

**MACQUARIE ISLAND  
SURVEY PROGRAM**

**FIELD WORK REPORT**

**VOYAGE 3 ROUND TRIP  
NOVEMBER/DECEMBER 1996**



Prepared by Richard Lemon for  
the Australian Antarctic Division  
January 1997



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# **MACQUARIE ISLAND SURVEY PROGRAM FIELD WORK REPORT VOYAGE 3 ROUND TRIP NOVEMBER/DECEMBER 1996**

## **1.0 Introduction**

This report details the survey work carried out on Macquarie Island during November and December of 1996 by the Australian Surveying and Land Information Group (AUSLIG) on behalf of the Australian Antarctic Division's Mapping Program. The principle aim of the program was to acquire aerial photography to enable the production of a new topographic map of the island. A number of other tasks were also required to be carried out. This report deals with each task and the results achieved.

The survey work was carried out by the following people:

Frank Hoogesteger	Tasmanian Department of Environment and Land Management
Roger Handsworth	Platypus Engineering
Richard Lemon	Australian Surveying and land Information Group

Although this report touches on the work carried out by Roger Handsworth and Frank Hoogesteger, it does not cover the specifics of their work, that being the subject of separate reports to be submitted the them.

## **2.0 Time Frame**

The Macquarie Island field party departed Hobart at about 5pm on Monday 25th November 1996 aboard the Aurora Australis, voyage 3 of the ANARE re-supply season. Voyage 3 arrived at Macquarie Island at about 9am eastern standard summer time (UT+11) on Thursday 28th November. The survey party departed Macquarie Island at about 10am on Monday 2nd December and arrived back in Hobart at about 7am on Thursday 5th December 1996.

This provided three and a half days on the island in which to complete the survey program.

### **3.0 Aims and Project Brief**

The 1996/97 Survey Program for Macquarie Island lists the following tasks and those responsible for their execution:

1. Aerial Photography of the island and station area (Lemon/Handsworth)
2. Precise leveling from AFN station, AUS211 RM1 and RM2 to Garden Cove Bench Mark AUS228 (Lemon)
3. Field survey of station buildings and services to check and update Digital Station Information System (Lemon)
4. Install tide gauge staff and carry out water level observations at Garden Cove (Handsworth/Lemon-assist)
5. GPS baseline from the AFN Station AUS211 to the Garden Cove Tide Gauge Bench Mark AUS92 (Lemon)
6. Retrieval of corner cube reflectors for use on Heard Island (Lemon)
7. Re-establish the Management Zone boundaries and identify to the new Station Leader (Hoogesteger)
8. Level connection by GPS from the aurora camera stand NMX1 to Hurd Point Trig. NMX7 (Hoogesteger)
9. Level connection by EDM from Hurd Point Trig NMX7 to tide gauge sensor (Hoogesteger)
10. Download data and Check Hurd Point Tide Gauge. Install temporary tide staff at Hurd Point and take water level and temperature readings (Hoogesteger)
11. Carry out maintenance of the tide gauges at Garden Cove (Handsworth)
12. On an opportunity basis check height and position of features on the plateau for ground truthing of SAR DEM (Lemon)

These tasks are listed in order of priority.

A copy of the 1996/97 Survey Brief for Macquarie Island is included as Appendix A.

### **4.0 Achievements**

#### **4.1 Aerial Photography**

The first day on the island, Thursday 28th November, provided the best weather conditions for aerial photography. The availability of aircraft time was discussed with Warren Papworth (VL) mid afternoon on the first day, by this time the conditions were marginal but still possible with some low cloud. The helicopter engineer was directing flight operations on the Aurora Australis and would have been required to fly over to the island to help install the camera equipment. This would have delayed the cargo operations with the other helicopter. The low level cloud was increasing, the sun angle and light was decreasing. Given the worsening conditions and the time required to fit the camera it was decided to hold off and try later. Unfortunately another opportunity did not present itself.

On the last night, Sunday 1st December, the camera equipment was installed aboard the helicopter in the hope that photography could be acquired before the Aurora Australis was due to sail. By 6:30am on Monday 2nd December it was obvious that photography would not be possible with cloud level at less than 300m and intermittent rain. The camera equipment was removed from the helicopter to enable it to resume cargo and personnel transfer to the Aurora Australis.

#### 4.2 Precise Leveling from AFN Station AUS211 to Garden Cove Tide Gauges

A precise levelling run was made from the AFN Station AUS211 RM2 to the Garden cove tide gauge benchmark AUS228 using an NA2000 digital level. The following stations were included in the levelling run:

NMX1	Steel top of Aurora Camera Stand
NMX1 RM1	Stainless steel bolt grouted in base of Aurora Camera Stand
AUS156	Holding down bolt on anemometer tower
AAE BM1 RM1	Stainless steel bolt grouted in rock
AAE BM1 RM2	Stainless steel bolt grouted in rock

Levels were also measured from AUS228 to AUS91, AUS92, the Aquatrak tide gauge rim and the Druck tide gauge rim. The height differences from the tide gauge rims to the tide gauge reference marks were also measured using a small spirit level and steel ruler.

A copy of the levelling field notes and reductions are included as Appendix B.

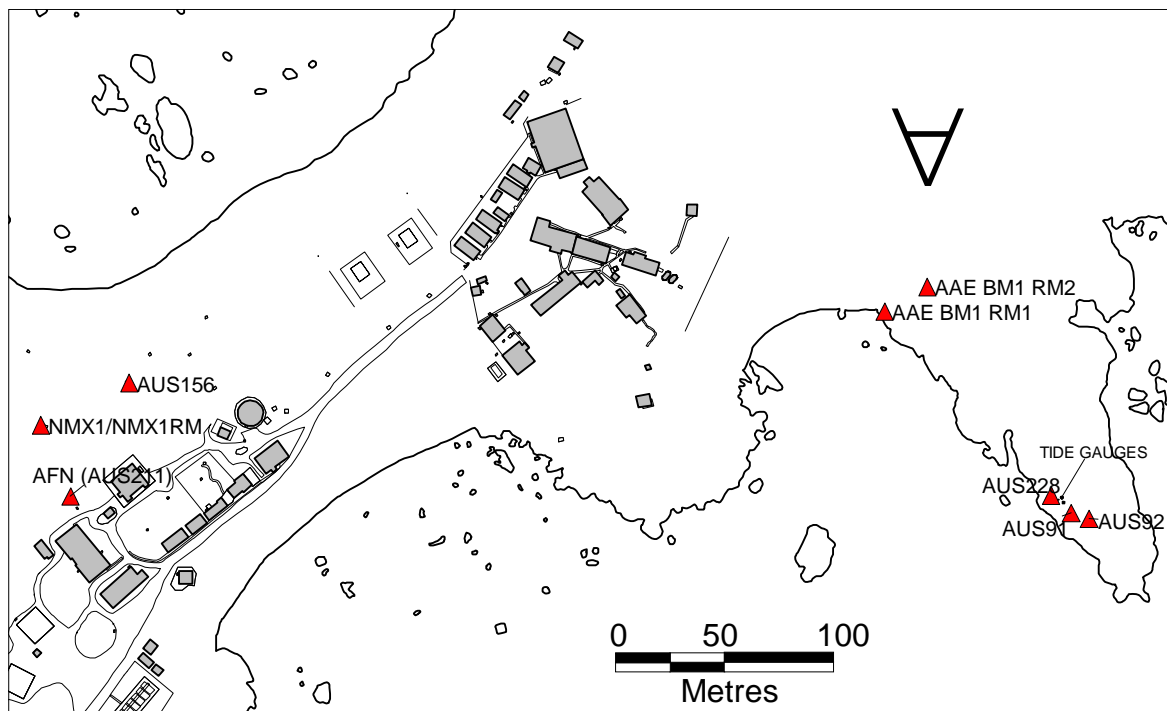
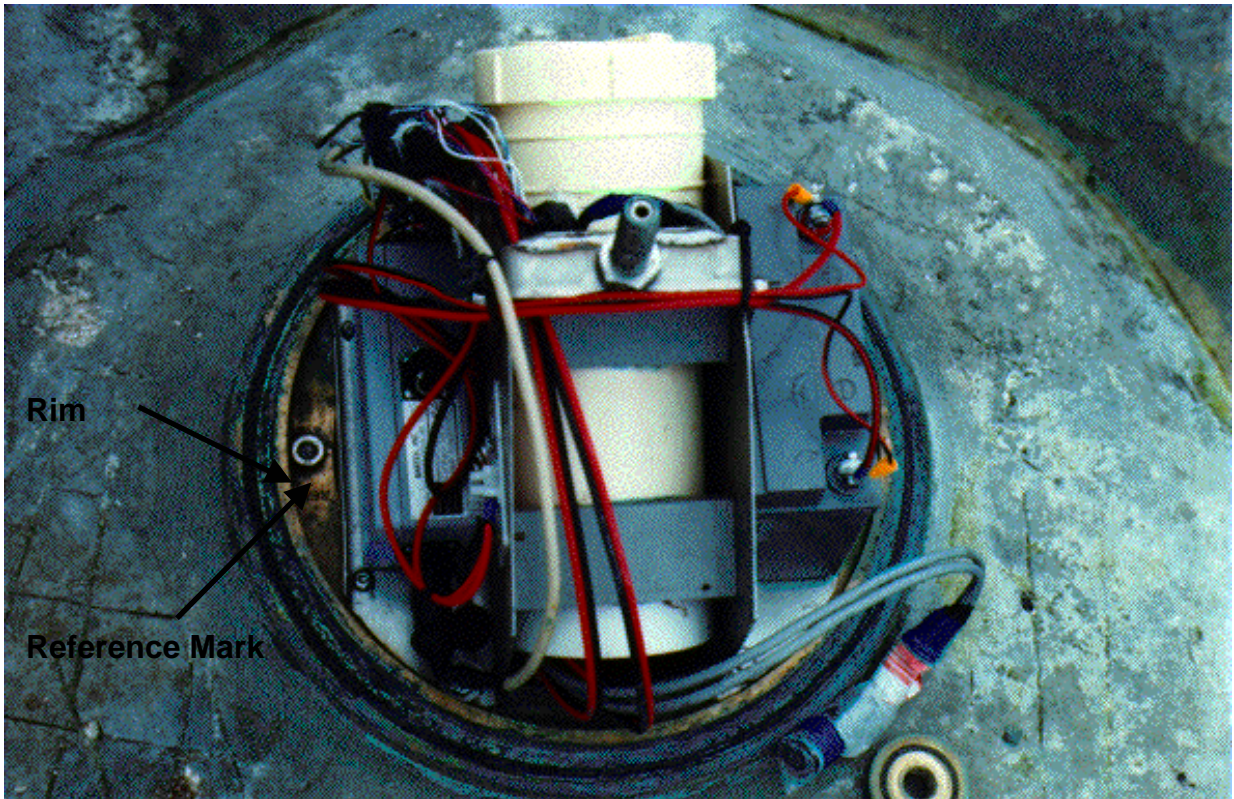
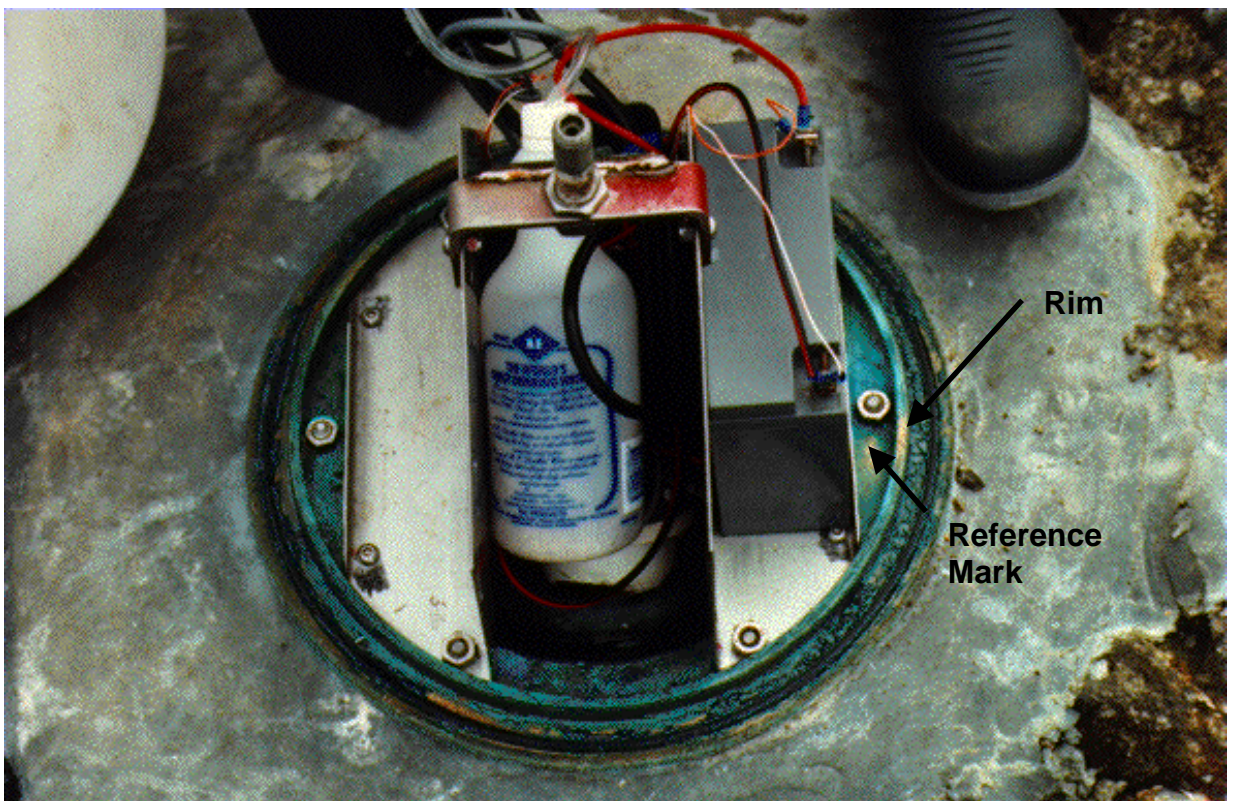


Diagram showing location of survey marks included in the precise levelling

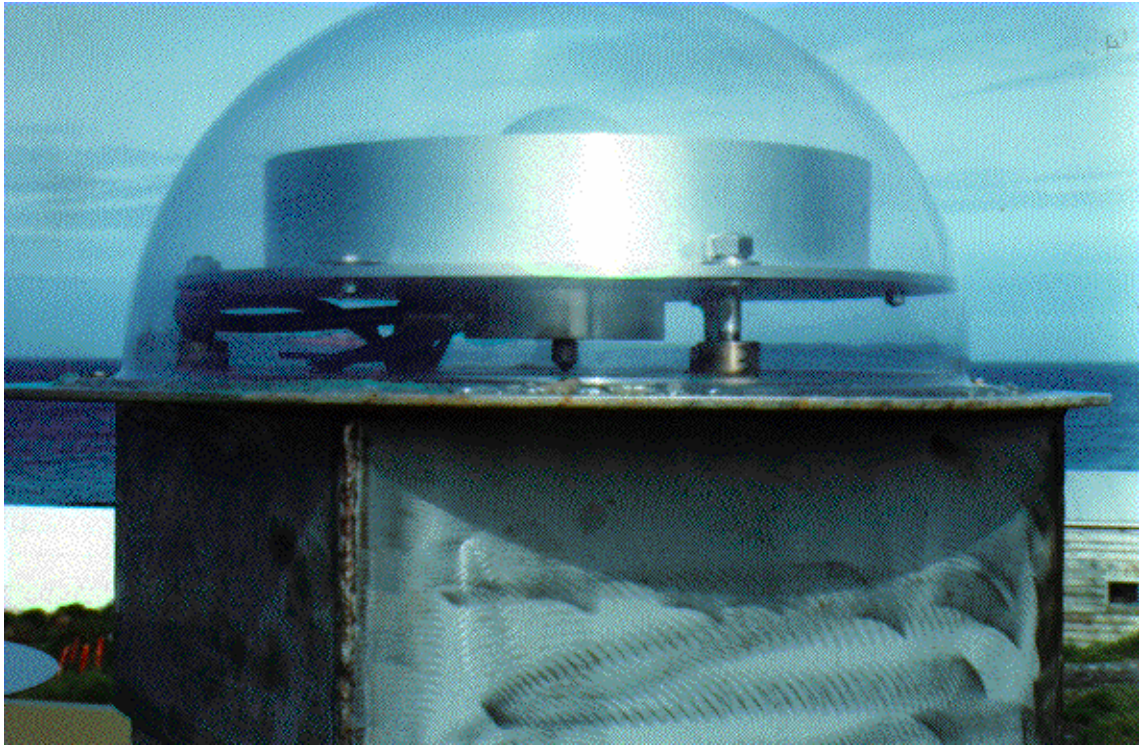


AQUATRAK Tide Gauge - rim and reference mark

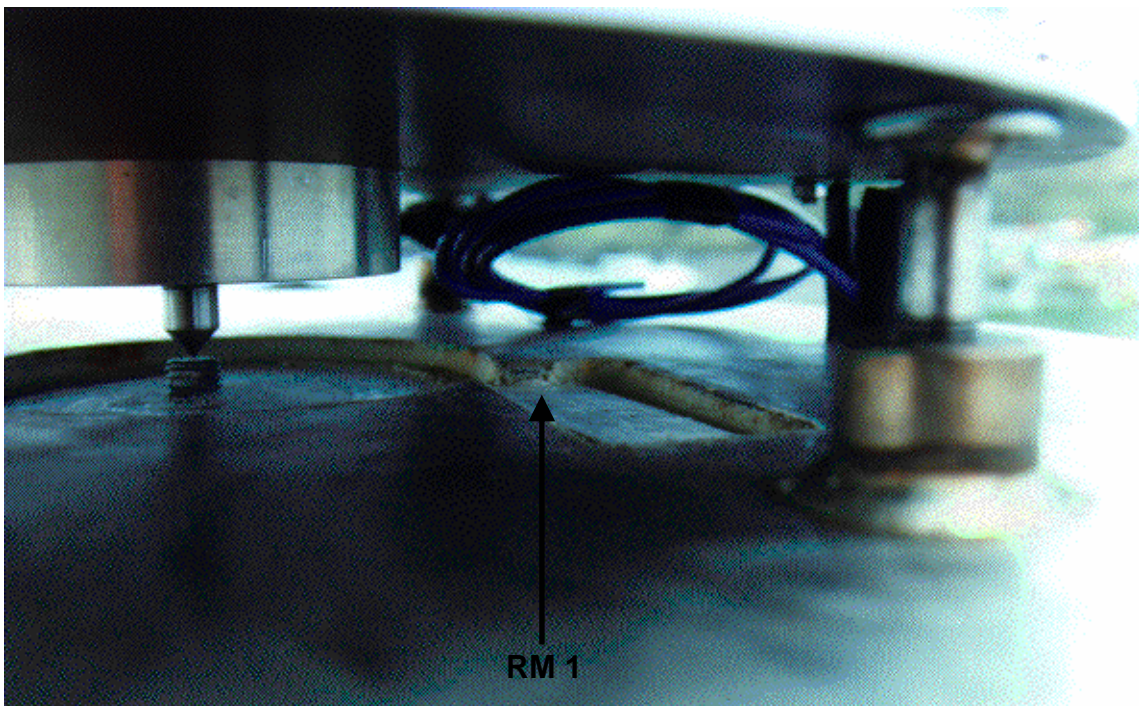


Druck Tide Gauge - rim and reference mark

In addition to the above, the height relationship between AUS211 RM1 and AUS211 RM2 was measured. This involved the removal of the weather proof perspex dome from the AFN GPS antenna. The dome was replaced and resealed on completion of this task.



AFN (AUS211) Weather proof perspex dome



AUS211 RM1



RM 2

AUS211 RM2

A summary of all new reduced levels is included at Appendix C.

#### **4.3 Update of Digital Station Information System**

The station facilities were checked for new and demolished buildings. There was one new building, 'Cumpston Cottage', this was surveyed and located with respect to the existing buildings.





Cumpston Cottage

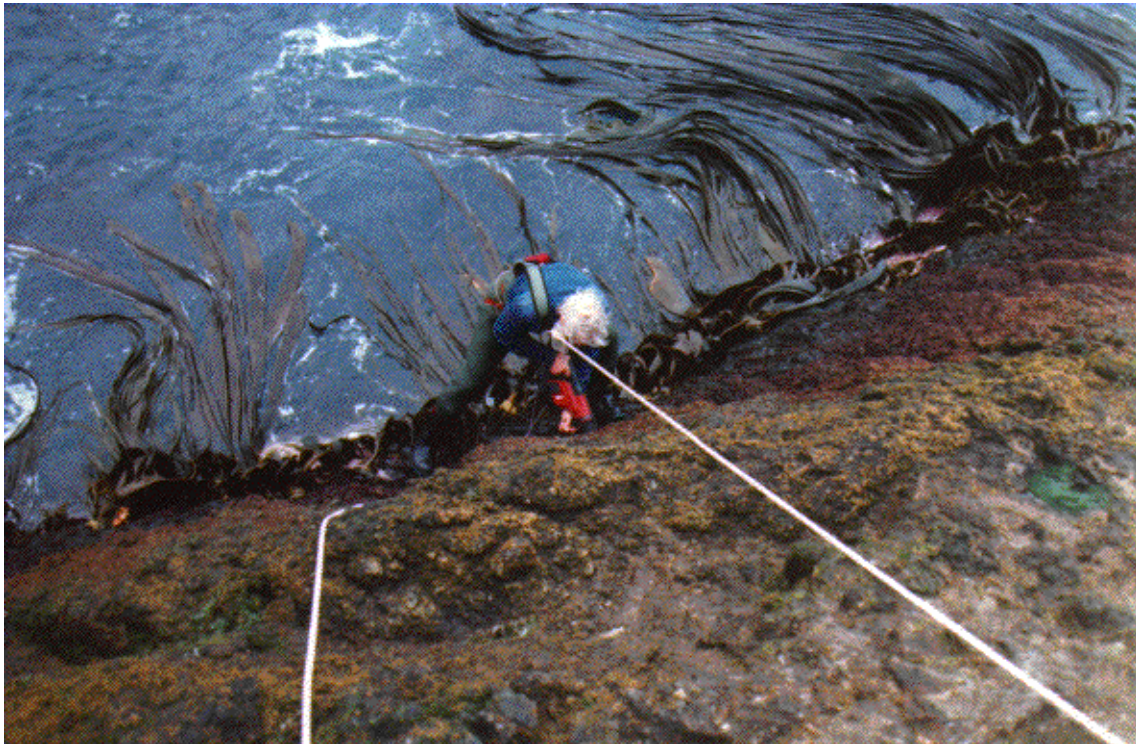
Service pits were also located by offsets from buildings and their sizes and orientations measured. Some features, including antenna guys and communication pits, outside the main station area were surveyed using Kinematic GPS. All survey information has been supplied to AUSLIG's Canberra office to enable updating of the Antarctic Division's Station Database.



Service Pits - near Emergency Power House

#### 4.4 Installation of tide staff and water level observations at Garden Cove

A tide staff was suspended from a fixture bolted to the sea wall face at Garden Cove in a swell which made drilling the holes and assembling the fixture difficult.



Roger Handsworth drilling bolt holes for tide staff in difficult conditions



Roger Handsworth checking the fixture after installation

The swell was too great to be able to take meaningful water level readings from the staff. The staff and fixture have been left in place in the hope that it will survive the seas for long enough for readings to be taken in a flat sea by station personnel.

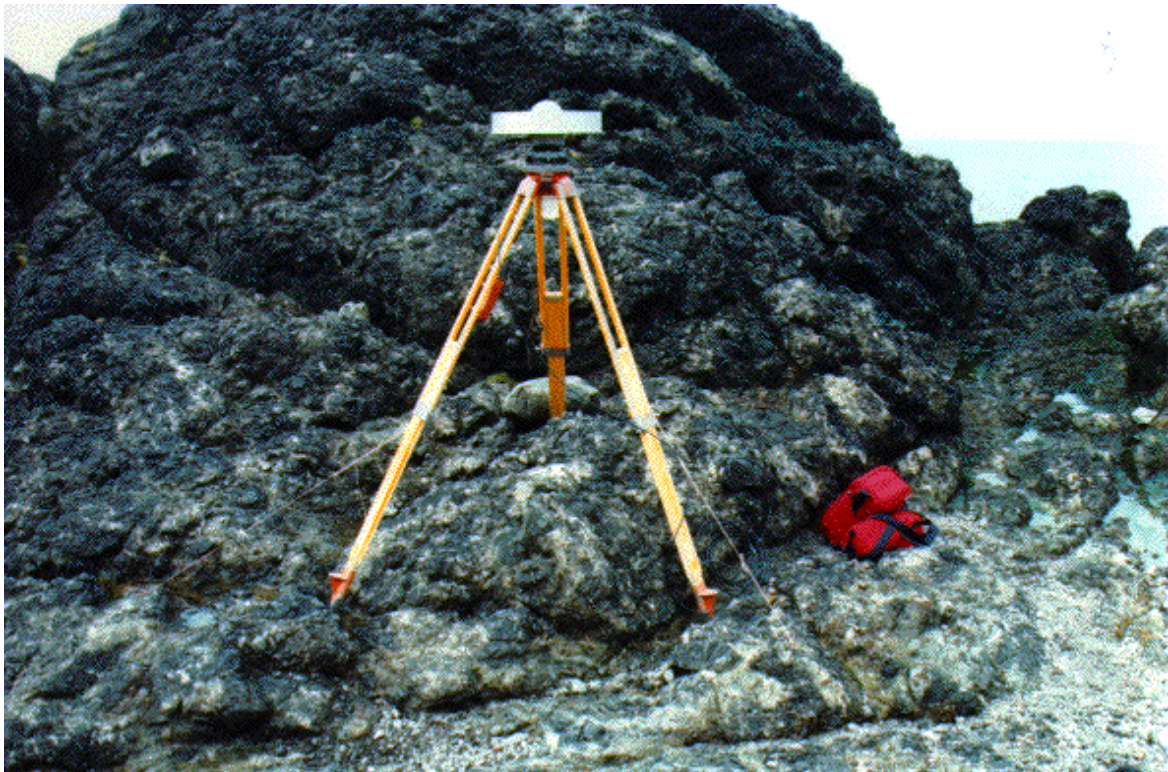
The tide staff was levelled by connection to AUS228. When abandoned, the zero of the tide staff had a reduced level of -0.530m based on a level of 3.297m for AUS228. Levelling field notes and reductions are included as Appendix B.

This task is the subject of a more detailed report by Roger Handsworth.

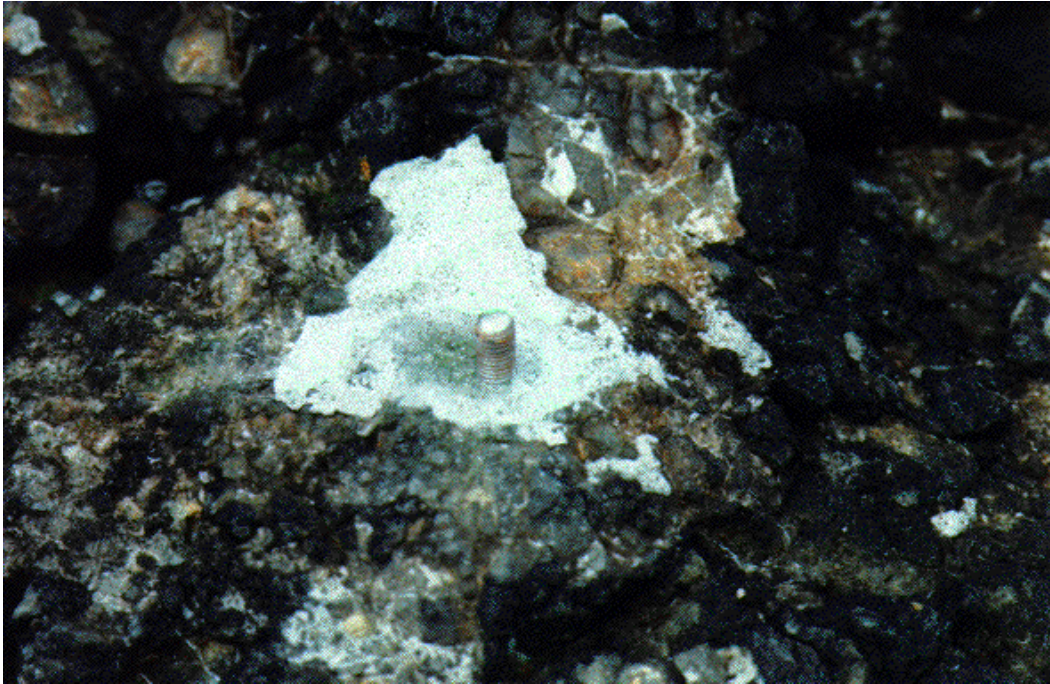
#### **4.5 GPS baseline from AFN station AUS211 to Garden Cove Tide Gauge Bench Mark AUS92**

An Ashtech Z12 GPS receiver equipped with a Dorne Margolin T antenna was used at AUS92 (a bench mark at the Garden Cove tide gauges). This antenna being the same as the one used at the AFN station. The equipment was centred over AUS92 using a tripod and tribrach and tied in place. Twenty hours of GPS data was collected at AUS92 before being notified that the AFN GPS system was not logging data. The Rogue GPS receiver was disconnected from the AFN antenna and another Ashtech Z12 GPS receiver was connected. Twenty four hours of common data was collected at the AFN and AUS92.

AUS92 was found to be missing its identification tag.



GPS receiver set up on AUS92



AUS92 - missing its identification tag

The results of the GPS processing and comparisons with previous results are shown at Appendix D.

#### **4.6 Retrieval of Corner Cube Reflectors**

On arrival the corner cube reflectors had been collected from the field and were in the store, packaged ready for transport to the Aurora Australis. Prior to departure the store was checked and the corner cube reflectors were no longer there. Phil Barnhaart the new station leader said they had definitely been loaded onto the ship.

#### **4.7 Management Zone Boundaries**

The locations of the surveyed marks placed by Noel Ward in January 1996 were re-established and flagged with red tape. The existence and approximate location of the zone boundaries were discussed with Phil Barnhaart, the new station leader.

This task is the subject of a more detailed report by Frank Hoogesteger.

#### **4.8 GPS baseline from Hurd Point Trig NMX7 to Aurora Camera Stand NMX1**

It was hoped that connection could be made between NMX1 at the Station and NMX7 at Hurd Point. Due to an equipment problem this was not possible. Had this connection been possible it would have provided a check on a previous measurement.

This task is the subject of a more detailed report by Frank Hoogesteger.

#### **4.9 Level Connection from Hurd Point Trig to Hurd Point Tide Gauge**

The Hurd Point tide gauge was connected by trigonometric levelling to Hurd Point Trig NMX7.

This task is the subject of a more detailed report by Frank Hoogesteger.

#### **4.10 Hurd Point Tide Gauge**

##### **4.10.1 Download Data and Check Tide Gauge**

The tide gauge was found to be in good working order and the data was retrieved. The gauge will probably require maintenance in 12 months time.

This task is the subject of a more detailed report by Frank Hoogesteger.

##### **4.10.2 Installation of Tide Staff at Hurd Point and Water Level Readings**

A temporary tide staff was erected in the vicinity of the Hurd Point tide gauge. Sea water levels were observed every ten minutes for an hour before and an hour after high and low tides on 29th November 1996 (ie at approximately 3.00pm (high) and 9.00pm (low)). The temporary tide staff was subsequently removed.

This task is the subject of a more detailed report by Frank Hoogesteger.

#### **4.11 Maintenance of Garden Cove Tide Gauges**

Both tide gauge installations at Garden Cove were checked and found to be undamaged. The maintenance of the gauges is the subject of a detailed report by Roger Handsworth. However, the maintenance procedure provided an opportunity to acquire some height measurements within the Aquatrak assembly.

The Aquatrak installation was disassembled down to the removal of the acoustic wave guide. Prior to removal, the level of the sensor reference point relative the tide gauge reference mark was measured. After installation the level of the new sensor reference point was also measured. The positions of the sensor reference points were identified by Roger Handsworth.

Diagrams of the Aquatrak tide gauge assembly and dimensions before and after maintenance are at Appendix E.

#### **4.12 Ground truthing for SAR DEM**

This was a very low priority item and with the limited time available there was no opportunity to carry out this task.

### **5.0 Remarks**

#### **5.1 Aerial Photography**

This is the latest of many unsuccessful attempts at acquiring aerial photography of Macquarie Island. If aerial photography is to be considered a priority for the Mapping Program's support of the scientific community it is evident that a different approach is required. Attempting to acquire a systematic coverage during a three to four day re-supply visit is unrealistic owing to the short time frame, emphasis on cargo operations and generally poor weather conditions. Other options put forward by Noel Ward in January this year are:

- Leave a suitably equipped aircraft on the island for a short summer season
- During a short ship visit place one aircraft under the control of the mapping program so that cargo operations cannot compromise attempts at aerial photography
- Engaging a contractor to acquire photography on a pay on results basis

Because of the weather conditions it is unrealistic to expect to be able to acquire photography of the whole island in one mission during a re-supply visit. The aircraft is required for cargo operations and it takes about 1-2 hours to equip the helicopter. If an aircraft were equipped and dedicated to the aerial photography it may be possible to photograph the island 'bit by bit' as the weather allows.

To improve response time most of the camera equipment could be permanently pre-fitted to the rack and a full wiring harness developed. This would reduce the time it takes to fit the camera equipment into the helicopter, enabling a faster response when weather conditions become suitable for aerial photography.

#### **5.2 GPS Problems at Hurd Point**

Problems with the Leica GPS equipment prevented the measurement of the baseline from the Aurora Camera Stand NMX1 to Hurd Point Trig NMX7. These problems may have been avoided if the surveyor, Frank Hoogesteger, had had the opportunity of testing the equipment prior to the departure of voyage 3.

## 6.0 Acknowledgments

Our thanks go to Warren Papworth (VL) and the voyage support team for their support for the surveying and tide gauge program. Also our thanks go out to the station leader and all station personnel, the pilots and aircraft engineer and the ships crew who were all extremely helpful.

Special thanks to Tamara Kincade for her assistance with the levelling in difficult conditions and Alison Phillips for her guidance and assistance in the work conducted at Hurd Point.

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**APPENDIX A: Survey Brief**









## **APPENDIX B: Levelling Field Notes and Reductions**











**APPENDIX C: Summary of Reduced Levels**

<u>Station</u>	<u>RL(m)</u>
AUS211 RM2	11.681
AUS211 RM1	12.883
NMX1 (northern corner)	10.494
NMX1 RM	9.161
AUS156	5.723
AAE BM1 RM1	1.903
AAE BM1 RM2	2.598
AUS228	3.297
AUS91	3.332
AUS92	3.495
AQUATRAK RIM	3.228
AQUATRAK REFERENCE MARK	3.212
DRUCK RIM	3.352
DRUCK REFERENCE MARK	3.336

**NOTE: ALL REDUCED LEVELS BASED ON STATION AUS211 RM2 HELD FIXED AT 11.681.**

**APPENDIX D: GPS Baseline Results**

**Project Report: Macquarie Island - Bern Processing - January 1997**

GPS data over three campaigns collected on Macquarie Island were processed using the Bernese processing package version 3.5. The precise IGS orbits were used for all computations. Constant L1 and L2 antenna phase centre offset modelling was used. The coordinates of the Rogue receiver at MAC1 were held fixed using coordinates obtained from MicroCosm results computed by Govind (see below). The coordinates are in the ITRF93 reference frame at epoch 1995.64 (day 233 of 1995). All geodetic coordinate values refer to the WGS84 ellipsoid. All coordinates are listed to the same number of decimal places as appear on the Bernese solution output files

MAC1	X	-3464038.5210
	Y	1334172.7760
	Z	-5169224.4020
	HEIGHT	-6.6886
	LATITUDE	-54 29 58.318540
	LONGITUDE	158 56 9.001628

**Results - December 1994 Observations**

Computed coordinates from the December 1994 data are listed below. A L1&L2 solution was computed and all the ambiguities were resolved. Due the proximity of the stations no tropospheric parameters were estimated. Bernese solution output file GPSEST.L05 of 30/05/96 11:59.

8	AU92	X	-3464193.8514
		Y	1333729.5124
		Z	-5169223.0031
		HEIGHT	-16.1514
		LATITUDE	- 54 29 58.669672
		LONGITUDE	158 56 35.088282
10	NMX1	X	-3464057.2829
		Y	1334194.5579
		Z	-5169203.4008
		HEIGHT	-9.0724
		LATITUDE	- 54 29 57.257025
		LONGITUDE	158 56 8.246879
9	NM14	X	-3463957.9998
		Y	1334073.1889
		Z	-5169289.8646
		HEIGHT	-17.8134
		LATITUDE	- 54 30 2.468743
		LONGITUDE	158 56 12.557507

<u>Station</u>	<u>Bern. ID</u>	<u>ARP</u> <u>height</u>	<u>Receiver</u>	<u>Antenna</u>	<u>Obs. Session (UT)</u>
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AUS211	MAC1	0.0675	Rogue 8100	SNR-	Dorne Margolin T	4/12/94 23:59:30	00:00:30	-
AUS211	MAC1	0.0675	Rogue 8100	SNR-	Dorne Margolin T	5/12/94 23:59:30	00:00:30	-
AUS211	MAC1	0.0675	Rogue 8100	SNR-	Dorne Margolin T	6/12/94 23:59:30	00:00:30	-
AUS092	AU92	1.0006	Ashtech Z-XII3		Dorne Margolin T	4/12/94 24:00:00	05:53:30	-
AUS092	AU92	1.0006	Ashtech Z-XII3		Dorne Margolin T	5/12/94 03:22:30	00:00:30	-
AUS092	AU92	0.870	Ashtech Z-XII3		Dorne Margolin T	6/12/94 20:35:00	09:58:00	-
NM/X/1	NMX1	0.074	Ashtech Z-XII3		Dorne Margolin T	5/12/94 14:25:30	11:14:30	-
NM/X/14	NM14	0.940	Ashtech Z-XII3		Dorne Margolin T	5/12/94 27:52:30	23:21:00	-

See AUSLIG fieldbook C0092 for receiver and antenna setup details.  
The observation session at AUS092 on 5/12/94 not included in above Bernese solution.

### Results - January 1996 Observations

The 1996 data was processed in two parts. The part 1 processing consisted of the shorter lines (AUS211-AUS092 and AUS211-NM/X/1). For these, a L1&L2 solution was computed, no tropospheric parameters were estimated. All ambiguities were resolved.

Part 2 consists of the longer baselines (AUS211-AUS190, AUS211-AUS188 and AUS188-AUS191). A L3 solution was computed, all L1&L2 ambiguities were resolved and 12 tropospheric parameters were estimated per day for each station.

#### Mac96 - Part 1 Bernese solution output file GPSEST.L04 of 30/05/96 12:11.

```

6 AU92          X          -3464193.8501
                Y           1333729.5134
                Z          -5169223.0058

                HEIGHT          -16.1497
                LATITUDE   - 54 29 58.669745
                LONGITUDE   158 56 35.088208

4 NMX1          X          -3464057.2848
                Y           1334194.5584
                Z          -5169203.4114

                HEIGHT          -9.0626
                LATITUDE   - 54 29 57.257174
                LONGITUDE   158 56  8.246887
    
```

#### Mac96 - Part 2 Bernese solution output file GPSEST.L05 of 30/05/96 11:59.

```

2 A190          X          -3439135.2112
                Y           1331929.8920
                Z          -5186565.7810

                HEIGHT          220.3226
                LATITUDE   - 54 45 56.873399
                LONGITUDE   158 49 45.471816

3 A188          X          -3438303.3190
    
```

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Y 1331754.8461  
 Z -5186875.7587  
 HEIGHT -10.4425  
 LATITUDE - 54 46 24.817822  
 LONGITUDE 158 49 37.796522

5 A191

X -3442231.7838  
 Y 1333025.2303  
 Z -5184339.4479  
 HEIGHT 297.2065  
 LATITUDE - 54 43 48.617440  
 LONGITUDE 158 49 50.886860

<u>Station</u>	<u>Bern. ID</u>	<u>ARP height</u>	<u>Receiver</u>	<u>Antenna</u>	<u>Obs. Session (UT)</u>
AUS211	MAC1	0.028	Rogue SNR-8100	Dorne Margolin T	8/1/96 00:19:00 - 24:00:00
AUS211	MAC1	0.028	Rogue SNR-8100	Dorne Margolin T	9/1/96 00:00:30 - 24:00:00
AUS092	AU92	0.8875	Ashtech Z-XII3	Dorne Margolin T	8/1/96 22:59:00 - 24:00:00
AUS092	AU92	0.8875	Ashtech Z-XII3	Dorne Margolin T	9/1/96 00:00:30 - 12:28:30
NM/X/1	NMX1	0.078	Ashtech Z-XII3	Geodetic L1/L2 III	8/1/96 03:42:00 - 08:08:00
AUS188	A188	1.150	Leica SR299	Internal	8/1/96 04:45:30 - 23:59:30
AUS188	A188	1.150	Leica SR299	Internal	9/1/96 00:00:00 - 05:52:30
AUS190	A190	1.755	Leica SR299	Internal	8/1/96 06:56:00 - 08:01:00
AUS191	A191	1.750	Leica SR299	Internal	9/1/96 01:23:30 - 03:33:00

See AUSLIG fieldbook C0092 for receiver and antenna setup details.

**Results - November 1996 Observations**

Computed coordinates from the November 1996 data are listed below. A L1&L2 solution was computed and all the ambiguities were resolved. Due the proximity of the stations no tropospheric parameters were estimated. Bernese solution output file GPSEST.L00 of 08/01/96 11:14.

```

6  AU92          X          -3464193.8507
                   Y          1333729.5095
                   Z          -5169223.0019

                   HEIGHT      -16.1533
                   LATITUDE    - 54 29 58.669695
                   LONGITUDE   158 56 35.088419

```

<u>Station</u>	<u>Bern. ID</u>	<u>ARP height</u>	<u>Receiver</u>	<u>Antenna</u>	<u>Obs. Session (UT)</u>		
AUS211	MAC1	0.028	Ashtech Z-XII3	Dorne Margolin T	30/11/96	00:00:30	-
					23:59:30		
AUS92	AU92	1.075	Ashtech Z-XII3	Dorne Margolin T	30/11/96	00:10:00	-
					23:59:30		

**Comments**

Six separate days of data with varying observation session lengths has been collected between AUS211 and AUS092. This data was processed separately to give an indication of repeatability. Adopting identical *a priori* coordinate values (from Bernese solution output file GPSEST.L05 of 30/05/96 11:59) for the station AUS092 coordinate estimate, the table below shows the variation of the estimated coordinates for station AUS092 from each Bernese solution of the individual daily data sets. The larger corrections to the height component previously identified for the 4/12/94 and 5/12/94 observation sessions in the May 1996 report have been eliminated during the January 1997 reprocessing of all sessions on this baseline .

Variation in estimated coordinate components for AUS092  
from solutions of daily data sets on baseline from AUS211 to AUS092

Obs. Session	$\Delta$ Height (m)	$\Delta$ Latitude (m)	$\Delta$ Longitude (m)	Bernese Solution Output File
04/12/94	+0.0033	+0.0029	-0.0009	GPSEST.L06 of 08/01/97 12:45
05/12/94	+0.0031	+0.0001	-0.0058	GPSEST.L07 of 08/01/97 14:21
06/12/94	-0.0060	-0.0044	+0.0027	GPSEST.L08 of 08/01/97 15:09
08/01/96	+0.0026	-0.0022	-0.0015	GPSEST.L06 of 08/01/97 17:54
09/01/96	+0.0015	-0.0022	-0.0013	GPSEST.L07 of 08/01/97 18:03
30/11/96	-0.0019	-0.0007	+0.0024	GPSEST.L02 of 09/01/97 17:30

**APPENDIX E: AQUATRAK Tide Gauge Internal Measurements**