Before the Hearings Commissioner appointed by the Invercargill City Council

Under	the Resource Management Act 1991 (**Act**)
And	
In the Matter of	a notice of requirement for a designation under Section 168 of the Act to place a restriction on built form and electromagnetic interference around the Awarua Satellite Ground Station

Statement of Evidence of **Craig Ian Morley** for Stewart Family Assets Limited (Engineering and EMI)

Dated: 21 September 2026

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INTRODUCTION

Qualifications and Experience

1. My full name is Craig Ian Morley. I am a specialist in Electromagnetic Compatibility (**EMC**) and Radio Frequency Interference (**RFI**).

2. I hold two New Zealand certificates in Engineering (**NZCE**) from Central Institute of Technology (**CIT**) - NZCE – Telecommunications, and NZCE– Electronics & Computer Technology. I also attended Massey University for a Bachelor of Engineering, BE (Electronics and Computer Engineering) and a Bachelor of Science (Mathematics).

3. I am a self-employed engineering consultant with particular expertise in EMC. I have advised on EMC solutions and issues across a large number of sectors and product types including utility scale solar farms, Megawatt electric ferries, video and touch screen displays, aviation, marine, food preparation, electric vehicles, energy generation and control, lighting, variable speed drives and softstarters. I have been self-employed as an Electronics and EMC Consultant since June 2006. Prior to that, I worked across a number of engineering roles in the public and private sector, including:

    (a) Avionics Technician/Engineer in the Royal New Zealand Air Force from 1981 to 1990. My main role was in ground and Tactical communications which included operating, managing and servicing HF, VHF, UHF, satellite systems and antenna. This provided an extensive RF Engineering background.

    (b) From 1993 to 1999 I was employed with Ericsson Communications Ltd in a number of roles including Production Engineer, Product Engineer, Support Test Engineer R&D Design Engineer and EMC Specialist. My main roles were the design and development of high efficiency, resonant, synchronous and zero voltage switching power supplies and EMC design/testing/compliance for all products.

    (c) From November 1999 to June 2006 as a Design Engineer, Project Manager and EMC Specialist at PDL Electronics Ltd (Schneider Electric) in the Power electronics R&D lab. Products included Variable speed drives, softstarters, dynamic brakes and filtering systems. My main role was EMC design/testing/compliance for all products.

Code of Conduct for Expert Witnesses

4. Although this is not an Environment Court hearing I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023. This evidence is within my area of expertise, except where I state that I am relying on material produced by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

5. The topics covered in my evidence are as follows

   (a) executive summary;

   (b) the existing regulatory environment;

   (c) effects of the Electromagnetic Interference (**EMI**) Limitation Area;

   (d) effects of the Horizon Mask;

   (e) response to Council reports; and

   (f) response to Space Operations New Zealand's (**Space Ops**) evidence.

6. I have read the Notice of Requirement application, Section 42A Report prepared by Invercargill City Council (**ICC**) and all accompanying reports. I have read Space Ops' evidence. I have read all other evidence prepared for Stewart Family Assets Limited (**SFAL**). I explain in my evidence where I refer to or rely on that assessment or evidence for the purposes of my evidence.

EXECUTIVE SUMMARY

7. I consider that the proposed 2km EMI limitation area and associated emission limits are arbitrary, unnecessary and duplicative. Radio frequency spectrum management is already comprehensively governed nationally by RSM under the Radiocommunications Act 1989 and Radiocommunications Regulations 2001. Regulating radio frequency (**RF**) interference sits entirely outside the resource management framework and is not the responsibility of Space Ops or the Invercargill City Council (**ICC**).

8. Standard electrical equipment or commercial operations which may generate electromagnetic interference on SFAL land act as unintentional radiators and do not pose a risk to Space Ops' receivers. Intentional transmitters operating in the

sensitive 2200MHz to 2290MHz S-band require RSM licenses, which would not be granted in close proximity to Space Ops receiving stations.

9. The proposed EMI restrictions target intentional radiators operating in the S-band 2200MHz to 2290MHz. Commercial/industrial facilities on South Port / SFAL land will primarily house unintentional radiators (e.g., personal computers, switching power supplies, LED drivers, solar panels), which are not designed to transmit RF wirelessly.

10. The 2km boundary is flawed. The associated 2km restriction is arbitrary and ineffective; ITU Radio Regulations Appendix 7 (and RSM's November 2020 Re-planning document) recognize a 100km coordination area and define this area as "*the area surrounding an earth station sharing the same frequency band with terrestrial stations, or surrounding a transmitting earth station sharing the same bidirectionally allocated frequency band with receiving earth stations, beyond which the level of permissible interference will not be exceeded and coordination is therefore not required*". There is no 2km zone in the ITU Radio regulations. Such a zone would be trivial and ineffective compared to a 100km coordination area. Potential emitters outside the proposed 2km zone (such as the Invercargill CBD, airport, Tiwai Point smelter, and South Port) present a far higher risk because operators there may be unaware of frequency restrictions.

11. Generating actual harmful interference requires multiple narrow conditions to occur concurrently: emissions must fall within the 2200-2290MHz bandwidth, intersect the very narrow beam width of the receiving antenna, and occur precisely during satellite acquisition. Furthermore, potential interference sources outside the 2km radius (such as Invercargill CBD, airport or industrial smelters) present a statistically higher risk than compliant operators.

12. There are flaws in the proposed horizon mask and obstruction controls. A blanket 3km or uniform horizon mask is overly conservative. Signal degradation depends heavily on physical variables, including weather, path attenuation and Fresnel zone effects. Wind turbine blades constructed of non-metallic composite materials (like fiberglass) are largely transparent to radio waves, meaning the effective physical obstruction height is dictated mainly by the steel tower rather than the total tip height.

13. Protection should rely on existing statutory RSM frameworks for frequency management, while structural and horizon mask penetrations must be independently evaluated on a rigorous, **case-by-case basis**. I consider this case-by-case process should apply as obstructions through the horizon mask do not necessarily result in harmful interference to Space Ops' operations. These decisions should not be made totally in Space Ops' hands and I consider the onus should not

be on SFAL to demonstrate whether or not the obstruction interferes with Space Ops' operations.

EXISTING REGULATORY ENVIRONMENT

14. Radio Spectrum Management (**RSM**) is the regulatory authority who are responsible for managing the complaints process and this sits outside of the resource management framework. The primary role of RSM is to efficiently allocate, regulate, and manage New Zealand's radio frequency spectrum to prevent interference and support wireless communication. They operate as a business unit within the Ministry for Business, Innovation and Employment (**MBIE**). It is not the role of Space Ops or Invercargill City Council to regulate radio frequency (**RF**) interference.

15. RSM are responsible for allocating rights for the use of the spectrum, enforcing compliance with licensing requirements and administering the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001.

Core Regulatory Functions of RSM

16. The following are the core regulatory functions of RSM which, from what I understand, are not managed by the Resource Management Act 1991 framework:

    (a) Spectrum Allocation: RSM assigns rights and issues radio licenses for public and private wireless use.

    (b) Compliance Enforcement: The unit monitors the airwaves and ensures users follow licensing and technical standards.

    (c) Interference Resolution: RSM investigates and resolves complaints about radio frequency interference that disrupt essential services.

    (d) Register Administration: RSM maintains the public Register of Radio Frequencies (**RRF**) to track active licenses and management rights.

    (e) Policy Advice: The agency advises the government on future spectrum needs, international treaties, and technology trends

EMI LIMITATION AREA

17. I consider that the 2km EMI Limitation Area with the emissions limit of -154dBw/MHz is arbitrary and unnecessary for the following reasons:

(a) electronic equipment on SFAL land would not pose a risk to Space Ops' receivers because the electronic equipment would not be an Intentional Radiator which are regulated by RSM;

(b) even if SFAL were to install Intentional Radiators, the probability of SFAL generating any harmful emissions would be low;

(c) despite the low probability of harmful emissions, Intentional Radiators could generate harmful emissions from outside of the 2km radius; and

(d) should Space Ops receive harmful interference, there may be an incorrect presumption that this originates from SFAL property when it's more likely to originate outside of the proposed 2km area.

18. I have described my rationale for the above reasons in the paragraphs below.

Intentional versus Unintentional Radiators

19. The proposed EMI limitation area only applies to Intentional Radiators.

Intentional Radiators

20. Intentional Radiators are devices designed to deliberately generate and emit radio frequency energy via radiation or induction for wireless communication. They act as radio transmitters, sending data or control signals through the air.

(a) Examples: Point to point communications links, satellite to Earth station links, Wi-Fi routers, Bluetooth devices, smartphones, aircraft and airport Radar, amateur radio, remote control toys and models.

Unintentional Radiators

21. Unintentional Radiators are devices that generate electrical signals for internal use or transmit them via cables, but are not designed to emit radio frequency energy wirelessly. RF energy is a by-product of internal digital, microprocessor, clocks or switching actions.

(a) Examples: Personal computers, TV's, switching power supplies, LED drivers, solar panels and power conversion, variable speed drives.

22. The proposed EMI restriction only applies to Intentional Radiators operating in the S-band 2200MHz to 2290MHz. RSM allocate user licenses for this band and it is their responsibility to ensure this frequency band is managed properly to minimise potential interference. SFAL do not hold licenses, nor do they intend to operate any Intentional Radiators in the 2200MHz to 2290MHz band, nor would they be granted

licenses by RSM to operate in this frequency range given the proximity to Space Ops' receiving stations. SFAL or their future occupiers or tenants would likely not be undertaking any harmful intentional terrestrial services, given they are now aware of RSM's licensing requirements

23. Electrical and electronic equipment intended for use on SFAL land would not be intentional radiators and would not pose a risk to Space Ops' receivers. The only exception is when specific UHF communications link equipment operating in the 2200MHz to 2290MHz S-band are included with unintentional radiators for monitoring/control. This should not occur as RSM regulates the user licenses for such equipment and where such links operate.

24. An intentional radiator that may be used with wind turbines on SFAL property is SCADA. These communications can operate in many dedicated frequency bands however it does not operate in the 2200MHz to 2290MHz band and so would fall outside of Space Ops' proposed conditions. There is therefore no risk to Space Ops.

Probability of SFAL generating harmful emissions is low

25. The probability of harmful EMI interference to Space Ops' satellite receivers is very low. In order to generate any such interference to Space Ops' satellite receivers, the emissions would have to be within the allocated 2200MHz to 2290MHz bandwidth, the interference source(s) would have to fall in the very narrow beam width of the receiving antenna(s), and the interference would have to occur during the short time the satellite is in acquisition range. These conditions must all occur concurrently to pose any interference risk.

Harmful emissions could be generated outside of 2km radius

26. The 2km protection zone seems to be arbitrary with no rationale provided for this specific distance. I am unfamiliar of any. It probably seemed a good round figure to use at the time. The ITU-R Radio Regulations do not specify fixed, universal geographical protection zones.

27. Regardless of a 2km protection zone, the reality is that harmful interference can originate from anywhere outside of this zone which includes the coastal marine area, all public conservation land, Invercargill Airport, the CBD and anywhere else.

28. RSM's November 2020 Re-planning document[1] refers to Radio Regulations Appendix 7 and the requirement for a 100km coordination distance and that interference analysis is undertaken for any new applications deployed within it. The

[1] 1c.NOR Application - Appendix 2_RSM Decision.pdf.

RSM document, section 3.3.2 includes a section on “Earth station receive-protection zone” where it is stated approved persons must undertake an interference analysis for any new applications deployed within 100km of the protection zone. This is based on the minimum coordination distance calculation from the International Radio Regulations, Appendix 7. Clearly ITU RR recognises that harmful interference is applicable to sources up to 100km distant. The 2km protection zone proposal is so insurmountably small that it does not address real interference risk.

29. The reality is that SFAL and future occupiers of the Industrial 4 Zone will now be aware of the restrictions of the 2200MHz to 2290MHz frequency band and present minimal risk, whereas other operators within a 100km radius present greatest risk of harmful interference as they would be unaware of these restrictions.

30. The recommended -154dBW limit in the proposed conditions for the Notice of Requirement equates to -124dBm. This is the level when measured at the Space Ops’ receivers – not at the emitting source. Considering the free space path loss of potential intentional radiators in the region, the actual RF power that would be required to create harmful interference at this level is very low. For these potential sources:

Invercargill CBD: 13km= 600uW (0.0006 of a watt)

Invercargill Airport: 13.7km= 660uW

Tiwai Point smelter: 6.7km distance= 158uW

South port: 7.8km distance= 214uW

31. A common 1000W microwave oven operating as an isotropic radiator would need to be at a distance of 16838 km away for it not to exceed the -124dBm interference level at the Space Ops receivers.

32. The proposed -154dBW limit by Space Ops appears to originate from the RSM document “*Re-planning the 1710–2300 MHz Band – Decisions*” dated November 2020 which is derived from ITU Radio Regulation 2020 Appendix 7 Table 8b “*Parameters required for the determination of coordination distance for a receiving earth station*”.

33. Table 8b parameters are calculated using equation (127) within Appendix 7. This equation requires the thermal noise temperature of the applicable receiving system which is not actually known. A generic value is provided however the critical factors used in the calculation are not stated.

34. The “noise temperature” is affected by factors such as whether or not the receiver front end is cryogenically cooled or is at ambient temperature. The specification of

the AWA4 antenna on the Space Ops site states a receiver G/T of 13.5 dB/K which is quite low and not typical for a large cryogenically cooled antenna system I cannot confirm the limit as correct.

35. This could be a significant factor in determining if the -154dBW is appropriate for the Space Ops interference limit. If the ITU calculations assume cryogenically cooled receiver front ends then the Space Ops receiver noise will exceed the limit as they operate at ambient temperature and the thermal noise will be higher. This means Space Ops will not be able to detect the source of any other emissions over the low noise limit of -154dBW as their own equipment generates more than the limit.

36. Overall, I consider that the 2km EMI Limitation is arbitrary and unnecessary as:

    (a) electronic equipment on SFAL land is unlikely to pose a risk to Space Ops' receivers due to it not being an Intentional Radiator which is already governed by RSM;

    (b) even if occupiers of the SFAL land were to operator Intentional Radiators, there are very specific concurrent conditions which would have to be place before the emissions could be considered harmful and all factors being in place at once are unlikely; and

    (c) other Intentional Radiators could generate harmful emissions from outside of the 2km radius and so this 2km radius is ineffective. It does not actually protect the efficient operation of the ground station, which is the entire objective of NOR limitation.

EFFECTS OF THE HORIZON MASK

37. To understand how the Horizon Mask affects satellite signal reception, the operation of the satellite to ground station must be considered. This is explained in some detail in paragraph [189] of the Section 42A report, 31 August 2026. The actual start position of the satellite on the horizon varies is predicted by computer software using Kepler elements which also provide orbital tracking data to the antenna(s). Just before the satellite appears on the horizon, the receiving antenna(s) are aimed at where the satellite should appear and then align/track the satellite orbit until it falls below the exit horizon. Even if the satellite signal is absent, the antenna still points and listens to where the satellite should be. If there is signal loss (because of horizon masking) this does not mean the entire communications are lost. It means some acquisition time could be lost.

38. When a satellite appears on the horizon it is at its greatest distance from the terrestrial receiver. For a 600km orbit height this distance is 2832km. The

communications signal is at its weakest and most vulnerable at this point and can be affected by:

(a) objects in the signal path;

(b) electromagnetic interference;

(c) atmospheric fade – rain, snow, dust, cloud, humidity;

(d) natural interference – electrical storms, sunspot and cosmic activity;

(e) other satellites in the spatial area;

(f) fixed and rotary wing aircraft; and

(g) Airport Surveillance Radar (**ASR**).

39. Heavy rain is normally not a problem for short range RF links however at these long distances it becomes a significant factor. Heavy rain attenuates the signal by about 0.03 to 0.05 dB per kilometre. A 1 to 2dB signal loss is tolerable which equates to about 40kms of rain in the signal path.

40. At 5 degrees elevation the slant distance is 2329km and at 10 degrees elevation the slant distance is 1932km. These higher capture elevations create shorter and higher quality signal paths that are also far less susceptible to harmful EMI. However, they result in shorter acquisition times.

41. While lower antenna elevations provide longer communications acquisition times, the signal is lower quality and more susceptible to atmospheric disturbances and weather fade effects (e.g.rain). This is beyond Space Ops' control. There are many existing factors that can limit Space Ops' communications activities and these would likely dominate any possible factors introduced by SFAL or activities on their industrially-zoned land.

42. Space Ops have proposed an elevation mask of 5° with a preference for lower elevations. However, this is not possible as their own facility already presents obstructions close to the 5° horizon mask. This existing "horizon pollution Manhattan" is presented in Robin McNeill's evidence as figure 8, copied below

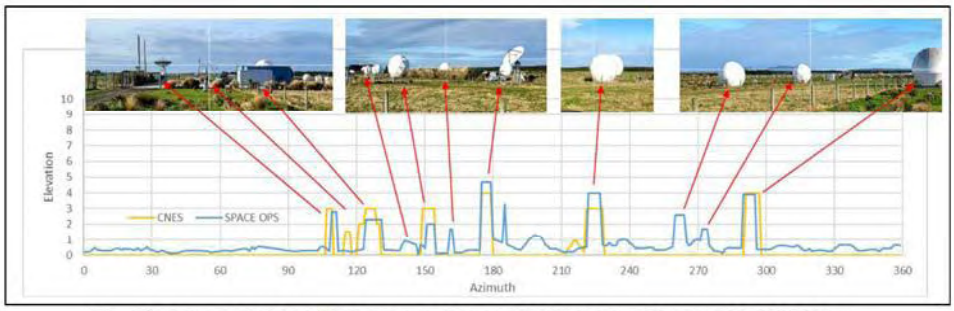


Figure 8. Horizon Mask for AWA-4 antenna at Awarua Satellite Ground Station (after CNES New Zealand Site Survey DTS/SDS/AS-2025.0006045 section 4.1.9).

43. Between 105° and 300° azimuth there are existing obstructions ranging from 4° to 8° wide originating from the Space Ops site. The proposed SFAL turbine towers 3, 4, 5 and 6, present comparatively far lesser potential obstruction widths of 0.21°. 0.22°, 0.31° and 0.35° respectfully. Space Ops' immediate horizon area will be further degraded by their own planned buildings and new antenna at the eastern boundary of the site.

44. The proposed 3km Horizon Mask in my opinion is excessive and has been determined by rather simplistic rationale. The use of a simple height variable to determine effects on the signal is flawed. The two main reasons for radio signal degradation are from path attenuation and phasing (Fresnel) effects.

45. Path attenuation is where the signal becomes partially obscured or absorbed by objects directly in the radio beam. These can be rain, snow, birds, aircraft, trees on hills/mountains etc. The amount of effect (attenuation) is dependent on how much of the path is obscured and/or how much of the beam area is obscured.

46. Fresnel effects are the result of multiple path signals with different phasing converging on a common point to either additively increase the signal or subtractively reduce the signal. The effect is greatly influenced by large reflective objects near, and parallel to what are referred to as Fresnel Zones. Each Fresnel zone is a large volume ellipsoid with foci at the transmitter and receiver which when viewed at any distance forms circular cross sections. There are multiple Fresnel zones with odd number zones containing predominately in-phase signals and even order zones containing predominantly out of phase signals. Nearby reflective surfaces determine if signals reflecting from odd-numbered zones (like the 1st zone) or even-numbered zones arrive at different phase delays (0 to 180 degrees or 180 to 360 degrees), leading to either signal enhancement (constructive) or severe fading and cancellation (destructive interference). The rule of thumb is that the primary Fresnel Zone should ideally be 80% clear of obstacles, but must be at least 60% clear. An important characteristic of Fresnel zone interference is that it can be used to <u>increase</u> signal quality and level – it is not always detrimental. A diagram

showing an example of Fresnel Zones is shown below.

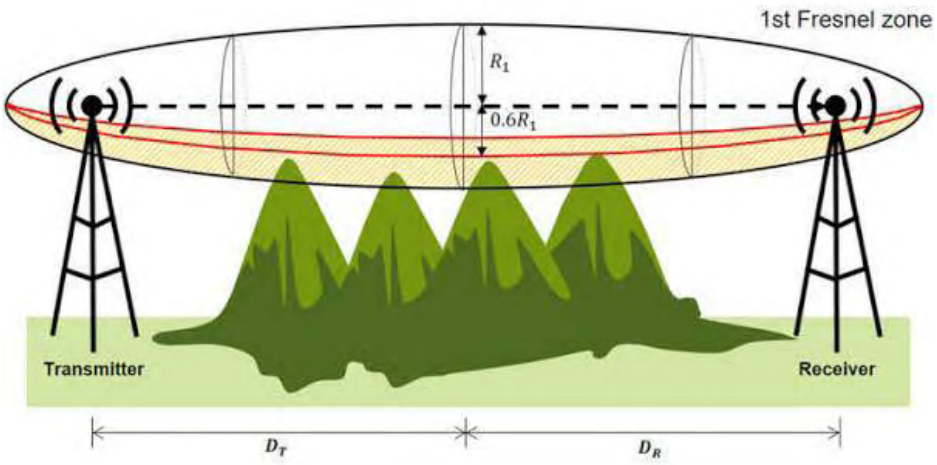


Figure 1 – Fresnel zone

47. While narrow beam signals are technically subject to the laws of Fresnel zones, their high operating frequencies make the required clearance zone so thin that absolute line-of-sight blockage (like a tree leaf or a bird) is a much bigger concern than traditional Fresnel zone encroachment. Earth reflection is one of the primary problems concerning the Fresnel zone and radio signals. The AWA4l S-band antenna dish has a half-power (-3 dB) beam-width[2] of 2.7 degrees. At 100m distance from the receiving antenna, there would be a circular beam with a diameter of around 2.37m while at 1km the circular beam diameter would be around 24m. This is around the size of a basketball court and this area would have to be significantly obstructed to impair any signal.

48. It is the area of an obstructing object relative to the circular beam area at a distance that determines how a signal will be affected. For a signal loss of 1db this equates to a 20% loss of signal and a 2dB loss equates to 40% loss of signal. The loss of signal is proportional to how much of the signal is obstructed. A 2dB is tolerable which could result from a 40% obstruction in the signal path. At 1km from the receiving antenna, the total -3dB beam area is approximately 443m^2 and a 40% maximum obstruction area of 177m^2 (a 13m x 13m square) would be permissible without a significant degradation of signal.

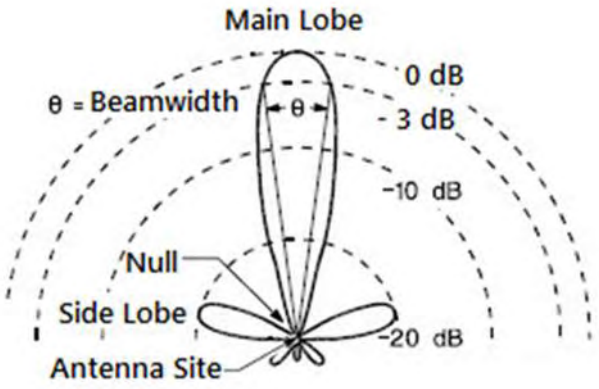


Figure 2 – definition of beam width

49. SFAL are proposing the installation of wind turbines in the 3km Horizon Mask zone. These turbines have a 119m hub height with a 162m rotor diameter giving a total maximum height of 200m. The actual base and hub tower diameters are unknown but can be approximated as 6m and 4m respectively. The rotors (turbine blades) are typically constructed of carbon fibre, fibre glass or other non-metallic composite materials. Typical blade construction is shown in Figure 3

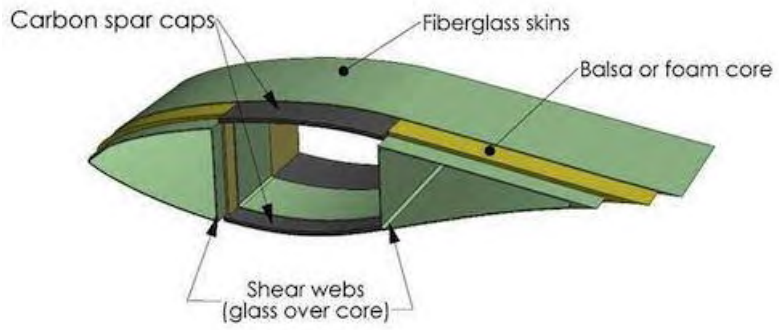


Figure 3. Typical blade construction

50. Fiberglass, composite polymers and pultrusion materials are transparent to radio waves. Glass fibre reinforced polymer (GFRP) is the primary material used for the majority of wind turbine blades worldwide due to lower costs. Carbon fibre is stronger but blocks radio signals. It is also significantly more expensive (10 to 15 times) than GFRP materials. Very large blades will usually include some carbon fibre in their spar cap design (the main structural beams). The more carbon fibre a blade contains, the more it can affect radio signals. Even so, these blades represent only a small blocking area compared to the signal beam area. The main tower will be constructed of steel which will affect RF signals. In the case of GFRP blades, the potential RF obstructing height is therefore 120m, not 200m. This is a significant factor that has been overlooked in analysis and discussion to date.

51. Literature and analysis of the effects of rotating turbine blades on RF signal paths is scarce. There is potential for part carbon fibre or metallic blades to absorb or reflect radio waves causing flicker and amplitude effects. With increasing wind turbine installations, more real world data should become available. There are many factors to consider such as the blade construction materials.

52. The most common method of "encoding" information into a RF signal (modulation) is Binary Phase Shift Keying (BPSK). It is exceptionally robust and is frequently used for critical telemetry, deep-space probes, command links, and GPS satellite broadcasts. Its high immunity to amplitude-based noise is because it encodes data in the wave's phase angles rather than its level or strength. Cyclic RF fading effects which could result from turbine blade attenuation of a radio signal, should have minimal effect on BPSK communications signal.

53. Considering antenna beam area and the tower blocking area, the distance at which 20% blocking will occur is at 1150m and 40% blocking occurs at 670m distance.[3] My calculations on this are at **Appendix 1**. This analysis considers the antenna beam as a circle formed using equal half power points. The circle is not a hard limit and the RF signal exists outside of it but at reduced levels. Even with 100% of the circular area obstructed, there will still be a partial visible signal.

54. Given the distance for a tower to obstruct the signal beam by 40% is 670m, only the currently proposed "Turbine 7" is at risk of significantly affecting a satellite signal. All other turbines in the current SFAL wind farm application pose minimal risk to Space Ops. In critical operations such as Space Ops', it is usual to have built in redundancy in case of equipment malfunction or loss of signal due to obstructions. Having at least two antenna acquiring a satellite signal at the same time ensures this. The outcome is that although Turbine 7 may block one antenna signal, it won't block both. Its position becomes non-critical to signal reception.

55. Buildings and other high, wide, solid structures present higher risk as their signal blocking areas are more significant. Buildings that have significant glassed areas (front and rear if sighted from antenna) become more transparent to radio beams. For any structure the signal blocking risk needs to be assessed on a case by case basis.

56. It should be noted that the effects of obstructions and structures in RF signal paths can be more accurately analysed using field analysis software.

57. Overall, I consider that the proposed Horizon Mask is a significant overreach given that the level of effect within a radio beam is very specific to the characteristics to

[3] Appendix 1, "Comparison of tower obstruction area to beam area"

the building or structure in question and as demonstrated by my analysis above, there may be many circumstances where a building or structure will not affect the reasonable operation of Space Ops' activities.

RESPONSE TO COUNCIL REPORTS

ICC Peer Review Report

58. In regard to the ICC's Peer Review by ANS Consulting dated June 2026, I disagree that the 2km EMI protection area is justified. The RSM November 2020 Re-planning document does define a 2km protection zone but this is a RSM decision, based on submissions and contains no information on its rationale or how it was derived. The 2km distance is not a justifiable or defendable barrier. There are significantly more potentially harmful emitters that can exist outside the 2km zone and, in my opinion, the 2km is arbitrary.

ICC Section 42A Recommendation Report, 31 August

59. I agree with paragraph 70 that protection already exists largely through Radio Spectrum Management (**RSM**) controls. The level of awareness among New Zealand suppliers and installers regarding RSM requirements for intentional radiators (wireless transmitting and radio products) varies significantly by industry sector, though overall regulatory compliance has been heavily reinforced by the government. While specialized telecommunications suppliers are highly knowledgeable, there are noticeable gaps in awareness among general importers, smart-device suppliers, and third-party installers.

60. Professional radio, maritime, and telecommunications suppliers generally maintain an excellent understanding of RSM rules. Because their core business operates around the Radiocommunications Act 1989, they are highly attuned to licensing fees, frequency allocations, and product declarations. A major vulnerability occurs when installer's source cheaper, unbranded wireless gear or smart switches directly from overseas online marketplaces. Many do not realize that under New Zealand law, the person or company placing the product on the market inherits the legal status of the Responsible Supplier and faces severe penalties if the device causes local frequency interference or uses a prohibited band.

61. I do not agree with the 2km EMI restriction proposed in paragraph 18, point 2 and paragraph 26 (1)a "Proposed Conditions" because as stated earlier in this evidence, I consider the EMI limitation to be arbitrary and unnecessary.

62. I agree with paragraph 82 to make plan users aware of the RSM protections by inserting them into the ICC District Plan. However, this is secondary to the

protections already provided by RSM in restricting licenses in the 2200MHz to 2290MHz band.

63. I agree with paragraphs 83, 84, & 85 that unintentional radiators are not covered by the EMI restriction noting their possible ancillary intentional radiators will be subject to Condition 3(b) and 3(c) if they operate in the 2200MHz to 2290MHz band. This frequency band is not a normal operating range for SCADA or other licensed microwave/radio links as RSM control the licenses and therefore the protection of the 2200MHz to 2290MHz band.

64. I agree with paragraphs 103 and 184 to the extent that a blanket approach to the Horizon Mask is not suitable given that the level of effect on Space Ops is specific to the characteristics of future buildings or structures. It is correct that narrow structures such as cranes and wind turbines can obstruct and reduce the radio signal, however this is a function of the structure blocking a smaller area of the beam compared to the total beam area of the receiving antenna. Impeding structures can absorb, reflect or reradiate radio signals in various degrees and the materials the structure is constructed of play a significant factor. It is therefore an unrealistic assumption to consider that every object in a 5 degree horizon mask to adversely compromise the radio signal path. I consider that the uniform envelope proposed by Space Ops is arbitrary and does not reflect all those variables that would allow the ground station to still receive a signal despite objects protruding through the Horizon Mask

65. I agree with the first three bullet point statements in para 189, being a summary of Space Ops' response to the ICC Peer Review, noting that with a 5° antenna elevation, and considering a AWA4 -3dB beam width of 2.7°, the antenna will cover an elevation down to ~3.65°. I do not agree with the last bullet point statement by Space Ops that any obstructions would totally compromise their operations.

66. I agree with paragraphs 190 to 193. Even where some physical obstruction occurs, the ground station would still be capable of operating with some reduced efficiency. EMI risk from SFAL is minimal and manageable with greatest risk likely to originate from other sources outside of the 2km EMI Limitation Area.

RESPONSE TO SPACE OPS' EVIDENCE

Planning Evidence of Alex Dunn

67. I agree with paragraph 313 of Mr Dunn's evidence that regardless of whether the 2km protection designation is in place or not, EMI is a real effect that should be assessed, but in my opinion, the RSM regulations already manage this.

68. Paragraph 318 raises an important point that operational onsite mitigation is still required to manage EMI. All works and future development at Space Ops will need to consider electrical and communications interference risk. Because of the very close location to sensitive antenna, it's not only the installed equipment that needs to be controlled but also human behaviour. Staff/visitors bringing in cellphones, Bluetooth devices, smart watches, computers etc. need to be aware that these items could cause local interference risk. These items should go into a RF secure room or Faraday shielded enclosure. The Space Ops directional antenna used have high forward gain characteristics, however also have side and rear lobes (areas behind the antenna which are very sensitive). It would be very easy to wipe out a wanted antenna signal by the accidental use of a transmitting device near a lobe

69. I do not agree with paragraph 324 that a 0.5 or 3 degree surface would provide greater protection to Space Ops. This is not achievable because Space Ops already breach a 3 degree surface horizon with their own equipment.[4]

70. In regard to paragraphs 335, 336 and 337 of Mr Dunn's evidence, I agree that "relatively narrow structures such as cranes or turbines can cause interference". However, the severity of interference caused by narrow structures compared to large solid obstructions is less. As stated in [336], this depends upon factors including their azimuth, elevation, distance, size and construction. Those factors support individual assessment on a case by case basis.

71. I agree with Mr Dunn's evidence in paragraph 340 that penetration of the 5 degree surface should not automatically be equated with an unacceptable operational effect in terms of interference with the Space Ops proposed activities

72. With regard to paragraph 361, I support using the primary alternative method for EMI control through reliance solely on the RSM regulations. There has been no evidence provided to date that the RSM regulations are ineffective in relation to Space Ops' continued operations.

Corporate Evidence of Robin McNeill

73. Mr McNeill states in his paragraph 25 that seeking a 5° elevation mask protection is a major concession by SpaceOps NZ. This is in conflict with para 93 stating "*5° is also the lowest limit that RSM and FCC (the USA equivalent to RSM) will normally licence a ground station to transmit at*." The use of a 5° elevation does not appear to be a Space Ops decision.

[4] Statement of Evidence of Craig Morley dated 21 September 2026 [40].

74. Mr McNeill's paragraph 44 states that it is not trivial to calculate actual degradation and for this reason a worst case is assumed until proved otherwise.

75. Mr McNeill's evidence refers to "Spark's Designation 7501 Warkworth Satellite Earth Station Restrictions "Spark New Zealand Trading Ltd Designation 7501". This document notes that "*Buildings or structures with metallic surfaces greater than 40m2 in any one plane to have the potential to cause unacceptable interference*". It is the **area** of a metallic interfering surface that has potential for interference. This essentially applies to structures such as building roofs & corrugated iron fences.

76. The figure presented in paragraph 70 is quite misleading. It depicts potential turbine blockage of around 5 to 10 degrees when actual tower blockage is around 0.21 to 0.35 degrees (assuming fiberglass blades).

77. I agree with Mr McNeill's statement in paragraph 82 of the need for modelling and that "*A turbine blade that was made of non-conducting material of a width in the order of wavelengths at the radio frequencies of interest may not interact with radio waves and so possibly not create problems*."

78. I still consider that the imposition of the horizon mask is a significant overreach given that there are many circumstances where an object may not cause a harmful level of interference to Space Ops, however, I strongly agree with paragraph 94 of Mr McNeill's evidence in regard to using a case-by-case basis to assess horizon mask interference risk. In my opinion, this case-by-case assessment must be a transparent, independent, and robust process. I do not agree that the onus should be on SFAL to prove any obstruction may be detrimental to Space Ops' horizon mask.

Radio and Horizon Mask Evidence of Graham Hulston

79. In paragraph 20, Mr Hulson states "*If any obstacle protrudes into the ellipsoid then diffraction will occur, weakening the signal*." A more accurate statement would be "If any obstacle protrudes into the ellipsoid then diffraction will occur, **possibly** weakening or **strengthening** the signal." Noting that Fresnel interference can be constructive or destructive.[5]

80. I agree with Mr Hulston's paragraph 27 that the significance of any penetration depends upon the specific characteristics of the obstruction / obstacle and the affected radio paths.

81. I agree with part of the paragraph 28 statement, that some intrusion into the Fresnel zone may be tolerated and analysis should be performed.

[5] Statement of Evidence of Craig Morley dated 21 September 2026 at [44].

CONCLUSION

82. The proposed 3km Horizon Mask with a 5-degree elevation is excessive and relies on a flawed, blanket approach rather than site-specific analysis.

83. EMI risk is low considering the many factors that must concur simultaneously to result in harmful interference. For the Awarua Satellite Ground Station, no historical or recent evidence of EMI breaches or operational interference has been documented.

84. Given the existing protection afforded by the Radio Spectrum Management decision, the Radio Communications Act 1989 and the Radio Regulation 2001, I consider that the EMI limitation creates a duplication of these protections, without adding any protection. Therefore, the EMI limitation cannot be considered reasonably necessary.

85. The proposed 2km EMI limitation area and rigid horizon masks are overly conservative, unnecessary, and largely redundant given the robust statutory protections already enforced by Radio Spectrum Management under the Radiocommunications Act 1989. The stringent conditions fail to account for structural material transparency, actual signal beam geometry, or the reality that interference risks span well beyond a 2km radius. Consequently, regulatory reliance should default to RSM frameworks, and structural intrusions should be assessed individually on their technical merits.

Craig Ian Morley

21 September 2026

Appendix 1: Antenna Specifications and Tower Obstruction Calculations

APPENDIX TO EVIDENCE OF CRAIG MORLEY ON BEHALF OF SFAL

21 SEPTEMBER 2026

1. AWA4 Antenna specification

AWA4 ANTENNA

Long :	**168.38034°**
Lat :	**-46.52845°**
Alt :	**11.4m**
Model :	**Cossor C.R.353D Frame**
Tracking :	**DO only**
Telemetry :	**LHCP & RHCP** **S Band**
Diameter:	**3.7m**
3dB beam:	**2.7°**
G/T:	**13.5 dB/K**
Deflection :	**AZ = -180° to +540°** **EL = 0° to +180°**
Max speed :	**AZ = 20 °/s** **EL = 5 °/s**

AWA4 Antenna in Awarua SpaceOps NZ facilities

The AWA4 antenna is made with a pedestal of 1962 that was initialy a S band meteorological radar (Cossor CR 353) used for windfinding by tracking passive corner reflectors attached to ballons, or for direct weather observation by the fitting of a suitable display unit. It can support very strong winds (up to 200km/h).

All the servo drive and servo control unit has been changed in 2023 into Beckhoff equipments (ax5000). SpaceOps NZ has made the programmation of the servo drive and the control unit, so is totally autonomous in software optimization of the servo drives parameters and in the configuration of the antenna control unit.

- ⇨ The upgrade of the ACU to implementant the real time antenna pointing (DO) provided by the CNES DO laptop, will be done by SpaceOps NZ Team. A CNES DO laptop and DO simulators were left to SpaceOps NZ during this mission, in order for SpaceOps NZ to be autonomous to implemeant ant test the real time DO solution.

The 3.7m reflector has also been changed in 2023, and is optimsed for S band telemetry

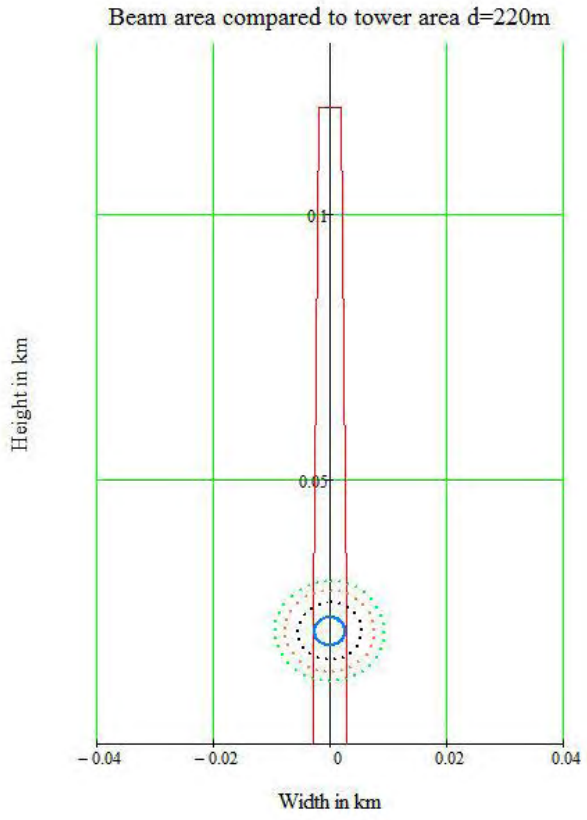
- ⇨ G/T of AWA4 is 13.5dBK while G/T of AWA1 antenna is 12dBK due to a reflector designed for S+X band.

2. Comparison of tower obstruction area to beam area

The following plots map the tower blocking area against the -3dB beam width at various distances from the receive antenna. The following parameters are used;

Tower height = 120m	Tower width at base = 6m	Tower width at hub = 4m
Antenna height = 2m	Antenna -3dB beam width[1] = 2.7°	Antenna inclination = 5°

The -3dB beam width of the antenna is represented as a light blue circle. The dashed black circle is the first Fresnel zone n=1, the dashed orange is the n=2 and the dashed green is n=3. Values are in km.



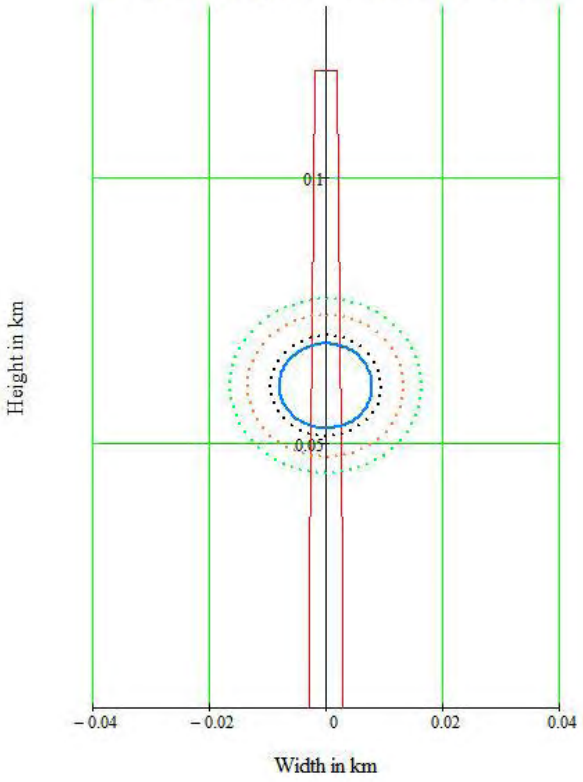
$d_{test} = 0.22$ test distance in km (from antenna to turbine)

$\Delta_{block}(d_{test}) = 100$ Percentage of beam blocked by tower at test distance. Maximum blocking is 40% but 20% preferred

$axis(d_{test}) = 0.021$ height to centre of beam axis in km at test distance

[1] As per AWA4 Antenna specification previous page

Beam area compared to tower area d=670m

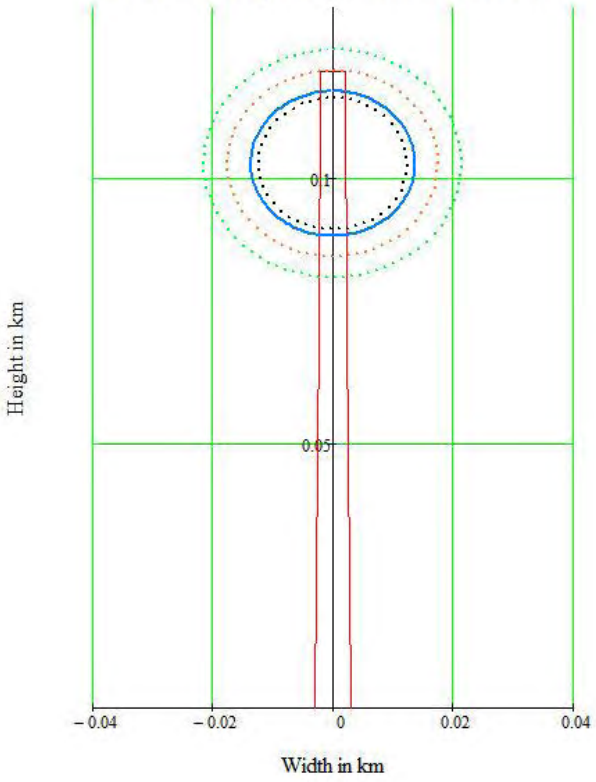


$d_{test} = 0.67$ test distance in km (from antenna to turbine)

$\Delta_{block}(d_{test}) = 39.936$ Percentage of beam blocked by tower at test distance
Maximum blocking is 40% but 20% preferred

$axis(d_{test}) = 0.061$ height to centre of beam axis in km at test distance

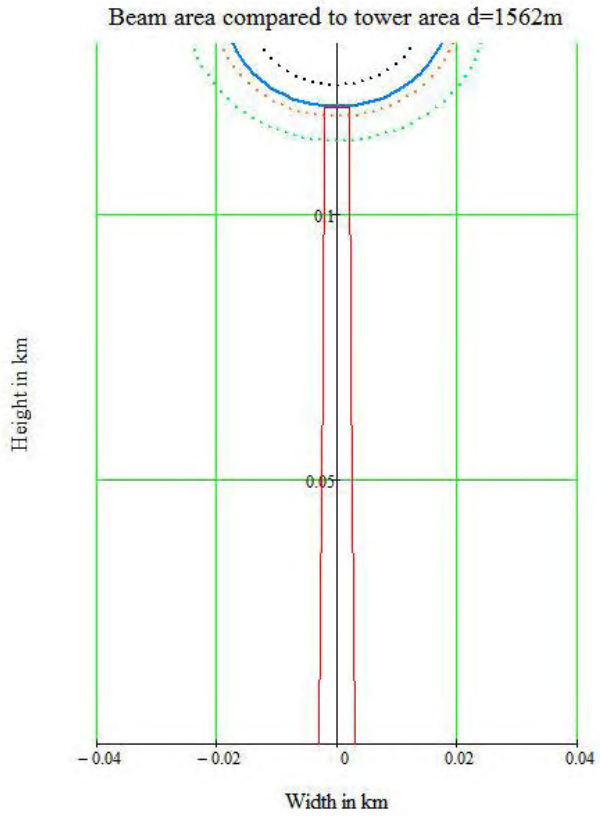
Beam area compared to tower area d=1150m



$d_{test} = 1.15$ test distance in km (from antenna to turbine)

$\Delta_{block}(d_{test}) = 20.004$ Percentage of beam blocked by tower at test distance
Maximum blocking is 40% but 20% preferred

$axis(d_{test}) = 0.103$ height to centre of beam axis in km at test distance



$d_{test} = 1.562$

test distance in km (from antenna to turbine)

$\Delta_{block}(d_{test}) = 0$

Percentage of beam blocked by tower at test distance
Maximum blocking is 40% but 20% preferred

$axis(d_{test}) = 0.139$

height to centre of beam axis in km at test distance