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PROVISIONAL
TEST SCHEDULE AND TEST PROCEDURE
FOR
UPLINK INTERFACILITY WAVE GUIDE FOR C BAND, Ext. C BAND and Ku BAND
(No.TEC/TSTP/GR/SWG-01/03.JAN 2009)

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PROVISIONAL
TEST SCHEDULE AND TEST PROCEDURE FOR
UPLINK INTERFACILITY WAVE GUIDE FOR C, Ext-C and Ku BAND
(N0.TEC/TSTP/GR/SWG-002/03.JAN 2009)

1.0 Scope:

The objective of the test schedule is to carry out design and performance evaluation of the Uplink Interfacility Wave Guide For C, Ext-C and Ku Band operating with all types of earth stations. Test schedule for inspection and testing and field acceptance will be largely based on this document. The design evaluation would consist of examining (a) the individual unit/module specification and test results recorded by factory for their adequacy (b) the maintenance philosophy built in the equipment construction practice (i.e. equipment layout, unit/ module layout, facilities provided and their locations etc) (c) examination of the types of components/modules (local/foreign) used from the point of view of the quality assurance. These aspects would be checked by subjecting the Combiner/Divider for Intermediate Frequency for ambient and climatic test. The design evaluation may be carried out separately or along with the performance evaluation.

2.0 Test Equipment Required:

The instruments listed below or their equivalent are used in normal test setups.

No.	Name of Instrument
1.	Frequency Counter
2.	Power Meter
3.	Sensor
4.	Synthesizer
5.	Spectrum Analyser
6.	Scalar Network Analyser (SNA)
7.	Precision Attenuator (75 ohm & 50 ohm)
8.	X-Y Plotter
9.	50 ohm load.

3.0 Figure:

BLOCK DIAGRAM FOR VSWR/RETURN LOSS MESUREMENTS

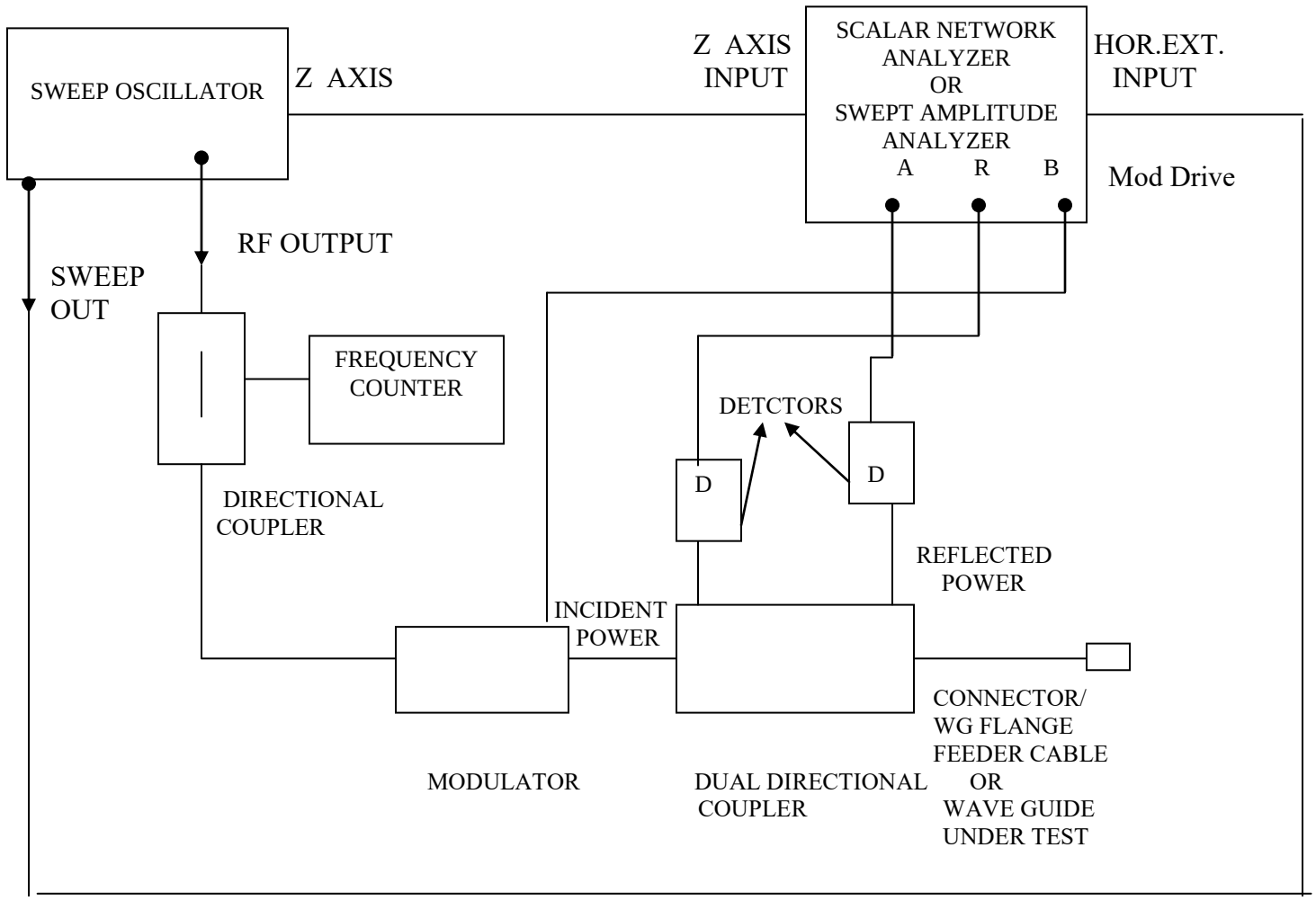

FIG.1

ATTENUATION MEASUREMENTS
OF FEEDER CABLE/WAVEGUIDE

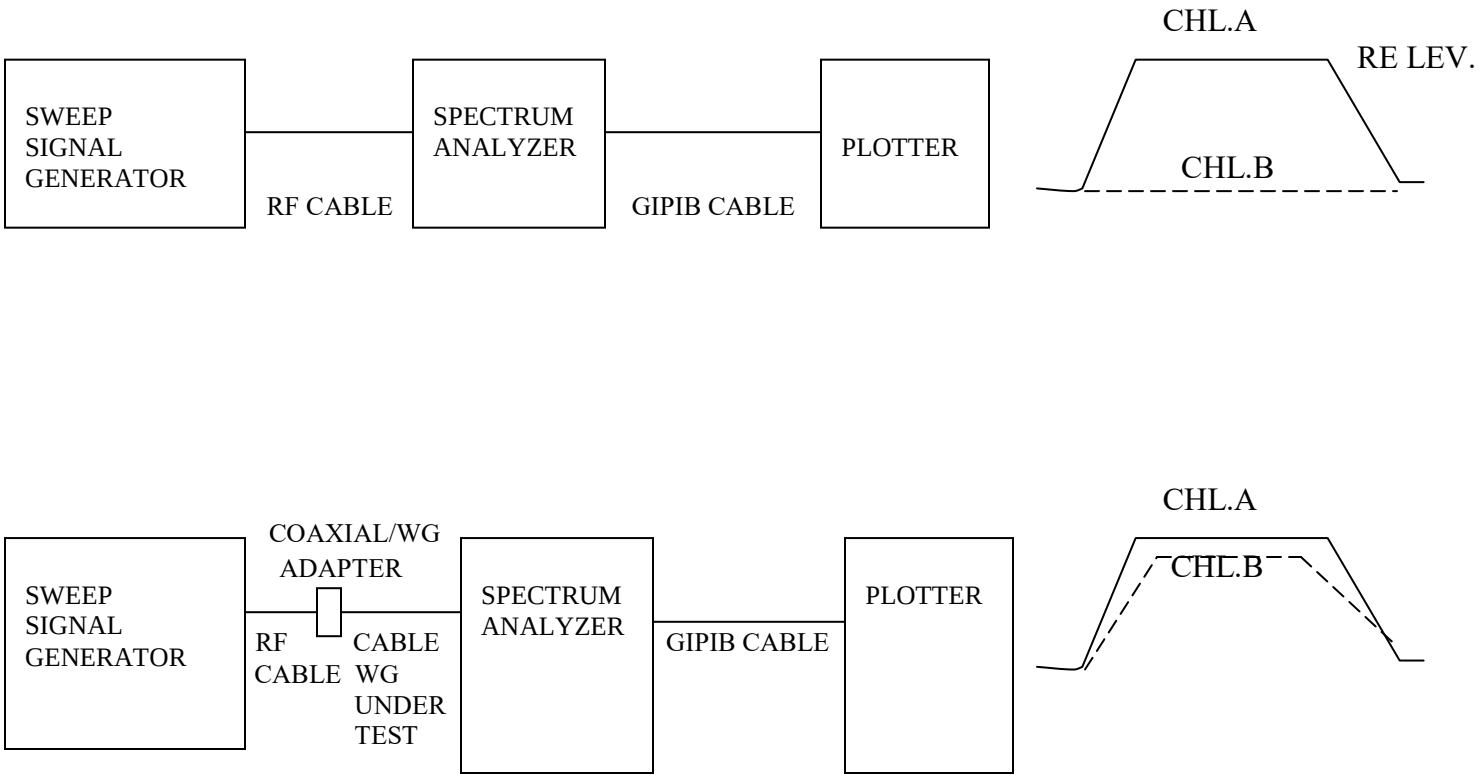

FIG.2

4.0 Test Procedures for measuring various parameters:

Clause No.	Clause	
1.0	**INTRODUCTION** This document contains the generic requirements of Uplink Interfacility Waveguide for C, Ext- C & Ku- band to be used in conjunction with High Power Amplifier subsystem at one end, and antenna at other end. It shall consist of non-circular corrugated flexible copper waveguide with rugged polyethylene jacket. The waveguide shall be pressurized and sealed for transport. The waveguide shall be rugged so as to be reusable by use of rebinds, if necessary. The waveguide shall be provided in the lengths indicated by a customer either with terminations at both ends, or termination at one end with termination at the other end to be field fitted, which shall be possible with standard hand-tools.	To be verified for the functions mentioned in this GR.
2.0	**Functional and Technical Requirements**	
2.1	**MATERIAL**	
2.1.1	Waveguide : Corrugated copper* with anticorrosive Coating *Copper used shall conform to BIS standard IS-1897 (1983) "Specification for copper strip for electrical purposes" (second revision).	Obtain a certificate from manufacturer

2.1.2	Jacket : Polyethylene jacket with any light colour, and UV stabilized to protect it from degradation in sunlight.	Obtain a certificate from manufacturer
2.2	**CHARACTERISTICS**	
2.2.1	Frequency of operation: 5.925 GHz to 6.425 GHz for C –Band : 6.725 GHz to 7.025 GHz for Ext. C-band : 13.75 GHz to 14.50 GHz for Ku-Band	The attenuation and return loss is to be checked over the concerned band
2.2.2	Attenuation characteristics (i) For C-Band :4.95dB/100 m (maximum) at 5.925 GHz at 25° C** (ii) For Ext c-band :6.95dB/100 m (maximum) at 6.725 GHz at 25° C** (iii) For Ku-Band :16.6dB/100 m (maximum) at 13.75 GHz at 25° C** ** Variation of ±0.2% per° C may be taken for temperature other than 25°C.	**Attenuation Measurement:** **Test procedure:** Attenuation measurements are made on the complete wave guide sample with specified flange connectors at both ends. Set up may be arranged as shown in Fig.2 (i) Connect the signal generator with Auto/manual sweep to the spectrum analyzer by the standard RF cable. Adjust the sweep signal generator to sweep over the prescribed frequency band. Set the spectrum analyzer to read the full frequency sweep and keep it on MAX hold position. If the dual channel SA is available, read the above sweep on channel A and store it when the clear reading is obtained. (ii) Nominal values for connector losses and meter inaccuracy may be taken into consideration while taking attenuation measurement. (iii) Repeat the step (i) with the RF cable replaced by RF cable + wave guide under test using the suitable adopter as shown in Fig 2. Store this trace in channel B. (iv) Take a plot of the above traces on the plotter connected with the spectrum analyzer. (vi) Insertion Loss or attenuation of the waveguide or cable at any frequency can be found out by taking the difference between two traces in dB at any particular frequency. Attenuation in dB/100m may be calculated as follows: Attenuation in dB/100m = Measured dB* 100/Length of the waveguide in meter (v) Worst value may be entered in the data sheet.
2.2.3	Return loss with frequency Connecters at both ends (i) For C-Band : 30dB minimum over whole Frequency band (ii) For Ext C-band : 29dB minimum over whole	**Return Loss Measurement:** **Test Procedure:** Return loss measurement of the waveguide may be made on the complete sample with suitable connectors at both ends. Set up may be arranged as in Fig 1. (a) Adjust the sweep signal generator to sweep over the desired band of frequencies. Verify the frequency with the frequency

	Frequency band (iii) For Ku-Band : 28.3dB minimum over whole Frequency band	counter. Sweep should be 'off' when checking the end frequencies. Disconnect the frequency counter. Set the analyzer scale calibration at 5 or 10 dB per division. (b) Calibrate the set up by putting a wave guide short at the test port of the directional coupler. The trace of the analyzer should be positioned at a convenient place. This trace will be for 0 dB return loss i.e. 100% reflection. (c) Remove the short and connect the wave guide at the test port with the distant end terminated with the specified flange connector. The trace will move down. (d) For return loss at any frequency, read the number of divisions the trace has moved down. Number of divisions* 5/10 will give the return loss at that point. (e) Return loss may be plotted over the prescribed frequency band. (f) Worst value of the return loss may be entered in the data sheet. Note: - If the manufacturer is having other instruments, suitable set up may be made and return loss may be measured accordingly.
2.2.4	**Minimum bending radius** (i) For C & Ext-C Band a. with single bending E-plane H-plane : 300 mm 600 mm b. With 10 re-bendings E-plane H-plane 900 mm 800 mm (ii) For Ku-Band a. With single bending E-plane H-plane :130 mm 360 mm b.With 10 re-bendings E-plane H-plane 130 mm 360 mm	**Test Procedure:** **Minimum Bending Radius: -** Two Specimens each of suitable length shall be cut from the sample unit. The middle section of the specimen shall be formed for two complete turns around a mandrel of the specified diameter (minimum bending radius). Remove the coiled specimen from mandrel and take the tests for return loss and attenuation loss, again take these tests after bringing the waveguide to normal, there should be no degradation in the performance. Also examine the outer surface for cracks, splits, fracturing and wrinkling or other damage on the Jacket. **Marking:** The marking shall be visible and legible from outside the jacket. The manufacturer's name or trademark, type of wave guide, year of manufacturing and frequency of operation may be seen and noted.
2.2.5	Minimum pulling length per: 30 m hoisting stocking during Installation	**Test Procedure:** **Maximum pulling length per hoisting stocking during installation measurement:** During this test, the waveguide is weighed for 30 meters of length. It is pulled with the same weight as measured above for an hour. The length of the wave guide to be measured after the pulling test and noted. There should be no change in the length.
2.2.6	Termination a. Type : PDR 70 for C &Ext-Band : PDR 120 for Ku – Band or as specified by the purchaser	To be checked and noted

2.2.7	Pressurisation: Up to 30 gm/cm^2	**Test Procedure:** **Pressurization:** The sealing caps be fixed firmly on both the ends of wave guide to be sealed entirely, and then the dry air with more than standard level shall be blown into from either end, and then the leaked volume of the dry air shall be measured after 12 hours.
2.2.8	Pressure window :For C &Ext-Band -To mate with PDR 70 flanges at both ends :For Ku-Band -To mate with PDR 120 flanges at both ends	Physical check
2.2.9	Clamps spacing at normal, Critical areas and bends(5% extra clamps for critical areas to be included: 0.5 m	To be checked and noted
2.2.10	Outer dimensions: To be furnished by the supplier	**Test Procedure:** **Dimensions Measurements:** The E & H diameter measurements of waveguide over the jacket as specified by the manufacturer shall be made with a micrometer caliper or any other instrument of equal accuracy. Measurement should be made on a 330 mm length of WG taken from the end of a sample unit. Four points of measurements may be taken. It should meet the values mentioned in the detailed specifications of the manufacturer.
2.2.11	Weight: To be furnished by the supplier	**Test Procedure:** **Weight:** A section of the waveguide shall be weighed on a scale that has 0.1% accuracy. The weight of the waveguide should be as specified by the manufacturer.
3.0	**QUALITY REQUIREMENTS**	
3.0.1	The waveguide shall be manufactured in accordance with International quality management system ISO 9001:2000 for which the manufacturer should be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted. And The equipment shall meet the latest operator's quality	Obtain a certificate from manufacturer

	manual on i) Quality and reliability in product design. ii) Guidelines for standard of workmanship for printed boards. iii) Guidelines for standard of workmanship for printed board assemblies. iv) Guidelines for standard of workmanship for surface mounted devices. v)Transmission equipment general documentation. The supplier shall furnish a certification from the manufacturer to this effect, which shall be verified at the time of technical specifications evaluation.	
4.0	**SAFETY REQUIREMENTS**	
4.1	**TEMPERATURE & HUMIDITY**	
4.1.1	The waveguide systems are for installation and operation under fully exposed weather conditions. The temperatures may range from subzero to extremely hot. The waveguide system shall be capable of working without any degradation in performance for the temperature range from -20° C to +70° C and the relative humidity range from near dry to 95% condensing at 40° C. Optional compliance for temperature lower than -20° C shall be called for specific sites, on need basis.	Obtain a certificate from manufacturer

4.2	**CORROSION**	
4.2.1	The waveguide system shall be capable of withstanding the effects of rains, snowfall, industrial pollution, salinity of atmosphere in costal areas, etc	**Environmental tests** i) Temperature range ii) Corrosion **Test procedure:** Testing may be done as per QA Document of operator for temperature range and corrosion test for the following parameters: i) Maximum attenuation per meter over the whole band ii) Return loss In case, it is not possible to conduct the tests beyond the temperature range specified in the QM Document, a certificate may be obtained from the manufacturer that there will be no degradation in the performance in this temperature range also. If it is not possible to conduct corrosion test, test report from an accredited laboratory may be obtained from the manufacturer mentioning that the equipment has been tested for salt-mist test and the equipment shall work without any degradation in performance in coastal areas also.
4.3	**ENGINEERING REQUIREMENTS**	
4.3.1	The joints in the waveguide assembly shall have protection as per BIS standard IS 12063 {1987} "Classification of degree of protection provided by enclosures of the electrical equipment" {equivalent to IEC-529} to meet at least the protection level of IP-65	Obtain a certificate from manufacturer
4.3.2	The waveguide system shall adopt state-of-the-art technology	Obtain a certificate from manufacturer
4.3.3	All connectors shall be reliable and of standard type to ensure for over 500 failure-free mating operations under the environmental conditions specified	Obtain a certificate from manufacturer
4.3.4	The mechanical design and construction of each/units shall be inherently robust and rigid under all conditions of operations, adjustment, replacement, storage and transport and	Obtain a certificate from manufacturer

	conforming to the latest operator's quality manual on "Specification for environmental testing of electronic equipments for transmission and switching use".	
5.0	**DESIRABLE REQUIREMENTS**	
5.0.1	The manufacturer shall guarantee the satisfactory performance of the equipment without any degradation in performance up to at an altitude of 3,000 meters.	Obtain a certificate from manufacturer
5.0.2	The equipment shall be able to work without any degradation in performance in saline atmosphere near coastal areas and should be protected against corrosion.	Obtain a certificate from manufacturer
5.0.3	The equipment shall conform to the requirements for the latest operator's quality manual for Specification for environmental testing of electronic equipments for transmission and switching use-for operation, transportation and storage, including vibration and corrosion (salt mist).	Obtain a certificate from manufacturer
5.1	**DOCUMENTATION**	
5.1.1	Technical literature in English or Hindi with complete layout, detailed block schematic and circuit diagram of various assemblies with test voltages/waveforms at different test points of the units shall be provided. All aspects of installation, operation, maintenance and repair shall be covered in the manuals. The soft copy as well as hard copy of the	To be checked

	manuals shall also be provided. The manuals shall include the following manuals.	
5.2	**INSTALLATION, OPERATION AND MAINTENANCE MANUAL** a) Safety measures to be observed in handling the equipment; b) Precautions for installation, operation and maintenance; c) Test jigs and fixtures required, and procedures for routine maintenance preventive maintenance, trouble shooting and subassembly replacement; d) Illustration of internal and external mechanical parts	To be checked
5.3	**REPAIR MANUAL** A)List of replaceable parts used, including their sources and the approving authority; B)Detailed ordering information for all the replaceable parts shall be listed in the manual to facilitate reordering of spares as and when required; c) Procedure with flowchart for troubleshooting and subassembly replacement shall be provided. Test fixtures and accessories required for repair shall also be indicated. Systematic troubleshooting charts (fault-tree) shall be given for the probable	To be checked

	faults with their remedial actions	
5.4	**ACCESSORIES**	
5.4.1	**COMPULSORY ACCESSORIES** a)Wall gland b)Hoisting stocking c)Clamps d) 2 flexible waveguide of 1 meter length each (1.06 VSWR) along with prefabricated at both ends. e)Pressure Window f**)** E and H bands	To be checked
5.4.2	**OPTIONAL ACCESSORIES** a. Earthing kit b. Cutting tool c. Flanging tool d. Bending tool kit e. Aluminimum foil f. Sealing compound g. Injection gun	To be checked
5.5	**MARKING**	
5.5.1	Waveguide shall be marked with the following information every 5/10 meters a)Name of manufacturer b)Year of manufacturing c) Frequency of operation	To be checked
6.0	**FIELD TRIAL:** Four week minimum	Field trial should be conducted at the "actual locations", on successful completion of both lab tests and environmental tests. The field trial shall be for a minimum period of one month from the date of commissioning of the amplifier at site. The following tests are to be conducted during field trial. 1. Frequency of operation 2. Attenuation characteristics 3. Return loss

5.0 Observation/Records:

Sl.No.	Clause No. of Specification	Parameters	Measured Values/ observations	Compliance Specifications	Remarks
1.0	**INTRODUCTION** This document contains the generic requirements of Uplink Interfacility Waveguide for C, Ext- C & Ku- band to be used in conjunction with High Power Amplifier subsystem at one end, and antenna at other end. It shall consist of non-circular corrugated flexible copper waveguide with rugged polyethylene jacket. The waveguide shall be pressurised and sealed for transport. The waveguide shall be rugged so as to be reusable by use of rebinds, if necessary. The waveguide shall be provided in the lengths indicated by a customer either with terminations at both ends, or termination at one end with termination at the other end to be field fitted, which shall be possible with standard hand-tools.				
2.2.1	Frequency of operation	5.925 GHz to 6.425 GHz 6.725 GHz to 7.025 GHz 13.75 GHz to 14.50 GHz			
2.2.2	Attenuation characteristics (i) For C-Band at 5.925 GHz at 25° C** (ii) For Ext c-band at 6.725 GHz at 25° C**	4.95 dB/100m (maximum) 6.95 dB/100 m (maximum)			

	(iii) For Ku-Band at 13.750 GHz at 25° C** * * Variation of ±0.2% per° C may be taken for temperature other than 25°C.	16.6 dB/100m (maximum)			
2.2.3	Return loss with frequency Connecters at both ends i) For C-Band ii)For Ext C-band iii)For Ku-Band	 30dB minimum over whole Frequency band 29dB minimum over whole Frequency band 28.3dB minimum over whole Frequency band			
2.2.4	Minimum bending radius (i) For C & Ext-Band a. With single bending b. With 10 re-bendings (ii) For Ku-Band a. With single bending b. b. With 10 re-bendings	 E-plane H-plane 300mm 600mm 900mm 800mm 130mm 130mm 130mm 360mm			
2.2.5	Minimum pulling length per Hoisting stocking during Installation	30 m			
2.2.6	Termination a. Type	PDR 70 for C &Ext-Band PDR 120 for Ku – Band			
2.2.7	Pressurisation	Up to 30 gm/cm2			
2.2.8	Pressure window	For C &Ext-Band -To mate with PDR 70 flanges at both ends For Ku-Band – To mate with PDR120 flanges at both			

		ends			
2.2.9	Clamps spacing at normal Critical areas and bends (5% extra clamps for critical areas to be included)	0.5 m			
2.2.10	Outer dimensions				
2.2.11	Weight				
4.2.1	**CORROSION** The waveguide system shall be capable of withstanding the effects of rains, snowfall, industrial pollution, salinity of atmosphere in costal areas, etc.				
5.1.1	Technical literature in English or Hindi with complete layout, detailed block schematic and circuit diagram of various assemblies with test voltages/waveforms at different test points of the units shall be provided. All aspects of installation, operation, maintenance and repair shall be covered in the manuals. The soft copy as well as hard copy of the manuals shall also be provided. The manuals shall include the following manuals.				
5.2	**INSTALLATION, OPERATION AND MAINTENANCE MANUAL** a. Safety measures to be observed in handling the equipment; b. Precautions for installation, operation and maintenance; c. Test jigs and fixtures required, and procedures for routine maintenance preventive maintenance,				

	troubleshooting and subassembly replacement; d. Illustration of internal and external mechanical parts.				
5.3	**REPAIR MANUAL** a. List of replaceable parts used, including their sources and the approving authority; b. Detailed ordering information for all the replaceable parts shall be listed in the manual to facilitate reordering of spares as and when required; c. Procedure with flowchart for troubleshooting and subassembly replacement shall be provided. Test fixtures and accessories required for repair shall also be indicated. Systematic troubleshooting charts (fault-tree) shall be given for the probable faults with their remedial actions.				
5.4.1	**COMPULSORY ACCESSORIES** a. Wall gland b. Hoisting stocking c. Clamps d. 2 flexible waveguide of 1 meter length each (1.06 VSWR) along with prefabricated at both ends. e. Pressure Window f. E and H bands				
5.4.2	**OPTIONAL ACCESSORIES** a. Earthing kit b. Cutting tool				

	c. Flanging tool d. Bending tool kit e. Aluminimum foil f. Sealing compound g. Injection gun				
5.5.1	Waveguide shall be marked with the following information every 5/10 meters a. Name of manufacturer b. Year of manufacturing c. Frequency of operation				

6.0 Certificate/ Lab Test Report, if any:

7.0 Conclusion: