Site Investigations for CNES: Awarua and Invercargill Airport

Prepared by R G McNeill BE(Elect)(Hons), BA, MIEEE, MIPENZ
McNeill & Associates
44 Duke Street, Invercargill
www.robinmcneill.co.nz

Date: 10 April 2004
Revised: 20 October 2004

Summary

Two potential sites for monitoring the AE A5ESATV1 launch in 2005 were investigated in Southland. Testing for possible radio interference and horizon clearance was conducted. Preliminary geotechnical testing was carried out.

The site at Awarua was found to meet all requirements set out by CNES and would be suitable for establishing a satellite earth station.

Scope

McNeill & Associates in conjunction with ASI Ltd were engaged by Venture Southland to carry out site investigations for two sites identified for potential use as a satellite tracking earth station in Southland for the AE A5ESATV1 launch in 2005 for use by the Centre National d'Etudes Spatiales (CNES).

The site investigations for each site comprise of a:

Horizon survey,

RF noise survey, and

Geotechnical evaluation.

The two sites identified for testing for the proposed earth station had been previously identified by M. Michel Starozinski of CNES and Mr Steve Canny of Venture Southland, being Invercargill Airport and Awarua.

Procedure

The test procedures for each site are set out below.

Horizon Survey

Requirements for the horizon survey were provided by M. Michel Starozinski of CNES. They are:

1. No obstruction of more than 0.5° elevation at AOS (acquisition of satellite) and LOS (loss of satellite), which are:
2. AOS: 291.5° ± 5.0° Tue North
3. LOS: 117.0° ± 5.0° True North

It was understood from discussions with M. Starozinski that the horizon should be as low as possible for the LOS bearing.

Magnetic compass bearings were used to locate AOS and LOS bearings at the sites, using a Suunto KB-20 360R direct viewing compass with 1° graduations and accurate to ± 0.5°.

Magnetic declination for True North was calculated to be 25.8° east of north, allowing for True North – Grid North offset of 3.4° and Grid North declination of 22.4°.

	Nominal bearing	Magnetic Bearings		
AOS	291.5°	260.7°	265.7°	270.7°
LOS	117.0°	86.2°	91.2°	96.2°

The horizon elevation was measured with an inclinometer with 1° graduation and accurate to within 0.3°.

RF Noise survey

M. Philippe Rochette of CNES advised that minimum signals received from Ariane can be as low as –130 dBm on an isotropic antenna, i.e. received flux of –102 dBm/m^2 and this power is spread over 1 MHz.

Noise levels at the horizon for the whole 2.200-2.300 GHz band were requested to be measured, paying special attention around both the Ariane nominal frequencies of 2.2545 GHz and 2.2840 GHz.

An Anritsu MS710A spectrum analyzer was used to measure noise over the 2.200 GHz – 2.300 GHz band. The spectrum analyser noise floor was measured at:

–101 dBm for a resolution bandwidth of 10 kHz and video bandwidth of 1 kHz,

–118 dBm for a resolution bandwidth of 1 kHz and video bandwidth of 1 Hz.

Three different antennas were used:

1. D-Link ANT24-1801 yagi, with 18 dBi gain designed for use over the 2.4 GHz – 2.5 GHz band, and with a measured return loss better than 18 dB over 2.200 GHz – 2.300 GHz,
2. Watties circular waveguide antenna with calculated gain of 20 dB, with measured return loss better than 18 dB over 2.200 GHz – 2.300 GHz and better than 27 dB over 2.2500 GHz – 2.290 GHz
3. Pacsat model 1007 7 dBi omni-directional co-linear antenna, with a measured return loss better than 18 dB over 2.200 GHz – 2.300 GHz.

The directional antennas were mounted on a tripod, approximately 1.2 metres above ground aimed at the horizon in the direction of AOL and LOS. The omni-directional antenna was hand-held some 3 metres above ground for the duration of the tests.

All tests were conducted using vertical polarisation.

The spectrum analyzer and antennas were connected with 5.0 m of Westflex 103 low-loss feeder cable, with calculated attenuation of 2.0 dB including connectors.

The test set-up was confirmed to be operating as expected by measuring a known W-CDMA site in the 2.100 GHz band. In addition, it was possible to measure a suspected microwave oven at least some kilometres away in the ISM band. The Watties and D-Link antennas were found to produce similar results during pre-tests, confirming that the testing methods employed were providing consistent results and operating with gains over the omni-directional antenna as expected.

Geotechnical Evaluation

A dynamic cone penetrometer was used to measure soil density and compaction.

Invercargill Airport

Site

1. Invercargill Airport site is located at 46° 25.096' South, 168° 18.414' East, to the south west of the Invercargill Airport runway, adjacent to a fire fighting practice area. The site is approximately 1 m above mean sea level. Access is from Co-Bakker Road.
2. The site is less than 10 minutes drive from the centre of Invercargill and lies in the airport security area.
3. Depending on the wind direction, aircraft take off and landing paths could eclipse the spacecraft trajectory.
4. There is no electrical power supply to the site.

Horizon

1. There are no obstructions in the foreground in any direction.
2. At bearing 291.5° ± 5°, there is a line of trees across the horizon some 500 metres distant at 0.8° ± 0.3° elevation.
3. At bearing 117.0° ± 5°, there is a line of trees across the horizon some 400 metres distant ranging from 0.5° to 1.8° ± 0.3° elevation.
4. In the vicinity of 117.0° + 5° some 1500 m distant HF radio masts intrude above the horizon.

RFI

1. No noise could be found in the frequency range 2.200 GHz – 2.300GHz over a one hour period. Several aircraft took off and landed in this period. At all settings on the spectrum analyzer no signal was found that exceeded the noise floor of the instrument within the band.
2. A radio source, most likely a microwave oven, was detected at 2.45 GHz, with signal strength – 85 dBm using the D-Link antenna for a period of around one minute at the AOL bearing.
3. We were concerned that airport radar and radio communications equipment had the possibility to generate RFI at this site. Given that several aircraft, including domestic network and private operators were active in the testing period and that the airport was operational at the time it is unlikely that there are any noise sources in the band. It is unlikely, but not impossible that there are other noise sources from airport and/or aircraft radar systems, etc., which were not in use during the measurement period.

Geotechnical

1. The ground surface is metalled and could easily carry heavy vehicles.
2. Dynamic cone penetrometer measurements are set out in Annex 2.

Awarua

Site

1. The Awarua site is located at 46° 31.730' South, 168° 22.870' East at the end of Awarua Siding Road. It is a remote farm paddock overlooking the Awarua Wetlands at an elevation of around 12 m above mean sea level. The site is on a local maxima.
2. The site is about 20 minutes drive from the centre of Invercargill.
3. There is one house about 1.5 km from the site, but otherwise there are no buildings or dwellings for some kilometres in any direction.
5. There is no electrical power supply to the site.

Horizon

1. There are no obstructions in the foreground in any direction.
2. At bearing 291.5° ± 5°, the horizon is uninterrupted to some 4 - 5 kilometres distant at less than 0.3° ± 0.3° elevation, and at LOS is close to 0.0°.

3. At bearing 117.0° ± 5°, there is a line of trees across the horizon some 1 - 2 kilometres distant at less than 0.5° ± 0.3° elevation, with a gap in the trees allowing elevation close to 0.0° between LOS - 1.0° and LOS + 0.8°.

RFI

1. No noise could be found in the frequency range 2.200 GHz – 2.300GHz over a 40 minute period. At all settings on the spectrum analyzer no signal was found to exceed the noise floor of the instrument.

Geotechnical

1. The site is presently pasture and would require paving to prevent pugging in winter under any prolonged vehicle or foot traffic.
2. The area is reclaimed wetland.
3. Dynamic cone penetrometer measurements are set out in Annex 2.

Discussion

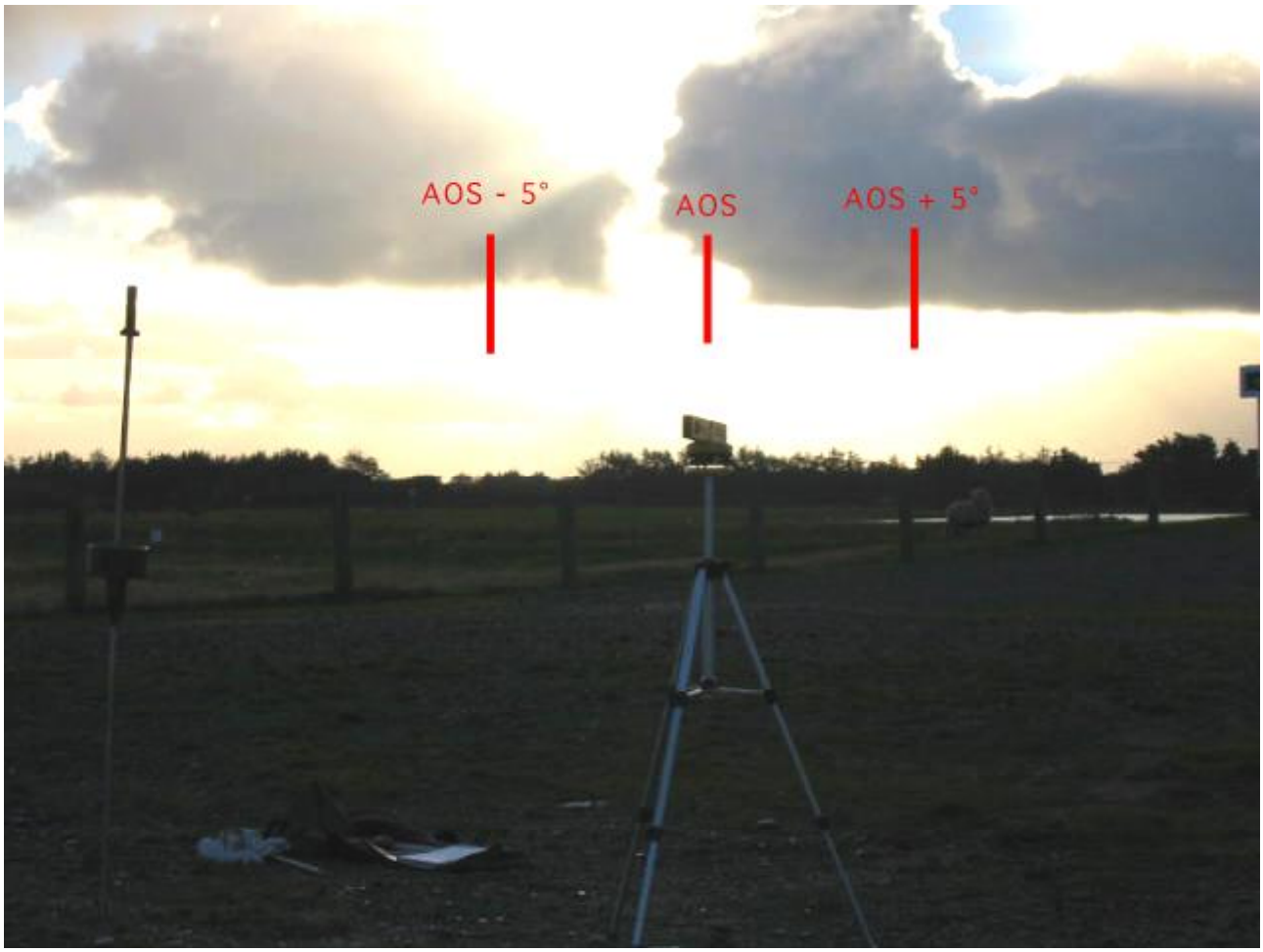
The Invercargill Airport site does not meet the requirements of CNES for a low horizon to the south-east, with trees encroaching to 1.8° elevation. The aspect to the west is also marginal. There is no electrical power supply to this site. The site is within 10 minutes drive from Invercargill and would be able to take advantage of normal airport security. The site would need minimal civil work to be undertaken for a trailer-mounted antenna and containerised earth station.

The Awarua site meets all horizon clearances, especially to the south-east LOS bearing. It would not be as straightforward to establish a station at this site due to its comparative remoteness and the undeveloped nature of the site. Some civil works would need to be carried out to even park-up a trailer-mounted antenna, though such work should not be major. The site is approximately 20 minutes drive from Invercargill. There is no electrical power supply at this site.

Conclusion

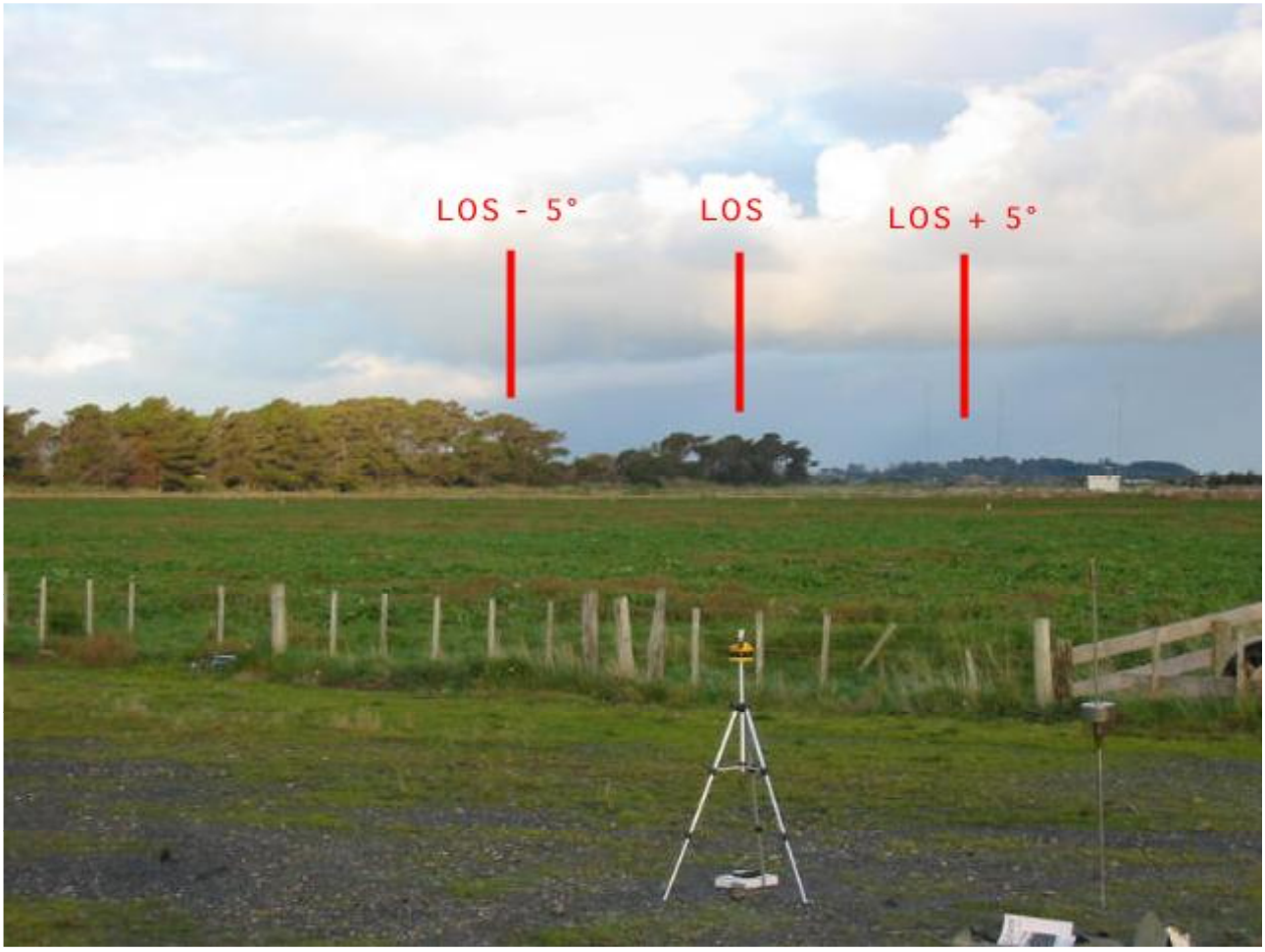
It is recommended that the satellite earth tracking station be established at the Awarua site to best track the space craft on the trajectory supplied by CNES.

Annex 1. Photographs of sites



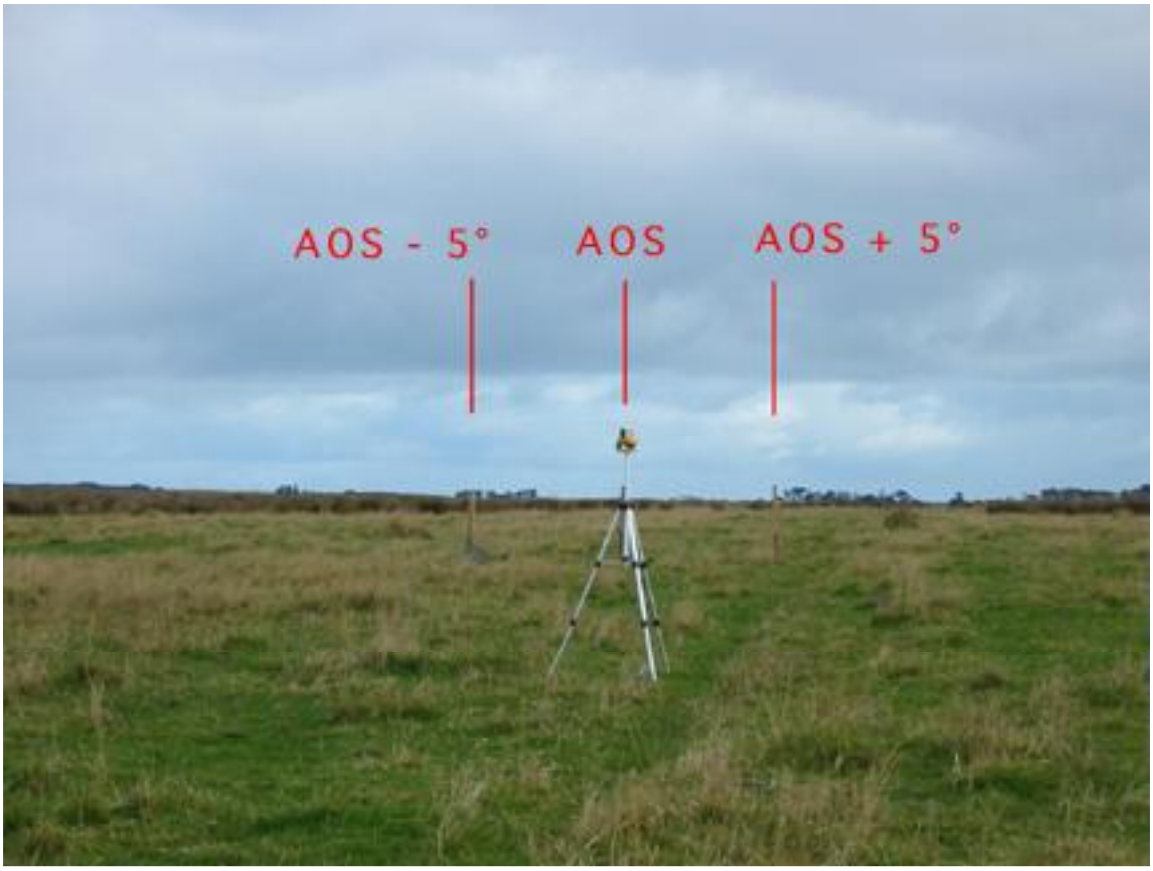
Invercargill Airport

Invercargill Airport site. AOS immediately behind tripod. Airport runway is visible to right and behind the sheep. Longwood Range is not visible through cloud, but is at approximately the same height as the trees to the right.

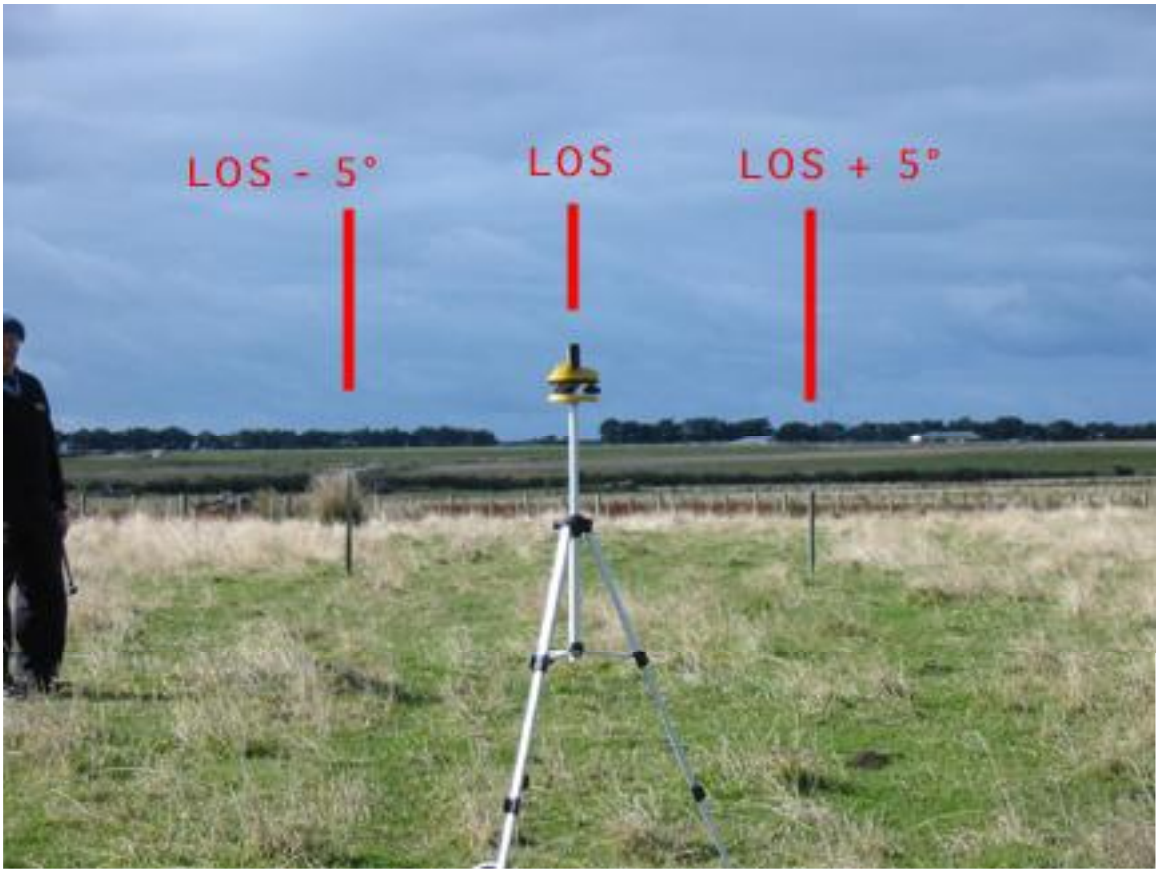


Invercargill Airport site. LOS immediately behind tripod. Airport HF antenna towers are visible to right and left of LOS + 5°.

Awarua



Awarua site. AOS directly behind tripod. Awarua Wetland to left.



Awarua site. LOS directly behind tripod.

Annex 2. Dynamic Cone Penetrometer test results

Depth	Number of blows	
	Invercargill Airport	Awarua
0” - 2”	31	1
- 4”	16	1
- 6”	22	1
- 8”	12	2
- 10”	7	1
- 12”	18	1
- 14”	27	1
- 16”	14	2
- 18”	5	6
- 20”	3	7
- 22”	2	7
- 24”	3	9
- 26”	2	8
- 28”	2	10
- 30”	2	8
- 32”		6
- 34”		7
- 36”		5
- 38”		7
- 40”		4
- 42”		3
- 44”		2
- 46”		2
- 48”		4
- 50”		4
- 52”		4
- 54”		3
- 56”		5
- 58”		5