AVIATION SAFETY™

Trials Classic Flyers October 2014

Experimental 406MHz Antenna Location testing within the confines of a helicopter tail boom

The background to these tests is that over the past 4-5 years we have seen a dismal rate of activations on 406MHz ELT signals being receipted by the Rescue Coordination Centre. Typical accidents either break the external antenna and or fracture the coaxial cable and or, in particular, only of one brand, a failure of the G-switch to activate either by G-switch failure and or because of the way the ELT was / is mounted.

It is apparent, in New Zealand, that a high number of Artex ME406 (AF) style installed in helicopters are fitted either horizontal or at approximately 23 degrees rather than the previously accepted 45 degrees.
This is due to the original manufacturer manual suggesting that installers of the ELT refer to the helicopter manufacturer and the helicopter manufacturer not having any written guidelines. The early ELT manuals also referred to not installing greater than 23 degrees to avoid preloading the G-Switch. Of course all these early guidelines referred to fixed wing installations, not rotary wing.
Consequently, these installations are probably skewing the non-activation rate but at this stage, the NZ regulator has not taken any action to remedy the situation despite warnings being raised in 2012.

During the development of a secondary antenna switching device (SASD) in New Zealand in 2006, we placed a 406AP in the tail boom of a Eurocopter EC120 and tested the ELT with a test protocol with homing signal. The test was receipted by the Cospas-sarsat satellites and the homing signal, although weak because of the metal structure, was radio direction located from over a mile away at only 1200 feet altitude. (See attached report from 2006 and further actual testing in February 2009 of the SASD).
Although the SASD clearly had merit and was proven to work by simply measuring the SWR of the external antenna, (before switching to the secondary antenna), we were unable to bring it to the market. The regulator, after consulting with FAA, would not grant approval to use the SASD within an existing approved TSO126 system. That refusal occurred even though the SASD did not interfere or change the “approved system” unless the “approved system” failed by way of a broken external antenna or a detached coaxial cable. We still see merit in the device especially if sold by an ELT manufacturer as it could be fitted in the after-market area into existing systems. Given that a secondary antenna worked on MH317, the the interest in internal secondary antennas will become very topical.

The SASD successful testing led to the Eurocopter development (in conjunction with Kannad) of the Integra ELT that has a secondary 406MHz antenna within the ELT and, in addition, a GPS . This improved development is a great leap forward to improving ELT activations within Aviation, in particular the rotary wing industry.

For an ELT to function as required, the ELT system including the antenna must be in the maximum crash worth position. To get the antenna into a crash worthy position, I believe that we should remove the antenna from the outside of the aircraft to the inside or build it into the aircraft structure. Having an ELT inside the Helicopter and the antenna on the Tail Boom is not sensible.
We could do away with the coaxial cable by using the 406AP ELT with the antenna directly attached as these tests successfully showed.

Another factor to improve crash worthiness is that when a coaxial Cable is utilised, it should have a sacrificial loop to act as a shock absorber and remove any tension from the cable and most importantly, the BNC fittings during an accident. Disconnection of the BNC fitting to the coaxial cable happens far too often.

The following test and results undertaken in Tauranga, New Zealand on the weekend of the 10th of October 2014 prove without question that the 406MHz signal from the antenna within the confines of a (non-carbon fibre) airframe will function as required.

In these tests we used different Hex ID codes over an extended period.

The first test was just a datum of a 406AP ELT on the ground to determine the power level receipted by the GEO and LEO satellites. The second and third subsequent tests were the antenna vertical within the tail boom for 12 hours then the antenna horizontal within the tail boom for 24 hours.

The result was that the signals were receipted by the GEO and LEO satellites with little loss of receipted power (dBm)

Lloyd Klee

Test 1

ELT with integrated antenna located outside in clear space with antenna vertical to ascertain a benchmark.

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Dongle TEST 01 FFFED0600F2490E1A42E869ECD10
15 Hex ID C01E4921C3485D0

(Check BT100 214-452

On approx. 1508 NZLT or 0208 GMT 10 October 2014

Off 1545 NZLT or 0245 GMT 10 October 2014

Test 2
ELT with integrated antenna located inside Tail boom with antenna vertical

Dongle test 02 FFFED0600F2490E1A42C806AD810

15 Hex. ID C01E4921C348590

(Check BT100 214-451

ON 1450hours NZLT or 0150 or GMT 10 October 2014
OFF 0800 NZLT 0800 11 October or 1900 GMT 10 October 2014

Test 3
ELT with integrated antenna located inside tail boom with antenna horizontal lengthwise within

Dongle Test 03 FFFE2F600F2490E1A42805898F90

15 Hex ID C0E44921C348500

(Check BT100 214-454
Internal antenna test 2014-455 under tail boom power measured 89%
Internal antenna test 2014-456 in front of tail boom power measured 74%

(in this test the BT100 was at the opposite end of the antenna tip)

ON 0810 hours 11 October NZLT or 1910 GMT 10 October 2014
OFF 0710 hours 12 October NZLT or 1810 GMT 11 October 2014

Data from the satellites was collected by John Asson (Australia)

Test 02 (Vertical) 406MHz transmission test was for approx.12 hours

Test 03 (Horizontal) 406MHz transmission test was for approx. 24 hours
There was no 121.5MHz Homing signal transmitted.

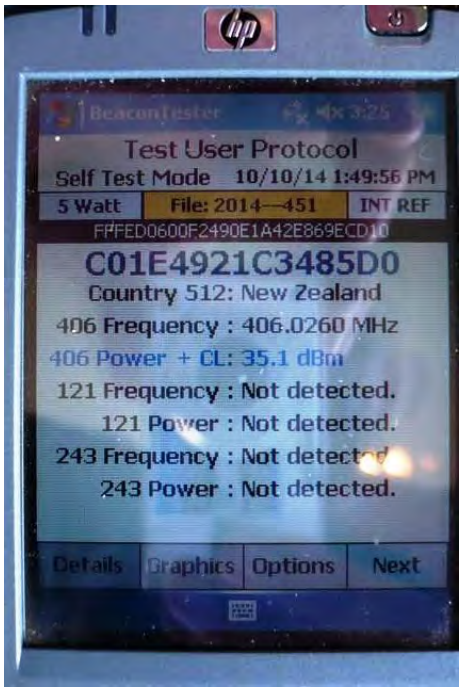
The airframe had most holes that were within the immediate vicinity of the operational antenna blocked off. Antenna transmitted through the aluminium structure successfully

Tail Boom Classic Flyers 37.668 South and 176.198 East

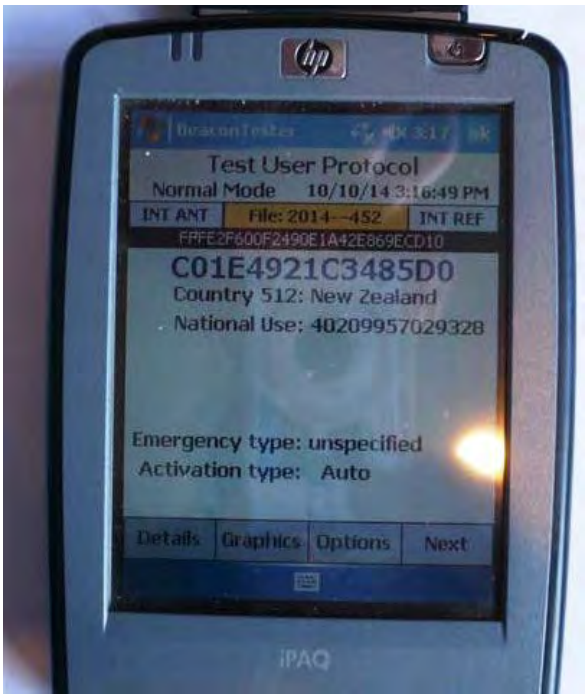
Holes in top of tail boom were covered with aluminium tape.
The closest inspection hole to the camera was covered
Tests were above the port lowest (closest to fence)

Testing underway

BT100 photos provided for evidence of timing and hex codes



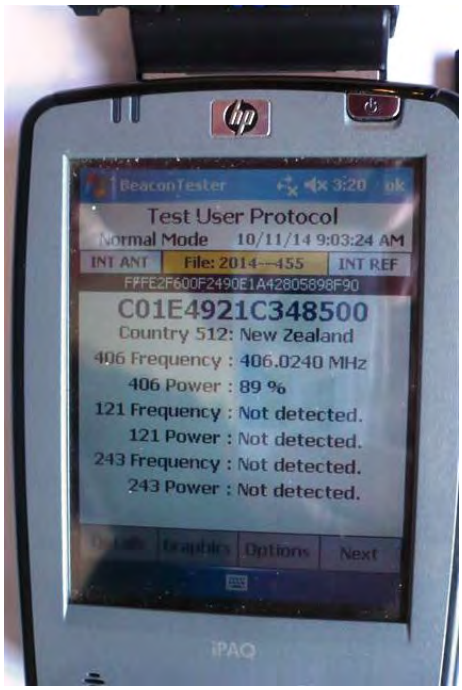
Datum Test 01 35.1 dBm 2014-451



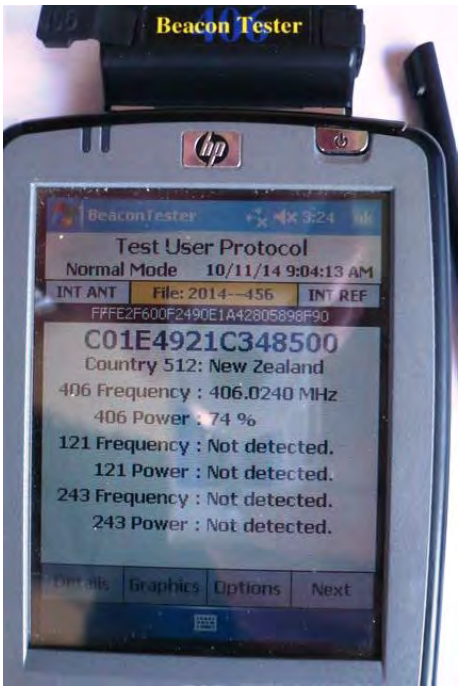
Datum Test 01 2014-452

Test 02 2014-453

Test 03 2014-454

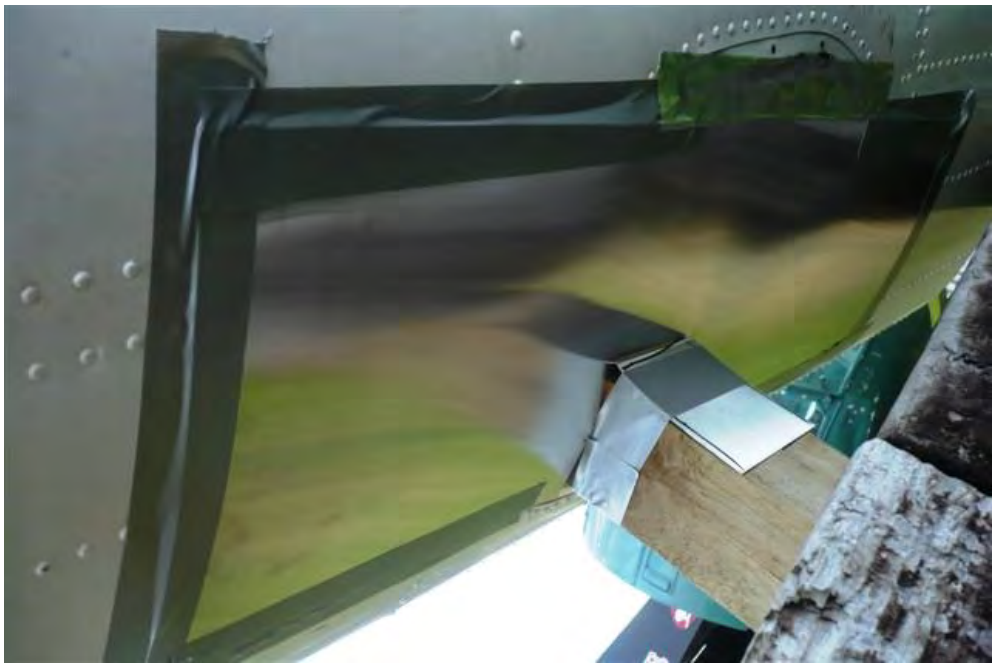


Test 03 2014-455 = 89% Power
Test taken underneath tail boom



Test 03 2014-456 = 74% Power
Test taken in front of tail boom

Radiated power Test 03 2014- 453 = 74% Power outside of tail boom



Port covered during TEST 02 and most of Test 03

Duct tape came undone sometime during 24 hour test of Test 03
(as it is on the underside of antenna unlikely to influence test)

Test 02 Vertical within tail boom

TEST 03 Horizontal antenna within tail boom

Unused inspection Port covered

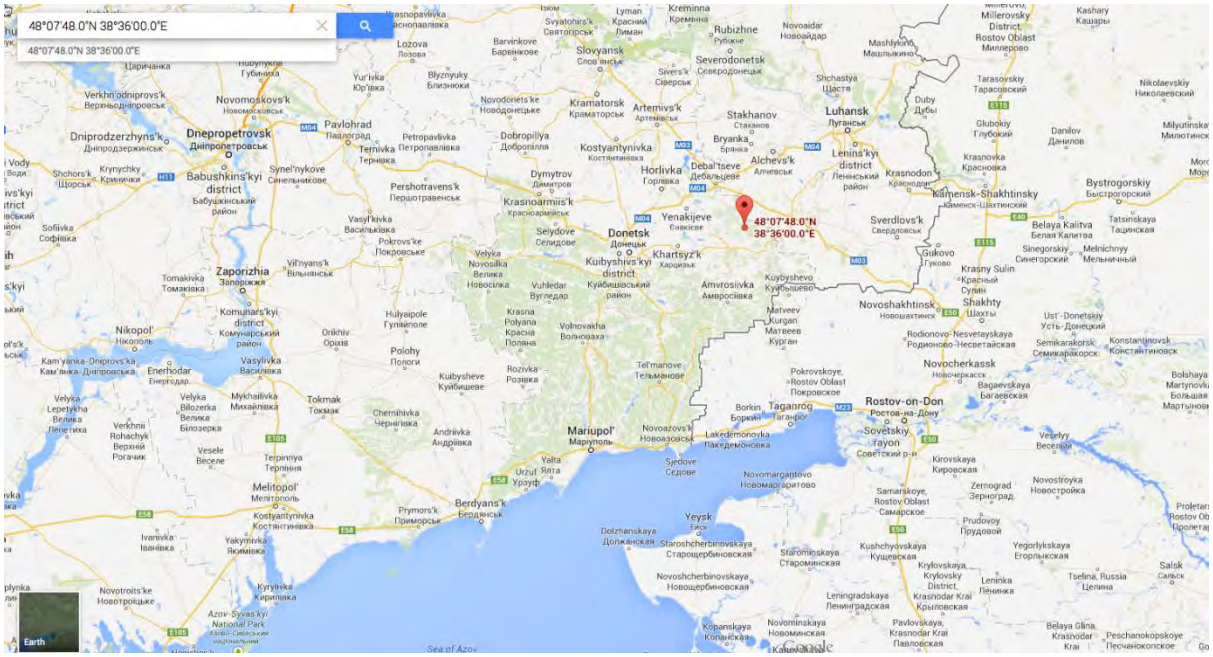
Test 01 Datum test. Power is only 35.1dBm

AVIATION SAFETY™

MH17 Crash Secondary Antenna Results

Output time : 18-JUL-2014 01:05:33.72

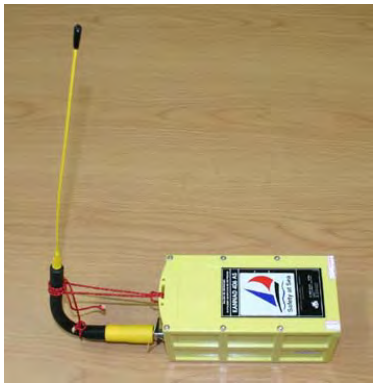
Alert Key	Sat ID	Src ID	Beacon ID	Lat A Deg	Min	Long A Deg	Min	Lat B Deg	Min	Long B Deg	Min	TCA DAY HR:MN	Transmit DAY HR:MN	SIT Mt	Route Name	Msg Num	Comms Hdlr	Sta
19075	G21	C2A439E7AB25CD1										191 13:32	191 13:46	SIT122	SIMCC	08628	NULL_IO	Tx
19083	S11	C2A439E7AB25CD1										191 13:32	191 13:56	SIT122	SIMCC	08630	NULL_IO	Tx
20803	G63	C2A439E7AB25CD1										198 13:20	198 13:35	SIT122	SIMCC	08745	NULL_IO	Tx
20804	G62	C2A439E7AB25CD1										198 13:20	198 13:35	SIT122	SIMCC	08746	NULL_IO	Tx
20807	S10	C2A439E7AB25CD1		48	8.6N	38	37.7E	44	27.5N	19	50.4E	198 13:37	198 13:50	SIT133	SIMCC	08747	NULL_IO	Tx
20817	S07	C2A439E7AB25CD1		48	7.8N	38	36.0E	48	27.9N	40	23.1E	198 13:50	198 14:50	SIT127	CMC	43783	NULL_IO	Tx
20818	S07	C2A439E7AB25CD1		48	7.8N	38	36.0E	48	27.9N	40	23.1E	198 13:50	198 14:50	SIT127	FMCC	50560	FTP_FMCC	Tx



Auxiliary Antenna Trials, 15 May 2006

The Westpac Rescue Helicopter, a BK117, undertook the RDF trials.
Photo shows Darryl on left and his crew Leon and paramedic Bruce. On the extreme left, Tom McCready CAA accident investigator and trial coordinator, and on right Murray Benns, Eurocopter NZ who loaned the EC120 to use for the trial.

The tight space in tail rotor boom meant that that the auxiliary antenna on the Kannad 406MHz ELT needed to be bent through 90 degrees to avoid contact with fuselage



Inside Tail Rotor boom, structure is Aluminium and Nomex; the antenna is visible behind battery box

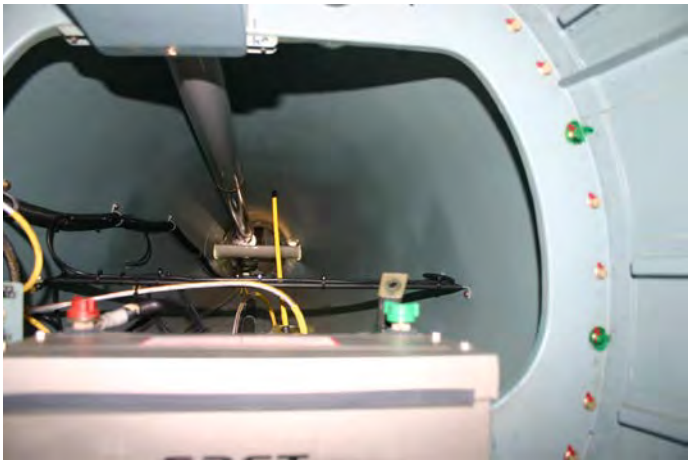
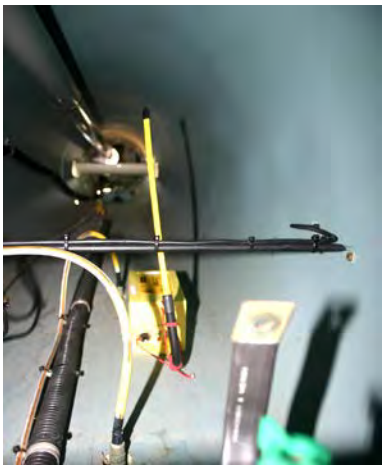


Photo inside Tail boom

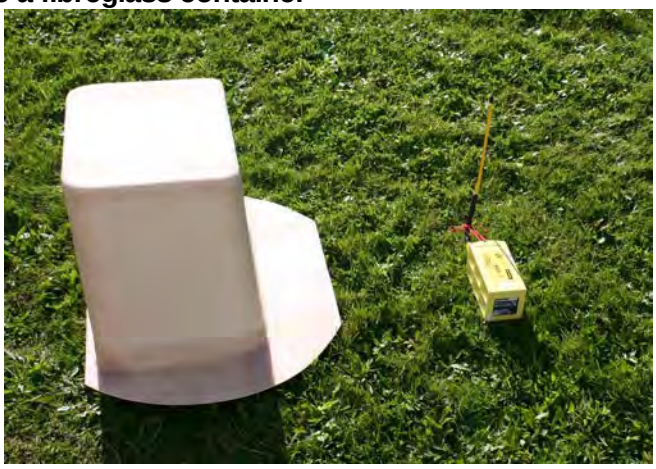


Interestingly, a satellite pass detected the 406MHz and the 243MHz but not 121.5MHz in this second serial

External showing tail boom access

Third serial, the cabin is composite structure including carbon fibre cloth and Nomex

Fourth trial inside a fibreglass container



Auxiliary Antenna Testing 15 May 2006 (preliminary)

Enclosure / hindrance	Time on NZLT	Time off	Radio Distance in nautical Miles at 1200 feet	RDF From at 1200 feet altitude	406MHz receipt on satellite	Satellite	121.5MHz Yes / No	243MHz Yes / No	Satellite GPS position Actual GPS position *37 02S & 174 58 E*
Nil	0835	0900	12.0	12.0	Y	G09 & G10 S06	Y	Y	174 57E / 37.01S
Helicopter tail boom, Alu. & Nomex	0935	0947	4.8	1.1	Y	S09 & G10	N	Y	174 57E / 37.02S
Cockpit of EC120	0950	1000	10.4	9.4	Y	G10	N/A	N/A	
Fibreglass housing	1003	1010	12.0	7.7	Y	G10	N/A	N/A	
Notes									
a	*When ELT antenna enclosed, RDF had little or no Audio*								
b	*Weather was fine, all serials at 1200feet*								
c	*ELT was a kannad 406 with 406, 121.5 and 243MHz output*								
d	*Test Location was 37 02S & 174 58 E*								

ACTUAL TEST of SASD 12 February 2009

Objective

The objective was a live test of the SASD utilizing the ERCEG ELT and an actual working sample SASD with two styles of secondary antennas.

General

This new test was conducted between 1000 hours and 1200 on the 12/02/2009 NZLT or 2100-2300 UTC and some will be aimed to coincide with satellite passes. We will phone at the start of each test that will be 15 minutes long, switched on 5 minutes before any specific satellite pass is due

All times are NZ standard times.

The set up was as per test as per test report No 60111.1 conducted 2 February 2006 but with the SASD between the ELT and the Whip

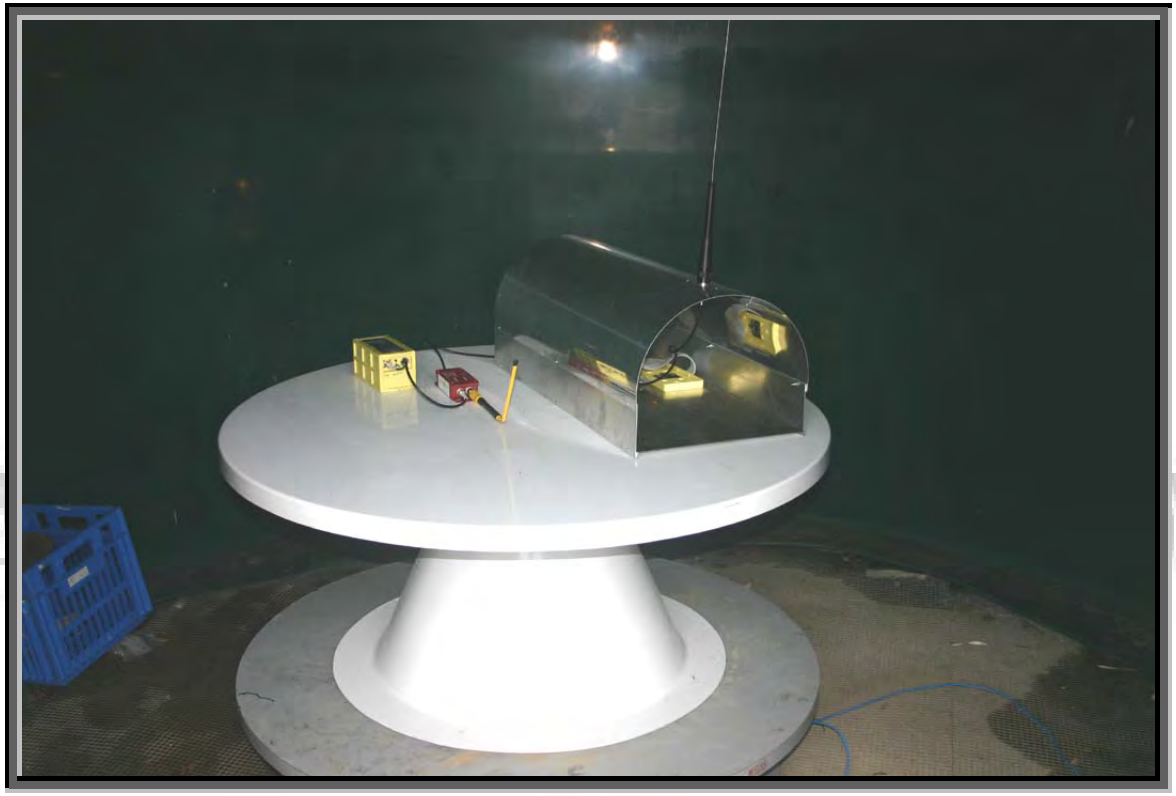
- **TEST # 1 and 1A (IESM134**)(Hex # **C01ECC349DD40A1**) Transmission of the ELT activated at 10am for 13 minutes (ANT200) then the Primary Whip antenna was disconnected so that the Secondary Antenna Switching Device was activated. (SASD) at 1013. The secondary antenna for test was a yellow (ANT110) This test duplicated the same ELT and antenna as tested February 2006. EMC conducted two power measurements during this test. This test was an open test that finished at 1026Hrs. This test was an open test

- **TEST # 2 (DONGLE KTEST 01)** (**C01FE870D2135D1**) At 1030 the primary whip antenna was connected and the secondary antenna was replaced with a black ¼ wave antenna. The SASD was connected at 1035.This test ran until 1049. This test was an open test

- **Test # 3 (DONGLE KTEST 03)** (**C01FE870D213501**) Note change of HEX Code than that originally advised. The enclosed SASD was fitted the ¼ wave stubby antenna enclosed in a structure. A minor issue occurred at 1100 when it was realized that the cable to the Primary antenna was loose. The test was restarted at 1105 on the primary antenna then SASD was switched at 1114. The enclosed SASD was switched off at 1135. This was an enclosed test.

- **Test # 4 (DONGLE KTEST 03)** (**C01FE870D2135D1**) Note change of HEX Code than that originally advised. Enclosed SASD in structure with the ANT110 antenna connected. Note that the antenna was horizontal then bent thru 90 degrees to fit enclosure. Primary Antenna transmitted at 1140 and SASD was switched at 1145. The test finished at 1200. This was an enclosed test.

- CONCLUSION **Tests show that an enclosed SASD as tested will provide a satellite alert on both the GEO and LEO Cospas-sarsat satellites**



Basic setup all tests **(NZ local time 1003Hrs)**

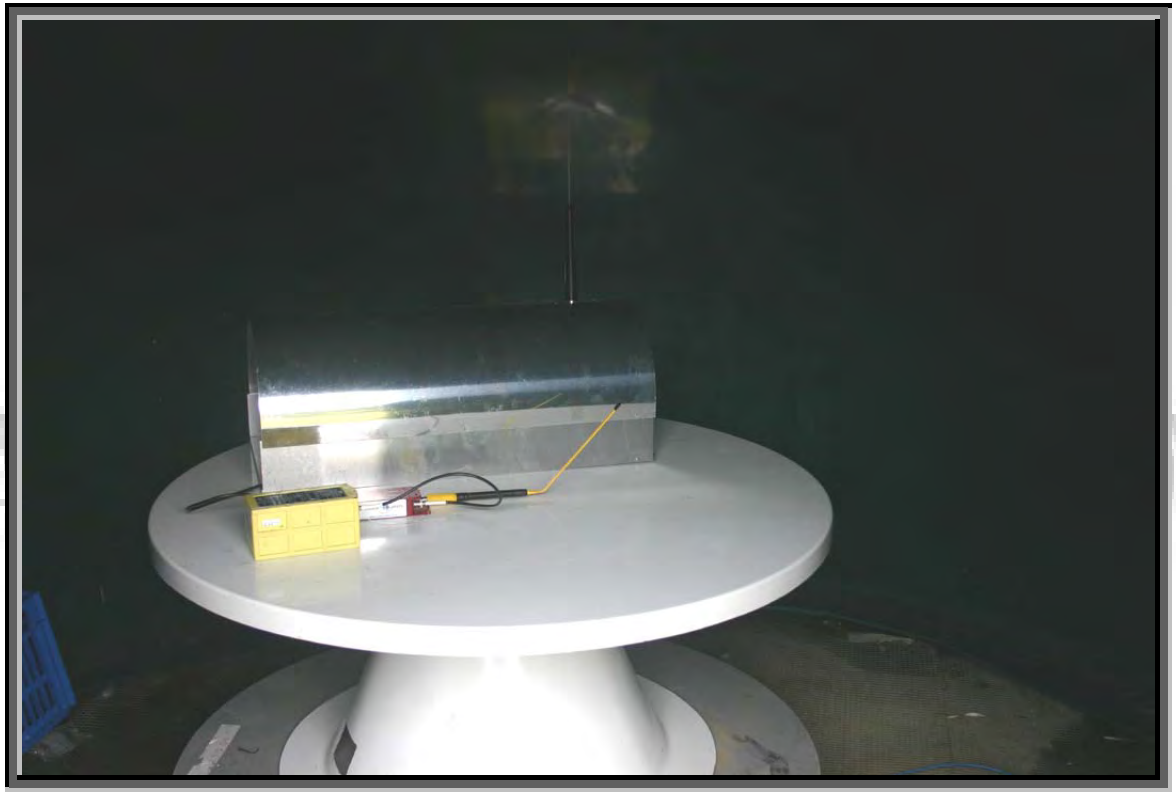
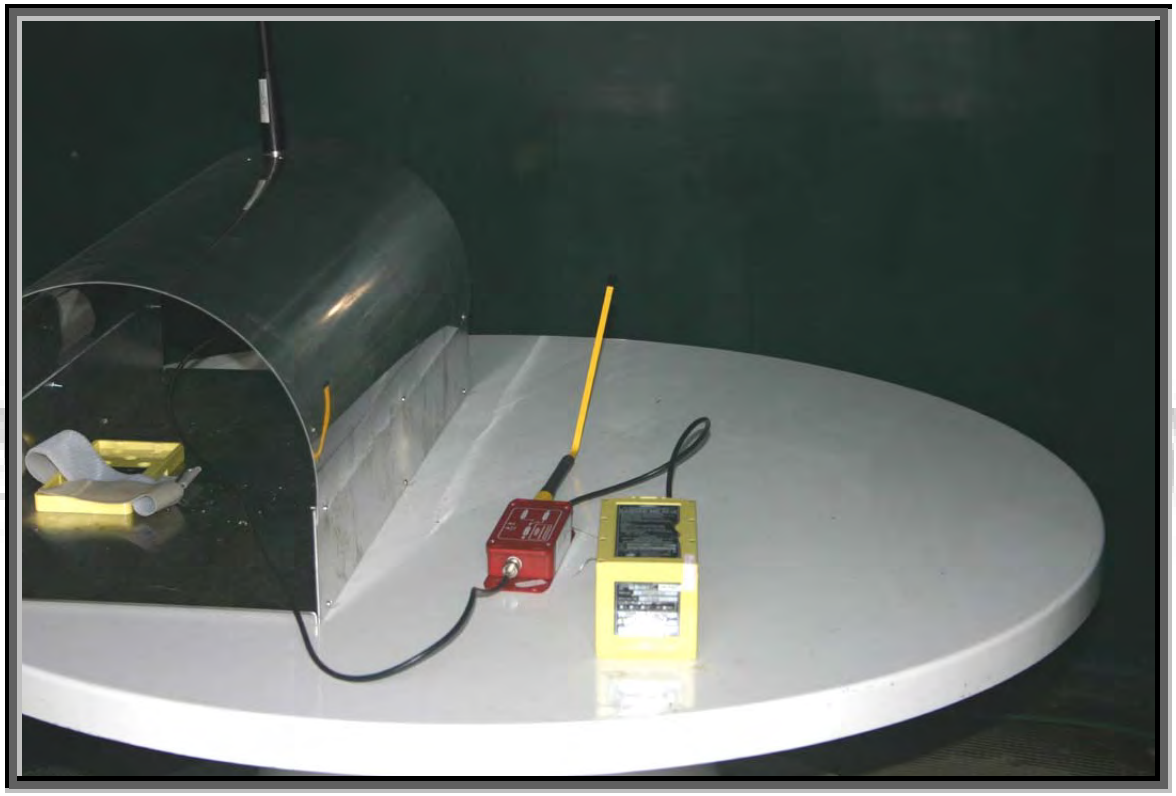
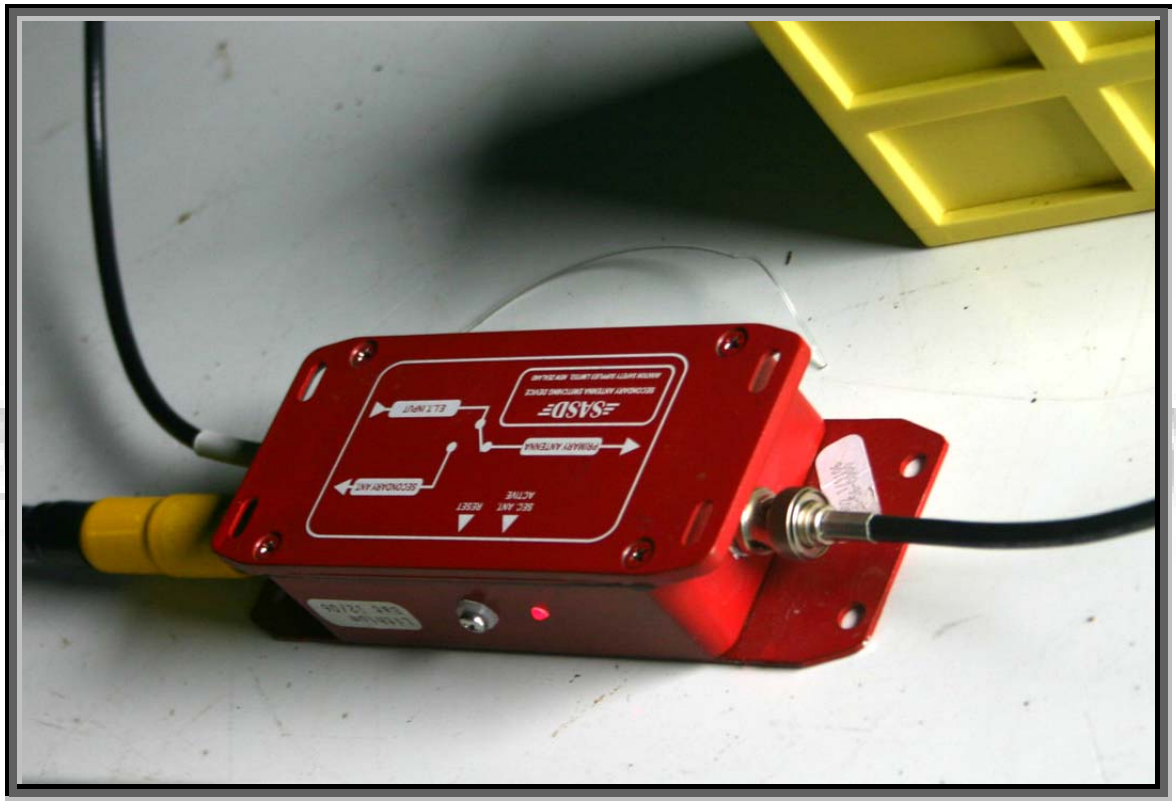


Table rotated during all power measurements (NZ local time 1004Hrs)

Test setup, table inside green tank, power receiver to right (NZ local time 1005Hrs)

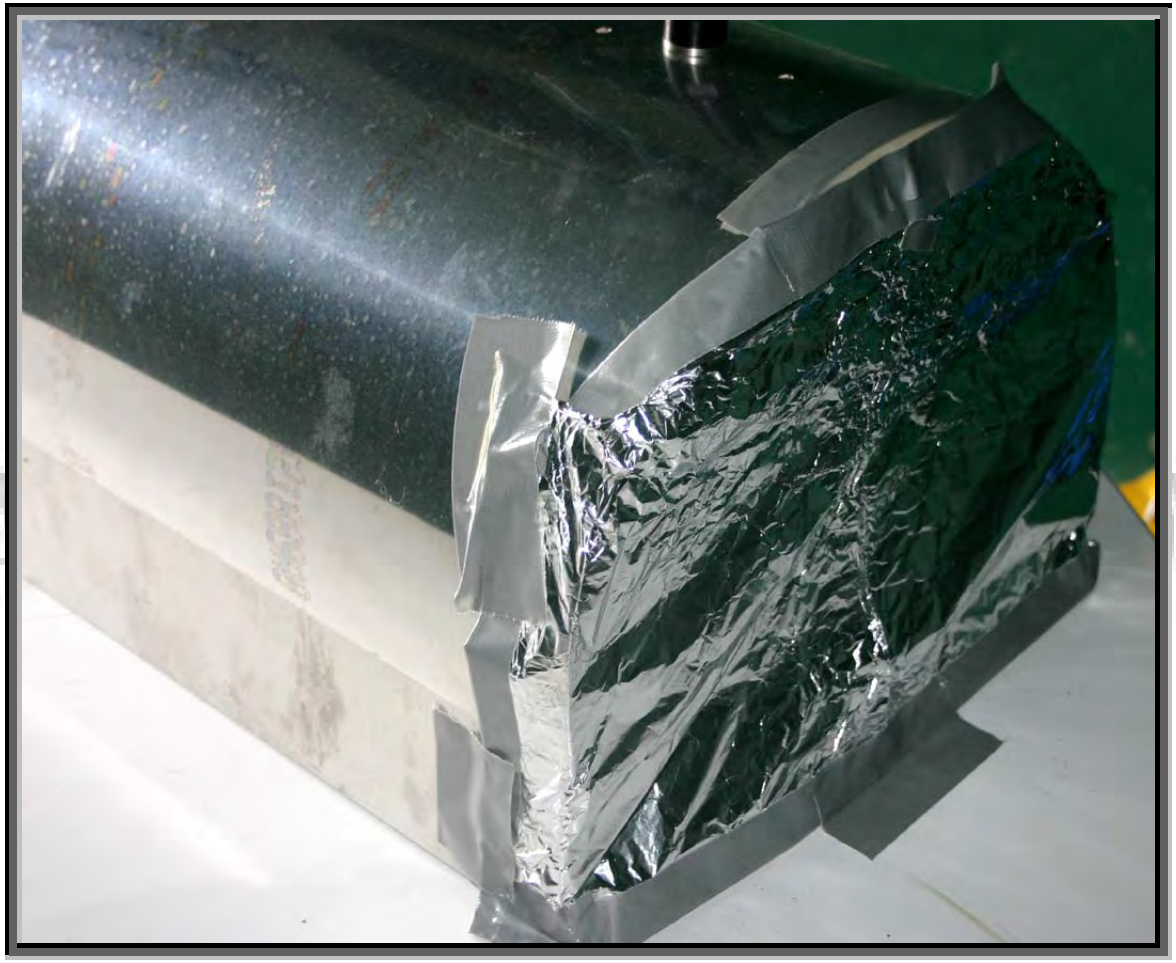


First test 12/02/09 ANT110 open test (NZ local time 1011Hrs)

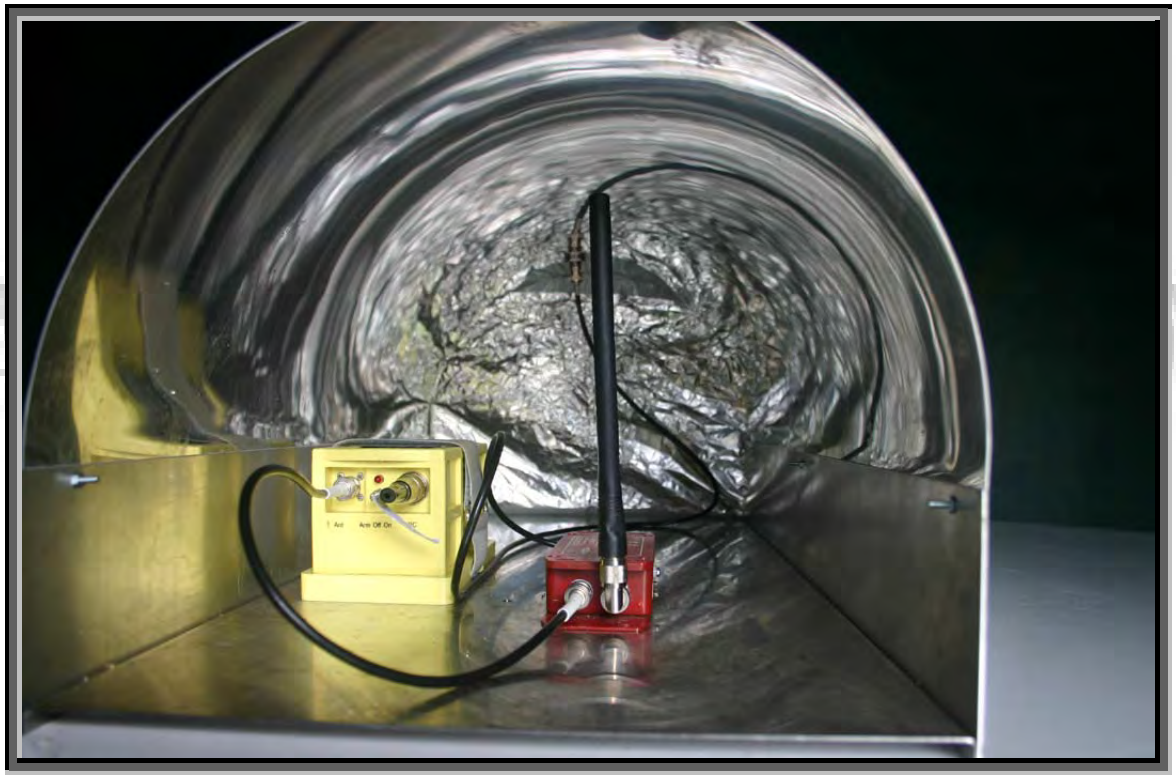


ANT110 switched over to SASD (NZ local time 1117Hrs).

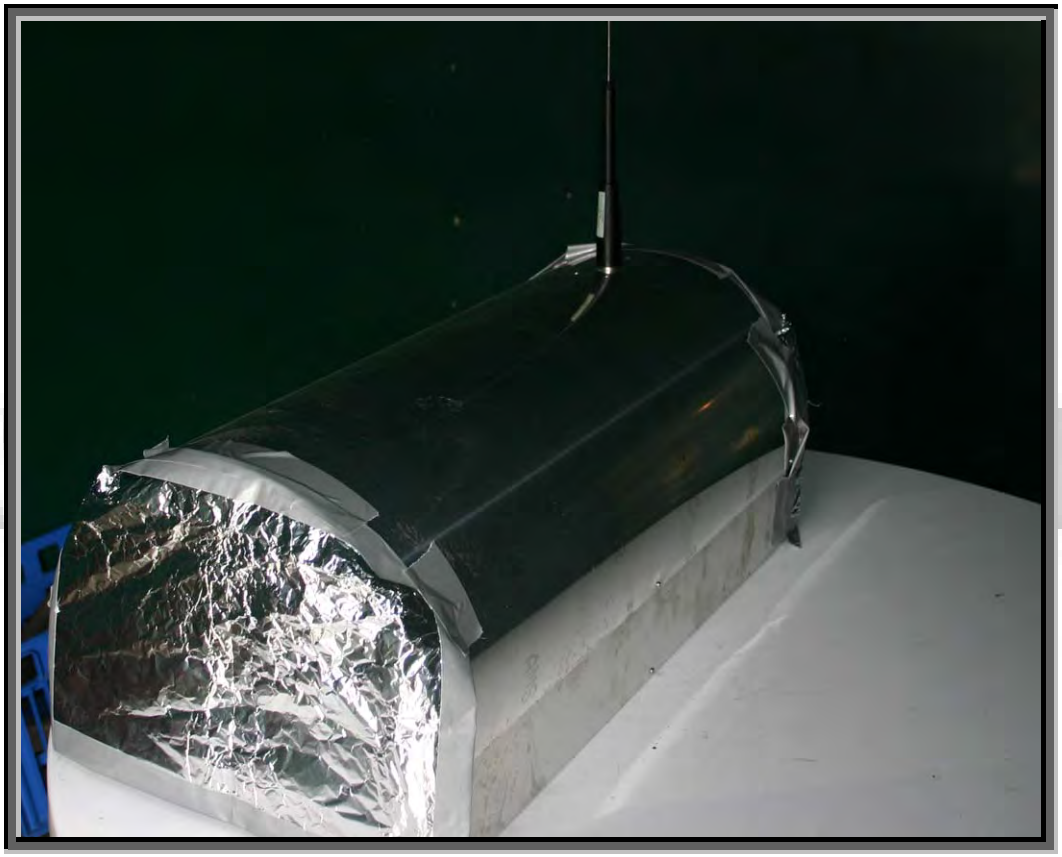
Note red LED showing SASD activated



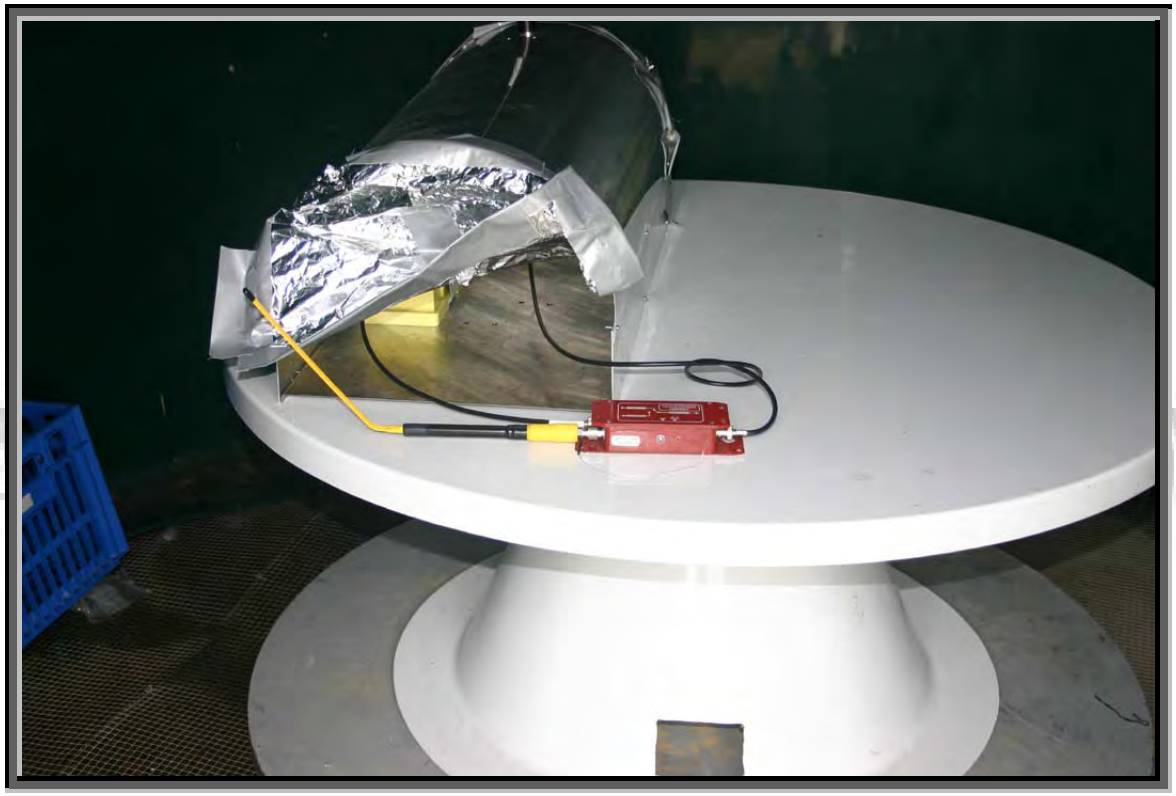
Enclosed test Enclosure rear (NZ local time 1055Hrs)



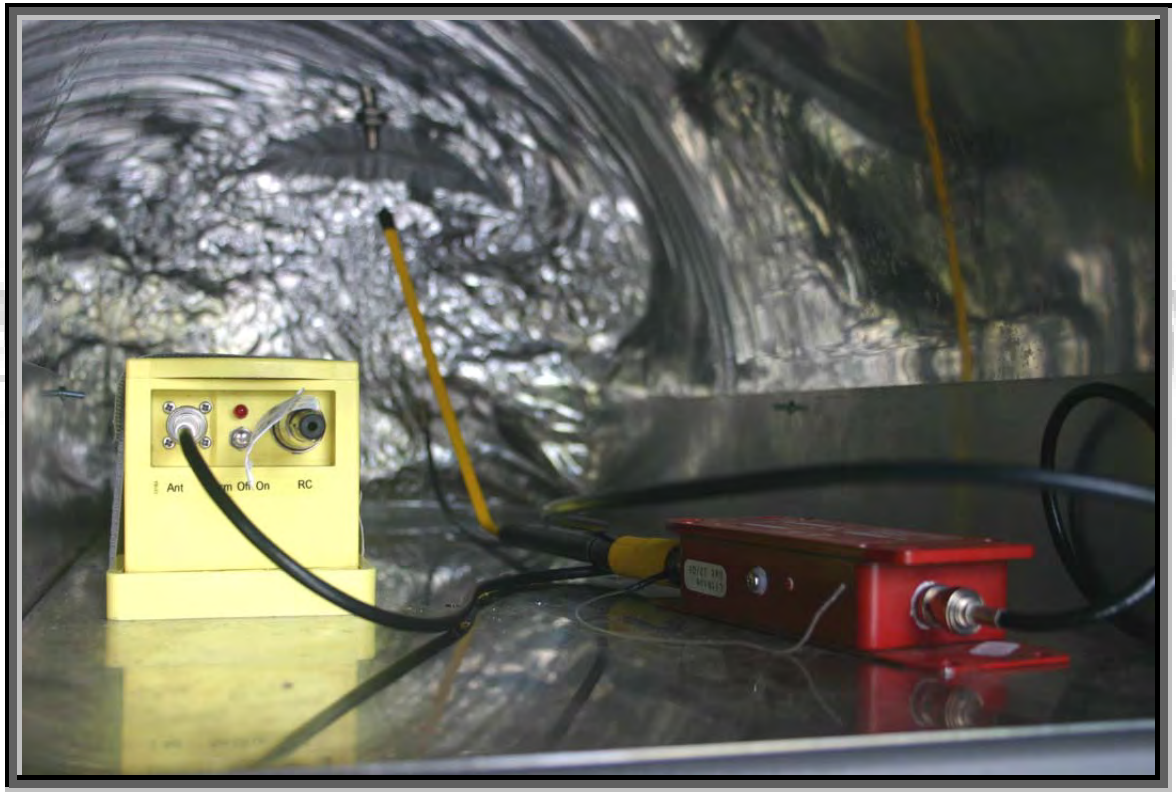
Test with ¼ wave stubby Antenna (NZ local time 1055Hrs)



Fully Enclosed setup (NZ local time 1108Hrs)



Final test enclosed ANT110 (NZ local time 1139Hrs)



ANT110 bent to allow in test rig, note this test the 406MHz antenna is effectively horizontal

(NZ local time 1158Hrs)

GEOSTATIONARY RESULTS line 9-12 inclusive

NZGEO2 406 Active Beacons

	LUT ID	Type	Mode	Country	Beacon ID	Detection Time	#Msg	GPS Latitude (degN)	GPS Longitude (degE)	Satellite ID	Power (dBm)	Frequency (Hz)
1	5123	406 SARR	N	BRA	D8CC4 06630 002F1	2009/042 20:58:54	1	N/A	N/A	211	-136.6	406028091.1
2	5123	406 SARR	N	BRA	D8CC4 05C6C 002F1	2009/042 18:40:55	1	N/A	N/A	211	-141.7	406028031.8
3	5123	TEST	N	CAN	A79EE E26E3 2E1D0	2007/232 23:54:04	121	N/A	N/A	211	-135.7	406021870.9
4	5123	406 SARR	N	CAN	A78DF 01E9E 00261	2009/042 22:35:39	1	N/A	N/A	211	-142.2	406028113.3
5	5123	TEST	N	CAN	A79EE E26E3 2E190	2009/040 15:17:47	121	N/A	N/A	211	-138.6	406022057.6
6	5123	406 SARR	N	CHI	DAA64 BAE62 E8721	2009/042 05:52:09	4	N/A	N/A	211	-148.3	406024485.4
7	5123	406 SARR	N	HON	A9C8C 70A34 D34D1	2009/042 22:24:09	121	N/A	N/A	211	-136.1	406027191.5
8	5123	406 SARR	N	MAL	9F090 30C34 D34D1	2009/042 20:50:15	2	N/A	N/A	211	-141.2	406025122.7
9	5123	TEST	N	NZL	C01FE 870D2 135D1	2009/042 22:41:12	3	N/A	N/A	211	-137.6	406024874.3
10	5123	TEST	N	NZL	C01FE 870D2 13501	2009/042 22:07:12	4	N/A	N/A	211	-139.7	406024876.7
11	5123	TEST	N	NZL	C01FE 870D2 13591	2009/042 21:33:08	17	N/A	N/A	211	-142.8	406024876.5
12	5123	TEST	N	NZL	C01EC C349D D40A1	2009/042 21:02:12	26	N/A	N/A	211	-142.6	406024876.0
13	5123	406 SARR	N	UKM	9D0E1 D2BD4 00001	2009/042 14:35:45	95	N/A	N/A	211	-135.6	406027223.5
14	5123	TEST	N	USA	ADDF8 E345C D35D0	2009/042 17:12:53	121	N/A	N/A	211	-149.0	406028091.5

LUT ID	Satellite ID	Beacon ID	NZ Local time Rx	Frequency (Hz)	Rx Power (dBm)	Bit Rate (bps)	Mean Bit Power
5121	9	C01FE 870D2 13591	2009/042 10:39:51.053	406034102.2	-127.03	2408.692	93.345
5121	9	C01FE 870D2 13591	2009/042 10:40:39.290	406033352.6	-120.26	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:41:27.507	406032966.4	-123.64	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:42:17.844	406032260.7	-121.95	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:43:08.161	406030977.9	-123.64	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:44:00.064	406028598.7	-119.70	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:44:48.816	406025248.8	-119.70	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:45:37.568	406021754.6	-130.98	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:46:29.471	406019120.0	-112.36	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:47:21.373	406017641.4	-140.00	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:47:21.373	406017641.4	-121.39	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:48:10.144	406016883.8	-119.70	2409.056	95.058
5121	9	C01FE 870D2 13591	2009/042 10:48:58.361	406016457.0	-119.13	2409.056	95.058
5121	11	C01FE 870D2 13501	2009/042 11:18:12.954	406031582.1	-130.65	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:19:53.594	406029664.2	-127.90	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:21:34.254	406026314.5	-129.55	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:22:22.494	406024355.8	-133.40	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:23:10.714	406022465.0	-129.00	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:24:01.054	406020783.8	-134.50	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:24:51.374	406019489.0	-132.85	2399.750	83.363
5121	11	C01FE 870D2 13501	2009/042 11:25:43.274	406018523.9	-130.10	2399.914	95.275
5121	11	C01FE 870D2 13501	2009/042 11:26:32.034	406017884.3	-130.65	2399.914	95.275
5121	11	C01FE 870D2 13501	2009/042 11:26:32.034	406017884.3	-130.65	2399.582	80.116

28	5121	TEST	A	N	NZL	C01FE 870D2 13591	2009/042 21:45:37	1	N/A	N/A	N/A	N/A	9	
29	5121	TEST	A	N	NZL	C01FE 870D2 13501	2009/042 22:18:12	17	-36.983	175.208	N/A	N/A	11	
30	5121	PLB SER	A	N	NZL	400E5 815F6 FFBFF	2009/042 07:58:55	1	N/A	N/A	N/A	N/A	7	
31	5121	ORB	A	N	NOR	A0234 BF8A7 335D0	2009/042 23:56:10	28	78.230	15.417	N/A	N/A	10	
32	5121	406 SARP	A	N	NET	9E89D 34334 D34D1	2009/042 12:45:02	13	53.359	-3.769	N/A	N/A	9	
33	5121	406 SARP	A	N	NET	9E8DD 2123B 802F1	2009/042 17:01:32	14	51.431	6.099	N/A	N/A	8	
34	5121	ELT AC24	A	N	NET	1E869 0823C FFBFF	2009/042 08:45:18	4	55.979	37.404	N/A	N/A	8	
35	5121	TEST	A	N	NET	1EDE4 803BF 81FE0	2009/042 09:34:46	2	N/A	N/A	N/A	N/A	9	
36	5121	406 SARP	A								N/A	N/A	11	
37	5121	406 SARP	A								N/A	N/A	11	
38	5121	406 SARP	A								N/A	N/A	10	
39	5121	406 SARP	A								46.000	13.067	9	
40	5121	406 SARP	A								N/A	N/A	10	
41	5121	TEST	A								N/A	N/A	10	
42	5121	406 SARP	A								N/A	N/A	9	
43	5121	TEST	A								N/A	N/A	11	
44	5121	TEST	A								N/A	N/A	10	
45	5121	ORB	B								N/A	N/A	10	
46	5121	TEST	A								46.114	-1.639	9	

These two here for NZ

Google Maps Address

AVIATION SAFETY

SASD Test 12 February 2009

										Power radiated		
			ANT200 Primary Antenna				Antenna #	Desciption	BT100 test	121.5MHz	243MHz	406MHz
Date	Location / Hex #	Test #	Time on	Time off	Time on	Time off			Power Measurements			
12 February 2009	- 36.9849,175.2092	1	1000	1013	1013	1026	ANT110	Open	BT100 2008.54	82%	0	78%
	C01ECC349DD40A1								Vertical, dBuV/m	117.5	108.3	131.2
	C01ECC349DD40A1								Hoizont. dBuV/m	116.6	93.6	116.6
12 February 2009	- 36.9849,175.2092	1A	1000	1013	1013	1026	ANT110	Open	BT100 2008.55	81%	78%	75%
	C01ECC349DD40A1								Vertical, dBuV/m	108.6	108.0	128.8
	C01ECC349DD40A1								Hoizont. dBuV/m	113.1	118.5	124.3
12 February 2009	- 36.9849,175.2092	2	1030	1035	1035	1049	1/4 Wave	Open	BT100 2008.58	64%	0	88%
	C01FE870D213591								Vertical, dBuV/m	100.3	85.3	115.5
	C01FE870D213591								Hoizont. dBuV/m	106.2	82.9	100.5
12 February 2009	- 36.9849,175.2092	3	1105	1114	1117	1135	1/4 Wave	Enclosed	BT100 2008.60	0	0	73%
	C01FE870D213501								Vertical, dBuV/m	69.9	78.5	97.8
	C01FE870D213501								Hoizont. dBuV/m	67.2	77.7	102.8
12 February 2009	- 36.9849,175.2092	4	1140	1145	1145	1200	ANT110	Enclosed	BT100 2008.62	22%	17%	62%
	C01FE870D2135D1								Vertical, dBuV/m	76.4	88.4	95.0
	C01FE870D2135D1								Hoizont. dBuV/m	76.5	92.2	111.0
# Antenna tested were both two frequency antenna only apart from ANT110 = 3 Frequency												
								ANT200	BT100 2008.57	94%	77%	96%
								ANT200	BT100 2008.60	90%	81%	97%

Test # 1 Open ANT200 attached to simulate exterior antenna

Test # 2 Open SASD activated with 3 Freq ANT110 attached to SASD

Test # 3 Open SASD activated with 2 Freq 1/4 wave stubby antenna attached to SASD

Test # 4 Enclosed SASD activated with 2 Freq 1/4 wave stubby antenna attached to SASD

Test # 5 Enclosed SASD activated with 2 Freq 1/4 wave stubby antenna attached to SASD

SASD – SECONDARY ANTENNA SWITCHING DEVICE
Provisional specification

Type Number: 15-56-0002		**Units**
Operating Frequencies	406.025/028	MHz
	121.5	MHz
	243.0	MHz
Insertion loss, input to main antenna port	0.25	dB
Insertion loss, input to alternative antenna port	0.25	dB
SWR all frequencies	1.1:1	
Reverse isolation at 1 metre		dB
SWR detection level (adjustable)	3:1	
Activation delay first burst	5	ms
Activation delay subsequent bursts (locked)	0	ms
Power source - internal	9	volt
Current supply – not active	0	mA
Current supply - active	30	mA
Endurance - active	>24	Hrs
Battery expiry shelf life	5	years
Connector type all ports input /output ELT	BNC	female
Connector type back up antenna	TNC	mm
Antenna ¼ wave 406/121.5MHz		
Environmental standard to be approved	C126	TSO
Fail safe mode (electrical or battery fail) defaults to connection	Main antenna.	

Dimensions SASD 170 x 60 x 35 mm (270grams)
Secondary Antenna 210mm long including TNC connector (53grams)
SASD Fitted preferably in line with ELT on the same structural member.

SASD with ¼ wave antenna

SASD with 406AF-H ELT