Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
SES SATELLITES (GIBRALTAR) LTD.	)	File No. SAT-MOD-_____
	)	Call Sign S2951
Petition to Modify	)	
U.S. Market Access for SES-15	)	

PETITION TO MODIFY U.S. MARKET ACCESS AUTHORIZATION

SES Satellites (Gibraltar) Ltd. ("SES Gibraltar," doing business as "SES") hereby requests modification of its authority to use the Gibraltar-licensed SES-15 spacecraft to serve the U.S. market from 129.15° W.L.[1] The purpose of this modification is to seek U.S. market access for the Wide Area Augmentation System ("WAAS") payload onboard SES-15 that will be used to support the U.S. Global Positioning System ("GPS").[2] SES requests that the Commission authorize U.S. radionavigation satellite service ("RNSS") using the SES-15 WAAS payload, with downlink spectrum in the 1564.42-1586.42 MHz and 1165.45-1187.45 MHz bands, feeder links in the 6628.27-6650.27 MHz and 6679.42-6701.42 MHz bands, and a beacon at 3700.2 MHz. Grant of the requested authority is consistent with Commission precedent and will serve the public interest by enhancing the accuracy of GPS signals, which are relied on for a broad range of government, business, and consumer applications.

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1 *See SES Satellites (Gibraltar) Ltd.,* File No. SAT-PPL-20160126-00007 (the "SES-15 Petition"), granted July 12, 2016 (the "SES-15 Grant").

2 SES is also supplementing the information in the SES Petition by providing additional link budgets and updated two-degree spacing analysis for the previously described Ku-band payload. The material provided in Attachment 1 to this legal narrative should be incorporated as part of Annexes B and C of the original Technical Appendix submitted with the SES-15 Petition.

A completed FCC Form 312 is attached, along with technical materials on Schedule S[3] and in narrative form pursuant to Section 25.114 of the Commission's rules. Construction of SES-15 began over a year ago, and launch of the spacecraft is currently scheduled to occur in 2017. SES seeks action on this modification request consistent with that schedule.

I. BACKGROUND

As noted in the original SES-15 Petition, SES Americom, an affiliate of SES Gibraltar, currently operates the AMC-1 spacecraft at 129.15° W.L. under U.S. license in accordance with International Telecommunication Union ("ITU") filings of the Gibraltar Regulatory Authority ("GRA").[4] SES-15 will provide follow-on service at 129.15° W.L., but will also provide service in additional frequencies. The table below identifies the spectrum that will be used by the SES-15 WAAS payload.

[3] In completing the Schedule S, SES has relied on the most recent Schedule S instructions. Consistent with those instructions, in cases where the Schedule S software requests information that space station applicants are no longer required to provide, SES has omitted data elements, or where necessary to permit validation of the Schedule S file, has entered a "1" as a placeholder. SES specifies that these "1" data entries are outside the scope of the certifications herein regarding accuracy of the information provided with this petition.

[4] *See SES Americom, Inc.*, Call Sign S2445, File Nos. SAT-MOD-20140730-00089 & SAT-AMD-20150219-00006, grant-stamped May 28, 2015 (authorizing operation of AMC-1 at 129.15° W.L. in the conventional Ku-band).

Frequency Band	AMC-1	SES-15
L-band	Not on AMC-1	WAAS payload uses L1 and L5 frequencies: 1165.45-1187.45 MHz downlink; 1564.42-1586.42 MHz downlink
Conventional C-band	AMC-1 has a conventional C-band payload, but it is authorized only for limited TT&C operations in that spectrum at 129.15° W.L.	WAAS payload includes a beacon frequency in the conventional C-band at 3700.2 MHz
Extended C-band	Not on AMC-1	WAAS Feeder Links: 6628.27-6650.27 MHz uplink 6679.42-6701.42 MHz uplink

The WAAS payload, including the L-band frequencies, extended C-band feeder links, and conventional C-band beacon, will operate under ITU filings submitted by Luxembourg.

II. AUTHORIZING THE SES-15 WAAS PAYLOAD TO SERVE THE U.S. IS CONSISTENT WITH FCC POLICIES AND THE PUBLIC INTEREST

In the *DISCO II* proceeding,[5] the Commission adopted policies for determining whether to permit foreign-licensed satellites to serve the U.S. market, and these standards are codified in Section 25.137 of the Commission's Rules.[6] The Commission's policies are intended to ensure that entry by a foreign-licensed satellite will not distort competition in the U.S.[7] Under the *DISCO II* framework, the Commission applies a presumption that, with respect to services covered by the WTO agreement, entry into the U.S. market by entities licensed by WTO member countries will promote competition in the U.S. market.[8] The Commission also considers whether

5 *See Amendment of the Commission's Policies to Allow Non-U.S. Licensed Space Stations providing Domestic and International Service in the United States,* Report & Order, 12 FCC Rcd 24094 (1997) ("*DISCO II*").

6 47 C.F.R. § 25.137.

7 *DISCO II* at ¶ 7.

8 *Id.* at ¶ 39.

there are spectrum availability issues or concerns relating to national security, law enforcement, foreign policy or trade that would present an obstacle to U.S. market access.[9]

The WAAS payload on SES-15 is part of a program managed by the Federal Aviation Administration ("FAA").[10] Data from the WAAS payload will be delivered to WAAS-enabled GPS receivers and used to correct the measured GPS position. The WAAS broadcast message increases GPS signal accuracy from 100 meters to less than 7 meters. The FAA provides this service because it improves the ability of GPS-enabled aircraft to make precision landings and enhances flight safety. The SES-15 WAAS payload will supplement the network of WAAS-equipped satellites that have previously been authorized by the Commission.[11]

The WAAS signal will be transmitted using extended C-band frequencies through redundant GEO Uplink Subsystem/Ground Uplink Stations ("GUS") located in the U.S., with the primary GUS located in Somis, CA with a "hot" backup in Brewster, WA. The data will then be relayed to GPS receivers using L-band GPS frequencies. The spacecraft also has a C-band beacon at 3700.2 MHz that will be used solely to permit antenna alignment and tracking.

Authorizing the SES-15 WAAS payload to communicate with U.S. earth stations for the purposes of providing RNSS is consistent with the market access framework set forth in *DISCO II* and with Commission precedent. Although RNSS is not identified as a covered

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9 *See id.* at ¶ 178.

10 Raytheon Integrated Defense Systems ("Raytheon") administers the WAAS network under an agreement with the FAA. Last year Raytheon entered into a subcontract with SES Government Solutions, Inc. ("SES-GS"), an affiliate of SES Gibraltar, for the WAAS payload to be deployed on SES-15. *See* http://www.ses-gs.com/featured/ses-host-waas-payload-ses-15/.

11 These include Intelsat's Galaxy 15 at 133° W.L., Telesat's Anik F1R at 107.3° W.L., and Inmarsat 4F3 at 98° W.L., as well as the payload on the recently launched Eutelsat Americas Eutelsat 117 West B (formerly Satmex 9) satellite to be positioned at 116.8° W.L.

service under the WTO, neither is it listed as an excluded service.[12] Moreover, the Commission has previously authorized the provision of RNSS to U.S. terminals using foreign-licensed satellites.[13]

Gibraltar, the licensing administration for SES-15, is a British Overseas Territory. The United Kingdom is responsible for the external relations of its territories, while each territory is responsible for its domestic law.[14] Through the United Kingdom, Gibraltar is a WTO-member country. Furthermore, Gibraltar and the United Kingdom both have open markets for satellite services provided by U.S. licensees. In particular, these countries are subject to a European Union ("EU") directive specifying that "Member States shall ensure that any regulatory prohibition or restriction on the offer of space segment capacity to any authorised satellite earth station network operator are abolished."[15] Accordingly, grant of market-access for the SES-15 WAAS payload conforms to the pro-competitive rationale underlying *DISCO II*.

SES recognizes that under the Commission's rules, some of the spectrum used for the WAAS payload is subject to specific requirements or recommendations to protect other services.[16] SES will conform to these provisions with respect to operations of the SES-15

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12 *See DISCO II* at ¶ 13.

13 *See, e.g., Satelites Mexicanos, S.A. de C.V.*, Call Sign S2926, File Nos. SAT-LOI-20140617-00070 & SAT-AMD-20141119-00123, grant-stamped Aug. 20, 2015 (the "Satmex 9 Grant").

14 Under the Colonial Laws Validity Act 1865 of the United Kingdom, the local legislative body of a British Overseas Territory is empowered to make laws for the "peace, order and good government" for that territory only, subject to a presumption that such laws cannot have extraterritorial effect.

15 Commission Directive 2002/77/EC, 16 September 2002 on competition in the markets for electronic communications networks and services, OJ L249, Article 7(1) at 21.

16 *See* 47 C.F.R. § 2.106, Footnote 5.458 (use of the 6425-7075 MHz band for passive microwave sensor measurements over the oceans should be considered by administrations in frequency planning); Footnote 5.458A (in making assignments to FSS in the 6700-7075 MHz

WAAS payload. Furthermore, as discussed in the attached Technical Appendix, SES has initiated the procedures set forth in ITU-R Resolution 609 regarding protection of aeronautical radionavigation satellite systems.

Authorizing use of the SES-15 WAAS payload will improve the accuracy of positioning data used to support safe aircraft navigation and will enhance the efficiency of aircraft operations by permitting reduced separation between aircraft. As a result, grant of the requested authority will benefit U.S. airlines and millions of air travelers.

III. RULE WAIVERS ARE WARRANTED FOR SES-15

SES seeks waivers of Commission rules in connection with the request to use the SES-15 WAAS payload to serve the U.S. market. Grant of these waivers is consistent with Commission policy:

> The Commission may waive a rule for good cause shown. Waiver is appropriate if special circumstances warrant a deviation from the general rule and such deviation would better serve the public interest than would strict adherence to the general rule. Generally, the Commission may grant a waiver of its rules in a particular case if the relief requested would not undermine the policy objective of the rule in question and would otherwise serve the public interest.[17]

The SES-15 WAAS payload substantially complies with the Commission's rules, but certain waivers are necessary in light of the frequencies used and the technical characteristics of the spacecraft. The Commission has granted similar waivers in other cases. Because the SES-15 WAAS payload will result in greater accuracy for GPS data, grant of the requested waivers will serve the public interest.

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band, administrations should take steps to protect spectral line observations of the radio astronomy service).

[17] *PanAmSat Licensee Corp.*, 17 FCC Rcd 10483, 10492 (Sat. Div. 2002) (footnotes omitted).

Section 25.131(j): Section 25.131(j) of the Commission's rules specifies that a license modification is necessary to permit receive-only earth stations to operate with a foreign-licensed satellite unless the operations are in frequencies for which the satellite has been placed on the Permitted List.[18] SES seeks waiver of this provision to allow RNSS terminals in the U.S. to receive signals from the SES-15 WAAS payload in the 1165.45-1187.45 MHz and 1564.42-1586.42 MHz downlink spectrum without the need for individual earth station licensing , which would be extremely burdensome given the number of GPS receive terminals deployed.

Grant of the requested waiver is consistent with Commission precedent and with the public interest. The Commission has previously waived Section 25.131(j) to permit reception of signals from the WAAS payload that will be hosted on the Satmex 9 spacecraft.[19] The waiver grant was based on the Commission's determination that reception of the WAAS signals by U.S. terminals had been coordinated with NTIA and would "further the FAA's goals of improving functionality and reliability of the Global Positioning System."[20] The same rationale supports grant of a waiver for the SES-15 WAAS payload.

Section 25.158: SES also seeks any necessary waiver of Section 25.158 of the Commission's rules, which permits consideration of space station applications on a first-come, first-served basis only if those satellites provide "GSO-like" services using directional antennas.[21] The SES-15 WAAS payload will communicate in the L-band frequencies with omnidirectional GPS receive terminals. The Commission has previously granted waivers to

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18 *See* 47 C.F.R. §25.131(j)(1) and (2).

19 *See* Satmex 9 Grant, Attachment to Grant at 3.

20 *Id*. *See also Inmarsat Hawaii Inc.*, File No. SES-MSC-20100415-00483, grant-stamped July 13, 2010, Attachment to Grant at 1 (waiving Section 25.131(j) to permit U.S. GPS terminals to receive signals from the WAAS payload on the U.K.-licensed Inmarsat 4F3 satellite).

21 47 C.F.R. § 25.138.

permit consideration of RNSS operations under the first-come, first-served framework,[22] and the same relief is warranted here.

Section 25.202(g): Section 25.202(g) requires that TT&C operations be conducted at the edges of the allocated bands.[23] The Commission has explained that:

> The purpose of this rule is to simplify the coordination process for satellite systems, to provide an incentive for an operator to maximize the efficiency of its system's TT&C operations, and to minimize the constraints placed on other satellite operations.[24]

The majority of the TT&C frequencies for SES-15 are located on the edges of the bands used for the satellite's communications operations.[25] However, the WAAS payload will operate a tracking beacon at 3700.2 MHz, at the band edge of the conventional C-band spectrum, which is not otherwise used on the satellite.

SES submits that this configuration conforms to Section 25.202(g), which does not require TT&C to be conducted in a space station's operating bands but simply in "either or both ends of the allocated bands for the service."[26] The 3700-4200 MHz conventional C-band is allocated for FSS service, and SES's request for authority to perform beacon functions at the edge of this band is therefore consistent with the plain language of Section 25.202(g).

SES is aware, however, that in some decisions the Commission has characterized Section 25.202(g) as requiring "FSS systems to operate their tracking, telemetry, and command

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22 *See, e.g., Lockheed Martin Corp.*, Order and Authorization, 20 FCC Rcd 14558, 14561 (Sat. Div. 2005) (waiving the rules to allow consideration of Lockheed's proposed RNSS operations in the L-band on a first-come, first-served basis).

23 47 C.F.R. § 25.202(g).

24 *Orbcomm License Corp*., 23 FCC Rcd 4804 at ¶ 20 (IB & OET 2008).

25 Technical Appendix, Section 3.0.

26 *DIRECTV Enterprises, LLC*, DA 06-1493, 21 FCC Rcd 8028 (Sat. Div. 2006) at ¶ 11.

(TT&C) links at the edges of the frequency bands *in which they are providing service*."[27] Accordingly, SES requests grant of any necessary waiver of Section 25.202(g) to allow use of the 3700.2 MHz frequency to perform satellite tracking for antennas using the WAAS payload.

Grant of a waiver will not undermine the objectives of the rule. As discussed in the Technical Appendix, SES has coordinated with Intelsat regarding operations of the WAAS beacon at 3700.2 MHz although there is no frequency overlap between the beacon signal and the frequencies in use on the adjacent Intelsat satellites. Thus, permitting use of the 3700.2 MHz beacon will serve the public interest and will not adversely affect adjacent spacecraft. Therefore, a waiver of Section 25.202(g) is warranted.

Section 25.210(f): Section 25.210(f) of the Commission's rules requires space stations using FSS frequencies to "employ state-of-the-art full frequency reuse" through either orthogonal polarizations within the same beam or the use of multiple beams.[28] The C-band feeder link frequencies used to support the SES-15 WAAS payload are subject to this rule, but only a single polarization is used in these frequencies.

A waiver of the rule is consistent with Commission precedent and would not undermine the purpose of the rule. The full frequency reuse requirement is intended to ensure efficient use of spectrum, but the Commission has waived the rule in a number of cases, including where permitting the non-compliant operations would not block another licensee from using the same spectrum with the opposite polarization.[29] In this instance, SES-15 uses only left-

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[27] *See, e.g., Northrop Grumman Space & Mission Systems Corp.*, DA 09-428, 24 FCC Rcd 2330 (IB 2009) at ¶ 94 (emphasis added).

[28] 47 C.F.R. § 25.210(f).

[29] *See, e.g.,* Satmex 9 Grant, Attachment to Grant at 1 (waiving Section 25.210(f) "would not prevent other licensees' use of the same spectrum through orthogonal polarization, preserving the maximum utilization of the spectrum"). *See also Columbia Communications Corporation*, Memorandum Opinion, Order and Authorization, 7 FCC Rcd 122, 123 (1991)

hand circular polarization in the WAAS feeder links pursuant to a mandate from the FAA, but another satellite could use these frequencies with right-hand circular polarization. Accordingly, grant of a waiver is consistent with Commission policies.

Section 25.210(i)(1): SES also seeks any necessary waiver of Section 25.210(i)(1), which sets a 30 dB minimum for cross-polarization isolation performance in the primary coverage area of a satellite using FSS frequencies.[30] As indicated in Schedule S, the minimum cross-polarization performance is below 30 dB for the extended C-band WAAS feeder link frequencies.

The Commission has recently determined that the FSS cross-polarization requirement is no longer necessary,[31] and Section 25.210(i)(1) will therefore be deleted when the Part 25 Second Order takes effect. Moreover, the Commission has routinely granted waivers of Section 25.210(i)(1) based on a finding that the primary effect of any increased interference is on the satellite operator itself,[32] which can manage the interference internally. Because the C-band WAAS feeder link transmissions use only a single polarization, the shortfall in cross-polarization performance will not affect those signals. Nor will there be any potential for increased interference to adjacent satellites. Accordingly, if Section 25.210(i)(1) is still in effect when the

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(Commission views full frequency reuse waiver requests favorably "as long as the non-compliant satellite is making some use of the orbit/spectrum resource which otherwise would not be used").

30 47 C.F.R. § 25.201(i)(1).

31 *See Comprehensive Review of Licensing and Operating Rules for Satellite Services*, Second Report and Order, IB Dkt No. 12-267, FCC 15-167 (rel. Dec. 17, 2015) ("Part 25 Second Order") at §§ 331-333.

32 *See, e.g., New Skies Satellites N.V.,* Call Sign S2828, File No. SAT-PPL-20110620-00112, grant-stamped Mar. 15, 2012, Attachment at 2 (waiving Section 25.210(i) for SES-4 based on a finding that shortfalls in the cross-polarization isolation performance "will not produce a significant increase in interference, except to the space station itself, and will not adversely affect any other operator.").

Commission acts on this modification request, granting a waiver of the rule for the SES-15 WAAS payload is consistent with applicable precedent.

Sections 25.114(d)(14)(ii) and 25.283(c): Sections 25.114(d)(14)(ii) and 25.283(c) impose requirements relating to venting stored energy sources during the disposal process for a spacecraft.[33] The SES-15 Petition sought limited waiver of these rules in connection with residual xenon that will be onboard the spacecraft at its end of life,[34] and this request was granted by the Commission.[35] To the extent necessary, SES incorporates that waiver request by reference herein.

IV. CONCLUSION

For the foregoing reasons, SES respectfully requests that the Commission authorize RNSS to U.S. receivers using the SES-15 WAAS payload.

Respectfully submitted,

SES SATELLITES (GIBRALTAR) LTD.

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33 Section 25.283(c) contains the substantive venting requirement, and Section 25.114(d)(14)(ii) requires applicants to submit information that addresses "whether stored energy will be removed at the spacecraft's end of life." 47 C.F.R. § 25.114(d)(14)(ii).

34 SES-15 Petition, Legal Narrative at 13-15.

35 SES-15 Grant at paragraph 8.

ATTACHMENT 1

ADDENDUM TO TECHNICAL APPENDIX

SES-15 AT 129.15° W.L.

To supplement the information already on file regarding SES-15,[1] SES is attaching additional link budgets in Annex A showing typical link budgets for the SES-15 Ku-band downlink beam, and a corresponding Ku-band downlink two-degree spacing analysis.

1.0 Emission Designators and Link Budgets (§25.114(d)(4))

Annex A shows additional typical link budgets for the SES-15 HTS Forwa**r**d links, the SES-15 Broadcast Beam, and the SES-15 North American Beam, which all use Ku-band downlink spectrum. The emission designators remain the same as what was previously submitted in the SES-15 Petition.

2.0 Ku-band Downlink Two Degree Spacing Analysis

For the 11.7-12.2 GHz band, the only operational Ku-band satellite adjacent to the 129.15° W.L. position is JSAT's Horizons 1 at 127° W.L. with more than 2° geocentric separation. Given that there is currently no Ku-band satellite at 131° W.L., a hypothetical satellite assumed to be transmitting at the same maximum downlink EIRP density levels as those being sought for the SES-15 satellite is used to estimate interference levels at that orbital location.

For this portion of the analysis, the carrier-to-interference ratio between two adjacent systems is estimated for a set of competing emissions using the same methodology and assumptions presented in the SES-15 Petition Technical Appendix.

Three space stations are considered: SES-15 and two adjacent stations - JSAT's Horizons 1 at 127° W.L., and a hypothetical satellite at 131° W.L. assumed to be transmitting at the same downlink EIRP density levels as those for SES-15.

[1] *See SES Satellites (Gibraltar) Ltd.*, File No. SAT-PPL-20160126-00007 (the "SES-15 Petition"), Technical Appendix, Annexes B and C.

Table C-1 is identical to the one presented in the SES-15 Technical Appendix and provides the space station name and orbital information, and assumed earth station parameters of the networks.

Table C-1: Station Parameters

Parameter	**System 1**	**System 2**	**System 3**
Space station name	Horizons-1	SES-15	Hypothetical satellite
Nominal orbit location (+E, -W)	-127.00	-129.15	-131.00
Station keeping tolerance (°)	0.05	0.05	0.05
Earth station pointing error (°)	0.15	0.15	0.15
Earth station antenna efficiency (fraction)	0.65	0.65	0.65

Table C-2 shows the emission characteristics considered for the downlink for Horizons-1.

Table C-2: Horizons 1 Typical Emissions

DOWNLINK -- Horizons 1 Carriers							
Emission	**Satellite EIRP**	**Bandw. (MHz)**	**Downlink EIRP density**	**Receive Ant. (m)**	**Earth Station Gain**	**Sidelobe Charact.**	**Off-axis Gain**
36M0G7W	51.8	36.0	-23.8	1.8	45.2	29	20.2
6M00G7W	51.8	5.565	-26.8	3.7	51.4	29	20.2
1M45G7W	51.8	1.229	-26.8	1.8	45.2	29	20.2
200KG7W	51.8	0.154	-26.8	2.4	47.7	29	20.2
100KG7W	51.8	0.077	-26.8	2.4	47.7	29	20.2
400KG7W	51.8	0.307	-26.8	6.1	55.8	29	20.2

Table C-3 shows the emission characteristics considered for the downlink for a hypothetical satellite at 131° W.L.

Table C-3: Hypothetical satellite at 131° W.L. Typical Emissions

Downlink: Carriers for Hypothetical Satellite at 131W							
Emission	**Satellite EIRP**	**Bandwidth (MHz)**	**Downlink EIRP density**	**Receive Ant. (m)**	**Earth Station Gain**	**Sidelobe Charact.**	**Off-axis Gain**
1M58G7W	30.8	1.58	-31.2	2.4	47.7	29	21.9
175KG7W	22.3	0.175	-30.1	2.8	49.0	29	21.9
36M0G7W	49.0	30.00	-25.8	1.2	41.7	29	21.9
36M0G7W	52.0	30.00	-22.8	0.55	34.9	29	21.9
36M0G7W	52.0	30.00	-22.8	1.0	40.1	29	21.9
36M0G7W	52.0	30.00	-22.8	1.2	41.7	29	21.9

Table C-4 shows the SES-15 emission characteristics considered for the downlink.

Table C-4: SES-15 Typical Emissions

Downlink: SES-15 Carriers						
Emission	1M58G7W	175KG7W	36M0G7W	36M0G7W	36M0G7W	36M0G7W
Bandwidth	1.58	0.175	30.00	30.00	30.00	30.00
Receive Earth Station (m)	2.40	2.80	1.20	0.55	1.00	1.20
Satellite EIRP	30.8	22.3	49.0	52.0	52.0	52.0
Downlink EIRP density	-31.2	-30.1	-25.8	-22.8	-22.8	-22.8
RX Earth Station Gain	47.7	49.0	41.7	34.9	40.1	41.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	20.2	20.2	20.2	20.2	20.2	20.2

Using the same methodology presented in the SES-15 Technical Appendix, the emission characteristics shown in Tables C-2, C-3 and C-4 result in the C/I levels shown in Appendix 1 to this Annex. All the calculated C/I values are shown in Appendix 1 to this Annex.

i. SES-15 Frequency Bands 10.95-11.2 and 11.45-11.7 GHz

Currently there are no operational GSO Extended Ku-band satellites that use the 10.95-11.2 GHz band or the 11.45-11.7 GHz band within two degrees of the 129.15º W.L. location, nor are there any pending applications before the Commission for use of these bands by a GSO satellite within two degrees.

Therefore, in order to demonstrate two-degree compatibility in these frequency ranges, the transmission parameters of the SES-15 satellite have been assumed as both the wanted and victim carriers, and the C/I level is calculated.

As the SES operations in this band are for the Broadcast beam, with the smallest antenna size being 0.55m for the downlink earth stations, the downlink C/I calculation is simplified. One can reasonably assume that the EIRP is the same from the wanted satellite and interfering satellite at the wanted location on the Earth, and hence only the receive earth station antenna discrimination factors in.

Therefore, the downlink C/I for similar operations can be simplified as the off-axis discrimination of the receive earth station antenna, as follows:

C/I_d = on-axis gain (dBi) – off-axis gain of the receive earth station antenna (dBi)

= 34.6 dBi (on-axis gain of the 0.55 m receive earth station antenna) – 29+25 * log (1.925°)

= 12.7 dB

Where the orbital separation is taken as the difference between 129.15° W.L. and the closest adjacent slot, 131°W.L., minus the station-keeping tolerance of each satellite (+/- 0.5°) and approximating the topocentric angle by adding 10% to the geocentric angular separation.

The resulting C/I is high and demonstrates that the operations proposed herein are two degree compatible.

ANNEX A

SES-15 Link Budgets

Table A-1
HTS Beams Forward Link Budgets

	Units	36M0G7W	36M0G7W	36M0G7W
Data rate	Mbps	43.489	54.438	60.556
Mod cod		8PSK 3/5 DVB-S2	8PSK 3/4 DVB-S2	8PSK 5/6 DVB-S2
Carrier bandwidth	MHz	30.0	30.0	30.0
Uplink:				
Uplink Frequency	GHz	28.042	28.018	29.636
Uplink transmit Power	dBW	5.4	5.4	4.9
Earth Station Diameter	m	7.30	7.30	7.30
Earth Station Gain	dBi	64.8	64.8	65.3
Earth station EIRP	dBW	70.2	70.2	70.2
Atmospheric Losses	dB	0.39	0.39	0.39
Free Space Loss	dB	213.1	213.1	213.6
Satellite G/T	dB/K	14.1	12.5	14.1
C/N Thermal Uplink	dB	24.6	23.0	24.1
C/I XPOL, ACI, IM, ASI	dB	28.0	28.0	28.0
C/(N+I) uplink	dB	23.0	21.8	22.6
Downlink:				
Downlink Frequency	GHz	11.242	11.218	11.318
Satellite EIRP per carrier	dBW	52.0	52.0	52.0
Atmospheric Losses	dB	0.02	0.14	0.14
Free Space Loss	dB	205.2	205.2	205.2
Earth Station Diameter	m	0.55	1.00	1.20
Earth Station Gain	dBi	34.4	39.6	41.2
System Noise Temperature	K	190	137	139
Earth Station G/T	dB/K	11.6	18.2	19.8
C/N Thermal Downlink	dB	12.2	18.7	20.3
C/I XPOL, ACI, IM, ASI	dB	10.7	15.8	17.5
C/(N+I) downlink	dB	8.4	14.0	15.7
Adjacent Satellite Interference:				
Uplink Input Power Density at 2 degrees	dBW/Hz	-56.5	-56.5	-56.5
Downlink EIRP density at 2 degrees	dBW/Hz	-23	-23	-23
C/I up (single satellite)	dB	31.0	31.0	31.0
C/I dn (single satellite)	dB	13.7	18.8	20.5
Aggregate C/I up	dB	28.0	28.0	28.0
Aggregate C/I down	dB	10.7	15.8	17.5
Overall:				
C/(N+I) overall	dB	8.2	13.4	14.9
C/(N+I) required	dB	6.7	9.1	10.5
Margin	dB	1.5	4.3	4.4

Table A-2
Broadcast Beam Link Budgets

Link Parameters	Units	36M0G7W	36M0G7W
Data rate	Mbps	34.8	43.562
Mod cod		QPSK 3/5 DVB-S2	QPSK 3/4 DVB-S2
Carrier bandwidth	MHz	30.0	30.0
Uplink:			
Uplink Frequency	GHz	28.354	27.836
Uplink Transmit Power	dBW	-2.9	-2.7
Earth Station Diameter	m	7.30	7.30
Earth Station Gain	dBi	64.9	64.7
Earth Station Transmit EIRP/Carrier	dBW	62.0	62.0
Atmospheric Losses	dB	0.36	0.37
Free Space Loss	dB	213.2	213.1
Satellite G/T	dB/K	15.8	15.8
C/N Thermal Uplink	dB	18.1	18.2
C/I XPOL, ACI, IM, ASI	dB	19.8	19.8
C/(N+I) uplink	dB	15.8	15.9
Downlink:			
Downlink Frequency	GHz	11.554	11.036
Satellite beam peak	dBW	50.0	50.0
Downlink aspect correction	dB	1.0	1.0
Satellite EIRP per carrier	dBW	49.0	49.0
Atmospheric Losses	dB	0.02	0.14
Free Space Loss	dB	205.4	205.0
Earth Station Diameter	m	0.55	0.85
Earth Station Gain	dBi	34.6	38.0
System Noise Temperature	K	171	120
Earth Station G/T	dB/K	12.3	17.2
C/N Thermal Downlink	dB	9.7	14.9
C/I XPOL, ACI, IM, ASI	dB	7.9	11.3
C/(N+I) downlink	dB	5.7	9.7
Adjacent Satellite Interference:			
Uplink Input Power Density at 2 degrees	dBW/Hz	-56.5	-56.5
Downlink EIRP density at 2 degrees	dBW/Hz	-23	-23
C/I up (single satellite)	dB	22.8	22.8
C/I dn (single satellite)	dB	10.9	14.3
Aggregate C/I up	dB	19.8	19.8
Aggregate C/I down	dB	7.9	11.3
Overall:			
C/(N+I) overall	dB	5.3	8.8
C/(N+I) required	dB	3.2	5.0
Margin	dB	2.1	3.8

Table A-3
NA Beam Link Budgets

Link Parameters	Units	1M58G7W	175K0G7W	36M0G7W	3M15G7W	36M0G7W	691K0G7W
Data rate	Mbps	2.048	0.256	58.069	4	38.723	0.256
Mod cod		QPSK 7/8 turbo	8PSK, 2/3 turbo	8PSK 2/3 DVB-S2	QPSK 6/7 turbo	QPSK 2/3 DVB-S2	BPSK 1/2 turbo
Carrier bandwidth	MHz	1.580	0.175	30.0	3.151	30.0	0.691
Uplink:							
Uplink Frequency	GHz	14.377	14.377	14.417	14.377	14.417	14.377
Uplink transmit Power	dBW	5.8	-2.8	16.5	12.2	16.5	2.1
Earth Station Diameter	m	2.40	2.40	6.30	1.20	6.30	0.55
Earth Station Gain	dBi	49.3	49.3	57.7	43.3	57.7	36.5
Earth station EIRP	dBW	55.1	46.5	74.2	55.5	74.2	38.6
Atmospheric Losses	dB	0.19	0.19	0.19	0.19	0.19	0.02
Free Space Loss	dB	207.3	207.3	207.3	207.3	207.3	207.3
Satellite G/T	dB/K	2.3	2.3	2.3	2.3	2.3	2.3
C/N Thermal Uplink	dB	16.5	17.5	22.8	13.9	22.8	3.8
C/I XPOL, ACI, IM, ASI	dB	19.2	20.1	25.5	16.6	25.5	6.3
C/(N+I) uplink	dB	14.6	15.6	20.9	12.0	20.9	1.8
Downlink:							
Downlink Frequency	GHz	12.077	12.077	12.117	12.077	12.117	12.077
Satellite downlink EIRP	dBW	33.4	24.9	50.4	33.8	50.4	17.1
Downlink aspect correction	dB	1.4	1.4	1.4	1.4	1.4	1.4
Satellite EIRP per carrier	dBW	30.8	22.3	49.0	31.2	49.0	14.5
Atmospheric Losses	dB	0.15	0.15	0.15	0.15	0.02	0.15
Free Space Loss	dB	205.8	205.8	205.8	205.8	205.8	205.8
Earth Station Diameter	m	2.40	2.80	1.20	6.30	0.55	6.30
Earth Station Gain	dBi	47.8	49.1	41.8	56.2	35.0	56.2
System Noise Temperature	K	195	156	170	173	175	173
Earth Station G/T	dB/K	24.9	27.2	19.5	33.8	12.6	33.8
C/N Thermal Downlink	dB	16.4	19.7	16.4	22.7	9.6	12.6
C/I XPOL, ACI, IM, ASI	dB	15.7	18.1	15.1	21.5	8.3	11.3
C/(N+I) downlink	dB	13.0	15.8	12.7	19.0	5.9	8.9
Adjacent Satellite Interference:							
Uplink Input Power Density at 2 degrees	dBW/Hz	-50	-50	-50	-50	-50	-50
Downlink EIRP density at 2 degrees	dBW/Hz	-23	-23	-23	-23	-23	-23
C/I up (single satellite)	dB	22.2	23.1	28.5	19.6	28.5	9.3
C/I dn (single satellite)	dB	18.7	21.1	18.1	24.5	11.3	14.3
Aggregate C/I up	dB	19.2	20.1	25.5	16.6	25.5	6.3
Aggregate C/I down	dB	15.7	18.1	15.1	21.5	8.3	11.3
Overall:							
C/(N+I) overall	dB	10.7	12.7	12.1	11.2	5.8	1.1
C/(N+I) required	dB	8.1	10.0	7.8	7.7	4.1	0.3
Margin	dB	2.6	2.7	4.3	3.5	1.7	0.8

APPENDIX 1 TO ANNEX A

C/I Calculations

Table A1-1: SES-15 into Horizons 1 Ku-Band Downlink C/I

Downlink C/I analysis	SES-15 into Horizons-1	
Frequency	11.95	GHz
SES-15 Orbital Position	129.15	W
Horizons-1 Orbital Position	127.0	W
Geocentric Separation	2.1	degrees
Topocentric Separation	2.3	degrees

Downlink: SES-15 Carriers						
Emission	1M58G7W	175K0G7W	36M0G7W	36M0G7W	36M0G7W	36M0G7W
Bandwidth	1.58	0.175	30.00	30.00	30.00	30.00
Receive Earth Station (m)	2.40	2.80	1.20	0.55	1.00	1.20
Satellite EIRP	30.8	22.3	49.0	52.0	52.0	52.0
Downlink EIRP density	-31.2	-30.1	-25.8	-22.8	-22.8	-22.8
RX Earth Station Gain	47.7	49.0	41.7	34.9	40.1	41.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	20.2	20.2	20.2	20.2	20.2	20.2

Downlink: Horizons-1 Carriers								Downlink C/I: SES-15 into Horizons-1 Carriers					
Emission	Satellite EIRP	Bandwidth (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain	C/I	C/I	C/I	C/I	C/I	C/I
36M0G7W	51.8	36.00	-23.8	1.8	45.2	29	20.2	32.4	31.4	27.0	24.0	24.0	24.0
6M00G7W	51.8	5.565	-26.8	3.7	51.4	29	20.2	35.7	34.6	30.3	27.3	27.3	27.3
1M454G7W	51.8	1.229	-26.8	1.8	45.2	29	20.2	29.4	28.4	24.0	21.0	21.0	21.0
200KG7W	51.8	0.154	-26.8	2.4	47.7	29	20.2	31.9	30.9	26.5	23.5	23.5	23.5
100KG7W	51.8	0.077	-26.8	2.4	47.7	29	20.2	31.9	30.9	26.5	23.5	23.5	23.5
400KG7W	51.8	0.307	-26.8	6.1	55.8	29	20.2	40.0	39.0	34.6	31.6	31.6	31.6

Table A1-2: Horizons 1 into SES-15 Ku-Band Downlink C/I

Downlink C/I analysis	Horizons-1 into SES-15	
Frequency	11.95	GHz
SES-15 Orbital Position	129.15	W
Horizons-1 Orbital Position	127.0	W
Geocentric Separation	2.1	degrees
Topocentric Separation	2.3	degrees

Downlink: SES-15 Carriers						
Emission	1M58G7W	175K0G7W	36M0G7W	36M0G7W	36M0G7W	36M0G7W
Bandwidth	1.58	0.175	30.00	30.00	30.00	30.00
Receive Earth Station (m)	2.40	2.80	1.20	0.55	1.00	1.20
Satellite EIRP	30.8	22.3	49.0	52.0	52.0	52.0
Downlink EIRP density	-31.2	-30.1	-25.8	-22.8	-22.8	-22.8
RX Earth Station Gain	47.7	49.0	41.7	34.9	40.1	41.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	20.2	20.2	20.2	20.2	20.2	20.2

Downlink: Horizons-1 Carriers								Downlink C/I: Horizons-1 into SES-15 Carriers					
Emission	Satellite EIRP	Bandw. (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain	C/I	C/I	C/I	C/I	C/I	C/I
36M0G7W	51.8	36.00	-23.8	1.8	45.2	29	20.2	20.1	22.5	19.5	15.7	20.9	22.5
6M00G7W	51.8	5.565	-26.8	3.7	51.4	29	20.2	23.1	25.5	22.5	18.7	23.9	25.5
1M454G7W	51.8	1.229	-26.8	1.8	45.2	29	20.2	23.1	25.5	22.5	18.7	23.9	25.5
200KG7W	51.8	0.154	-26.8	2.4	47.7	29	20.2	23.1	25.5	22.5	18.7	23.9	25.5
100KG7W	51.8	0.077	-26.8	2.4	47.7	29	20.2	23.1	25.5	22.5	18.7	23.9	25.5
400KG7W	51.8	0.307	-26.8	6.1	55.8	29	20.2	23.1	25.5	22.5	18.7	23.9	25.5

Table A1-3: SES-15 into Hypothetical satellite at 131° W.L. Ku-Band Downlink C/I

Downlink C/I analysis	SES-15 into Hypothetical Sat at 131W	
Frequency	11.95	GHz
SES-15 Orbital Position	129.15	W
Hypothetical Sat at 131W Orbital Position	131.0	W
Geocentric Separation	1.7	degrees
Topocentric Separation	1.9	degrees

Downlink: SES-15 Carriers						
Emission	1M58G7W	175K0G7W	36M0G7W	36M0G7W	36M0G7W	36M0G7W
Bandwidth	1.58	0.175	30.00	30.00	30.00	30.00
Receive Earth Station (m)	2.40	2.80	1.20	0.55	1.00	1.20
Satellite EIRP	30.8	22.3	49.0	52.0	52.0	52.0
Downlink EIRP density	-31.2	-30.1	-25.8	-22.8	-22.8	-22.8
RX Earth Station Gain	47.7	49.0	41.7	34.9	40.1	41.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	21.9	21.9	21.9	21.9	21.9	21.9

Downlink: Hypothetical Sat at 131W Carriers								Downlink C/I: SES-15 into Hypothetical Sat at 131W Carriers					
Emission	Satellite EIRP	Bandwidth (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain	C/I	C/I	C/I	C/I	C/I	C/I
1M58G7W	30.8	1.58	-31.2	2.4	47.7	29	21.9	25.8	24.7	20.4	17.4	17.4	17.4
175K0G7W	22.3	0.175	-30.1	2.8	49.0	29	21.9	28.2	27.1	22.8	19.8	19.8	19.8
36M0G7W	49.0	30.00	-25.8	1.2	41.7	29	21.9	25.2	24.1	19.8	16.8	16.8	16.8
36M0G7W	52.0	30.00	-22.8	0.55	34.9	29	21.9	21.4	20.4	16.0	13.0	13.0	13.0
36M0G7W	52.0	30.00	-22.8	1.0	40.1	29	21.9	26.6	25.5	21.2	18.2	18.2	18.2
36M0G7W	52.0	30.00	-22.8	1.2	41.7	29	21.9	28.2	27.1	22.8	19.8	19.8	19.8

Table A1-4: Hypothetical satellite at 131° W.L. into SES-15 Ku-Band Downlink C/I

Downlink C/I analysis	Hypothetical Sat at 131W into SES-15	
Frequency	11.95	GHz
SES-15 Orbital Position	129.15	W
Hypothetical Sat at 131W Orbital Position	131.0	W
Geocentric Separation	1.7	degrees
Topocentric Separation	1.9	degrees

Downlink: SES-15 Carriers						
Emission	1M58G7W	175K0G7W	36M0G7W	36M0G7W	36M0G7W	36M0G7W
Bandwidth	1.58	0.175	30.00	30.00	30.00	30.00
Receive Earth Station (m)	2.4	2.8	1.2	0.55	1.0	1.2
Satellite EIRP	30.8	22.3	49.0	52.0	52.0	52.0
Downlink EIRP density	-31.2	-30.1	-25.8	-22.8	-22.8	-22.8
RX Earth Station Gain	47.7	49.0	41.7	34.9	40.1	41.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	21.9	21.9	21.9	21.9	21.9	21.9

Downlink: Hypothetical Sat at 131W Carriers								Downlink C/I: Hypothetical Sat at 131W into SES-15 Carriers					
Emission	Satellite EIRP	Bandw. (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain	C/I	C/I	C/I	C/I	C/I	C/I
1M58G7W	30.8	1.58	-31.2	2.4	47.7	29	21.9	25.8	28.2	25.2	21.4	26.6	28.2
175K0G7W	22.3	0.175	-30.1	2.8	49.0	29	21.9	24.7	27.1	24.1	20.4	25.5	27.1
36M0G7W	49.0	30.00	-25.8	1.2	41.7	29	21.9	20.4	22.8	19.8	16.0	21.2	22.8
36M0G7W	52.0	30.00	-22.8	0.55	34.9	29	21.9	17.4	19.8	16.8	13.0	18.2	19.8
36M0G7W	52.0	30.00	-22.8	1.0	40.1	29	21.9	17.4	19.8	16.8	13.0	18.2	19.8
36M0G7W	52.0	30.00	-22.8	1.2	41.7	29	21.9	17.4	19.8	16.8	13.0	18.2	19.8

DECLARATION

I, Pascale Dumit, hereby certify under penalty of perjury that I am the technically qualified person responsible for preparation of the technical information contained in the foregoing exhibit; that I am familiar with the technical requirements of Part 25; and that I either prepared or reviewed the technical information contained in the exhibit and that it is complete and accurate to the best of my knowledge, information and belief.

/s/ Pascale Dumit

Pascale Dumit
Manager, Spectrum Management and Development
SES Americom, Inc.

Dated: July 18, 2016

TECHNICAL APPENDIX

SES-15 WAAS PAYLOAD AT 129.15° W.L.

1.0 Overall Description (§25.114(d)(1))

This technical appendix is submitted in support of the modification request of SES Satellites (Gibraltar) Limited ("SES") seeking U.S. market access for the Wide Area Augmentation System ("WAAS") payload onboard the SES-15 spacecraft to be located at 129.15° W.L. SES provides herein technical information regarding the WAAS payload to supplement the data previously provided regarding SES-15.[1]

SES-15 is currently under construction by The Boeing Corporation, with the WAAS payload operating in portions of the L-band and C-band.

The WAAS payload is hosted onboard SES-15 for the Federal Aviation Administration ("FAA") and will operate service links in the L-band across the visible Earth on Global Positioning System ("GPS") frequencies L1 and L5 with feeder links provided for this service through extended C-band uplinks in the United States in the 6628.27-6650.27 MHz and 6679.42-6701.42 MHz frequencies. The WAAS payload delivers data to WAAS-enabled GPS receivers. This information is then used to correct the measured GPS position, improving GPS signal accuracy from 100 meters to less than 7 meters. The FAA provides this service because it improves the ability of GPS-enabled aircraft to make precision landings and provides additional safety of flight. The primary feeder link station uplinking the WAAS signal will be SES's South Mountain earth station in Somis, CA, with a "hot" backup located in Brewster, WA. The WAAS payload will also use a tracking beacon at 3700.2 MHz.[2]

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[1] *See SES Satellites (Gibraltar) Ltd.*, File No. SAT-PPL-20160126-00007 (the "SES-15 Petition"), granted July 12, 2016.

[2] As discussed in Annex C, Intelsat operates Galaxy 12 in the conventional C-band at 129° W.L., and SES has coordinated the WAAS payload's beacon with Intelsat. Coordination will be facilitated by the fact that the Galaxy 12 transponders do not use any frequencies below 3702 MHz, and the Galaxy 12 telemetry carriers are on the upper edge of the band. Moreover,

2.0 Schedule S (§25.114(c))

The Schedule S database is included with this filing. In preparing the Schedule S, SES relied on the most recent instructions that take into account the changes to Section 25.114 adopted in the Part 25 reform proceeding, which eliminated or modified various requirements for information that must be provided in the Schedule.[3]

3.0 Telemetry and Telecommand (TT&C) frequencies and beams

In addition to the TT&C carriers described in the SES-15 Petition, the WAAS payload operates a vertically polarized tracking beacon at 3700.2 MHz with an allocated bandwidth of 400 kHz (described in Schedule S).

4.0 PFD limits (§25.208 and 25.138)

Table 1 demonstrates that the PFD values for SES-15's C-band tracking beacon will comply with §25.208(a).

Table 1: Maximum PFD values and margins relative to permissible limits of §25.208(a)

Elevation angle, deg	5.0	10.0	15.0	20.0	25.0	90.0
Gain roll-off at elevation angle, dBi	0.0	0.0	0.0	0.0	0.0	0.0
Max EIRP density at elevation angle dBW/4kHz	10.5	10.5	10.5	10.5	10.5	10.5
Minimum spreading loss, dB/m2	-163.3	-163.2	-163.1	-162.9	-162.8	-162.1
25.208(a) pfd limit (3650-4200 MHz), dBW/m2/4kHz	-152.0	-149.5	-147.0	-144.5	-142.0	-142.0
pfd, dBW/m2/4KHz	-152.8	-152.7	-152.6	-152.4	-152.3	-151.6
Margin, dB, relative to 25.208	0.8	3.2	5.6	7.9	10.3	9.6

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the SES-15 WAAS payload tracking beacon at 3700.2 MHz is cross polarized with Galaxy 12's transponder 1C.

[3] Consistent with those instructions, in cases where the Schedule S software requests information that space station applicants are no longer required to provide, SES has omitted data elements, or where necessary to permit validation of the Schedule S file, has entered a "1" as a placeholder. SES specifies that these "1" data entries are outside the scope of the certifications herein regarding accuracy of the information provided with this amendment.

5.0 Satellite Antenna Gain Contours (§25.114(c)(4)(vi)(A) & (vii))

In accordance with §25.114(c)(4)(vi)(A), the gxt files are not provided for the transmit and receive antenna beams of the WAAS payload because the contour at 8 dB below peak for these beams falls entirely beyond the edge of the visible Earth.

6.0 Emission Designators and Link Budgets (§25.114(d)(4))

Annex A shows typical link budgets for the WAAS payload on the satellite, including emission designators.

7.0 Coordination Matters including Two Degree Spacing Analysis (§25.114(d)(7) and §25.140(b)(2))

Annex B provides analyses demonstrating the compatibility of the SES-15 WAAS payload at 129.15° W.L. with neighboring spacecraft in the extended C-band.

With respect to operation of the WAAS payload in the GPS frequencies, SES notes that there are two main coordination matters – ensuring compatibility with aeronautical radionavigation satellite (ARNS) systems and ensuring compatibility with the U.S. GPS system. With respect to sharing with ARNS, SES will follow the procedure set forth in ITU-R Resolution 609. Resolution 609 outlines a process by which administrations operating or planning to operate systems in certain radionavigation satellite service (RNSS) frequencies[4] cooperate to achieve protection for ARNS systems. Specifically, Resolution 609 requires that the equivalent power flux density (EPFD) produced by all RNSS space stations operating in the 1154-1215 MHz band shall not exceed the aggregate EPFD level of -121.5 dB(W/m2) in any 1 MHz band. SES has provided the necessary notifications and information on the SES-15 WAAS payload to the Resolution 609 group through the notifying administration for the WAAS payload, Luxembourg,

[4] The downlink frequencies of SES-15's WAAS payload – the GPS frequencies – fall under the RNSS service definition.

and will be participating in the consultation meetings and correspondence as necessary in order to achieve compliance of this payload with Resolution 609 prior to launch of SES-15.

With respect to coordination with the U.S. GPS system, the WAAS payload on SES-15 is an augmentation of the U.S. GPS system and is developed in support of and at the direction of the FAA. As such, the FAA will manage operation of the SES-15 WAAS payload to ensure its compatibility within the broader U.S. GPS system framework.

ANNEX A

SES-15 WAAS PAYLOAD LINK BUDGETS

Table A-1
WAAS Beacon Link Budget

Link Parameters	Units	400KF9D
Downlink Frequency	MHz	3700.2
Carrier Allocated Bandwidth	kHz	400
Downlink:		
Satellite EIRP for beacon carrier	dBW	10.5
Free Space Loss	dB	194.9
Earth Station Diameter	m	11.1
Earth Station Gain	dBi	50.3
System Noise Temperature	K	80
Earth Station G/T	dB/K	31.3
C/No Downlink	dB	75.5
C/Io XPOL, ACI, IM, ASI	dB	71.9
C/(No+Io) downlink	dB	70.3
Adjacent Satellite Interference:		
Downlink EIRP Density at 2 degrees	dBW/Hz	-35
C/Io dn (single satellite)	dB	74.9
Aggregate C/Io down	dB	71.9
Overall:		
C/(No+Io) overall	dB	70.3
C/(No+Io) required	dB	35.0
System Margin	dB	35.3

Table A-2
WAAS C1 to L1 link budget

Link Parameters	**Units**	**22M0G7W**
Carrier bandwidth	MHz	22.0
Uplink:		**C1**
Uplink Frequency	GHz	6.63927
Uplink transmit Power	dBW	16.8
Earth Station Diameter	m	11.1
Earth Station Gain	dBi	55.2
Earth station EIRP	dBW	72.0
Free Space Loss	dB	200.6
Satellite G/T towards earth station	dB/K	-8.7
C/N Thermal Uplink	dB	17.9
Downlink:		**L1**
Downlink Frequency	GHz	1.57542
Satellite EIRP for carrier	dBW	35.5
Free Space Loss	dB	188.1
Rx E/S Antenna Gain	dBi	0.0
System Noise Temperature	K	100
Receive E/S G/T	dB/K	-20.0
C/N Thermal Downlink	dB	-17.4
Overall:		
C/N Total	dB	-17.4
C/N Total required	dB	-26.0
Margin	dB	8.6

Table A-3
WAAS C5 to L5 link budget

Link Parameters	**Units**	**22M0G7W**
Carrier bandwidth	MHz	22.0
Uplink:		**C5**
Uplink Frequency	GHz	6.69042
Uplink transmit Power	dBW	16.8
Earth Station Diameter	m	11.1
Earth Station Gain	dBi	55.2
Earth station EIRP	dBW	72.0
Free Space Loss	dB	200.7
Satellite G/T towards earth station	dB/K	-8.7
C/N Thermal Uplink	dB	17.8
Downlink:		**L5**
Downlink Frequency	GHz	1.17645
Satellite EIRP for carrier	dBW	34.7
Free Space Loss	dB	185.6
Rx E/S Antenna Gain	dBi	0.0
System Noise Temperature	K	100
Receive E/S G/T	dB/K	-20.0
C/N Thermal Downlink	dB	-15.7
Overall:		
C/N Total	dB	-15.7
C/N Total required	dB	-26.0
Margin	dB	10.3

ANNEX B

Interference Analysis

Interference Analyses

1- SES-15 WAAS Payload:

a) SES-15 WAAS Payload Beacon at 3700.2 MHz:

As discussed below, the SES-15 WAAS payload beacon does not overlap with the frequencies of the adjacent satellites, Galaxy 12 at 129.0° W.L. and Galaxy 13/Horizons 1 at 127.0° W.L. Neither the Galaxy 12 nor the Galaxy 13/Horizons 1 transponders use any frequencies below 3702 MHz, and the telemetry carriers for both satellites are on the upper edge of the conventional C-band. Moreover, the SES-15 WAAS payload tracking beacon at 3700.2 MHz is cross polarized with Galaxy 12's transponder 1C. Notwithstanding the absence of any frequency overlap, SES has coordinated use of this beacon with Intelsat to ensure compatibility.

The AMC-11 adjacent satellite at 131.0° W.L.is controlled by SES, and SES will manage its satellites' operations to ensure avoidance of interference.

The following analysis describes the specific factors that allow the SES-15 WAAS C-band beacon operations proposed herein to operate in a two-degree spacing environment without causing or experiencing harmful adjacent satellite interference.

i. **C-band Downlink Interference Assessment – Galaxy 12 at 129.0° W.L.**

SES has carefully planned the SES-15 WAAS C-band beacon operations to facilitate coordination with Galaxy 12. In order to maximize compatibility, SES has chosen to operate the SES-15 WAAS C-band beacon at 3700.2 MHz, which does not overlap with the Galaxy 12 telemetry operations at the upper edge of the band or with the communications carriers of Galaxy 12 Transponder 1C, which starts at 3702 MHz. Furthermore, the WAAS C-band beacon operates at the opposite polarization of Galaxy 12's Transponder 1C carriers.

Management of the interference potential from TT&C carriers is done on a case-by-case basis. Therefore the downlink interference environment has been addressed through coordination of the

proposed SES-15 C-band beacon operations with Intelsat, taking into account the lack of frequency overlap and SES's use of opposite polarization to ensure adequate isolation towards the neighboring satellite.

ii. **C-band Downlink Interference Assessment – Galaxy 13/Horizons 1 at 127.0° W.L.**

Similar factors will facilitate coordination with Galaxy 13/Horizons 1. The SES-15 WAAS C-band beacon does not overlap with the Galaxy 13/Horizons 1 telemetry operations, which are also at the upper edge of the band, or with the communications carriers of Galaxy 13/Horizons 1 Transponder 1C, which also start at 3702 MHz.

iii. **C-band Downlink Interference Assessment – AMC-11 at 131.0° W.L.**

The SES-15 WAAS C-band beacon is cross-polarized with the AMC-11 beacon at 3700.5 MHz. Moreover, it does not overlap with the communications carriers of AMC-11 Transponder 1C, which start at 3702 MHz. As previously mentioned, since SES controls the AMC-11 satellite, SES will manage the TT&C carriers to avoid interference.

b) SES-15 WAAS Feeder Links, C1 at 6639.27 MHz and C5 at 6690.42 MHz:

Currently there are no operational GSO Extended C-band satellites that use the 6628.27-6650.27 MHz band or the 6679.42-6701.42 MHz band within two degrees of the 129.15º W.L. location, nor are there any pending applications before the Commission for use of these bands by a GSO satellite within two degrees. Therefore, in order to demonstrate two-degree compatibility in these frequency ranges, the transmission parameters of the SES-15 satellite have been assumed as both the wanted and victim carriers, and the C/I level is calculated.

As the SES operations in this band are feeder links, with one 11.1 meter uplink earth station antenna and a single emission, the uplink C/I calculation is simplified. Further, the receive gain of the space station antenna does not roll off significantly across the service area. Therefore, the

uplink C/I for similar operations at both slots can be simplified as the off-axis discrimination of the earth station antenna, as follows:

C/I_u = on-axis gain (dBi) – off-axis gain towards the wanted satellite (dBi)

= 55.2 dBi (on-axis gain of 11.1 m earth station antenna) – 29+25 * log (1.925°)

= 33.3 dB

Where the orbital separation is taken as the difference between 129.15° W.L. and the closest adjacent slot, 131°W.L., minus the station-keeping tolerance of each satellite (+/- 0.5°) and approximating the topocentric angle by adding 10% to the geocentric angular separation.

The off-axis gain of the earth station antenna is modeled using Section 25.209. The resulting C/I is high, as one would expect for such large uplink earth station antennas, and demonstrates that the WAAS feeder links are two degree compatible.

DECLARATION

I, Pascale Dumit, hereby certify under penalty of perjury that I am the technically qualified person responsible for preparation of the technical information contained in the foregoing exhibit; that I am familiar with the technical requirements of Part 25; and that I either prepared or reviewed the technical information contained in the exhibit and that it is complete and accurate to the best of my knowledge, information and belief.

/s/ Pascale Dumit

Pascale Dumit
Manager, Spectrum Management and Development
SES Americom, Inc.

Dated: July 18, 2016