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INTERFACE REQUIREMENTS
No.: TEC/IR/SS/SCB-109/01/MAR-19

वीसैट बेस्ड मोबिलिटी सर्विसेस
VSAT based Mobility Services
(Mandatory Technical Requirements)

दूरसंचारअभियांत्रिकीकेंद्र
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FOREWORD

Telecommunication Engineering Centre (TEC) functions under Department of Telecommunications (DOT), Government of India. Its activities include:

- Issue of Generic Requirements (GR), Interface Requirements (IR), Service Requirements (SR) and Standards for Telecom Products and Services
- Field evaluation of products and Systems
- National Fundamental Plans
- Support to DOT on technology issues
- Testing & Certification of Telecom products

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This IR pertains to VSAT based Mobility Platform which includes AES (Aircraft Earth Station) and ESV (Earth Station on Vessels). The VSAT based mobility platforms referred to in this document shall be used to provide data services aboard aircrafts and sea vessels

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PART II: REQUIREMENTS FOR EARTH STATION ON VESSELS (ESV) BASED NETWORK

Chapter 2

HISTORY SHEET

S. No.	*IR No.*	*Title*	*Remarks*
1.	TEC/IR/SS/SCB-109/01/MAR-19	Interface Requirement for VSAT based Mobility Services	First Issue

REFERENCES

i. Standard for Communication and Broadcast Networks for FSS/BSS Mandatory Technical Interface Requirements No. TEC/IR/SCB-08/03.OCT 2013

ii. ITU-R Recommendations S.580-6 (Off-axis transmit and receive radiation pattern)

iii. ITU-R Recommendations S.524-8 (Off-axis EIRP Density Limits)

iv. ITU-R Recommendations S.726-1 (Spurious emission limits)

v. ITU-R Recommendations S.729 (Control and Monitoring of VSAT Networks)

vi. ETSI EN 302 186: Satellite Earth Stations and Systems (SES); Harmonised Standard for satellite mobile Aircraft Earth Stations (AESs) operating in the 11/12/14 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU.

vii. ETSI EN 303 978: Satellite Earth Stations and Systems (SES); Harmonised Standard for Earth Stations on Mobile Platforms (ESOMP) transmitting towards satellites in geostationary orbit, operating in the 27,5 GHz to 30,0 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU

viii. ETSI EN 301 447: Satellite Earth Stations and Systems (SES); Harmonized EN for satellite Earth Stations on board Vessels (ESVs) operating in the 4/6 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering essential requirements of article 3.2 of the R&TTE directive.

ix. ETSI EN 302 340: Satellite Earth Stations and Systems (SES); Harmonised Standard for satellite Earth Stations on board Vessels (ESVs) operating in the 11/12/14 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering the essential requirements of article 3.2 of the Directive 2014/53/EU

CHAPTER-1

1 Introduction

1.1 This document pertains to Interface Requirements for VSAT based Mobility Platform which includes AES (Aircraft Earth Station) and ESV (Earth Station on Vessels). The document is divided into two parts namely: Part I: Requirements for Aircraft Earth Station (AES) based network, & Part II: Requirements for Earth Station on Vessels (ESV) based network.

1.2 The VSAT based mobility platforms referred to in this document shall be used to provide data services aboard aircrafts and sea vessels subject to adherence to relevant guidelines and other terms and conditions as defined by DoT, TEC, WPC, DoS, NOCC, DGCA from time to time.

1.3 The requirements of this document are applicable to terminals of the VSAT based mobility platform that shall operate in the Indian airspace and Indian waters and as per the licence conditions of DoT.

1.4 The present document does not contain any requirement, recommendation or information about the installation of the AES/ESV terminal on aircraft/sea vessel. Necessary regulatory clearances for the same shall be taken from concerned departments/organizations.

1.5 The licences for two-way communication services will be issued by the Department of Telecom. The technical information (along with other details as prescribed by DoT) to be submitted by the IFMC (AES/ESV) service provider while applying to DoT is given in Annexure-III. The mandatory technical requirements are contained in this document whereas the regulatory & legal requirements are specified in the licence conditions. Necessary clearances/authorizations/licences shall have to be taken from DoT, TEC, DoS, WPC, NOCC, before commencing transmissions.

1.6 The document also contains the technical details for providing services through the INSAT/GSAT satellites as per the extant “Policy framework for Satellite Communication in India”. The technical parameters of these satellites are given in Annexure-I for link calculations and the link budget format is given in Annexure-II. The ITU recommendations on antenna patterns for VSAT mobility services are given as a part of the mandatory requirements for networks to be established by the applicant.

PART I

Requirements for
Aircraft Earth Station (AES) based network

2 Scope:

This section covers the requirements for Aircraft Earth Stations (AES) based VSAT network.

2.1 Network Topology

The AES VSAT network shall follow the star topology.

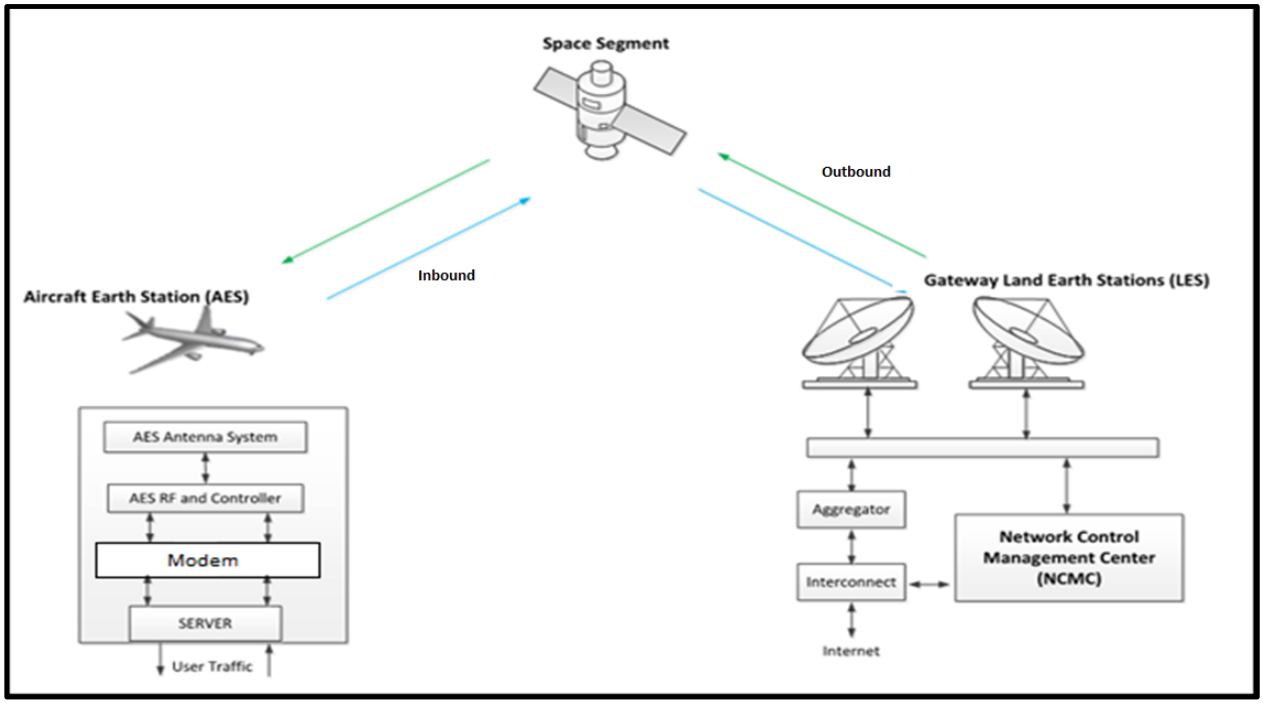

Figure 1

2.2 Frequency of operation

Table 1

Frequency band	Receive (GHz)		Transmit (GHz)	
Ku band	10.7-11.7, 12.2 -12.75		12.75-13.25, 13.75-14.5	
Ka band	Gateway 17.7-21.2	User/Remote VSAT Terminal 19.7-21.2	Gateway 27.0 – 31.0	User/Remote VSAT Terminal 29.5-31.0

2.3 Reference to specifications:

The system shall adhere to the following apart from where specific Indian regulations have been prescribed:

i. RECOMMENDATION ITU-R M.1643: Technical and operational requirements for aircraft earth stations of aeronautical mobile-satellite service including those using fixed-satellite service network transponders in the Ku band stated in Table-1 of 2.2.

ii. Resolution 156 (WRC-15): Use of the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service.

2.4 PSD LIMITS

2.4.1 Maximum uplink psd limits at the input to the earth station antenna:

a) -42dBW/Hz for Ku band

b) -56dBW/Hz for Ka band

2.4.2 Maximum downlink EIRP density limits at the output to the satellite antenna:

a) -22.9 dBW/Hz for Ku band

b) -17dBW/Hz for Ka band

2.5 ANTENNA SIZE

The minimum diameter of circular equivalent of the antenna for the different frequency bands at the hub/gateway station shall be as per the Table 2 below.

Table 2

Ku band	Ka band
Hub	Hub
8 m	8 m

2.6 POLARIZATION

Transmit and receive polarizations of the satellite are linear (usually for Ku band)/ circular (usually for Ka band) over entire coverage. The AES/earth station shall be compatible to both polarizations i.e. vertical & horizontal (linear) and RHCP & LHCP (circular). The polarization angle should match the spacecraft polarization angle under clear sky conditions.

In case of intended operations with multi-beam/high throughput satellite, the AES/earth station shall be capable of automatic and seamless change over in terms of frequency and polarization when moving from one beam to other.

2.7 G/T REQUIREMENTS

2.7.1 For HUB Station

Table 3

Ku band (8m or above)	36.0 dB/K minimum
Ka band (8m or above)	38.0 dB/K minimum

2.8 Off-axis radiation pattern of antenna: As per ITU-R Recommendation S.580-6

The new antennas of an earth station operating with GEO stationary satellites should have a design objective such that gain, G of at least 90% of the side-lobe peak does not exceed:

$$G = 29\text{-}25 \log \theta \text{ dBi}$$

(G being the gain relative to an isotropic antenna and θ being the off-axis angle in the direction of the GSO referred to the main-lobe axis.)

This requirement should be met for θ between 1 deg or (100λ/D) whichever is greater and 20 deg. for any off-axis direction which is within 3 deg. of the GSO.

2.9 Maximum permissible Off-axis EIRP:

The Off-Axis EIRP Density limits for different Off-Axis angles are given in Table 4 below:

Table 4

S. No.	Ku band Off-Axis EIRP Density Limits		Ka band Off-Axis EIRP Density Limits	
	Angle (θ) (deg)	Limit (dBW/40 KHz)	Angle (θ) (deg)	Limit (dBW/40 KHz)
(i)	2.0≤ θ≤ 7	(33-25 log θ -K)	2.0≤ θ ≤ 7	(19 − 25 log θ-K)
(ii)	7 ≤ θ≤ 9.2	12.0-K	7 ≤ θ≤ 9.2	−2-KdB
(iii)	9.2 ≤ θ≤ 48	(36-25 log θ-K)	9.2 ≤ θ≤ 48	(22 − 25 log θ-K)
(iv)	48 ≤ θ≤ 180	-6-K	48 ≤ θ≤ 180	−10-K dB

Where K is the factor that accounts for a reduction on the off-axis EIRP level in case of multiple Earth Station Onboard Mobile Platform (ESOMPs) operating on the same frequency and the value is given by one of the following cases:

1) For the case where only one ESOMP transmits at any one time on a given carrier frequency, the value of K is 0.

2) For the case where several ESOMPs are expected to transmit simultaneously on a given carrier frequency at the same EIRP then;

K = 10 log (N) where N is the maximum number of these ESOMPs.

The value of N and the operational conditions of the system shall be declared by the applicant.

θ is the angle, in degrees, between the main beam axis and the direction considered.

2.10 **Pointing Error:**

Each AES transmitter shall maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the AES antenna. The transmission from the AES terminal shall be blocked within 100 ms if pointing error reaches 0.5° and will commence only once it is within the limit of 0.2°.

2.11 **Transmit and Receive on axis cross polar discrimination within the pointing accuracy declared by the applicant:**

On axis - Better than 21 dB (Ka band)

Better than 25 dB (Ku band)

2.12 **Off-axis Cross-polarization Specification**

The maximum EIRP in any 40 kHz band of the cross-polarized component in any direction θ degrees from the antenna main beam axis shall not exceed the following limits for more than 0.01 % of the time:

Ka band:

9 - 25 log θ-K dBW for 2° ≤θ≤7°;

-12 -K dBW for 7° < θ≤9.2°;

Ku band:

29 - 25 log θ-K dBW for 2° ≤θ≤ 7°;

8 -K dBW for 7° < θ≤9.2°;

where:

θ and K is as defined in clause 2.9

2.13 **Transmit off-axis Spurious Emission Limits:**

The transmit off-axis spurious emission limits shall be as below:

i. For Ku band:

As per clause 4.2.2 of ETSI EN 302 186.

ii. For Ka band:

As per clause 4.2.1 of ETSI EN 303 978.

2.14 On-axis spurious Emission Limits

The limits shall be as below:

i. For Ku band:

As per clause 4.2.3 of ETSI EN 302 186.

ii. For Ka band:

As per clause 4.2.2 of ETSI EN 303 978.

2.15 EIRP Stability (for Hub and remote VSATs):

± 0.5 dB/24 hrs

2.16 Transmit IM Products (for Hub and remote VSATs):

23 dB below two equal carriers each at 6 dB output back-off (total output back-off of 3dB)

2.17 Frequency Stability:

Hub: Better than 1 ppm over the temperature range of -5°C to + 60°C

User Terminals: Better than 1 ppm over the temperature range of -50°C to + 60°C

2.18 Long term frequency stability (for Hub and remote VSATs):

Better than 0.1 ppm over a day

2.19 Network Control and Management Centre (NCMC) Requirements

2.19.1 The VSAT network shall operate under the control of a Network Control Centre.

2.19.2 It shall be possible to define the service area contour through the Network Control Centre. The AES shall operate only in the specified service area

contour in accordance with the service area requirements as defined in the license conditions. The operation of the AES shall shut down from the Indian gateway as soon as it goes out of the defined service area.

2.19.3 It shall be possible to shut down transmissions from an AES terminal through the Network Control Centre if it exceeds the off-axis EIRP limits as prescribed under section 2.9 of this document or if the operation of the AES terminal is found to cause harmful interference to any other satellite network or terminal.

2.19.4 The AES terminal shall be capable of receiving and acting upon at least “enable transmission” and “disable transmission” commands from the NCMC.

2.19.5 Each AES terminal shall be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the terminal must automatically cease transmissions.

2.19.6 It shall be possible to track in real-time the location (latitude, longitude, altitude) pertaining to an AES terminal through the Network Control Centre.

2.19.7 The Network Control Centre shall facilitate the LIM/LIS requirements as per the license conditions.

2.19.8 For each AES terminal, a record of its location (latitude, longitude, altitude), transmit frequency, channel bandwidth, satellite used and on-axis EIRP shall be time annotated and maintained for a period of not less than one year. Records shall be recorded at time intervals no greater than one minute while the AES terminal is transmitting.

2.19.9 During beam switch over in the Indian airspace from one satellite to another, the location (latitude, longitude, altitude) of the AES terminal at which the beam switch over has taken place in the Indian territory shall be recorded along with timestamp.

2.20 Satellite Parameters

The salient parameters of INSAT/GSAT satellites, including leased satellite capacity under SATCOM policy, network for the purpose of link budgeting are as given in Annexure -I.

2.21 Link Budget Format

Sample format for link calculation to be submitted for approval is provided in Annexure-II.

2.22 Other requirements

2.22.1 The AES terminal on entering the Indian airspace shall set-up communication link only through the Hub station in the Indian territory.

2.22.2 On entering and while in the Indian airspace, the AES shall use the regional IP addresses as allocated to Indian service providers.

2.22.3 The Wi-Fi access provided on board the aircraft shall be as per the relevant regulatory conditions of India like the frequency bands of operation, EIRP etc. which shall be as per the prevalent National Frequency Allocation Plan (NFAP).

PART II

Requirements for
ESV (Earth Station on Vessels) based network

3 Scope:

This section covers the requirements for Earth Stations on Vessels.

3.1 Network Topology

The ESV VSAT network shall follow the star topology.

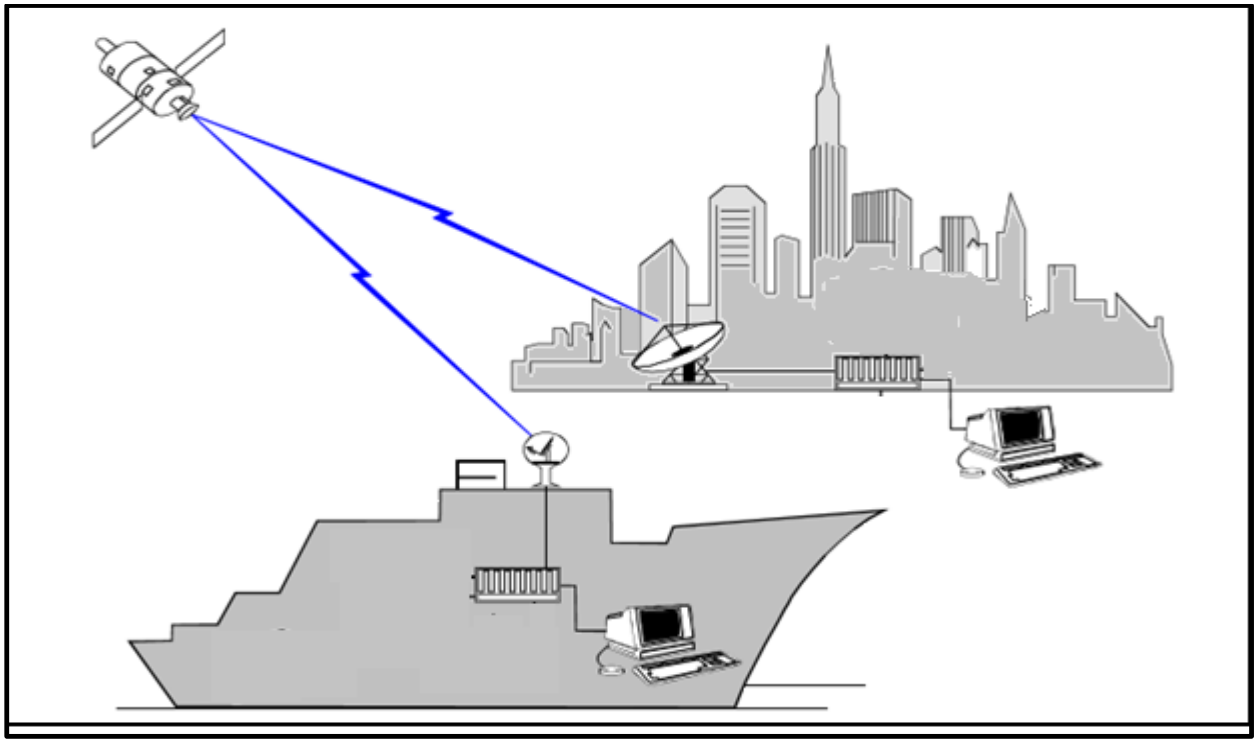

Figure 2

3.2 Frequency of operation

Table 5

Frequency band	Receive (GHz)		Transmit (GHz)	
C band	3.600-4.200, 4.500-4.800		5.925-7.025	
Ku band	10.7-11.7, 12.2-12.75		13.75-14.5, 12.75-13.25	
Ka band	Gateway 17.7- 21.2	User/Remote VSAT Terminal 19.7-21.2	Gateway 27.0 – 31.0	User/Remote VSAT Terminal 29.5-31.0

3.3 Reference to specifications

The system shall adhere to the following apart from where specific Indian regulations have been prescribed:

i. Resolution 902 (WRC-03): Provisions relating to earth stations located on board vessels which operate in fixed-satellite service networks in the uplink bands 5.925-6.425 GHz and 14-14.5 GHz.

ii. RECOMMENDATION ITU-R S.1587-3: Technical characteristics of earth stations on board vessels communicating with FSS satellites in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz which are allocated to the fixed-satellite service

iii. Resolution 156 (WRC-15): Use of the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service.

3.4 PSD LIMITS

3.4.1 Maximum uplink psd limits at the input to the earth station antenna:

a) -35dBW/Hz for C band (-38dBW/Hz for slot 74°E,-42dBW/Hz for slot 55°E)
b) -42dBW/Hz for Ku band
c) -56dBW/Hz for Ka band

3.4.2 Maximum downlink EIRP density limits at the output to the satellite antenna:

a) -20.0dBW/Hz for C band (-34dBW/Hz for slot 74°E,-37dBW/Hz for slot 55°E)
b) -22.9dBW/Hz for Ku band
c) -17dBW/Hz for Ka band

3.5 ANTENNA SIZE

The minimum diameter of circular equivalent of the antenna for the different frequency bands shall be as per the Table 6 below.

Table 6

C band		Ku band		Ka band	
Hub	VSAT	Hub	VSAT	Hub	VSAT
9 m	2.4m	8 m	1.2 m	8 m	0.65 m

Smaller size antennas of upto 1.2m and 0.6m in C and Ku band respectively shall be considered subject to satisfying the regulatory requirements such as maximum EIRP density, actual Off-axis curve, satellite parameters and orbital locations etc. to ensure interference free operations.

3.6 POLARIZATION

Transmit and receive polarizations of the satellite are linear (usually for C and Ku bands)/ circular (usually for Ka band) over entire coverage. The ESV/earth station shall be compatible to both polarizations i.e. vertical & horizontal (linear) and RHCP & LHCP (circular). The polarization angle should match the spacecraft polarization angle under clear sky conditions.

In case of intended operations with multi-beam/high throughput satellite, the ESV/earth station shall be capable of automatic and seamless change over in terms of frequency and polarization when moving from one beam to other.

3.7 G/T REQUIREMENTS

3.7.1 For HUB Station

Table 7

C band (9m or above)	31.7 dB/K minimum
Ku band (8m or above)	36.0 dB/K minimum
Ka band (8 m or above)	38.0 dB/K minimum

3.7.2 For Remote VSAT Station

Table 8

C band	16.5 dB/K minimum

Ku band	17.0 dB/K minimum
Ka band	11.1 dB/K minimum

3.8 Off-axis radiation pattern of antenna: As per ITU-R Recommendation S.580-6

The new antennas of an earth station operating with GSO satellites should have a design objective such that gain, G of at least 90% of the side-lobe peak does not exceed:

$$G = 29\text{-}25 \log \theta \text{ dBi}$$

(G being the gain relative to an isotropic antenna and θ being the off-axis angle in the direction of the GSO referred to the main-lobe axis.)

This requirement should be met forθ between 1 deg. or (100λ/D) whichever is greater and 20 deg. for any off-axis director which is within 3 deg. of the GSO.

3.9 Maximum permissible Off-axis EIRP:

The Off-Axis EIRP Density limits for different Off-Axis angles are given in Table 9 below:

Table 9

Off-Axis Angle (θ) (deg.)	Off-Axis EIRP Density Limits		
	C& Ext. C-Bands (dBW/4 KHz)	Ku-Band (dBW/40 KHz)	Ka band (dBW/40 KHz)
$2.5 \le \theta+\delta\theta \le 7$ $2.0 \le \theta+\delta\theta \le 7$	32-25 log (θ+δθ)-K	33-25 log(θ+δθ)-K	19 − 25 log(θ+δθ)-K
$7 \le \theta+\delta\theta \le 9.2$	11.0-K	12.0-K	−2 –K
$9.2 \le \theta+\delta\theta \le 48$	35-25 log (θ+δθ)-K	36-25 log (θ+δθ)-K	22 − 25 log(θ+δθ)-K
$48 \le \theta+\delta\theta \le 180$	-7.0-K	-6-K	−10 –K

Where K is for a reduction on the off-axis EIRP level in case of multiple ESOMPs operating on the same frequency and the value is given by one of the following cases:

1) For the case where only one ESOMP transmits at any one time on a given carrier frequency, the value of K is 0.

2) For the case where several ESOMPs are expected to transmit simultaneously on a given carrier frequency at the same EIRP then;

K = 10 log (N), where N is the maximum number of these ESOMPs.

The value of N and the operational conditions of the system shall be declared by the applicant.

θ is the angle, in degrees, between the main beam axis and the direction considered. $\delta\theta$ is the peak pointing accuracy declared by the applicant.

3.10 Pointing Error:

Each ESV transmitter shall maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna. The transmission from the ESV terminal shall be blocked within 100 ms if pointing error reaches 0.5° and will commence only once it is within the limit of 0.2°.

3.11 Transmit and Receive on axis cross polar discrimination (within the pointing accuracy declared by the applicant):

On axis
- better than 21 dB (Ka band)
- better than 25 dB (Ku band)
- better than 25 dB (C band)

3.12 Off-axis Cross-polarization Specification

In C band:

The maximum EIRP in any 4 kHz band of the cross-polarized component in any direction θ degrees from the antenna main beam axis shall not exceed the following limits for more than 0.01 % of the time:

22- 25 log (θ+δθ)-K dBW for 2.5° ≤ (θ+δθ) ≤ 7°;

+1 –K dBW for 7° < (θ+δθ) ≤ 9.2°;

In Ku and Ka band:

The maximum EIRP in any 40 kHz band of the cross-polarized component in any direction θ degrees from the antenna main beam axis shall not exceed the following limits for more than 0.01 % of the time:

In Ku band:

23 - 25 log (θ+δθ)-K dBW for 2° ≤ (θ+δθ) ≤ 7°;

+2 – K dBW for 7° < (θ+δθ) ≤ 9.2°;

In Ka band:

9 - 25 log θ-K dBW for 2° ≤ θ ≤ 7°;

-12 -K dBW for 7° < θ ≤ 9.2°;

Where θ and K is as defined in clause 3.9

3.13 Transmit Off-axis Spurious Emission Limits:

The transmit off-axis spurious emission limits shall be as below:

i. For C band:

As per clause 4.2.3 of ETSI EN 301 447.

ii. For Ku band:

As per clause 4.2.1 of ETSI EN 302 340.

iii. For Ka band:

As per clause 4.2.1 of ETSI EN 303 978.

3.14 On-axis Spurious Emission Limits:

The limits shall be as below:

i. For C band:

As per clause 4.2.4 of ETSI EN 301 447

ii. For Ku band:

As per clause 4.2.2 of ETSI EN 302 340.

iii. For Ka band:

As per clause 4.2.2 of ETSI EN 303 978.

3.15 EIRP Stability (for Hub and remote VSATs):

± 0.5 dB/24 hrs

3.16 Transmit IM Products (for Hub and remote VSATs):

23 dB below two equal carriers each at 6 dB output back-off (total output back-off of 3dB)

3.17 Frequency Stability:

Hub: Better than 1 ppm over the temperature range of -5°C to + 60°C

User Terminals: Better than 1 ppm over the temperature range of -50°C to + 60°C

3.18 Long term frequency stability (for Hub and remote VSATs):

Better than 0.1 ppm over a day

3.19 Network Control and Management Centre (NCMC) Requirements

3.19.1 The VSAT network shall operate under the control of a Network Control Centre.

3.19.2 It shall be possible to define the service area contour through the Network Control Centre. The ESV shall operate only in the specified service area contour in accordance with the service area requirements as defined in the license conditions. The operation of the ESV shall shut down from the Indian gateway as soon as it goes out of the defined service area.

3.19.3 It shall be possible to shut down transmissions from an ESV terminal through the Network Control Centre if it exceeds the off-axis EIRP limits as prescribed under section 3.9 of this document or if the operation of the ESV terminal is found to cause harmful interference to any other satellite network or terminal.

3.19.4 The ESV terminal shall be capable of receiving and acting upon at least “enable transmission” and “disable transmission” commands from the NCMC.

3.19.5 Each ESV terminal shall be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the terminal must automatically cease transmissions.

3.19.6 It shall be possible to track in real-time the location (latitude, longitude, altitude) pertaining to an ESV terminal through the Network Control Centre.

3.19.7 The Network Control Centre shall facilitate the LIM/LIS requirements as per the license conditions.

3.19.8 For each ESV terminal, a record of its location (latitude, longitude, altitude), transmit frequency, channel bandwidth, satellite used and on-axis EIRP shall be time annotated and maintained for a period of not less than one year. Records shall be recorded at time intervals no greater than one minute while the ESV terminal is transmitting.

3.20 Satellite Parameters

The salient parameters of INSAT/GSAT satellites, including leased satellite capacity under SATCOM policy, network for the purpose of link budgeting are as given in Annexure -I.

3.21 Link Budget Format

Sample format for link calculation to be submitted for approval is provided in Annexure-II.

3.22 Other requirements

3.22.1 The ESV terminal on entering the Indian waters shall set-up communication link only through the Hub station in the Indian territory.

3.22.2 On entering and while in the Indian waters, the ESV shall use the regional IP addresses as allocated to Indian service providers.

3.22.3 The Wi-Fi access provided on board the vessel shall be as per the relevant regulatory conditions of India like the frequency bands of operation, EIRP etc. which shall be as per the prevalent National Frequency Allocation Plan (NFAP).

4 General Requirements (applicable to both AES and ESV based networks)

4.1 Electromagnetic Compatibility (EMC) Requirements

General Electromagnetic Compatibility (EMC) Requirements: - The equipments shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from an accredited test agency.

a) Conducted and radiated emission(applicable to telecom equipment):

Name of EMC Standard: "CISPR 22 (2008) - Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment".

Limits:-

i. To comply with Class A of CISPR 22 (2008).
ii. The values of limits shall be as per TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.
iii. For Radiated Emission tests, limits below 1 GHz shall be as per Table 4 (a) or 5 (a) for measuring distance of 10m.

b) Immunity to Electrostatic discharge:

Name of EMC Standard: IEC 61000-4-2 (2008) "Testing and measurement techniques of Electrostatic discharge immunity test".

Limits: -

i. Contact discharge level 2 {± 4 kV} or higher voltage;
ii. Air discharge level 3 {± 8 kV} or higher voltage;

c) Immunity to radiated RF:

Name of EMC Standard: IEC 61000-4-3 (2010) "Testing and measurement techniques-Radiated RF Electromagnetic Field Immunity test"

Limits:-

For Telecom Equipment and Telecom Terminal Equipment with Voice interface (s)

i. Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and
ii. Under test level 3 (10 V/m) for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.

For Telecom Terminal Equipment without Voice interface (s)

Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.

d) Immunity to fast transients (burst):

Name of EMC Standard: IEC 61000- 4- 4 (2012) "Testing and measurement techniques of electrical fast transients/burst immunity test"

Limits:-

Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0. 5 kV for signal / control / data / telecom lines;

e) Immunity to surges:

Name of EMC Standard: IEC 61000-4-5 (2014) “Testing & Measurement techniques for Surge immunity test"

Limits:-

i. For mains power input ports: (a)2 kV peak open circuit voltage for line to ground coupling (b) 1 kV peak open circuit voltage for line to line coupling

ii. For telecom ports: (a) 2 kV peak open circuit voltage for line to ground (b) 2 kV peak open circuit voltage for line to line coupling.

f) Immunity to conducted disturbance induced by Radio frequency fields:

Name of EMC Standard: IEC 61000-4-6 (2013) "Testing & measurement techniques-Immunity to conducted disturbances induced by radio- frequency fields"

Limits:-

Under the test level 2 {3 V r.m.s.} in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.

g) Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any):

Name of EMC Standard: IEC 61000-4-11 (2004) "Testing & measurement techniques- voltage dips, short interruptions and voltage variations immunity tests"

Limits:-

i. a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500ms)

ii. a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e. 40% supply voltage for 200ms)

iii. a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s.

iv. a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms.

Note: For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (g) and TEC Standard No.TEC/SD/DD/EMC-221/05/OCT-16. The details of IEC/CISPR and their corresponding Euro Norms are as follows:

IEC/CISPR	Euro Norm
CISPR 11	EN 55011
CISPR 22	EN 55022
IEC 61000-4-2	EN 61000-4-2
IEC 61000-4-3	EN 61000-4-3
IEC 61000-4-4	EN 61000-4-4
IEC 61000-4-5	EN 61000-4-5
IEC 61000-4-6	EN 61000-4-6
IEC 61000-4-11	EN 61000-4-11

4.2 Safety Requirements

All the telecom equipment being used in the solution shall conform to IS 13252 part 1: 2010 “Information Technology Equipment –Safety- Part 1: General Requirements” [equivalent to IEC 60950-1 {2005} “Information Technology Equipment –Safety- Part 1: General Requirements”] and IS 10437{1986} “Safety requirements for radio transmitting equipments” [equivalent to IEC 60215].

CHAPTER 2

ANNEXURE-I

SATELLITE PARAMETERS

A. INSAT-4A (83°E)

Parameters	C- band
EIRP in 36 MHz under single carrier saturation over India (EOC)	39 dBW
Saturation Flux Density	-75 to -92 dBW/m^2 (-84.5±2 dBW/m^2 nominal)
G/T minimum	-4 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	2.5 dB
Output back off for multiple carriers	1.5 dB
C/3IM	18 dB
SatelliteTx.Peak Ant gain	23.5 dB

B. GSAT-12 (83°E)

Parameters	Extended C Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	37dBW over main land and 33dBW over islands
Saturation Flux Density	(-70 to -92 dBW/m^2) ±2 dB

	(-90 dBW/m^2 Nominal)
G/T minimum	-2 dB/°K for mainland -4.0 dB/°K for islands
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output bake off for multiple carriers	3 dB
C/3IM	18dB
Satellite Tx. Ant Gain	26.3 dB(EoC) to 34 dB (Beam Peak)

C. GSAT-10 (83ºE)

Parameters	C- band
EIRP in 36 MHz under single carrier saturation over India (EOC)	40 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 (-74 to -92dBW/m^2) ± 2 dB -86dBW/m^2± 2 dB
G/T minimum	-4 dB/°K
Transponder Bandwidth	36MHz
Input back off for multiple carriers	6dB
Output back off for multiple carriers	3dB

C/3IM	21.5dB
Satellite Tx. Ant gain	28dBi

D. GSAT-16 (55°E)

Parameters	C- band	Extended C Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	37 dBW	37dBW
Saturation Flux Density	(-74 to -92dBW/m^2) ± 2 dB -88 dBW/m^2± 2 dB Nominal	(-74 to -92 dBW/m^2) ±2 dB -88 dBW/m^2 ± 2Nominal
G/T minimum	-4 dB/°K	-4 dB/°K
Transponder Bandwidth	36MHz	36 MHz
Input back off for multiple carriers	3dB	3dB
Output bake off for multiple carriers	2 dB	1.5 dB
C/3IM	18 dB	16.5 dB
Satellite Tx. Ant Gain	28.22 dBi (EoC)	27.9 dBi (EoC)

E. GSAT-18 (74°E)

Parameters	C- band	Extended C Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	37 dBW	37dBW over main land and over islands
Saturation Flux Density	(-76 to -94dBW/m^2) ± 2 dB -91 dBW/m^2± 2 dB	(-76 to -94 dBW/m^2) ±2 dB (-90 dBW/m^2 Nominal)
G/T minimum	-4 dB/°K	-4 dB/°K
Transponder Bandwidth	36MHz	36 MHz
Input back off for multiple carriers	3.0 dB	3 dB
Output bake off for multiple carriers	1.5 dB	1.5 dB
C/3IM	17 dB	17 dB
Satellite Tx. Ant Gain	27.6 dBi (EoC)	28.1 dBi (EoC)

F. GSAT-14 (74°E)

Parameters	Extended C Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	36 dBW
Saturation Flux Density	(-74 to -92 dBW/m^2) ±2 dB (-86 dBW/m^2 Nominal)
G/T minimum	-3 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple	3 dB

carriers	
Output bake off for multiple carriers	1.5 dB
C/3IM	16 dB
Satellite Tx. Ant Gain	27 dBi (EoC)

G. GSAT-17 (93.5°E)

Parameters	C- band	Upper Extended C Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	39 dBW	37dBW over coverage Area
Saturation Flux Density	(-76 to -94 dBW/m^2) ± 2 dB -90dBW/m^2± 2 dB	(-76 to -94 dBW/m^2) ±2 dB (-90dBW/m^2 Nominal)
G/T minimum	-4 dB/°K	-4 dB/°K
Transponder Bandwidth	36MHz	36 MHz
Input back off for multiple carriers	2.5 dB	2.5 dB
Output bake off for multiple carriers	1.5 dB	1.5 dB
C/3IM	21dB	16 dB
Satellite Tx. Ant Gain	23.4dBi (EoC)	27.1 dBi (EoC)

H. INSAT-48R (48°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51.5 dBW
Saturation Flux Density	-84 to -96 dBW/m^2 (-90 dBW/m^2 nominal)
G/T minimum	+3 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	4 dB
Output back off for multiple carriers	2.5 dB
C/3IM	18 dB

I. GSAT-16(55°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	52 dBW over main land and 51dBW over A&N islands
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 (-84 to -96dBW/m^2) ± 2 dB -90dBW/m^2± 2 dB (at 6 dB BOA) (-84 to -102dBW/m^2) ± 2 dB
G/T minimum	+3 dB/°K for mainland

	+2 dB/°K for A&N islands
Transponder Bandwidth	36 MHz
Input back off for multiple carrier	3.5 dB
Output back off for multiple carrier	1.0 dB
C/3IM	18 dB
Satellite Tx. Antenna gain	32.5 dBW (for Mainland) 31.0 dBW (for A&N islands)

J. GSAT-18 (74°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51.5dBW over main land and 48.5 dBW over A&N islands
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 (-84 to -96dBW/m^2) ± 2 dB -90dBW/m^2± 2 dB (at 6 dB BOA) (-84 to -102dBW/m^2) ± 2 dB
G/T minimum	+3 dB/°K for mainland +0 dB/°K for A&N islands
Transponder Bandwidth	36 MHz
Input back off for multiple carrier	3.5 dB
Output back off for multiple carrier	1.0 dB

C/3IM	18 dB
Satellite Tx. Antenna gain	31.5 dB (for mainland) 28.5 dB (For A&N islands)

K. GSAT-14 (74°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51.5dBW over main land
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value	 (-84 to -96dBW/m^2) ± 2 dB -90dBW/m^2± 2 dB (at 6 dB BOA)
G/T minimum	+3 dB/°K for mainland
Transponder Bandwidth	36 MHz
Input back off for multiple carrier	3.5 dB
Output back off for multiple carrier	1.0 dB
C/3IM	18 dB
Satellite Tx. Antenna gain	31.2 dB

L. GSAT-8 (55°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	52 dBW over main land 51 dBW over Andaman & Nicobar islands
Saturation Flux Density	a. Fixed Gain Mode: i. SFD range : (-84 to -96 dBW/m^2) ±2dB ii. Nominal SFD : -90 dBW/m^2 ±2dB (at 6 dB BOA) b. Automatic Level Control Mode : (-84 to -96 dBW/m^2) ±2dB
G/T minimum	+3 dB/°K for Mainland +2 dB/°K for Andaman & Nicobar islands
Transponder Bandwidth	36 MHz
Input back off (*As per 2-tone IMD of 18 dB*)	3.5 dB
Output back off (*As per 2-tone IMD of 18 dB*)	1.0 dB
C/3IM	18dB
Satellite Transmit Antenna Gain	32.5 dBi over main land 31.5 dBi for A&N islands

ANNEXURE – II

LINK BUDGET FORMAT

Satellite Name :

Type of Service :

Mode of transmission :

Name of Tx. Earth Station :

Name of Rx. Station/Hub :

Link Type :

	SLANT RANGE CALCULATION	value	units					
	Satlat		deg					
	satlong		deg					
	eslat		deg					
	eslong		deg					
	Elevation range within service area		deg					
	height		Km					
	SLANTRANGE		Km					
	SATELLITE LINK CALCULATION							
	SATELLITE INFORMATION							
1	satellite type	INSAT/GSAT			UPLINK ANALYSIS	In Cl sky	with rain	units
2	orbital location		deg	1	Uplink pathloss			dB
3	Satellite G/T		dB/K	2	Power at satellite antenna			dBW

4	SFD		dBW/m^2	3	Tx EIRP of E/X			dBW
5	Input Backoff		dB	4	Sat Ant Rx Gain/m^2			dB/m^2
6	Output Backoff		dB	5	PFD at input of Sat Ant			dBW/m^2
7	saturation EIRP		dBW	6	Input BO/carrier			dB
8	Transponder/Beam Bandwidth		MHz	7	Sat G/T			dB/deg.K
9	Uplink frequency		MHz	8	Uplink C/N0 Available			dB-Hz
10	Downlink frequency		MHz	9	Uplink C/N Available			dB
				10	Uplink PSD			dBW/Hz
11	Sat Tx Ant Gain		dB	11	U/L EIRP Density			dBW/40KHz
12	Sat Ant Rx Gain/m^2		dB/m^2		DOWNLINK ANALYSIS			
13	Transponder Gain		dB	1	Saturation EIRP			dBW
				2	Output BO			dB
				3	Output BO/carrier			dB
	LINK PARAMETERS			4	Carrier down EIRP			dBW
1	Carrier info rate		Kbps	5	Downlink path loss			dB
2	FEC*			6	Cl sky G/T			dB/deg.K
3	Modulation			7	Degradation in G/T			dB
4	No of Bits / Symbol			8	Dn link C/N0 Available			dB-Hz
5	Transmission Rate		kbps	9	Dnlink C/N Available			dB
6	Spectral Efficiency factor			10	Dnlink PSD			dBW/Hz
7	Noise bandwidth factor							
8	Noise bandwidth		KHz		TOTAL LINK ANALYSIS	In Cl sky	with rain	
9	Es/N0 Required			1	Uplink C/N Available			dB
10	Eb/N0 Required		dB	2	D/L C/N Available			dB
11	Cl.Sky C/N0 Required		dB-Hz	3	C/IM E/S HPA			dB
12	Cl.Sky C/N Required		dB	4	Co Channel Interference			
13	Link availability		%	5	C/I (Multibeam)			
	Tx.. STATION DETAILS			6	C/IM Transponder HPA			
1	Antenna Diameter		m	7	C/XPI (Uplink Earth Station)			
2	Tx. Ant. Efficiency		%	8	C/XPI (Downlink Earth Station)			
3	Tx. Gain		dB	9	Comp./N Available			dB
4	Tx. Ant. pointing Loss		dB	10	Required C/N			dB

				11	Link margin			dB
					TX E/S AMPLIFIER POWER SIZING			
1	Antenna Diameter		m					
2	Rx. Ant. Efficiency		%	1	Tx EIRP of E/S			dBW
3	Rx. Ant Gain		dB	2	Tx ant gain			dB
4	Rx. Ant. Pointing Loss		dB	3	Power at Tx ant input			dBW
5	Pre LNA losses		dB					
6	LNA Noise Temp		deg.k	4	Tx. amplr to ant. loss			dB
7	Ant Noise temp		deg.k	5	Power amplr op/carrier			Watts
8	Total Rx.Sys.NoiseTemp		deg.k	6	No of carriers			
9	Cl.Sky G/T		dB/deg.K		Total power output			Watts
	MISC. LOSSES							
1	Tx. Rain Zone				% TRANSPONDER UTILIZATION			
2	Rx. rain Zone			1	Power wise			%
3	Uplink Rain Attn.		dB	2	Occupied wise			%
4	Downlink Rain Attn.		dB	4	Allocated BW wise			%
5	Uplink Free Space Loss		dB					
6	Downlink Free Space Loss		dB	5	Power Equivalent BW			KHz
7	Uplink Atm. Attn.		dB	6	Allocated BW			KHz
8	Downlink Atm. Attn.		dB	7	Symbol Rate			Msps

LINK SUMMARY: -

Type of Carrier	Satellite EIRP for Single Carrier	Satellite EIRP in Watts	No. of Carriers	Total Power in Watts	% of the Transponder Power	Total Power in dBW	BW per Carrier	Total BW	% of Transponder Frequency

FREQUENCY PLAN: -

Sl. No.	Carrier Size in Kbps	No. of Carriers	FEC & RS	Carrier Type	Modulation	Bandwidth in KHz per Carrier	Total BW in KHz	D/L Satellite EIRP per Carrier	Total D/L Satellite EIRP in dBW	Uplink/ Downlink RF Frequency in MHz

ANNEXURE-III

INFORMATION TO BE PROVIDED BY AES/ESV SERVICE PROVIDER AT THE TIME OF APPLICATION

THE AES/ESV SERVICE PROVIDER IS REQUIRED TO SUBMIT THE FOLLOWING INFORMATION WHILE APPLYING TO DEPARTMENT OF TELECOMMUNICATIONS (DoT):

Technical Specification(s) of AES/ESV equipment type(s) used in the network

1. AES/ESV & Gateway/Hub Antenna
    i. Antenna type
    ii. Antenna size
    iii. Transmit peak gain
    iv. Max e.i.r.p. per carrier
    v. Transmit frequency bands
    vi. Min. operating elevation
    vii. Antenna pointing accuracy
    viii. Off-axis gain envelope
    ix. Compatibility to operate in multi-beam/high throughput satellite environment (support seamless switching operation in frequency and polarization) (YES/NO)

2. Waveform/network characteristics
    i. Number(s) of carriers per AES/ESV
    ii. Occupied bandwidth(s) per carrier
    iii. Carrier centre frequency(-ies)
    iv. Modulation Multiple access scheme
    v. No. of simultaneous user terminals operating in the same frequency (factor K as defined in Clause 2.9/ 3.9)
    vi. No. of user terminals proposed to be operated.

3. Operating details of each satellite
    i. Satellite operator(s) (commercial) name
    ii. Whether intended satellite is multi-beam/high throughput and/or conventional single beam bent pipe satellite?
    iii. GSO longitude (East or West from Greenwich)
    iv. Satellite service area (text description and/or a figure of the area)

4. Forward Channel details (Satellite to AES/ESV)
    i. Transponder(s) downlink centre frequency
    ii. Transponder(s) downlink bandwidth

5. Return Channel details (AES/ESV to satellite)
    i. Transponder(s) uplink centre frequency
    ii. Transponder(s) uplink bandwidth

ABBREVIATIONS

For the purpose of this document the following abbreviations apply:

AES -Aircraft Earth Station
BER - Bit Error Ratio
BSS - Broadcast Satellite Service
CUG - Closed Users Group
dBc - Decibel referenced to the carrier level
dB/K - Decibel per degree Kelvin
dBm - Decibel referenced to a milli-Watt
dBW - Decibel referenced to a Watt
dBW/Hz - Decibel referenced to a Watt per Hertz
dBW/m^2 - Decibel referenced to a Watt per square meter
dBpW - Decibel referenced to Pico Watt
DGCA - Directorate General of Civil Aviation
DSNG - Digital Satellite News Gathering
DTH - Direct-To-Home
EIRP - Effective Isotropic Radiated Power
EOC - Edge of Coverage
ESOMP - Earth Station on Mobile Platform
ESV - Earth Station on Vessel
FSS - Fixed Satellite Service
GHz - Giga Hertz
G/T - Gain-to-noise temperature ratio for antenna
IFMC - Inflight & Maritime Connectivity
IM - Inter-modulation
INSAT - Indian National Satellite System
IR - Interface Requirements
ITU-R - Radio communication Sector of International Telecommunication Union

kbps - Kilobits per second

kHz - Kilo Hertz

LHCP - Left Hand Circular Polarisation

m - Metre

Mbps - Megabits per second

MHz - Mega Hertz

NOCC - Network Operation and Control Centre

NCMC - Network Control & Management Centre

ppm - Part per million

psd - Power spectral density

PSTN - Public Switched Telephone Network

RHCP - Right Hand Circular Polarisation

SFD - Saturation Flux Density

SSPA - Solid State Power Amplifier

TEC - Telecommunication Engineering Centre

TWTA - Travelling-wave Tube Amplifier

VAS - Value Added Services

VSAT - Very Small Aperture Terminal

λ - Wavelength

θ - Off-axis angle

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