MALAYSIAN COMMUNICATIONS AND MULTIMEDIA COMMISSION
(SURUHANJAYA KOMUNIKASI DAN MULTIMEDIA MALAYSIA)

INVITATION TO REGISTER INTEREST

AS

UNIVERSAL SERVICE PROVIDER

SISTEM KABEL RAKYAT 1MALAYSIA (SKR1M)

Appendix 6

Submarine Cable System Specifications

Ref.: MCMC/RDD/PDD(3)/SKR1M/TCA/07/14(06)
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1. PERFORMANCE

1.1. The SKR1M cable system will form part of the domestic backbone transmission network between East and West Malaysia and the performance shall conform, unless explicitly indicated, to the transmission standards recommended by the ITU-T where applicable as defined in this Specification. Core submarine cable shall conform to G.652.D or G.654.

1.2. The fiber, fiber splices, cable joints, cable transitions, terminations and interconnection devices shall be designed such that the overall performance requirements are met throughout the Design Life of the System in the actual environmental and operation condition.

2. GENERAL REQUIREMENTS

2.1. The licensees shall provide General Information supplied on the Cable Product which contain and not be limited to detailed dimension, mechanical, electrical, Optical characteristics of the cables including the qualification test programs, results, and information on deployment at sea or sea trials of all cable types requested in this Specification.

2.2. If the cable has already been qualified, the licensees shall give details of such qualification, together with any certification the licensees may have received from any qualified body.

2.3. Specifically, the licensees shall specify the different types of fiber and the manufacturing sources for the fibers, and provide qualification program including sea-trials to verify that the use of such fibers are suitable for the design of the System.

Cable Structure

2.4. The cable shall have such characteristics that it can be handled by cable ship equipment without the need for significant modifications. In particular, no modifications to the normal equipment provided or working practices on a cable ship are required, either for laying or maintenance operations.

Cable Type

2.5. Cable types suitable for use in various situations is required i.e. deployment of repeated or unrepeated submarine cable system. The designs of the different types of cable shall ensure that they may be jointed together without undue complexity and shall be formally qualified by the Universal Joint Consortium.

2.6. Submersible Cable shall be suitable for installation (including lying, burial and recovery), use in appropriate water depths. They shall comprise external protection against any external agents either natural or manmade (e.g. abrasion and tension breaks). The electrical resistance of submersible cables shall be design to enable the electroding function for fault location purpose along the cable route.

Un-repeatered Submarine Cable System

2.7. The types of un-repeatered submarine cable system to be used shall meet as a minimum the following requirements:

2.7.1. **Light Weight (LW)**:This type of cable shall be suitable for deployment, operation and recovery in water depths down to 7000 meters.

2.7.2. **Light Weight Protected (LWP**): The LWP submarine cable shall be used in any depth down to 4000 meters and possible to recover and re-used for both surface laid and burial conditions cable for as follows:

- shall be applied more then 1000 meters water depth;
- surface lying;

2.7.3. **Single Armoured (SA)**: This cable is sufficiently heavy so as to be unlikely to be moved by tidal action, detail tension specification is provided below. The SA submarine cable shall be used at any depth down to 1500 meters and possible to recover and re-used for both surface laid and burial conditions. It is strongly requested to design the SA cable for un-repeatered as follows:

- shall be applied after 15 km from BMH or the water depth between 200-1000 meters.
- 1.5 meters burial depth

2.7.4. **Double Armoured (DA):** The DA submarine cable shall be used at any depth down to 500 meters and possible to recover and re-used for both surface laid and burial conditions. It is strongly requested to design the DA cable as follows :

- shall be applied maximum 5 km from BMH or to the water depth of 200 meter, whichever occurs first;
- three (3) meters burial depth shall use articulated pipe at the first 300 meters from BMH or to the water depth of 200 meter, whichever occurs first where required

Repeatered Submarine Cable System

2.8. The types of repeatered submarine cable system to be used shall meet as a minimum the following requirements:

2.8.1. **One Layer Armoring**

The construction and material type of the high strength steel members shall be stated along with any special characteristics applicable.

2.8.2. **Cable Sheathing**

A natural high-density polyethylene jacket shall surround the first steel layer armoring and the composite conductor. The polyethylene jacket shall provide high-voltage insulation from the sea which is at ground potential and resists abrasion, corrosion and UV-light resistance. It shall also provide a suitable finish for cable handling.

2.8.3. **Two Layer And/Or Three Layer Armoring**

The material and construction of the armor used to protect the shallow water sections of the cable shall be stated. This is applicable to the two layer armored or three layer armored cable types.

2.8.4. **Environmental Conditions For Cables**

All cables and joints shall be capable of being operated; deployed, and repaired in the temperature range –10°C to +50°C. Any special requirements regarding environmental control during storage shall be stated.

2.8.5. **ITU-T Recommendation G.976 (10/2000)**

The sub-sea cable design (including joints) must meet certain requirements such as protecting single mode fibers from excessive strain and lateral pressure during laying and recovery operations from the effects of pressure on the ocean floor and from external aggression. The ITU T G.976 recommendation created by major cable manufacturers, academic experts and leading companies in the submarine telecommunications systems field must be fulfilled.

2.8.6. **Optical And Mechanical Parameters**

A full description of the mechanical and optical aspects of the cable shall be provided. It is to take note of the following definitions (under consideration of the ITU-T recommendation G.976, see below):

- Nominal Permanent Tensile Strength (NPTS)
- Nominal Operating Tensile Strength (NOTS)
- Nominal Transient Tensile Strength (NTTS).
- Cable Breaking Load (CBL) due to residual cable strain following a tension approaching the ultimate tensile strength of the cable, and the probability of fiber survival against distance from a tension break in cable. The following Cable Breaking Loads must be fulfilled to for each cable type:

One Layer Armored Cable	-	50 kN
Two Layer Armored Cable	-	200 kN
Three Layer Armored Cable	-	400 kN

2.8.7. **Power Feeding Conductor**

The cable and joint design shall incorporate a power-feeding conductor to support transmission of electroding signals for fault location purposes. The integrity of the insulation of this conductor will be demonstrated before and after installation.

The current carrying capability of the cable, joints and terminations shall be adequate to allow efficient and reliable power feeding to any system components as required by the system design. Joints and terminations shall provide a reliable power connection of constant resistance value no higher per unit length than that of the parent cable**.**

2.8.8. **High Voltage**

Cable, joints and terminations shall be adequately insulated to withstand the maximum designed system voltage, as well as any predictable fault conditions, for the design life of the system. Effects due to handling and working the plant must be demonstrated not to affect lifetime performance. In the case of un-powered systems, this requirement shall be met with regards to electroding voltages.

Submersible Repeaters

2.9. Submersible Repeaters:

2.9.1. Submersible Repeaters shall be designed to operate over the Design Life of the System**.**

2.9.2. The repeaters shall be of a qualified design. For example, optical filters - bandwidth, wavelength stability, insertion losses and high power stability. Pump Lasers - output power stability, performance under transient power conditions and drive current stability. The list of such parameters to be specified and tested.

2.9.3. Undersea repeaters shall contain optical amplifiers each capable of amplifying a composite signal containing a minimum of 64 x 10Gb/s optical digital transmission channels providing a total capacity of at least 640 Gb/s per fiber pair.

2.9.4. Failure of an amplifier pair in a repeater shall not produce failure or significant performance degradation on another amplifier pair and shall affect only one fiber pair.

2.9.5. Supervisory failure shall not lead to failure or impairment in the main transmission path

2.9.6. The supervisory system shall be capable of monitoring critical parameters that indicate the performance of each repeater. The information obtained shall include the capability of being accessible to all cable stations on the link.

2.9.7. The supervisory system shall permit measurements to be made in-service throughout the life of the System without degradation of any System performance parameters.

2.9.8. Details of the optical design of the repeaters shall be provided, including pump laser configuration, optical gain and noise figure, optical bandwidth, channel spacing, optical gain equalization, and monitoring or loopback paths.

2.9.9. Repeaters in any Segment shall be of one type.

2.9.10. The traceability shall conform to industry standards ISO-9001.

Qualification Information

2.10. The Qualification Information supplied on a Cable Product shall contain and not be limited to:

2.10.1. Where the product has not been qualified :

- Qualification Test Plans and Procedures.
- Qualification Test Specifications.
- The performance criteria and safety margins used to set the specification.

2.10.2. Where previously qualified:

- Qualification Reports
- Information on sea trials
- Any relevant certification which have been received from any qualified body
- Previous supply record and service record of the product.

Manufacturing Information

2.11. Manufacturing Information supplied on the Cable Product shall contain and not be limited to:

- Manufacturing Process Flow Diagrams*
- Manufacturing locations
- Production line qualifications and qualification procedures
- Raw materials
- Raw materials suppliers qualifications and qualification procedures
- Operator qualification

2.12. Shall include information on how and where fiber sets are compiled in order to ensure fiber dispersion limits are achieved.

2.13. Where the Cable Product is manufactured at multiple sites and / or on plant not used for the manufacture of the qualification samples, the licensees shall indicate all the differences between the products.

Personnel Protection

2.14. All aspects of cable construction and jointing shall meet the requirements of all relevant national standards. All land cable and land cable joints shall have an earthed circumferential conductor interposed between any power feeding conductor and the outer cable surface.

2.15. Splicing equipment shall be designed to ensure the protection of personnel from hazards including but not limited to optical (LASER, UV), electrical (high voltage), chemical and mechanical hazards.

2.16. The overall dimensions of any splicing equipment used in the field shall allow an easy handling by a single operator. Its weight shall be less than twenty-five (25) kg.

Operating Temperature Range

2.17. The cable, cable joints, and terminations shall be capable of being operated, deployed and repaired over the temperature range while meeting the overall System performance.

Cable transportation and storage

2.18. The cable, cable joints and terminations shall also be capable of being stored or transported during long periods at temperatures over the range -20°C to +50°C without causing any impairment to their specified performance.

2.19. The cable, cable joints and terminations shall also be capable of being handled and deployed over the temperature range -10°C to +50°C without causing any impairment to their specified performance.

2.20. The cables shall be suitable for transportation, installation and storage on drums having a maximum flange diameter of 2400 mm and maximum flange spacing of 1100 mm.

2.21. Where cable drums are used to transport manufactured cable lengths, the method used to secure protective battens or identification labels to the drum shall not be such as to cause any possible damage to the cable contained within.

2.22. The Licensees shall state the recommended storage and transportation conditions for long term storage of cables including the permissible ranges of temperature, moisture and any other relevant factors.

Cable Breaks and Repairs

2.23. Design of the cable and jointing method shall be such that a cable break may be repaired and the associated section restored such that no known failure mechanisms are introduced within the Design Life of the System.

Water and Gaseous Ingress

2.24. The design of the cable and joints shall inhibit the ingress of water and gas into its internal structure under normal operating conditions. In the event of cable damage, the maximum length of cable to be replaced due to water ingress from the point of damage shall not exceed:

- Deep Water: < 1 km in either directions;
- Shallow Water: < 0.25 km in either direction.

2.25. The Licensees shall provide information on the longitudinal penetration distance of water as a function of time and depth. Particular reference shall be made to the amount of cable that would need replacing after a failure to ensure that :

- No long term degradation effects attributable to water and gas ingress remain;
- The life expectancy of the fibers is maintained following a tension break.

Electrode Feed Conductor

2.26. The cable shall incorporate with an electrode feed conductor in order to feed tone to submersible plant. This conductor shall have DC and low frequency AC characteristics consistent with the fault location and electroding specification.

Hydrogen and Radiation Effects

2.27. The cable and cable joints design shall limit degradation in optical performance due to hydrogen present in, or produced by, the cable or its environment, taking into account cable breaks.

2.28. The optical transmission impairment due to the hydrogen effects shall be included in the System power budget, being supported by test results and trials.

2.29. The Licensees shall present :

- the measures which have been incorporated in the cable System in order to protect it from hydrogen sulphide generated on the sea bottom;
- an estimation of the attenuation increase which may be caused by radioactive sources, relative to the intensity of radiation;
- an estimation of the attenuation increase resulting from corrosion effects on installed armoured cable;
- an estimation of the attenuation increase resulting from magneto hydrodynamic effects along the proposed route.

Fiber Identification

2.30. It shall be possible to identify the individual fibers in the cable both at any point of a cable section and in each repeater.

2.31. The marker used for identification of each individual fiber shall be maintained over the whole length of the System.

3. MECHANICAL REQUIREMENTS

General

3.1. The cable design/inherent fiber strength shall be such that the fiber shall not significantly change its mechanical, transmission, or reliability properties before any of the requirements given below are exceeded.

3.2. The cable, cable joints and terminations shall be sufficiently robust to withstand laying, burying, recovery, reuse (where appropriate), and normal handling without degrading the overall System performance or impairing their mechanical properties or that of the fiber during the System Design Life.

3.3. The cable, cable joints, and terminations shall be able to sustain during the System Design Life any permanent or oscillatory tension to be expected on the sea bottom (due to current, slope, suspension, etc.).

Cable Structure

3.4. The optical core of the cable shall be a tube structure housing the fibers, so that the fibers are decoupled from the cable mechanical structure.

Cable Operations

3.5. The design and construction of the cable and cable joints shall be such that no electrical, mechanical, or transmission impairment results, when in suspension over the bow of a cable ship operating in the maximum design depth of the cable for at least the period needed to make three full line cable joints.

3.6. This requirement shall be met under adverse cable ship operating conditions, such conditions being wind force eight (8) (Beaufort Scale), and a sea swell of up to 4 meters height and any adverse water currents that may exist on the route.

Cable Recovery

3.7. It is required that each cable type, cable joint and interconnection device be recoverable from its maximum deployment depth at a maximum speed of 0,7 knot and minimum recovery angle of 80 degrees at a sea swell state of up to four (4) meters height.

3.8. For each cable type, the Licensees shall provide the envelope of performance for these parameters (ship speed, recovery angle and sea swell) applicable simultaneously, recognising potential kinking problems due to tension transients at shallow recovery depths.

3.9. It shall be possible to recover each type of cable from its maximum deployment depth from either side of transitions between two cable types.

Cable Tensile Strength

3.10. The Licensees shall provide the following characteristics for each type of cable, and give evidence that these characteristics are adequate to respond to the encountered constraints:

- Nominal Permanent Tensile Strength (NPTS): the tension which the cable/fiber can support (the System staying in compliance with the performance requirements of this Specification) during the System Design Life.
- Nominal Operating Tensile Strength (NOTS): the tension which can be applied to the cable during the time necessary to make three full line cable joints, once the cable has been recovered, without significant reduction of NPTS.
- Nominal Transient Tensile Strength (NTTS): the tension which can be applied to the cable during a cumulative period of one hour, without significant reduction of the NPTS/NOTS. This condition is typically encountered during recovery operations.
- Fiber Breaking Load (FBL): The load which when applied to the cable may result in an instantaneous fiber break.
- Cable Breaking Load (CBL).

3.11. For each type of cable the Licensees shall present :

- the fiber survival probability for cable tensions of short duration approaching the FBL;
- the long term probability of fiber failure due to residual cable strain following a strike approaching the FBL;
- following a tension break the incremental length of cable to be removed to ensure 100% fiber survivability from stress corrosion for the Design Life of the System as well as the method of determining this incremental length.

Submersible Plant

3.12. The composite tensile strength of the submersible plant i.e., cable, joint(s) and terminations shall meet the following requirements:

Shallow Water

3.12.1. the tensile strength of the shallow water submersible plant shall be sufficient to enable recovery when buried in the sea bed (deliberate or otherwise) to a depth of at least 1.0 (one) meters, or more when the cable is deliberately buried at greater depths.

Deep Water

3.12.2. The Deep Water cable shall be able to be recovered from 7 000 meters under the conditions described above. The recommended NTTS for laying, recovery and maintenance operation of cables deployed in deep water is 40 kN. The Licensees may offer cables with different characteristics provided performance of the cable including tensile strength and interlayer adhesion are suitable for laying, recovery and maintenance operations.

3.13. Where necessity the Licensees shall provide additional tensile strength and result penetration of the cable structure by fishing trawls and anchors.

Localization of Damage

3.14. In the event of cable damage from external causes, for example anchor hook- ups or trawlers, the length of cable extending from the break over which the transmission or reliability performance of the fiber is compromised shall be as short as possible and in any case no more than 1,000 meters in either direction. The Licensees shall propose the rules and criteria for evaluating the length of cable to be replaced bearing in mind water ingress requirements.

Reverse Bend Performance

3.15. The cable shall not suffer impaired optical, electrical or mechanical performance when subjected to thirty (30) reverse bends of one (1) meter radius without tension. The Licensees shall provide details of the test parameters used.

Minimum Bend Requirements

3.16. The cable shall be capable of being installed in situations that require it to be pulled through or left permanently in place with bends having minimum radius of 0.80 meter.

Abrasion Resistance

3.17. The cable shall be sufficiently abrasion resistant such that during normal cable handling and in rough ground, the outer surface of the cable shall not be significantly damaged.

Corrosion Resistance

3.18. The finish of those surfaces of the submersible plant which will be in contact with sea water when the submersible plant is in service, excluding any deliberate sacrificial anode, shall be such that it will not suffer any deleterious effects from chemical, electrolytic or galvanic corrosion due to the presence of sea water, marine life, and/or other metals used in the construction of the submersible plant such that the performance of the System could be impaired.

Crushing and Impact Performance

3.19. The Licensees shall provide the limiting values of weight and energy, due to water pressure on sea bed and to accidental stress respectively, causing cable crushing and percussion so as to prevent permanent mechanical damages and/or degradation of the transmission characteristics.

3.20. The Licensees shall justify the fitness for purpose of crush and impact qualification against worst case conditions during installation and service.

3.21. Crush and impact resistance being the most critical parameter determining the reliability and the ability to withstand external aggression during the life time of the system, the cable shall have an impact resistance of not less than 400N*m for armoured cables and 20N*m for light weight cables.

3.22. The licensees shall provide the limiting value of crush loading over a distance of 100mm under which no mechanical deformation of the optical core occurs.

Torsion Performance

3.23. The torsion performance of the sea cable, joints and terminations shall be sufficient to permit it to be laid recovered and reused without any impairment. The Licensees shall provide details of test parameters used.

Coiling

3.24. All cable shall coil naturally, in a clockwise direction, without the tendency to throw bights or form kinks. This requirement shall be met when the cable is manufactured, after storage in cable tanks and after recovery from its designed depth of water under the tension applied due to catenary's effects.

Cable Finish (General)

3.25. In addition to the above mentioned in the previous Paragraphs and Sub-Paragraphs, the outer surface of the cable, as appropriate to the cable type, shall be:

- Of uniform profile;
- Provide sufficient flexibility to permit the cable to follow sea bed contours and have sufficient weight to resist movement on sea bed;
- Notwithstanding pure tensile stress requirements, armoured cables should have sufficient armouring material to provide effective penetration, corrosion and abrasion resistance;

- Have sufficient frictional properties to permit handling, laying and recovery during cable ship operations when operating in the maximum design depth of the cable;
- Rodent-resistant;
- Rot-resistant;
- Non-sticky, Non-toxic;
- Preferably non-flammable. The Licensees shall state what design and test procedures will be used to ensure that no fire hazards will exist.
- Designed to inhibit corrosion of any underlying armour;
- Designed to retain any cable protection;
- Designed to localise incidental damage;
- Clean i.e. shall not clog or foul cable machinery;
- Preferably light in colour, in the case of sea cable.

4. POWER FEED EQUIPMENT FOR REPEATERED CABLE

General

4.1. The Power Feed Equipment at all stations shall have 1+1 converter protection and include a full rated dummy load. The PFE shall be capable of feeding the Segment it is powering. In case of PFE failure in one CLS, the PFE redundant converter(s) shall be capable of automatically feeding the Segment without intervention and without causing interruptions to traffic. Indication shall be provided both on the equipment and Element Management System to clearly show which parts of the equipment are working and which are on stand-by or off-line.

Design

4.2. The power for feeding the Submerged Plant shall be derived from the station DC power supply.

4.3. Cable Terminating Unit (CTU)

4.3.1. Construction

The CTU shall comprise an enclosed unit which shall be mounted inside the PFE or be capable of being mounted in racks of the same type used for the SLTE or PFE. For safety, the entrance to the unit shall be protected by a safety switch.

4.3.2. Electroding

The CTU shall provide access to the copper wires for electroding purposes.

4.3.3. Cable Termination

The CTU shall provide the mechanical, electrical and optical means of terminating the cable. The cable shall be fixed permanently and facilities shall be provided to isolate the cable for testing without disturbing permanent cabling, wiring or fibers. Each electrical conductor assembly in the submarine cable shall be separately terminated in the Cable Terminating Unit and the conductors shall be insulated from each other to the maximum design output voltage of the equipment type.

4.3.4. Optical Fiber Interconnection

The design of the CTU shall facilitate easy access to the optical fibers for the purpose of jointing, testing or interconnection. This area should be accessible while the Submerged Plant is powered and meet all relevant Safety standards.

4.3.5. Cable Power Indicator

An indicating device shall be permanently connected to indicate the presence of power on the submarine cable at the CTU. The indication shall be visible from the outside of the equipment at the point of access into the CTU but shall not distract the operator's attention during normal operation of the equipment.

4.3.6. Operational Controls

The equipment shall give access to all PFE set-up, control and monitoring functions locally and provide a connection to the Management System. The equipment design shall ensure that all operational controls and major status/performance indicators are prominently positioned. Non-operational controls, fuse-holders and subsidiary indicators shall be hidden from sight during normal operation but made reasonably accessible for maintenance and commissioning purposes (e.g. by the use of hinge-down flaps).

4.3.7. Protection Of Operating Personnel

4.3.7.1. Emergency Shut Down

The equipment shall include a press button facility with remote extension by which the System may be de-energized by non-technical staff should a safety hazard exist. The facility shall be distinctively marked and shall be provided on the front and rear of the equipment at suitable strategic positions. The design should pay special attention to ways of preventing the facility from being operated inadvertently.

4.3.7.2. Earthing Device

The equipment shall include an adequately insulated device to enable potentially high voltage points, in particular the power conductor feeding the submarine cable, to be discharged to earth before handling.

4.3.8. Protection Of The Submarine System

4.3.8.1. Surge

The design shall ensure that no hazardous current or voltage is applied to the cable system at any time, either during normal operating conditions or under fault conditions arising from faults external or internal to the equipment. The design shall ensure that the equipment itself and the Submerged Plant is protected in the event of a lightning strike at or adjacent to either terminal or any power surge which may result from a cable fault anywhere on the system when the power feeding equipment is feeding its maximum output.

4.3.8.2. Voltage Limiting

The output voltage from both PFEs shall be inherently restricted to a maximum safe value in respect of the design value of the Repeaters or of the System as a whole. Where the equipment offered is one which may be used

for a range of longer systems, voltage limiting shall be capable of adjustment in steps. The limiting action shall not rely on alarm devices.

4.3.8.3. Switch-On

The design shall incorporate a closely controlled switch-on sequence for energizing the Submerged Plant. The switch-on shall be capable of initiation from either Terminal Station.

4.3.8.4. Output Current Control

Current control device(s) shall be capable of coarse and fine adjustment, commensurate with the tolerance of the repeater to line current changes.

4.3.8.5. Power Feed Cable

The high voltage cable between the CTU and the PFE shall be constructed so as not to create an electrical safety hazard to personnel. Sufficient mechanical protection

4.3.9. Performance

4.3.9.1. Regulation

The equipment shall provide a transient free regulated supply such that the overall stability requirements of the System can be met. The regulation method shall tolerate:

i. The failure of one set of the PFE.
ii. Variation of power supply voltages and any transients such as those produced when end cell switching takes place on the station battery due to mains failure on power supplies employing end cell switching.
iii. Ambient temperature changes within the range specified in this tender.

4.3.9.2. Current Surges

The equipment shall be designed such that a current surge caused by a short circuit applied to the far side of the first Repeater, while the equipment is feeding it maximum design voltage, is not sufficient to damage the Repeater.

4.3.9.3. Output Voltage

The output voltage of the equipment shall automatically adjust to maintain the nominal line current in the presence of naturally induced voltages, which are assumed to reach a maximum of 0.25 volts/km.

4.3.9.4. Electrical Noise

The PFE shall not generate or pass on to the Submerged Plant any appreciable energy at frequencies other than the primary frequency of any inverter or converter. The levels transmitted shall not affect the repeater performance to cause interference to traffic.

4.3.9.5. Electro-Magnetic Compatibility

The electro-magnetic compatibility of the equipment or any of its component units shall not exceed the limits as defined in industry standards.

4.3.9.6. Ingress Of Dust

The equipment shall be designed to minimize the effect of dust on the performance of the equipment. Unless the ingress of dust can be entirely prevented all high voltage parts shall be capable of being cleaned during maintenance following the Tenderer's procedures.

4.3.9.7. Ionization

The high voltage parts of the equipment shall be free from ionization discharges up to the maximum design voltage of the equipment.

5. CABLE JOINT AND JOINTING REQUIREMENTS

5.1. Provision shall be made to joint land and sea cable utilising reproducible, reliable, economic and easily learned techniques, both on board the cable ships and in land section jointing chambers. The requirements for compatibility of maintenance equipment and procedures defined in this Specification shall be satisfied. A joint shall not degrade the properties of the parent cable to less than 90% of tensile strength. Ultimate Tensile Strength of joints between all cable types shall be demonstrated by proof test in order to allow operators to establish safe working loads during handling.

Jointing Time

5.2. The Licensees shall indicate the time required to complete a typical joint for each type of cable.

Shipboard Testing of Fiber Splice Performance

5.3. Provisions shall be made to adequately test the optical performance of any fiber splice made. The Licensees shall indicate what provisions are proposed to test both the optical and mechanical performance of the fiber splice.

Cable Joint Fatigue Performance

5.4. The cable joint shall be able to pass fifteen (15) times over a three (3) meters diameter bow of a cable ship or equivalent, when subjected to a tension equal to the NTTS of the weaker cable without any impact on the cable joint optical/mechanical performance.

Cable End Seal

5.5. It shall be possible to adequately seal and earth (ground) the cut end of a cable in order to permit buoying off.

5.6. The Licensees shall indicate the sealing method of the cable end.

Manufacturing Joints

5.7. Joints made during manufacture shall meet the mechanical (including dimensional) requirements of the parent cable & shall not use jointing box.

Universal Joint

5.8. The use of Universal Jointing techniques in the maintenance of the System shall be compatible with the submersible plant components. The Licensee shall be responsible to ensure the qualification of all used cable types to Universal Joint prior to commencement of marine installation.

5.9. The use of such a joint over the System Design Life time shall not imply any relaxation of the contractual obligations for product, equipment, and services supplied by the Licensees.

Beach Joint

5.10. The land cable will be interconnected to the submarine cable in the beach manhole. A detailed description of the beach joint shall be provided by the Licensees. The beach joint closure should have qualification as follows:

- Easy assembly
- Corrosion resistant material and waterproof
- All cavity inside are jelly or resin filled
- Equipped with cable bending restrictor

6. OPTICAL FIBER REQUIREMENTS

Characteristics

6.1. The Licensees shall indicate the characteristics of all types of optical fiber to be used, and their relation to System performance, in particular:

- The operating wavelength range and propagation velocity;
- The dimensional characteristics as per the relevant ITU-T Recommendation;
- The average attenuation coefficient of the fibers, including the splice losses together with an RMS (or other statistical parameter), deviation together with the maximum acceptable value of localised attenuation increase due to local heterogeneity of the fiber core occurring during the production process.
- The measuring sensitivity and acceptance criteria for localised attenuation variations in fibers.
- The chromatic dispersion management along the System, including dispersion tolerances and their impact on System maintainability.
- The zero chromatic dispersion wavelengths and its slope (if DSF is to be used).
- The polarisation mode dispersion.
- The effective area of the fiber core.
- The fiber non-linear parameters.
- The cut-off wavelength, as measured by the relevant ITU-T Recommendation Reference Test Method, or any method providing equivalent results.
- The fiber elongation during the strength proof test and the test duration values; these values should be such that the cumulative effect of fiber elongation during laying, recovery and of any permanent fiber elongation due to residual elongation of the cable is compliant with the System Design Life objective.
- The test methods to be adopted for the measurement of the fiber geometrical, optical and transmission characteristics, which should provide results in agreement

with the results obtained by the Reference Test Methods as indicated in the ITU-T Rec. G.650.

- The fibers splices shall have at least the same mechanical characteristics as the specified parent fibers.

Environmental Effects on Fibers

6.2. If temperature induces variations on fiber characteristics, this variation must be reversible and taken into account in the System design. The Licensees shall provide the cabled fiber attenuation for temperatures ranging within -20°C to + 45 °C for submarine cables.

6.3. If other environmental conditions (i.e. laying effect, etc.) induce variations on fiber characteristics, the Licensees shall describe the effects and also indicate how this has been taken into account in the System's design.