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MONTAGE: REC. G.652 AU DEBUT DE CETTE PAGE

CHARACTERISTICS OF A DISPERSION-SHIFTED SINGLE-MODE OPTICAL FIBRE CABLE

(Melbourne, 1988)

The CCITT,

considering

(a) that dispersion-shifted optical fibre cables are going to be used widely in telecommunication networks;

(b) that the foreseen potential applications may require several kinds of single-mode fibres differing in operation wavelength geometrical and optical characteristics, and attenuation dispersion and other transmission characteristics,

recommends

a dispersion-shifted single-mode fibre which has the zero-dispersion wavelength in the 1550 nm wavelength region and which is optimized for use at wavelengths around 1550 nm. This fibre may also be used at around 1300 nm subject to the constraints which are outlined in this Recommendation.

Recommendation G.653

Its geometrical, optical and transmission parameters are described below.

The meaning of the terms used in this Recommendation are given in Annex A to Recommendation G.652 and the guidelines to be followed in the measurements to verify the various characteristics are indicated in Annex B to Recommendation G.652. The characteristics of this fibre and the relevant values will be refined as studies and experience progress.

1 Fibre characteristics

Only those characteristics of the fibre providing a minimum essential design framework for fibre manufacture are recommended in § 1. Of these, the cabled fibre cut-off wavelength may be significantly affected by cable manufacture or installation. Otherwise, the recommended characteristics will apply equally to individual fibres, fibres incorporated into a cable wound on a drum, and fibres in an installed cable.

This Recommendation applies to fibres having a nominally circular mode field.

1.1 *Mode field diameter*

The nominal value of the mode field diameter at 1550 nm shall lie within the range of 7.0 to 8.3 μm. The mode field diameter deviation should not exceed the limits of ± | 0% of the nominal value.

Note 1 — The choice of a specific value within the above range is not necessarily associated with a specific fibre design.

Note 2 — It should be noted that the fibre performance required for any given application is a function of essential fibre and systems parameters, i.e., mode field diameters, cut-off wavelength, chromatic dispersion, system operating wavelength, and bit rateB/Ffrequency of operation, and not primarily of the fibre design.

Note 3 — All the above needs further study.

1.2 *Cladding diameter*

The recommended nominal value of the cladding diameter is 125 μm. The cladding deviation should not exceed the limits of ± 2.4% (± 3 μm).

For some particular jointing techniques and joint loss requirements, other tolerances may be appropriate.

1.3 *Mode field concentricity error*

The recommended mode field concentricity error at 1550 nm should not exceed 1 μm.

Note — For some particular jointing techniques and joint loss requirements, tolerances up to 3 μm may be approrpriate.

1.4 *Non-circularity*

1.4.1 *Mode field non-circularity*

In practice, the mode field non-circularity of fibres having nominally circular mode fields is found to be sufficiently low that propagation and jointing are not affected. It is therefore not considered necessary to recommend a particular value for the mode field non-circularity. It is not normally necessary to measure the mode field non-circularity for acceptance purposes.

1.4.2 *Cladding non-circularity*

The cladding non-circularity should be less than 2%. For some particular jointing techniques and joint loss requirements, other tolerances may be appropriate.

1.5 *Cut-off wavelength*

Under study.

1.6 *1550 nm bend performance*

The loss increase for 100 turns of fibre, loosely wound with a 37.5 mm radius and measured at 1550 nm, shall be less than 0.5 dB.

Note 1 — A qualification test may be sufficient to ensure that this requirement is being met.

Note 2 — The above value of 100 turns corresponds to the approximate number of turns deployed in all splice cases of typical repeater span. The radius of 37.5 mm is equivalent to the minimum bend-radius widely accepted for long-term deployment of fibres in practical systems installations to avoid static-fatigue failure.

Note 3 — If for pratical reasons fewer than 100 turns are chosen to implement this test, it is suggested that not less than 40 turns, and a proportionately smaller loss increase be used.

Note 4 — If bending radii smaller than 37.5 mm are planned to be used in splice cases or elsewhere in the system (for example, R = 30 mm) it is suggested that the same loss value of 0.5 dB shall apply to 100 turns of fibre deployed with this smaller radius.

Note 5 — The 1550 nm bend-loss recommendation relates to the deployment of fibres in practical single-mode fibre installations. The influence of the stranding-related bending radii of cabled single-mode fibres on the loss performance is included in the loss specification of the cabled fibre.

Note 6 — In the event that routine tests are required, a small diameter loop with one or several turns can be used instead of the 100-turn test, for accuracy and measurement ease of the 1550 nm bend sensitivity. In this case, the loop diameter, number of turns, and the maximum permissible bend loss for the several-turn test, should be chosen, so as to correlate with the 0.5 dB loss recommendation of the 37.5 mm radius 100 turn functional test.

1.7 *Material properties of the fibre*

1.7.1 *Fibre materials*

The substances of which the fibres are made should be indicated.

Note — Care may be needed in fusion splicing fibres of different substances. Provisional results indicate that adequate splice loss and strength can be achieved when splicing different high-silica fibres.

1.7.2 *Protective materials*

The physical and chemical properties of the material used for the fibre primary coating, and the best way of removing it (if necessary) should be indicated. In the case of a single jacketed fibre similar indications shall be given.

1.8 *Refractive index profile*

The refractive index profile of the fibre does not generally need to be known: if one wishes to measure it, the Reference Test Method in Recommendation G.651 may be used.

2 Factory length specifications

Since the geometrical and optical characteristics of fibres given in § 1 are barely affected by the cabling process, § 2 will give recommendations mainly relevant to transmission characteristics of cabled factory lengths.

Environmental and test conditions are paramount and are described in the guidelines for Test Methods.

2.1 *Attenuation coefficient*

Optical fibre cables covered by this Recommendation generally have attenuation coefficients in the 1550 nm region below 0.5 dB/km. When they are intended for use in the 1300 nm region, their attenuation coefficient in that region is genrally below 1 dB/km.

Note — The lowest values depend on the fabrication process, fibre composition and design, and cable design. Values in the rage 0.19-0.25 dB/km in the 1550 nm region have been achieved.

2.2 *Chromatic dispersion coefficient*

Under study.

Note 1 — The maximum chromatic dispersion coefficient of single-mode fibres covered in this Recommendation shall be:

H.T. [T1.653]

Wavelength (nm) Maximum chromatic dispersion coefficient [ps/(nm×km)] }	{
1525-1575 1300 nm region	3.5 Under study

Table [T1.653], p.

Note 2 — The value of 3.5 ps/(nm | (mu | m) allows for attenuation limited section lengths at 560 MbitB/Fs, using suitable multi-longitudinal mode lasers and adequate line coding.

Note 3 — For higher capacity (larger than 560 MbitB/Fs) or longer length systems, operation closer to the zero-dispersion wavelength is required (unless single-longitudinal mode laser diodes are used). Additional fibre parameters may then have to be specified (such as zero-dispersion wavelength, dispersion-slope, etc.). Further studies are needed to identify these parameters.

Note 4 — It is not necessary to measure the chromatic dispersion coefficient on a routine basis.

3 Elementary cable sections

An elementary cable section usually includes a number of spliced factory lengths. The requirements for factory lengths are given in § 2 of this Recommendation. The transmission parameters for elementary cable section must take into account not only the performance of the individual cable lengths but also amongst the other factors, such things as splice losses and connector losses (if applicable).

3.1 *Attenuation*

The attenuation *A* of an elementary cable section is given by:

$$A = \sum_{n=1}^{f\,\mathrm{Im}} a_n \times L_n + a_s \times X + a_c \times y$$

where

a_n = attenuation coefficient of *n* th fibre in elementary cable section,

L_n = length of *n* th fibre,

m = total number of concatenated fibres in elementary cable section,

a = mean splice loss,

X = number of splices in elementary cable section,

a_c = mean loss of line connectors,

y = number of line connectors in elementary cable section (if provided).

A suitable allowance should be allocated for a suitable cable marging for future modifications of cable configurations (additional splices, extra cable lengths, aging effects, temperature variations, etc.). The above equation does not include the loss of equipment connectors.

The mean loss is used for the loss splices and connectors. The attenuation budget used in designing an actual system should account for the statistical variations in these parameters.

3.2 *Chromatic dispersion*

The chromatic dispersion in ps can be calculated from the chromatic dispersion coefficients of the factory lengths, assuming a linear dependence on length, and with due regard for the signs of the coefficients and system source characteristics (see § 2.2).

ANNEX A

(to Recommendation G.653)

Meaning of the terms used in the Recommendation

Most of the definitions contained in Annex A to Recommendation G.652 are in principle applicable also to dispersion-shifted fibre. Because of limited experience with this type of fibre, further study of the suitability of some definitions is needed.

ANNEX B

(to Recommendation G.653)

Test Methods for dispersion-shifted single-mode fibres

The present experience on dispersion-shifted single-mode fibres is rather limited; therefore further study is needed on some Reference and Alternative Test Methods for this type of fibre. Nevertheless, most of the test methods described in Annex B to Recommendation G.652 are in principle applicable also to dispersion-shifted fibres. Therefore, for this Annex, reference is made to the corresponding Test Methods of Annex B in Recommendation G.652; the specifics of each test procedure need further study. It should be noted that the working wavelength for G.653 fibres is in the 1550 nm region.

Recommendation G.654

CHARACTERISTICS OF A 1550 nm WAVELENGTH LOSS-MINIMIZED

SINGLE-MODE OPTICAL FIBRE CABLE

(Melbourne, 1988)

The CCITT,

considering

(a) that very low loss fibres are required in some telecommunication network applications;

(b) that the foreseen potential applications may require several kinds of single-mode fibres differing in:

— geometrical characteristics;

— operation wavelength;

— attenuation, dispersion and other optical characteristics,

(c) that Recommendations on different kinds of single-mode fibres can be prepared when practical use studies have sufficiently progressed,

recommends

a single-mode fibre which has the zero dispersion wavelength in the 1300 nm wavelength region, which is loss minimized at a wavelength around 1550 nm and which is designed for use in this region.

The geometrical, optical and transmission characteristics of this fibre are described below.

The meaning of the terms used in this Recommendation are given in Annex A, and the guidelines to be followed in the measurements to verify the various characteristics are indicated in Annex B.

Note — The characteristics of this fibre and the relevant values will be refined as studies and experience progress.

1 Fibre characteristics

1.1 *Mode field diameter*

The nominal value of the mode field diameter at 1550 nm shall be xx µm. The mode field diameter deviation should not exceed the limits of ± 10% of the nominal value.

Note — The value for xx has to be specified. A value of 10.5 for xx is one possibility.

1.2 *Cladding diameter*

Under study.
The recommended nominal value of the cladding diameter is 125 µm. The cladding deviation should not exceed the limits of ± 2.4% (± 3 µm).

1.3 *Mode field concentricity error*

The recommended mode field concentricity error at 1550 nm should not exceed 1 µm

1.4 *Non-circularity*

1.4.1 *Mode field non-circulatory*

In practice, the mode field non-circularity of fibres having nominally circular mode fields is found to be sufficiently low that propagation and jointing are not affected. It is therefore not considered necessary to recommend a particular value for the mode field non-circularity. It is not normally necessary to measure the mode field non-circularity for acceptance purposes.

1.4.2 *Cladding non-circularity*

The cladding non-circularity should be less than 2%. For some particular jointing techniques and joint loss requirements, other tolerances may be appropriate.

1.5 *Cut-off wavelength*

The cut-off wavelength values shall be between xxxx nm and yyyy nm for λ_c, and smaller than zzzz nm for $\lambda_{c\backslash dc}$.

Note — The values for xxxx, yyyy and zzzz have to be specified; values of 1350 for xxxx, 1600 for yyyy and 1530 for zzzz are one possibility.

1.6 *1550 nm bend loss performance*

Under study.

Note — The performance of this fibre should not be worse than fibre designed to meet Recommendation G.653.

1.7 *Material properties of the fibre*

This is given in § 1.7 of Recommendation G.652.

1.8 *Example of fibre design guidelines*

Supplement No. 33 gives an example of fibre design guidelines for matched cladding fibres used by one organization.

2 Factory length specifications

2.1 *Attenuation coefficient*

Optical fibre cables covered by this Recommendation shall have attenuation coefficients in the 1550 nm region

Note — The lowest values depend on fabrication process, fibre composition and design, and cables design. Values of 0.15 to 0.20 dB/km in the 1550 nm region have been achieved.

2.2 *Chromatic dispersion coefficient*

The maximum chromatic dispersion coefficient in the 1550 nm wavelength region of single-mode fibres covered in this Recommendation shall be 20 ps/(nm | (mu | m).

3 Elementary cable sections

As given in § 3 of Recommendation G.652.

ANNEX A

(to Recommendation G.654)

Meaning of the terms used in the Recommendation

Most of the definitions contained in Annex A to Recommendation G.652 are in principle applicable also to loss-minimized fibre. Because of limited experience with this type of fibre, further study of the suitability of some definitions is needed.

ANNEX B

(to Recommendation G.654)

Test methods for loss-minimized single-mode fibres

The present experience on loss-minimized single-mode fibres is rather limited; therefore further study is needed on some Reference and Alternative Test Methods for this type of fibre. Nevertheless, most of the test methods described in Annex B to Recommendation G.652 are in principle applicable also to loss-minimized fibres. Therefore, for this Annex, reference is made to the corresponding Test Methods of Annex B in Recommendation G.652; the specifics of each test procedure need further study. It should be noted that the working wavelength for G.654 fibres is in the 1550 nm region.

PART II

SUPPLEMENTS TO RECOMMENDATIONS IN

SECTION 6 OF THE SERIE G RECOMMENDATIONS

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MONTAGE: PAGE 118 = PAGE BLANCHE

Supplement No. 11

{

DATA ON CABLE SHIPS AND SUBMERSIBLE EQUIPMENTS OF VARIOUS | OUNTRIES

}

{

(Mar del Plata, 1968, amended at Geneva, 1972, 1976, 1980, 1984 and 1988; referred to in Subsection 6.3 of the Series G Recommendations)

}

Section 1 — CABLE SHIPS

Name of ship	{			
		CANADA		
John Cabot 1×3.0 (30 t) + linear engine (18 pairs of wheels) }	1985	6400	95	7
Repair ship. Plough capabilities. }	3.0	—	All	{
	DENMARK {			
Ship belonging to Telecom Denmark }				
Peter Faber Reinforced for operation in ice-filled waters. On the aft deck: one A-frame with hydraulic topping. Max. load 35 tons. One hydraulic towing and general purpose winch. Two hydraulic double-drum warping winches. }	1982	Open 750 Closed 1830	78.4	Open 3.8 Closed 5.0

Table [1T1.11], p. (disposition à l'italienne)

{ Section 1 — CABLE SHIPS *(cont.)* }

Name of ship	{								
		FRANCE							
Vercors 4.0 + linear engine (18 pairs of wheels) }	1974	10 | 70	133	7.3	16.5	13 | 00	3	2535	6000*
Laying and repair of all types of telephone (coaxial and optical fibre) and power cables. Capacity: 3500 km deep-sea optical fibre cables, 1300 nautical miles 1-inch cable; 650 nautical miles 1.5-inch cable; 500 nautical miles 1.7-inch cable. * A different weight in the case of power cable. }	All	{							
L´eon Th´evenin 4.0 + linear engine (18 pairs of wheels) }	1983	6200	107	6.25	15.0	10 | 00	2	1060	1000
Repair ship, armoured coaxial and optical fibre cables. }	All	{							
Raymond Croze 4.0 + linear engine (8 pairs of wheels) }	1983	6200	107	6.25	15.0	10 | 00	2	1400	1300
Lays/repairs—approx. half the strage capacity of the *Vercors* *Note* — *L´eon Th´evenin* | and *Raymond Croze* are identical except for the positioning of the cable tanks. }	All	{							

Table [2T1.11], p. (disposition à l'italienne)

{ Section 1 — CABLE SHIPS *(cont.)* }

Name of ship	{								
	ITALY {								
Ships belonging to Pirelli/Euroshipping }									
Arabella	1975	2620	76.66	5.18	11	2000	2	1100	2000
G. Verne	1983	13 | 00	127.5	5.37	10	5000	3	5000	12 | 00
	JAPAN {								
1. Ship belonging to KDD }									
KDD Maru Lays and repairs all types of telephone cables. }	1967	6026	113.83	6.3	16	7000	3	1012	2700
	{								
2. Ships belonging to NTT }									
{ *NTT Tsugaru Maru* } Lays and repairs all types of telephone cables. }	1969	1961	84.6	4.60	13.5	4000	1	320	650
{ *NTT Kuroshio Maru* } Laying by linear engine. Lays and repairs all types of telephone cables. }	1974	3345	119.3	5.60	16.5	6883	3	887	1200
{ *NTT Setouchi Maru* } Lays and repairs all types of telephone cables. }	1979	819	64.8	3.50	12.0	3690	2	139	250
{ *NTT Koyo Maru* } Laying by linear engine. Lays and repairs all types of telephone cables (especially optical cables). }	1983	1295	74.0	43.50	13.5	4500	2	169	250

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Table [3T1.11], p. (disposition à l'italienne)

H.T. [4T1.11]

{ Section 1 — CABLE SHIPS *(cont.)* }

Name of ship	{							
	UNITED KINGDOM {							
1. Ships belonging to British Telecom (Marine) Limited }								
Alert Laying by linear engine and sea-bed burial by plow. Lays/repairs all types of coaxial and optical fibre cables. }	1961	9477	130	7.1	14	10 | 00	3	150
Monarch Lays/repairs armoured coaxial and optical fibre cables. Repairs lightweight coaxial and optical fibre cables. Detrenching/reburial by submersible jetting. }	1975	4639	97	5.5	14	7000	4	41
Iris Lays/repairs armoured coaxial and optical fibre cables. Repairs lightweight coaxial and optical fibre cables. }	1976	4639	97	5.5	14	7000	4	41
2. Ships belonging to Cable & Wireless (Marine) Limited }	{							
Retreiver Lays/repairs armoured cables. Repairs lightweight cables. }	1961	5650	112	5,82	13	8000	3	62
Northern	1962	3363	83.5	5.3	10	7200	3	48

Note — Only relatively short cables are laid and only shore-ends.

Table [4T1.11], p. (disposition à l'italienne)

Section 1 — CABLE SHIPS *(end)*

Name of ship							
2. Ships belonging to Cable & Wireless (Marine) Limited (cont.)							
Cable Venture Laying by linear cable engine. Lays and repairs armoured and lightweight coaxial cables.	1962	16 | 83	153	8.97	12.5	10 | 00	
Mercury	1962	11 | 83	144	7.5	14.5	8000	
Cable Enterprise Lays/repairs armoured cables. Repairs lightweight cables. (See Note)	1964	5759	113	5.84	13	8000	
Cable Protector 2.6 m stern cable drum and small LCE.	1976	4608	86	4.7	10.0	7200	
Pacific Guardian Laying by linear cable engine. Lays and repairs armoured and lightweight coaxial cables.	1984	7526	116	6.32	14.0	8000	
	UNITED STATES OF AMERICA						
Ships belonging to AT&T							
Charlie Brown Repairs all types of telephone cables. Lays short and shore systems.	1952	2881	99.9	5.8	15	7000	
Long Lines	1963	11 | 26	156	7.9	15	10 | 00	

Note — Only relatively short cables are laid and only shore-ends.

Table [5T1.11], p. (disposition à l'italienne)

{
Section 2 — SUBMERSIBLE EQUIPMENTS
}

Type of submersible	Displacement (tons)	Overall length (m)	Width (m)	Heigh
{ *Submersible plough system* } Immediate burial of cable (up to 0.7 m) on ploughing } Lay and bury cables and small pipes. }	23 Towed by support ship	9.06 950	3 {	2.90
{ *Self-advancing buried system* } Burial of existing cables down to 2 m }	11.3 Tracked vehicle	5.50 150	2.45 Burial of cables and pipes.	3.50
JAPAN *1. Submersibles belonging to KDD* }	{			
{ *KS-2 cable plough* } Immediate burial of cable on ploughing } Lay and bury cable in one action. }	9.3 Towed by support ship	11.2 200	2.56 {	2.0
MARCAS crawler	4.7	4.0	3.0	2.15
MARCAS-2500 2 vertical and 4 horizontal thrusters } Post-lay burial, maintenance of cable and survey of senbed. }	3.6 2500	2.65 {	1.8	1.9
2. Submersibles belonging to NTT }	{			
{ *Plough-type Mark IV submarine cable burying system* } Up to 1.5 m depth, immediate burial of cable on ploughing } Simultaneous or post-lay burial of cable. }	16.8 Towed by support ship	8.4 500	4.0 {	4.0
{ *Self-advancing burying system* } Fluidisation, and cutting jets, and dredge pump } Up to 1.5 m depth with cutting and fluidisation jets } Self-advancing by water jets }	3.5 { { 40	3.4 Trench in existing cable.	2.3	1.8

Table [1T2.11], p. (disposition à l'italienne)

{ Section 2 — SUBMERSIBLE EQUIPMENTS *(cont.)* }

Type of submersible	Displacement (tons)	Overall length (m)	Width (m)	Height (m)	
UNITED KINGDOM *1. Submersibles belonging to British Telecom (Marine) Ltd.* }	{				
{ *Submersible trencher* } Fluidisation and cutting jets and dredge pump } Up to 1 m depth with cutting and fluidisation jets } Three vertical and four horizontal thrusters, track drive differential steering } Trench in existing cable and pipe. }	17.0 { { 274	6.6 {	4	3.4	{
{ *Submersible plough system* } Immediate burial of cable on ploughing } Lay and bury cable, umbilical and pipe in one action giving full cable protection. }	9.75 Towed by support ship	6.1 900	2.6 {	2.6	Ploug
{ *Modular plough system* } Immediate burial of cable on ploughing } Simultaneous or post lay burial of cable and umbilicals post lay burial of pipeline. }	40 Towed by support ship	14 350	6 {	4.5	Ploug
2. Submersibles belonging to Cables & Wireless (Marine) Ltd. }	{				
{ *Remote control submersible, Cirrus* } Visual inspection cable location/inspection/ deburial. Manipulation. }	3.2	3.5	2.1	2.3	Wate
CWM sea bed plough Steerable. Backfill Capability Partial Repeater burial. }	12.0	7.2	4.0	2.5	Passi

Table [2T2.11], p. (disposition à l'italienne)

H.T. [3T2.11]

{
Section 2 — SUBMERSIBLE EQUIPMENTS *(end)*
}

Type of submersible	Displacement (tons)	Overall length (m)	Width (m)	Height (m)	*Tranching*
	UNITED STATES OF AMERICA				
Sea plough IV A Plough trench 16'' wide to maximum 24'' depth. }	—	—	—	—	—
Sea plough V Same as *sea plough IV A.* }	—	—	—	—	—
Scarab I/II Multi owners used for maintenance. }	—	—	—	—	—

Table [3T2.11], p. (disposition à l'italienne)

Supplement No. 14

METHODS FOR MEASURING REGULARITY RETURN LOSS

(referred to in Recommendation G.623;

this Supplement is to be found on page 669 of Fascicle III.3

of Orange Book, Geneva, 1977)

Supplement No. 18

INFORMATION ON SUBMARINE CABLES USED IN DEEP WATER

(referred to in Subsection 6.3;

this Supplement is to be found on page 313 of Fascicle III.2

of the Red Book, Geneva, 1985)

Supplement No. 19

DIGITAL CROSSTALK MEASUREMENT (METHOD USED BY THE ADMINISTRATIONS OF FRANCE, THE NETHERLANDS AND SPAIN)

(referred to in Recommendation G.612;

this Supplement is to be found on page 326 of Fascicle III.2

of the Red Book, Geneva, 1985)

Supplement No. 33

EXAMPLES OF FIBRE DESIGN GUIDELINES

(Diagrams used in Japan and in the United Kingdom)

(referred to in Recommendations G.652 and G.654)

The following two diagrams provide and overview of the characteristics of two particular types of fibre. The aim of these diagrams is to give guidance to potential fibre users when preparing optical fibre specifications.

Figure 1, which is used in Japan and in the United Kingdom, gives empirically determined relationships between mode field diameter and cut-off wavelength, as independent variables, with 1550 nm bend loss performance and chromatic dispersion coefficients at 1285 nm and 1330 nm for matched-clad, single-mode fibre compliant with Rec. G.652. Two types of 1550 nm bend loss performance tests are described, the Rec. G.652 test (37.5 mm radius mandrel/100 turns, maximum loss 1.0 dB) and the test most commonly specified in the United Kingdom (30 mm radius mandrel/10 turns, maximum loss 0.2 dB).

Figure 2, which is used by KDD, Japan, gives relationships between mode field diameter and cut-off wavelength with theoretical 1550 nm bend loss performance and various chromatic dispersion coefficients. This information is for matched-clad, single-mode fibre which is compliant with Rec. G.654.

Figure 1/Supp.33, p.

Figure 2/Supp.33, p.