
Review of Space Operations New Zealand application

Prepared for Invercargill City Council

June 2026

Exec Summary

1. Invercargill City Council, through Taylor Planning, asked me to review the Space Operations New Zealand Limited (Space Ops) application for a designation to protect the Awarua Satellite Ground Station, together with the submissions made on it. This summary sets out my main conclusions; the reasoning and supporting analysis are in the body of the report.
2. The application relies on two sources of protection: the Radio Spectrum Management (RSM) November 2020 decision (which in turn relies on the Radio Communications Act 1989 and Radio Regulations 2001) and the ITU-R Radio Regulations. That reliance is, in itself, correct. However, the application interprets those documents as giving Space Ops a far broader protection than they in fact provide, and it offers no analysis to justify the protection it claims.
3. The -154 dBW/MHz limit is real, but it is narrower than the application assumes. It protects the ground station only from terrestrial radio services, and only from those that came into operation after the November 2020 decision. It does not, on its own terms, protect against every activity that produces an electromagnetic emission, and it cannot be applied retrospectively to services that were already operating.
4. There is already background interference at the site, mainly from cellular base stations operating below and above the protected band, all of which predate the November 2020 decision. The Act protects against individual interferers, not against the cumulative effect of many. This means that emissions which are individually harmless could together push the total interference past -154 dBW/MHz, and the Act would provide no protection in that situation.
5. The 2 km protection area is justified, because it is what the November 2020 decision specifies. The 3 km horizon mask is different: it concerns physical structures rather than radio emissions. Neither the Radiocommunications Act 1989 and Regulations 2001 nor the RSM November 2020 decision deals with physical obstruction, and the application does not explain how the horizon mask envelope was derived. Its basis therefore needs to be explained before it can be assessed.
6. The concerns raised in submissions, such as those about virtual fencing, wind and solar generation, inverters and electrical distribution networks, are valid concerns to raise. But it cannot simply be assumed that these devices will cause harmful interference; that would need to be established by analysis, and no such analysis has been provided by the applicant or in the submissions.
7. It is also important to note that meeting the EMC standards does not answer this question. Those standards are generic: compliance establishes only that a device may lawfully be supplied, leaving open whether it will contribute interference at this particular, highly sensitive receiver. Whether any of these devices causes harmful interference therefore remains a matter for evidence, on which I am not presently able to reach a concluded view

8. The application does not appear to consider any way of managing interference other than preventing emissions within the 2 km area. Given the background interference the site already faces, and the Act's limited protection against cumulative effects, Space Ops would be better served by also considering mitigation at its own site.
9. In short, Space Ops is entitled to the protection that the -154 dBW/MHz limit and the general interference provisions of the Act and the regulation actually provide. It has not, however, shown that the much broader protection sought in the application is within its rights. There are significant gaps in the information provided, and until those gaps are addressed I am not able to recommend conditions or to confirm that the protections claimed are justified.

1 Background and scope

10. I have been asked by Taylor Planning on behalf of Invercargill City Council to provide an opinion on the Space Operations New Zealand Limited (Space Ops) application for resource consent.
11. My instructions are as follows:
 - Review of all application material
 - Review of all submissions
 - Advise whether you need any further information from the applicant
 - Consideration of the following key questions:
 - Is the information provided in the application accurate and robust?
 - Is there anything in the application material that you do not agree with?
 - Is the -154 dBW/MHz EMI restriction technically justified?
 - Is a 2 km blanket EMI control area justified/necessary?
 - Is the 3km height plane 'horizon mask' justified/necessary? How sensitive is the ground station to built form in this area?
 - Are the concerns raised in submissions valid? Would industrial, infrastructure, and farm technology activities breach the EMI threshold? -In particular the activities discussed in submissions eg virtual fencing, wind farms/solar energy generation, inverters, electrical distribution networks (overhead/underground)
 - Are there any potential alternatives that the applicant hasn't considered or addressed?
 - Can interference be managed in less restrictive ways? Eg equipment standards
 - Is shielding / filtering at the ground station site an option that could be considered?
 - Are there any conditions that you would recommend be placed on the designation, if granted by the hearing panel?
 - Provide a report / memorandum addressing the above questions and the concerns raised in submissions, including a plain-language summary which can be understood by members of the public/submitters/the hearing panel.
12. This report addresses the questions above. Because several of them overlap, I have grouped related questions together. The overlap is not perfect, however, so the grouping is a matter of convenience rather than a strict division.
13. This report is structured as follows:

- Section 2 addresses the questions
 - Is the information provided in the application accurate and robust?
 - Is there anything in the application material that you do not agree with?
 - Is the -154 dBW/MHz EMI restriction technically justified?
 - Is a 2 km blanket EMI control area justified/necessary?

These questions relate to the electromagnetic signal and interference.

- Section 3 addresses “Is the 3km height plane 'horizon mask' justified/necessary? How sensitive is the ground station to built form in this area?”
- Section 4 addresses “Are the concerns raised in submissions valid?”
- Section 5 addresses “Are there any potential alternatives that the applicant hasn't considered or addressed?”
- Section 6 addresses “Are there any conditions that you would recommend be placed on the designation, if granted by the hearing panel?”

2 Information provided and restrictions

2.1 Analysis of the restrictions claimed and its limitations

14. This section carries out a detailed analysis of the protection claimed in the application.
15. The application makes two broad claims of protection. The first is a restriction on emissions, which is stated in a number of places. In essence, protection is claimed from any activity that produces an electromagnetic emission.
16. Page 4 of the application outlines the restriction claimed:

“This designation would also restrict the establishment of any activity on land that results in electromagnetic emissions greater than -154 dBW/MHz at frequencies used for the reception of radio signals from spacecraft at Awarua Satellite Ground Station as set out in Table of Radio Spectrum Usage in New Zealand (PIB 21).”

17. Page 14 further claims

“It is a fundamental component of the satellite ground station’s operation to communicate between the ground and orbiting satellites. In this regard, New Zealand is bound by the International Telecommunications Union (ITU) which is an implementing agency of the United Nations. The ITU has established the Radio Regulations (RR). Of particular relevance with regard to the RR, is Chapter 4 (Section II) which deals with interference from electrical apparatus and installations. These regulations state:

Administrations shall take all practicable and necessary steps to ensure that the operation of electrical apparatus or installations of any kind, including power and telecommunication distribution networks, but excluding equipment used for industrial scientific and medical application, does not cause harmful interference to a radiocommunication service and, in particular, to radionavigation or any other safety service operation in accordance with the provisions of these Regulations.

To this effect, the current protection to the satellite ground station afforded by the RSM confirm adherence to these international regulations.”

18. In essence, two sets of protection, or restrictions, are claimed:
 - No interference greater than -154dBW/MHz from electromagnetic signals
 - No interference from other equipment e.g virtual fencing, wind farms/solar energy
19. The application claims this protection without providing any analysis of why it should be afforded. In the remainder of this section, I examine what has been claimed against what is set out in the RSM decision and what the Radiocommunications Act 1989 and Radiocommunication Regulations 2001 (the Act) provides, including by reference to the ITU-R Radio Regulations.

2.1.1 No interference greater than -154dBW/MHz from electromagnetic signals

20. Section 3.3.2 of the Radio Spectrum Management (RSM) November 2020 decision states ¹

“RSM has decided to define three protection zones (Warkworth Earth Station, Awarua Earth Station and Mahia Peninsula) allocated for SR, EES and SO with parameters as follows.

1. Each protection zone is centred on a point location, as shown in [Table 1](#) below
 2. Each protection zone has a radius of 2 km from that point location
 3. The protection frequency range is 2200–2290 MHz
 4. To avoid desensitisation of the satellite station receivers, permissible interference from terrestrial services within the protection area shall be less than -154 dBW/MHz.
21. Examining the statement “To avoid desensitisation of the satellite station receivers, permissible interference from terrestrial services within the protection area shall be less than -154 dBW/MHz”, there are two important components to it:
 - -154 dBW/MHz and

¹ Radio Spectrum Management “Re-planning the 1710–2300 MHz Band – Decisions” November 2020.

- Interference from terrestrial services
22. Article 1 (para 1.7) of the ITU-R Radio Regulations defines terrestrial as:
- “terrestrial radiocommunication: Any radiocommunication other than space radiocommunication or radio astronomy.”
23. The information in Section III of Article 1, under the heading Radio services, refers to the transmission and reception of electromagnetic signals, and not to instances where electromagnetic signals are merely a by-product.
24. The -154 dBW/MHz protection is afforded only from interference from terrestrial services. Examples of terrestrial services include fixed services, broadcasting services and mobile services.
25. The protection sought, however, is from any activity whose electromagnetic emissions exceed -154 dBW/MHz. This is a broader protection than the RSM decision provides.
26. Below, I examine the extent of the protection actually afforded to Space Ops.
27. The RSM ruling states that the interference should not exceed -154 dBW/MHz. Interference can be made up of various components:
- Interference generated by electromagnetic signals transmitted from the same frequencies.
 - Signals that fall outside the band the transmitter is intended to transmit. This includes out of band emission, spurious emission and intermodulation products/signals.

2.1.1.1 Interference from 2200 – 2290MHz

28. This section considers interference from electromagnetic signals transmitted on the same frequencies, that is, transmitters operating in the range 2200–2290 MHz.
29. The RSM decision came into effect in November 2020 and cannot be applied retrospectively.
30. The band 2200–2290 MHz is allocated to both satellite and fixed services. There are currently no fixed services operating in this band, and therefore no terrestrial services operating in it.
31. Figure 1 below is a reproduction of Figure 2 from the RSM November 2020 decision.

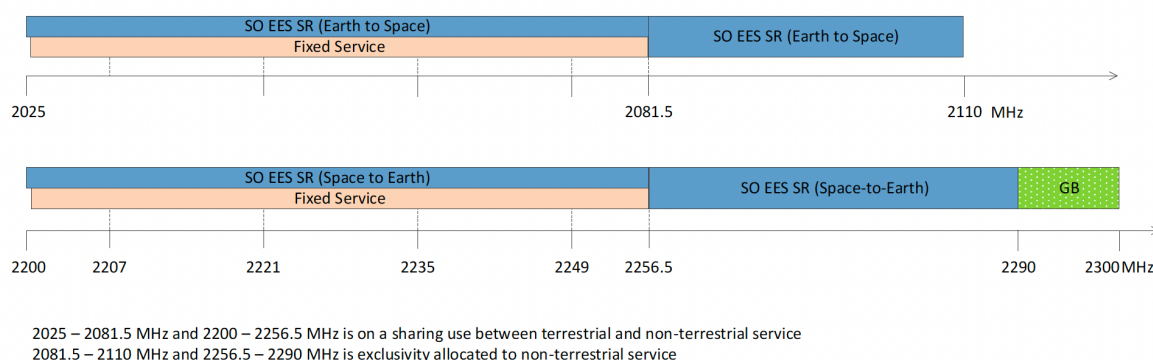


Figure 2 2025 – 2110 / 2200 -2290 MHz band plan

Figure 1: 2025-2300MHz band usage in New Zealand.

32. A review of the licences within 100 kilometres of the Awarua Earth Station shows that there are (100km threshold is used as that is what an Approved Radio Engineer need to consider when issuing licenses around Awarua Earth Station):
- No fixed licenses,
 - 4 Aero Mobile (Off Route) transmit licences in the range 2278 – 2280.5MHz licensed to Dawn Aerospace SPL Limited (Dawn Aerospace),
 - 4 Space operations spacecraft transmit licences in the range 2278 – 2280.5MHz licensed to Dawn Aerospace,
 - 197 satellite licenses (these licenses are listed in Appendix A).
33. The following table shows the eight Dawn Aerospace licences.

Table 1: Dawn Aerospace licenses.

Licence Category	Licence type	Spectrum Low	Spectrum High	Tx Location name	Rx Location name
Aeronautical / Mobile / >= 30MHz / Aero Mobile (Off Route) (A4)	Aero Mobile (Off Route)	2278	2283	AERO MOBILE AREA	GLENTANNER
Aeronautical / Mobile / >= 30MHz / Aero Mobile (Off Route) (A4)	Aero Mobile (Off Route)	2278	2283	AERO MOBILE AREA	SH8 PUKAKI AERODROME
Aeronautical / Mobile / >= 30MHz / Aero Mobile (Off Route) (A4)	Aero Mobile (Off Route)	2278	2283	AERO MOBILE AREA	OAMARU AIRPORT TOWER
Aeronautical / Mobile / >= 30MHz / Aero Mobile (Off Route) (A4)	Aero Mobile (Off Route)	2278	2283	AERO MOBILE AREA	WIGRAM AIR MUSEUM

Space Operations / Spacecraft / Space operations spacecraft (GS)	Space operations spacecraft	2275.5	2285.5	AERONAUTIC AL MOBILE AREA	Kaitorete Spit (Dawn Aerospace)
Space Operations / Spacecraft / Space operations spacecraft (GS)	Space operations spacecraft	2275.5	2285.5	AERONAUTIC AL MOBILE AREA	WIGRAM AIR MUSEUM
Space Operations / Spacecraft / Space operations spacecraft (GS)	Space operations spacecraft	2275.5	2285.5	AERONAUTIC AL MOBILE AREA	SH8 PUKAKI AERODROME
Space Operations / Spacecraft / Space operations spacecraft (GS)	Space operations spacecraft	2275.5	2285.5	AERONAUTIC AL MOBILE AREA	GLENTANNER

34. The receive locations of the Dawn Aerospace licences are shown below.

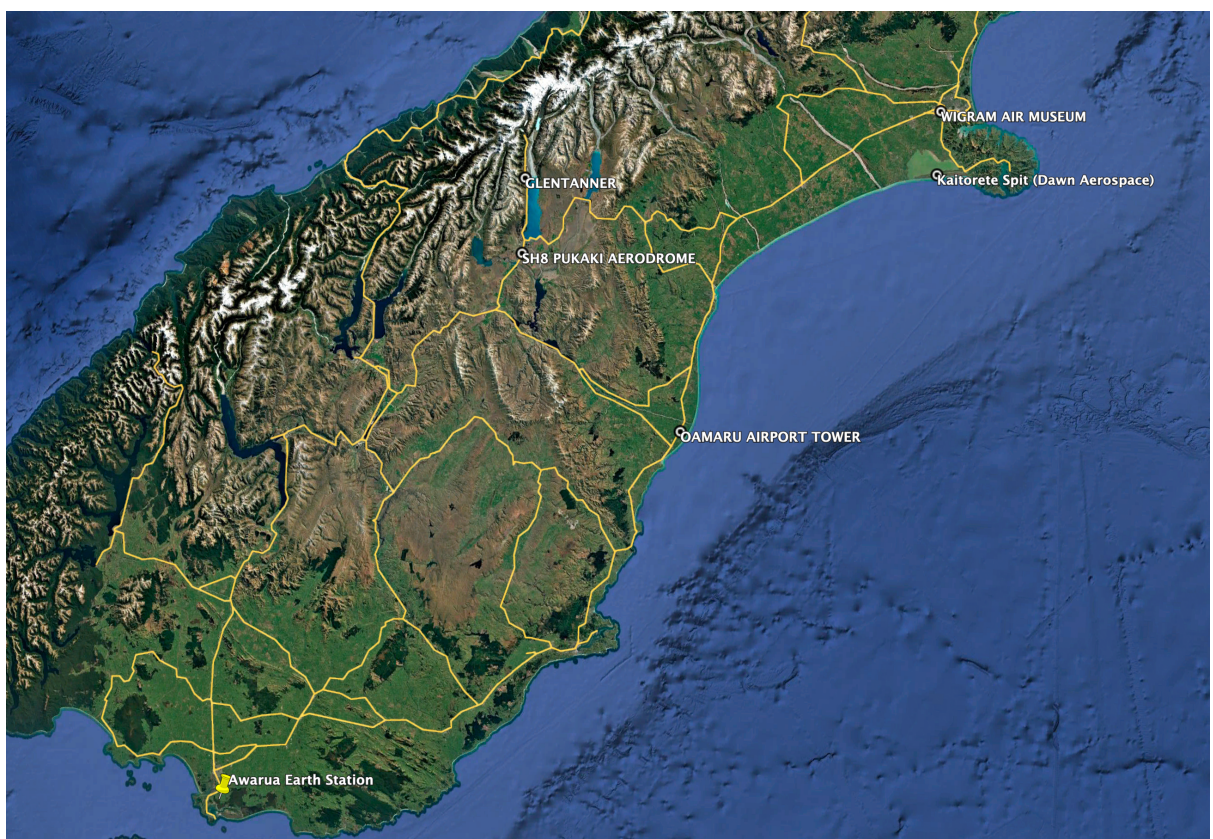


Figure 2: Receive location of the Dawn Aerospace licenses in the band 2200-2290MHz.

35. The receive locations of the Dawn Aerospace licences are over 100 km from the Awarua Earth Station. In any event, these transmitters are mobiles and are not terrestrial services. Therefore, even if interference from these mobiles were to exceed -154 dBW/MHz, Space Ops could not claim protection from them.

36. The transmit locations of the Dawn Aerospace licences are AERO MOBILE AREA and AERONAUTICAL MOBILE AREA. Both are defined as areas covering all of New Zealand, so the transmitters are permitted to operate anywhere in the country, including near Awarua.

2.1.1.2 Interference from frequencies outside 2200 – 2290 MHz.

37. This section considers whether interference could arise from signals outside the band 2200–2290 MHz.
38. The figure below shows the adjacent band usage in the range 2100 – 2400 MHz.



Figure 3: Band usage in the range 2100 – 2400 MHz.

39. Cellular base stations operate in the range 2110–2170 MHz. This band has been in use since April 2001.
40. Figure 4 shows the mobile base stations that were operational before November 2020. These are sites I was able to confirm were operational before that date. There may be other sites that were also operational before November 2020 but have since changed name; these are not included.

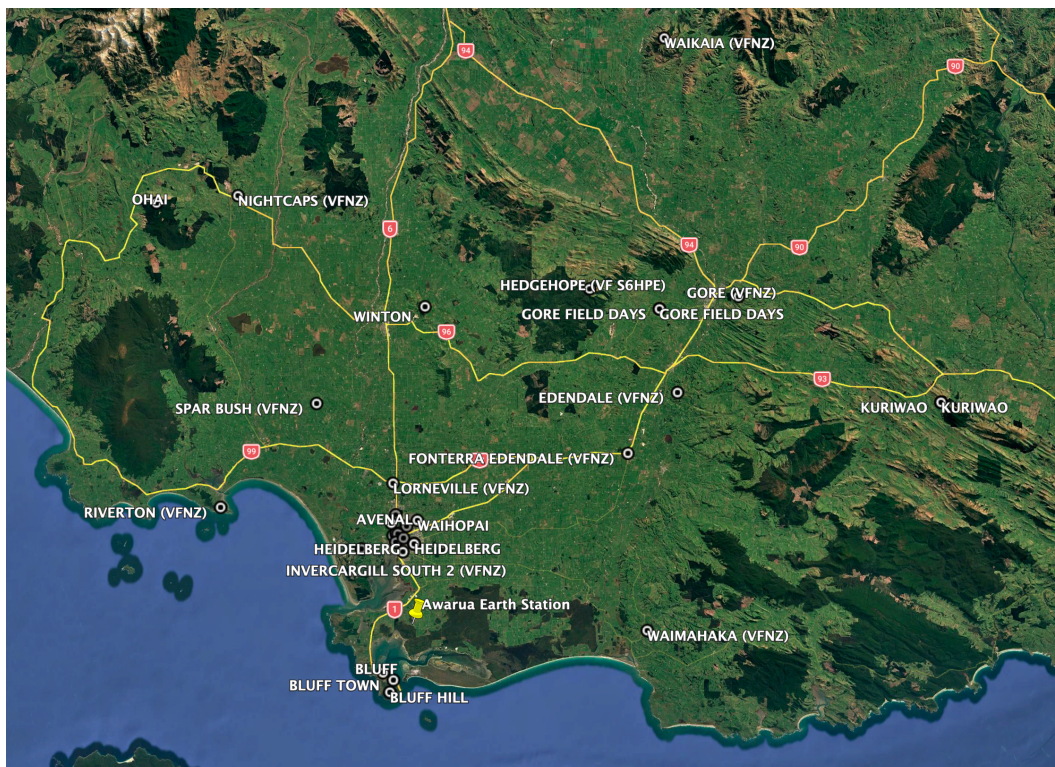


Figure 4: Locations of 2100MHz cellular base stations that were operational before November 2020.

41. The 2100MHz licenses had to comply with a -50 dBW/MHz^2 adjacent frequency emission limit (AFEL) at the time of the decision in November 2020. AFEL refers to emission that the base station allowed emit outside the operational band, that is outside 2110 – 2170 MHz, which could extend to 2200 – 2290 MHz.
42. The area around the Awarua Earth Station is relatively flat, which means any interference from cellular base stations is likely to travel without much obstruction.
43. Further the area between Awarua and Bluff is largely made up of (salt) water (electromagnetic signals travel further over salt water compared to land). The Bluff cell sites are around 8-10 km from the earth station, with Bluff Hill cell site at elevated location (251m above sea level compared to Awarua Earth Station ground height of 10m), resulting signals reaching Awarua Earth Station without significant path loss (elevated location and flat terrain gives clear visibility between the two locations).
44. I do not have the cell site details needed to estimate the exact signal levels; however, my estimate is that the emission from these cell sites that fall within the 2200 – 2290 MHz range from individual cell site is not likely to exceed the -154 dBW/MHz limit. The cumulative interference from the various 2100 MHz cell sites could, however, exceed that limit. Cumulative interference is addressed separately below.
45. The 2300 MHz frequencies were allocated from January 2009. Licences in the 2300 MHz band had to comply with a -10 dBW/MHz AFEL.



Figure 5: 2300MHz cellular base station locations that came into operation before November 2020.

² The emission limit is set at -50dBW . The measurement bandwidth for mobile services in the 2GHz range is 1MHz.

46. There are a number of 2300 MHz cell sites in Invercargill, around 11 km from the Awarua Earth Station. I do not have the cell site details needed to estimate the exact signal levels; however, it is possible that the signal from these cell sites that fall within the 2200 – 2290 MHz range exceed the -154 dBW/MHz limit.
47. These cell sites were operational before November 2020, so Space Ops does not have protection from their emissions.

2.1.1.3 Cumulative interference

48. As set out in the previous section, there is existing interference, and the cumulative effect of that interference could exceed -154 dBW/MHz.
49. The Act provides protection against individual interferers. It does not provide any mechanism to consider cumulative interference.
50. This means that, while no individual interferer may exceed the -154 dBW/MHz limit, if their combined emissions do, there is no protection under the Act.
51. When issuing a licence, the Approved Radio Engineer (ARE) only considers the impact of the new licence on other existing licences. There is no requirement to consider the cumulative impact.
52. Section 25A of the Act outlines what an ARE should consider:

25A Matters relevant to radio engineer's certificate under section 25

A radio engineer issuing a certificate under section 25—

(a) must, before issuing the certificate, have regard to—

- (i) the nature and characteristics of the rights described in the spectrum licence; and
- (ii) the International Radio Regulations; and
- (iii) the ITU-R reports and recommendations; and
- (iv) Annex 10 of the Convention on International Civil Aviation; and
- (v) the International Convention for the Safety of Life at Sea; and
- (vi) the nature of the service proposed to be operated under the spectrum licence; and
- (vii) any relevant reference standards issued by the Secretary; but

(b) must not, in considering whether to issue the certificate, have regard to the reception of radio waves by inappropriate receivers.

53. With existing background interference any new additional interferer increases the chance of exceeding the -154 dBW/MHz threshold. If there are multiple potential interferers, collectively, these could raise the background interference to a point where any further interferer pushes the total above -154 dBW/MHz.
54. The Act will not provide protection against such a scenario.

2.1.2 Interference from non-transmitting devices

55. Non-transmitting devices refer to devices that produce electromagnetic signals as by product. Example of such devices include switched-mode power supplies, inverters, variable-speed motor drives and other power electronics, electrical switchgear, solar generation equipment, wind turbine generators and their associated converters, virtual fencing units, EV chargers, and electrical distribution networks (overhead and underground).
56. In Section 8.2, the application quotes paragraph 15.12 of Article 15 of the ITU-R Radio Regulations to claim protection requiring that the “operation of electrical apparatus or installations of any kind, including power and telecommunication distribution networks, but excluding equipment used for industrial scientific and medical application, does not cause harmful interference to a radiocommunication service”.
57. Article 15 of the Radio Regulations deals with interference and provides guidance to administrations on how interference should be handled. It should be noted that the ITU-R, as an arm of the United Nations, can only provide guidance; it is for sovereign nations such as New Zealand to decide how much of that guidance to adopt.
58. New Zealand gives effect to the Radio Regulations’ guidance on interference in several ways. The primary instruments for electromagnetic interference are the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001, which protect the rights of radiocommunication users and ensure that those users comply with their own obligations.
59. The interference referred to in paragraph 15.12 of Article 15 of the Radio Regulations is addressed in two stages. First through compliance:
 - Radiocommunications (Compliance) Notice³ and
 - Radiocommunications Regulations (Radio Standards) Notice⁴ and
 - Radiocommunications (EMC Standards) Notice⁵
60. These notices do not themselves set numerical emission limits. Instead, they prescribe classes of equipment, assign each class a level of conformity, and point to external

³ <https://gazette.govt.nz/notice/id/2021-go52>

⁴ <https://gazette.govt.nz/notice/id/2025-go4751>

⁵ <https://gazette.govt.nz/notice/id/2019-go2372>

standards, principally the AS/NZS CISPR, IEC and EN series, in which the actual emission and immunity limits are set. The notices are updated regularly.

61. This is a self-certification regime, under which suppliers of equipment complete a Supplier's Declaration of Conformity (SDoC).
62. Manufacturers of the devices covered in the Radiocommunications (Compliance) Notice, Radiocommunications Regulations (Radio Standards) Notice and Radiocommunications (EMC Standards) Notice get these devices tested by accredited laboratories for compliance with relevant standards.
63. Compliance testing is carried out against those referenced standards: a device is shown to meet the limits set in the standard for its class, and the supplier then completes the declaration of conformity on that basis.
64. Importantly, the limits in those standards are generic and type-level. They are set to protect radio services in general at ordinary separation distances, and are not calibrated to an exceptionally sensitive victim receivers such as a satellite earth station receiving at -154 dBW/MHz.
65. Demonstrating compliance therefore shows that a product may lawfully be supplied and used; it does not measure, or guarantee, the level of interference the device contributes at the Awarua receiver. If a compliant device nonetheless causes harmful interference, it is still caught by the general interference provisions of the Act, which apply regardless of whether the equipment is EMC compliant.
66. This is the disconnect at the heart of the submissions concern. The EMC regime answers one question, namely whether equipment may be supplied and used; the interference provisions of the Act answer a different one, namely whether harmful interference is in fact being caused. Passing the first does not dispose of the second. EMC compliance is a defence to a claim that non-conforming equipment has been supplied; it is not a defence to a claim that compliant equipment is causing harmful interference to a radio service.
67. Part 12 of the Act deals with interference, and its underlying assumption is that interference comes primarily from other transmitters. The EMC machinery sits instead in regulation 32 of the Regulations, the relevant parts of which provide:

32 Notification in Gazette

(1) The chief executive may, by notice in the Gazette,—

- (a) prescribe classes of interfering equipment and classes of susceptible equipment:
- (b) prescribe the electromagnetic compatibility standards that apply to classes of interfering equipment and classes of susceptible equipment, being standards that specify the procedures and methods to be used for measuring—

- (i) the radiation produced by the equipment and the limits within which that radiation must be suppressed; and
 - (ii) the susceptibility of the equipment and the limits of susceptibility that must be met:
 - (c) prescribe the codes of practice that apply to classes of interfering equipment and classes of susceptible equipment, being codes of practice that specify requirements for the sale, installation, or use of the equipment:
 - (d) prescribe the levels of conformity that apply to classes of interfering equipment and classes of susceptible equipment, and the requirements to be met for those levels of conformity:
 - (e) prescribe the requirements to be met for labelling the interfering equipment and susceptible equipment:
 - (f) prescribe the form of a declaration of conformity:
 - (g) prescribe the requirements to be met for the security and availability of declarations of conformity and associated documentation:
 - (h) prescribe the documentation, test facilities, and competent persons that are approved by the chief executive in relation to the testing of interfering equipment and susceptible equipment, and any conditions or restrictions imposed in relation to the chief executive's approval:
 - (i) prohibit the installation, use, sale, distribution, manufacture, or importation of specified interfering equipment or susceptible equipment or classes of interfering equipment or susceptible equipment:
 - (j) prescribe the class or classes of interfering equipment and susceptible equipment (being a class or classes specified in the notice) that are exempt from the need to comply with a prescribed standard or required to be the subject of a declaration of conformity:
 - (k) prescribe, for the purposes of regulation 35, minimum field strengths that apply to radiocommunication reception.
- (2) Nothing in these regulations exempts any person from the requirement to transmit radio waves only under, and in conformity with, a radio licence, a general user radio licence, an exemption, or a spectrum licence registered in accordance with Part 3 of the Act.
- (3) Nothing in these regulations applies to the installation, use, or manufacture of interfering equipment or susceptible equipment for the purpose of testing that equipment for compliance with the requirements of these regulations.

68. Two further points follow. First, harmful interference must be demonstrated, not assumed. Second, even where a single compliant device is individually harmless, the cumulative interference point made in the cumulative interference section applies with full force here, because the Act provides no mechanism to address the combined effect of many individually compliant sources.
69. The November 2020 ruling does not address interference, or EMC compatibility, from the devices raised in submissions.
70. This compounds a problem already identified above: the cell sites operating around Awarua predate the November 2020 decision, so Space Ops has no protection against their emissions, and that existing background interference is precisely what makes any additional contribution, compliant or not, more likely to tip the total into harmful interference.
71. Space Ops has not provided any analysis or reasoning as to why any particular device would cause harmful interference, or why such a device should cease to operate. If Space Ops provides that analysis, I will be able to review it and respond.

2.2 Is the information provided in the application accurate and robust?

72. The application's reliance on the RSM ruling and the ITU-R Radio Regulations is, in itself, correct.
73. However, the interpretation of the protection those documents offer is not robust. As a result, the protection sought is significantly greater than the protection actually available.

2.3 Is there anything in the application material that you do not agree with?

74. Yes. As set out in the analysis above, I do not agree with the application's interpretation of the protection available to it. In summary, the application treats the -154 dBW/MHz limit as protecting against any source of electromagnetic emission, whereas it protects only against terrestrial services, and only those that came into operation after the November 2020 decision; it does not account for the existing background interference at the site, or for the fact that the Act does not protect against cumulative interference; and it assumes that the EMC regime resolves the position for the devices raised in submissions, which, for the reasons given above, it does not.
75. Section 2.1 outlines the areas where I do not agree with the material presented in the application.

2.4 Is the -154 dBW/MHz EMI restriction technically justified?

- 76. The -154 dBW/MHz restriction is justified as against terrestrial services. However, it is only from terrestrial services that came into operation after November 2020.
- 77. Further, there is no protection from cumulative interference. That is, if the signal level exceeds -154 dBW/MHz within the 2 km restriction area because of the combined effect of multiple interferers, the Act provides no protection.

2.5 Is a 2 km blanket EMI control area justified/necessary?

- 78. The 2 km restriction is justified, in that it is what is specified in RSM's November 2020 decision. As above, that protection extends only to terrestrial services, and only to those that came into operation after the decision took effect.
- 79. Further, there are limitations in the protection the Act offers, which confine that protection to single interferers rather than cumulative interference.

2.6 In summary

- 80. Blanket protection from electromagnetic transmissions and other electromagnetic sources has been claimed without any justification for the claim.
- 81. No analysis has been provided to show how the November 2020 decision, the Radiocommunications Act, the Radiocommunications Regulations and the various articles of the ITU-R Radio Regulations justify the protection claimed.
- 82. The analysis in this section shows that establishing the level of protection actually available requires further analysis which application has not undertaken.
- 83. Because that analysis has not been provided, there is a limit to how far I can verify the protection claimed.
- 84. As a final note, the purpose of the various Acts and Regulations is to ensure peaceful co-existence. Space Ops does have protection, through the -154 dBW/MHz limit, the general interference provisions of the Act, and the EMC provisions of the Regulations.
- 85. An applicant cannot, however, claim blanket protection without demonstrating that the protection sought is within its rights, and no such demonstration has been provided in the Space Ops application.

3 Is the 3km height plane 'horizon mask' justified/necessary? How sensitive is the ground station to built form in this area?

- 86. Section 5 of the application states:

“ With specific regard to the horizon mask, the restrictive designation would prohibit any objective from penetrating the horizon mask surface unless approval was obtained from the Requiring Authority. The restrictive surface is measured at a 5-degree angle commencing two meters above any point of the boundary of the existing satellite ground station,”

87. The Radiocommunications Act 1989 and the Radiocommunications Regulations 2001 deal with electromagnetic signals; they do not deal with interference or obstruction caused by physical infrastructure.
88. Similarly, the RSM November 2020 decision does not deal with any physical interference or obstruction.
89. No analysis has been provided as to how the envelope described as a “restrictive surface... measured at a 5-degree angle commencing two metres above any point of the boundary of the existing satellite ground station” was derived.
90. Because the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001 do not deal with physical interference or obstruction, this envelope cannot be based on the Act or the Regulations.
91. Nor is the envelope derived from the RSM November 2020 decision.
92. The basis on which the envelope has been derived, if any, therefore needs to be explained before I can assess and review it.
93. If that analysis is provided, I will be able to assess whether physical obstruction is a genuine possibility and whether the proposed envelope is justified.

4 Are the concerns raised in submissions valid?

94. Concerns of interference from
 - industrial, infrastructure and farm technology activities; and
 - virtual fencing, wind farms/solar energy generation, inverters, electrical distribution networks (overhead/underground)are valid.
95. However, it cannot simply be assumed that these devices will cause interference. An analysis is required to establish whether there is actual or potential interference, and no evidence has been provided to substantiate that the above devices will in fact cause interference.
96. Without such evidence or analysis, no concluded view can be provided.
97. As set out in the interference and cumulative interference sections above, there is already background interference at the site from cellular base stations operating below

and above the band, all of which predates the November 2020 decision and none of which Space Ops is protected against.

98. Against that background, any additional interference from the devices raised in submissions, even where each device is individually compliant and individually harmless, could push the total into harmful interference territory.
99. Even then, the Act or the Regulation may not provide protection, because it does not deal effectively with cumulative interference.

5 Are there any potential alternatives that the applicant hasn't considered or addressed?

100. I was asked to comment on:
 - Can interference be managed in less restrictive ways? Eg equipment standards
 - Is shielding / filtering at the ground station site an option that could be considered?
101. On the first point, managing interference through equipment standards is, in principle, a less restrictive approach than a blanket prohibition, and the EMC regime already requires the relevant classes of equipment to meet those standards.
102. However, as set out in the interference from non-transmitting devices section above, compliance with the generic standards does not guarantee that a device will not contribute interference at a receiver as sensitive as this one. Equipment standards therefore reduce, but do not eliminate, the issue, and they are not by themselves a complete substitute for the protection the application seeks.
103. A review of the Space Ops licence at Awarua shows an antenna height of 3 metres above ground level. I am not sure whether there is room to increase the elevation which could provide greater clearance from the potential neighbouring structures.
104. No other information about the ground station has been provided, such as its minimum operating elevation angle. Without this information, I am not able to establish whether the receive dishes or antennae are obstructed.
105. In any event, what the application has not considered is that there is existing interference against which the Space Ops operation has no protection.
106. As already established, out-of-band and spurious emissions from the surrounding cell sites fall within the 2 km area and create background interference against which Space Ops has no protection. It is this existing exposure, rather than any single new source, that creates the risk.
107. The Space Ops material does not appear to recognise this, and instead appears to rely on a complete shutdown of emissions within the 2 km area as its means of protection. As a result, Space Ops does not appear to have considered any mitigation solutions.

108. Because that background interference leaves Space Ops exposed to further interference it would not otherwise be vulnerable to, the more robust response is to reduce that exposure at the receiver.
109. Space Ops should therefore consider mitigation solutions for its own protection.

6 Are there any conditions that you would recommend be placed on the designation, if granted by the hearing panel?

110. The information provided is not sufficient for me to recommend any conditions. There are significant gaps in the material provided, and until those gaps are addressed, I am not able to answer this question.
111. I have not commented in detail on the submissions, as they largely deal with the physical restrictions arising from the horizon mask rather than electromagnetic interference. Until the basis for the horizon mask is explained (Section 3), I am not able to comment on them.

Appendix A: Space Ops receive licenses at Awarua

112. Space Ops licenses details are listed in Table 2.

Table 2: Space Ops licenses in Awarua.

Licence Category	Licence classification	Spectrum Low	Spectrum High	Tx Location name	Rx Location name
Satellite / Satellite (G1)	Transmit with Receive Protection	2274.1	2277.7	ODYSSEY CUBESAT (NGSO)	AWARUA EARTH STATION
Satellite / Satellite - Satellite Transmit (GM)	Transmit with Receive Protection	2280	2285	M6P (NGSO)	AWARUA EARTH STATION
Satellite / Satellite - Satellite Transmit (GM)	Transmit with Receive Protection	2263.65	2266.2	F-SAT-NG-12 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2240	2244	USASAT-30G (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2252	2256	USASAT-30G (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Transmit with Receive Protection	2258	2262	USASAT-30G (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2238	2246	BRONET (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2257	2264	BRONET (NGSO)	AWARUA EARTH STATION
Space Operations / Spacecraft / Space operations spacecraft (GS)	Transmit with Receive Protection	2264.7	2265.3	ELECTRONN Z-4 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2204.32	2207.7	HYTI (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2225.3	2235.3	EOS AGRISAT-1 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2251	2253	GHGSAT-CX (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2260.5	2266.5	USASAT-300 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)		2253.15	2254.9	QPS-SAR(NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2224.2	2225.8	AEROCUBE-16 (NGSO) Satellite	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2257.95	2262.1	Milspace2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2204.5	2208.5	Milspace2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2287	2289.5	F-SAT-NG-12 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2214.05	2219.2	Urdaneta (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2244	2246	SL-OMV-1 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2201.68	2202.3	SATLNET-02 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2224.2	2225.8	Moonlighter (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2270	2275	WINNEBAGO 1 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2259.75	2262.3	TYVAK-1015 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2270.92	2271.1	TYVAK-1015 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2248.77	2249.2	GLOBAL-GEN-3 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2257.77	2258.2	GLOBAL-GEN-3 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2241.5	2242.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2241.5	2244.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.5	2244.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.5	2246.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.5	2248.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245	2250	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.5	2248.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2281.5	2282.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2280	2285	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2281.5	2284.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2283.5	2284.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2283.5	2286.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2285.5	2286.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2285.5	2288.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2287.5	2288.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.5	2246.5	USASAT-30L-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2224.75	2225.3	MICRONSA T-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2234.75	2235.3	MICRONSA T-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2244.75	2245.3	MICRONSA T-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2254.75	2255.3	MICRONSA T-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2264.75	2265.3	MICRONSA T-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2274.75	2275.3	MICRONSA T-2 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2210	2216	ROSE (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2220	2226	SPIP (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2218	2224	CASTORS-SENIORS (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2250	2256	CASTORS-SENIORS (NGSO)	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2280	2286	CASTORS- SENIORS (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2248.6	2251.4	TYVAK- 0262 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2273.6	2276.4	TYVAK- 0262 (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2233.5	2235.5	MethaneSA T-1	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2223.2	2228.2	USPWSA- T1TL	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2211.47	2214.3	PTD	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2233	2237	TYVAK- 213B	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2253	2257	TYVAK- 213B	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2273	2277	TYVAK- 213B	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2286.5	2289	F-SAT-NG- 12	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2277.17	2277.4	STRIX	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2256.38	2258.6	York Bane	Awarua Earth Station - Atlas Space
Satellite / Satellite (G1)	Receive	2216.95	2217	ORASAT	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2272.95	2273	ORASAT	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2268.25	2271.3	LESSONIA	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2270	2275	WINNEBAG O 2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2262	2265	BAYANAT	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245	2250	USMIG	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2262	2265	LESSONIA	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2200	2201	MINAS (NGSO)	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2200	2201	LEMUR-2-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2200	2201	COLUGO	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2253.5	2254.5	USASAT- 30P	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2215	2219	RROCI-2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2240.75	2243.3	TYVAK-1005	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2225.47	2225.9	USPWSA-T1TL	Awarua Earth Station_Atlas
Satellite / Satellite (G1)	Receive	2237.7	2238.3	FIREFLY	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2242.7	2243.3	FIREFLY	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.7	2248.3	FIREFLY	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245	2250	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2250.6	2255.6	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2280	2285	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2241.5	2244.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.5	2246.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.5	2248.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2281.5	2284.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2283.5	2286.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2285.5	2288.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2241.5	2242.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.5	2244.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.5	2246.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.5	2248.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2281.5	2282.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2283.5	2284.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2285.5	2286.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2287.5	2288.5	USASAT-30L-4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2274.8	2279.8	USASAT-30L-4	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2227.82	2232.2	HAVEN-DEMO	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2237.82	2242.2	HAVEN-DEMO	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.29	2245.4	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.29	2247.4	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2249.29	2249.4	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2251.29	2251.4	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.87	2244.8	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.87	2248.8	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2249.87	2250.8	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2252.87	2253.8	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2254.87	2255.8	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2250.6	2255.6	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2274.8	2279.8	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2285	2290	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.77	2246.7	USASAT-30L-5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2282	2283	MX.2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2254.87	2255.8	USPWSA-NEXT	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.29	2245.4	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.29	2247.4	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2249.29	2249.4	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2251.29	2251.4	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2253.29	2253.4	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2255.29	2255.4	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.87	2244.8	USASAT-30L-3	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2245.77	2246.7	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.87	2248.8	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2249.87	2250.8	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2252.87	2253.8	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2254.87	2255.8	USASAT-30L-3	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2230.15	2230.7	GUHUZA-1A	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2255.24	2259.8	PEXT DEMO	Awarua Earth Station_Atlas
Satellite / Satellite (G1)	Receive	2200	2202.5	USASAT-30V	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2239.74	2240.3	AAC-CYCLOPS	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2208.1	2212.1	JAMES	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2233	2237	JAMES	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2273	2277	JAMES	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2222.45	2227.6	SATLNET-03	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2252.3	2253.7	FGN-100-D1	Awarua Earth Station_Atlas
Satellite / Satellite (G1)	Receive	2279.3	2280.7	FGN-100-D1	Awarua Earth Station_Atlas
Satellite / Satellite (G1)	Receive	2220	2222	CHIMERA_GEO_2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2239	2241	CHIMERA_GEO_2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2263	2265	CHIMERA_GEO_2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2261.5	2263.5	ASIOT_NBI OT22	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2227	2233	FOSSASAT-2E	Awarua Earth Station_Fossa
Satellite / Satellite (G1)	Receive	2257	2263	FOSSASAT-2E	Awarua Earth Station_Fossa
Satellite / Satellite (G1)	Receive	2260.04	2265	Otter SDM	Awarua Earth Station_Fossa
Satellite / Satellite (G1)	Receive	2245.29	2245.4	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.29	2247.4	USASAT-30L-6	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2249.29	2249.4	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2251.29	2251.4	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2253.29	2253.4	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2255.29	2255.4	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2243.87	2244.8	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2245.77	2246.7	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2247.87	2248.8	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2249.87	2250.8	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2252.87	2253.8	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2254.87	2255.8	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2228	2232	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2251.1	2255.1	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2275.3	2279.3	USASAT-30L-6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2252.18	2252.3	USASAT-30P	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2273	2279	ICEYE_GREEN	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2277.05	2277.6	STRIX2	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2244.75	2245.3	USASAT-NGSO-20	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2216.31	2216.4	HELLENIC FIRE SATELLITE SYSTEM	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2216.61	2216.7	HELLENIC FIRE SATELLITE SYSTEM	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2216.91	2217	HELLENIC FIRE SATELLITE SYSTEM	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2217.21	2217.3	HELLENIC FIRE SATELLITE SYSTEM	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2244.98	2245	GEMS02-AMETHYST	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2232.73	2233.3	USASAT-30Y	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2242.73	2243.3	USASAT-30Y	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2252.73	2253.3	USASAT-30Y	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2244.76	2245.2	GEMS02-AMETHYST	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2221	2223	GRAVITAS	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2284.06	2285.9	Ratatosk-1A	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2283.75	2286.3	Ratatosk-1A	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2270	2275	WINNEBAG O4	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2270	2275	WINNEBAG O5	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2270	2275	WINNEBAG O6	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2223.72	2224.2	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2224.72	2225.2	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2225.47	2225.9	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2225.72	2226.2	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2225.97	2226.4	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2227.22	2227.7	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2227.72	2228.2	USPWSA-T1TRK	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2273	2279	CA-01	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2260.5	2266.5	CA-01	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2266.75	2272.8	CA-01	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2263.63	2269.6	CA-01	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2269.88	2275.9	CA-01	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2265.5	2269.5	Mikroglob	AWARUA EARTH STATION

Satellite / Satellite (G1)	Receive	2270	2274	Mikroglob	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2274.5	2278.5	Mikroglob	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2279	2283	Mikroglob	AWARUA EARTH STATION
Satellite / Satellite (G1)	Receive	2283.5	2287.5	Mikroglob	AWARUA EARTH STATION