopt best practices when using splicing equipment

Acknowledgements



INSTALLATION	2000-4-1-1	INSTALLATION PRACTICE: SPLICING
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Fibreoptic Industry Association	Mike Gilmore
	John Colton
Optilan	Mike Haynes
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Fujikura Europe Limited	Ian Tweedle
Sumitomo Electric Europe Limited	David Randall
	Yakeen Patel