



# PROJECT PLAN

PGS Geophysical

Origin Energy

MV RAMFORM STERLING

Bellerive 3D Seismic Survey  
Block T30P - Offshore Tasmania  
Otway Basin, Australia

Project no 2010184

version **2**



**AUTHORISATION**

Leif-Inge Iversen

Singapore

Operations Manager



01<sup>st</sup> February 2011

**DISTRIBUTION**

DESTINATION	MEDIA
Master	
Party Chief	
Chief Seismic	
Chief Mechanic	
Chief Navigator	
Chief QC Geophysicist	
Support vessel – M/V OCEAN DYNASTY	
Origin Energy – Brisbane	
Operations Manager – RAMFORM STERLING	
PGS Geophysical archive	
Crew lounge *	
Marie Henøen - Designated person – PGS Geophysical AS *	

\* Part 1 - 3 only

**REVISED VERSIONS: Note: Amendments/Updates are highlighted in RED**

NUMBER	CHANGES	AUTHOR	DATE
2	Page 4: Contents Page [ <b>Updated to include Appendix 9.7</b> ] Page 8: Section 1.4 Survey area information [ <b>Updated</b> ] Page 11: Cetaceans [ <b>Updated</b> ] Page 14: Section 2.3 Origin Energy contacts [ <b>Updated</b> ] Page 15: Section 2.4 Onboard Representatives [ <b>Updated</b> ] Page 23: Section 4.1 Data Acquisition Parameters [ <b>Updated</b> ] Page 26: Section 5 Deliverables [ <b>Updated Navigation</b> ] Page 28: Section 6.1.2 Datum Shift from GDA94 to WGS84 [ <b>Updated</b> ] Page 109: <b>Appendix 9.7 International Terrestrial Reference Frame (ITRF) to GDA94 Coordinate Transformations [NEW]</b>	Leif-Inge Iverse	01.02.2011

---

**CONTENTS**

<b>1</b>	<b>GENERAL</b>	<b>5</b>
1.1	SCOPE OF WORK	5
1.2	SURVEY AREA OVERVIEW	6
1.3	HSE OBJECTIVES	7
1.4	SURVEY AREA INFORMATION	8
<b>2</b>	<b>COMMUNICATION</b>	<b>13</b>
2.1	KEY PERSONNEL OFFSHORE	13
2.2	PGS OFFICE PERSONNEL	13
2.3	ORIGIN ENERGY CONTACTS	14
2.4	ONBOARD REPRESENTATIVES	15
2.5	VESSEL	15
2.6	SUPPORT / CHASE VESSELS	15
2.7	VESSEL MANAGEMENT COMPANIES	16
2.8	AGENT	17
2.9	OTHERS	18
<b>3</b>	<b>EMERGENCY PROCEDURES</b>	<b>19</b>
3.1	EMERGENCY NUMBERS	19
3.2	CONTINGENCY CONTACTS	20
3.3	MEDEVAC FLOW CHART	21
3.4	ACCIDENT AND INCIDENT COMMUNICATION FLOW CHART	22
<b>4</b>	<b>TECHNICAL INFORMATION</b>	<b>23</b>
4.1	DATA ACQUISITION PARAMETERS	23
4.2	MINIATURE OF PREPLOT	24
4.3	LINE NAMES	25
4.4	SHOT NUMBERING	25
4.5	TAPE NUMBERING	25
<b>5</b>	<b>DELIVERABLES</b>	<b>26</b>
5.1	DATA SHIPMENT DETAILS	27
<b>6</b>	<b>POSITIONING</b>	<b>28</b>
6.1	GEODETIC REFERENCE	28
6.2	SURFACE POSITIONING	29
6.3	GPS COVERAGE	29
6.4	ACOUSTIC NETWORK	30
6.5	MAGNETIC COMPASSES	31
6.6	SOUND PROPAGATION VELOCITY MEASUREMENTS	31
<b>7</b>	<b>BINNING GRID</b>	<b>32</b>
7.1	GRID DEFINITION	32
7.2	3D BIN COVERAGE SPECIFICATIONS	33
<b>8</b>	<b>ACQUISITION QC</b>	<b>34</b>
8.1	ACQUISITION QC SEQUENCE	34
8.2	ADDITIONAL REQUIREMENTS	34
<b>9</b>	<b>APPENDIX</b>	<b>35</b>
9.1	SOURCE MODELLING	36
9.2	SOURCE DROP-OUT SPECIFICATIONS	51
9.3	PGS STANDARD NAVMERGED SEG-Y FORMAT	67

---

9.4	AUSTRALIAN CETACEAN MONITORING GUIDELINES .....	71
9.5	BRIDGING DOCUMENT .....	85
9.6	INTERNATIONAL SOS - MEDICAL EMERGENCY RESPONSE PLAN .....	86
9.7	INTERNATIONAL TERRESTRIAL REFERENCE FRAME (ITRF) TO GDA94 COORDINATE TRANSFORMATIONS ...	109

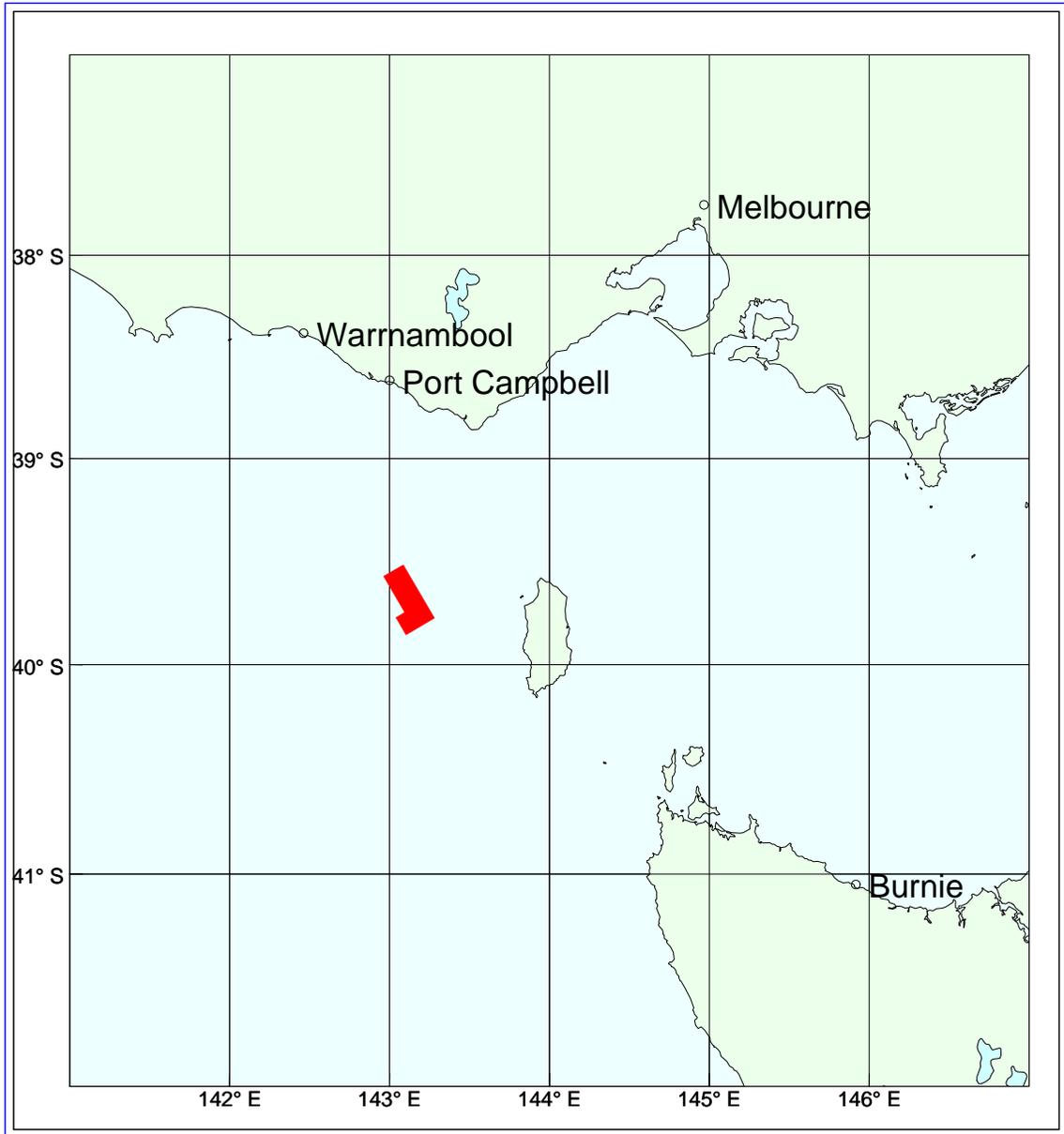
# 1 GENERAL

## 1.1 Scope of work

Type of Survey	:	Contract 3D - Towed Streamer
Client	:	Origin Energy
Location	:	Block T/34P Tasmania, Otway Basin - Australia
Survey size	:	451.77 km <sup>2</sup> (Full Fold Sail Area - preplot ver. 2)
Vessel	:	M/V RAMFORM STERLING
Support Vessel	:	M/V OCEAN DYNASTY
Mobilisation	:	Sydney tentatively 20 <sup>th</sup> - 21 <sup>st</sup> January 2011
Time schedule	:	15 days for the survey

This document is highlighting the main parameters and giving an overview of the survey area and the expected conditions. Reference is made to the contract between Origin Energy and PGS.

## 1.2 Survey area overview



### **1.3 HSE Objectives**

Refer to the following document which will be issued in separate volume:

Otway and Bass Basins 3D Seismic Program Environment Plan

Reference should also be made to:

Bridging Document - Appendix 9.6

#### **1.3.1 PGS objectives:**

These will be given when the Level 3 Plan for 2011 is issued.

#### **1.3.2 Client objectives:**

Origin Energy's HSE goals for the Chappell 3D survey:

- Nobody gets hurt
- No damage to the environment
- No complaints from third parties
- Promote a proactive HSE culture

## 1.4 Survey area information

### Oilfield installations and Oilfield activity

There is no known activity within the survey area.

The nearest oilfield installation is the Thylacine platform 20 nm northwest of the surveys area. The Thylacine well head platform is remotely operated with **Origin** as operator.

### Shipping Activity

Bass Strait and the entrance to the strait is one of Australia's busiest shipping areas with more than 3,000 vessels passing through Bass Strait each year. The Bellerive 3D seismic survey area is south of the main east-west shipping lane in the region.

Any vessels crossing or coming near the deployed equipment should be logged with all data available.

The M/V RAMFORM STERLING will be assisted by the support vessel M/V OCEAN DYNASTY, which may also be used for re-supply. In addition will the local fishing vessel M/V WESTERN LIGHT assist as a chase vessel.

### Fishing Activity

The survey area is the subject of a number of fisheries.

Activity in the survey area is limited to the Commonwealth managed demersal trawl, demersal longline and the Victorian managed Southern Rock lobster and Giant Crab fisheries.

In addition to the support vessel M/V OCEAN DYNASTY, PGS will employ the local fishing vessel M/V WESTERN LIGHT (supplied by West Cape Fisheries) to scout ahead of the M/V RAMFORM STERLING to ensure a trouble free operation.

Origin Energy has an ongoing program of consultation with local fisheries; this is done to ensure minimal disruption to all activities.

As a result, we do not anticipate fishing activities will cause any disruptions.

Any encounters with fishing activity is to be logged with date and position, and if possible the name of the fishing vessel. **This information is to be reported to the Origin onboard representative.**

Please refer to the *'Otway and Bass Basins 3D Seismic Program Environment Plan'* for further information.

### Sea Conditions, Tides and Currents

Swell heights throughout summer seasons are usually below 5 metres with 15-20% of the swell being 2-3 meters or more in the summer.

Storms in the area result from extra-tropical low pressure systems with associated "cold fronts" moving from west to east across the Great Australian Bight. These systems will likely pass through the area on average about 2 - 3 times per month during the months of January and February.

In the western entrance to the Bass Strait (west of King Island) currents most commonly set east or ESE, however sets in any direction may occur at all seasons. The mean rate is normally less than 0.5 knots,

There is a considerable diurnal inequality in the tides for the Bass Strait and nearby area, ranging from 2 to 2.5 m and is generally west on the rising and east on the falling tide. The tidal current seldom exceeds 1 knot.

The mean Sea Surface temperature is expected to be around 15°C - 17°C.

Please refer to the '*Otway and Bass Basins 3D Seismic Program Environment Plan*' for further information.

### Weather

The areas around Bass Strait and King Island has a climate that is described as moist temperate with cool wet winters and warm summers.

Winds in the area are dominated by patterns described as the easterly quarter winds and westerly quarter winds. The easterly quarter winds are dominant in the summer months and are created by the sub-tropical ridge, a belt of high pressure, which moves southwards creating easterly winds.

For January and February the predominant wind direction will be from west and south-west varying between forces 4-6 on the Beaufort's scale. The wind will only occasionally be stronger than force 4-6, but also weaker wind can be experienced.

Mean wave heights will typically range from 2.5 - 3.0 m.

The survey is outside the tracks of Tropical Cyclones, but in case of bad weather refer to PGS Procedure - 'Extreme Weather' - 813VES00.

The vessel will receive a weather forecast from Offshore Weather Services (OWS) in Australia, twice daily, via e-mail.

Weather information is available via the internet (Bureau of Meteorology) and radio. For further contacts where weather information can be obtained, refer to section 2.9.3.

Please refer to the '*Otway and Bass Basins 3D Seismic Program Environment Plan*' for further information regarding the weather in the survey area.

### In Sea Dangers and Water Depth

There are no known shallows or obstructions in the full fold survey area. Water depths range from 100 to 800m.

There are known to be sharks and jelly fish in the area and care should be taken when working on all in-sea equipment from the workboat, and gloves should be used.

Refer to Procedure 953VES00 - 'Small Boat Operations'.

When recovering deployed equipment care should be taken for any marine species that may have become entangled or attached.

### Time sharing

Perenco is planning to acquire the 1,000km<sup>2</sup> Wolseley 3D survey in T/32P with WesternGeco's M/V WESTERN PATRIOT.

The M/V WESTERN PATRIOT is scheduled to arrive in the Otway basin on 18<sup>th</sup> February 2011, and the survey should take around 30 days.

The closest approach between the 2 acquisition areas is 85km - current modelling is showing that seismic interference should not cause a problem.

### Health

Generally working offshore or transiting in Australia does not pose any significant health issues.

It is recommended that PGS offshore employees have the following vaccinations as per WHO Guidelines (in addition to yellow fever); Hepatitis A and B, Tetanus, Typhoid, Diphtheria and Polio.

All crew should be aware of the intensity of the sun when working offshore in this region and all persons exposed should use suitable clothing, including hats and sun cream. Refer to the "Sun Smart" presentation, which will be made available onboard.

### Medical Support / Medevac Route

The contingency, Medevac Plan relies on PGS emergency procedures.

**International SOS - Sydney to be contacted in all emergencies and Medevac situations.**

The M/V RAMFORM STERLING has a full time paramedic onboard and a well equipped hospital.

For immediate medical evacuation the first point of contact will be Air Ambulance Victoria based in Melbourne.

The Medevac route will be via helicopter to shore (Melbourne) and supported by International SOS Sydney.

If for any reason helicopter is not available the medevac route will be with M/V OCEAN DYNASTY to port in Melbourne, supported by International SOS.

Should a crewmember on the support vessel M/V OCEAN DYNASTY or the chase vessel M/V WESTERN LIGHT be injured or become ill, the paramedic will be transferred to the vessel by small boat to assess the situation.

If a Medevac should be deemed necessary, the patient will be transferred to the M/V RAMFORM STERLING for Helicopter Medevac. Should the weather and sea state be unsuitable for a small boat transfer then the vessel will transit to the port in Melbourne.

For further details of the Medevac Plan, please consult the Medevac Plan and Emergency Contact Numbers in Section 3 of this document.

The Medevac Plan is based on support from International SOS, with reference to the International SOS Emergency Response Procedure, in Section 9.5.

### Environmental Risks

The main issues for Origin Energy are as follows:

- Fisheries Interaction
- Cetacean Interaction

There are very stringent reporting requirements in Australia and all environmental incidents, no matter how minor, should be reported to the onboard client rep as soon as they happen and at least within two hours after occurrence.

The *'Otway and Bass Basins 3D Seismic Program Environment Plan'*, which is issued in a separate volume details the environmental aspects of the survey. The Environmental Plan will be followed for the duration of the project and details the procedures to be followed to minimise the environmental impact in the area.

Reference should be made to - Environmental Procedure 941VES00.

### Cetaceans

Mitigation measures for this survey are designed to reduce the potential impact of seismic activities on marine mammals.

Refer to appendix 9.4 for the Australian Cetacean Monitoring Guidelines (EPBC Act Policy statement 2.1 - Interaction between offshore seismic exploration and whales (DEWHA, 2008b)) which will be used during the survey.

Standard management measures, as outlined in these guidelines, including:

- 30 minute pre-shooting watch
- Delay to start up in the event of animals being within 2km of the airgun array
- **35 minute soft start (Australian Cetacean Monitoring Guidelines indicates minimum 30 minute soft start, but we will add 5 minutes to this)**
- 3 km precautionary zone
- 2 km low power zone
- 500 m shut down zone.

There will be two MMO's onboard, but the Captain and PC will still be responsible for ensuring that the requirements of the guidelines are followed. All Department Chiefs should ensure that their departments are aware of and comply with the requirements.

There will in addition be two MMO's onboard the support vessel M/V OCEAN DYNASTY.

A copy of any marine mammal sighting forms to be submitted to Origin Energy after completion of the survey.

**There will be additional measures to manage interactions with Blue Whales, including spotter plane flights and increased radius power down zones. These will be specified clearly in a separate document in advance of the Otway operations.**

### Oil Spill Response

The vessel will apply strict pollution control procedures (Marpol)

PGS has a rigid maintenance and inspection schedule, but in case of any unforeseen spills, the vessels Shipboard Oil Pollution Emergency Plan (SOPEP) will be followed, (843VES00).

All oil spill incidents will be reported immediately to the Client Onboard Representative.

Please refer to the '*Otway and Bass Basins 3D Seismic Program Environment Plan*' for further information and the requirements for local reporting in case of oil spill.

### Waste Management

PGS Geophysical follows the IAGC Environmental Guidelines for worldwide geophysical operations.

The Environmental procedure 941VES00 should be read in conjunction with

- Waste Management procedure 841VES00
- Emergency and Contingency plan 901VES00
- The vessels Waste Management Plan
- Annex V of Marpol 73/78 convention

The only waste to be discharged into the sea is treated sewage, macerated biodegradable food waste and separated bilge water.

All reports and documents will be available onboard for the Client Onboard Representative.

### Security Including Lobbyist Activity

At the moment there is no security or lobbyist activity that would cause concern in the survey area.

### Military Activity

No military activity or military exercises is expected.

### Aircraft And Transportation

The method for crew change will be by helicopter to shore (Melbourne or Warnambool).

Commercial airlines will be used for flights into and out of Australia and on domestic legs.

All land transportation will, where possible, be audited by the PGS VSS and/or PGS' Agent (according to IAGC recommendations) before any PGS personnel ride in these vehicles and use of seat belts for all passengers is mandatory.

Crew-changes are scheduled for Wednesday 23<sup>rd</sup> February 2011 and 30<sup>th</sup> March 2011.

### Other

Vessel agent during the survey will be 'NT Shipping' with their office in Darwin - Australia. For contact details refer to section 2.8.

## 2 COMMUNICATION

### 2.1 Key Personnel offshore

	Shift B - Period Mobilisation to 23 <sup>rd</sup> February 2011	Shift A - Period 23 <sup>rd</sup> February 2011 to 30 <sup>th</sup> March 2011
Party Chief	Neil Jackson	Phil Shriner
Chief Seismic	Jørn Helmen	Paal Halvorsen
Chief Mechanic	Bjørn Brandal	Frank Svelund
Chief Navigator	Steve White	Paul Twa
Chief QC Geophysicist	Murray Brown	Phil Banks
Master	Robert Heggdal	Roger Honningdal
Medic	James Gallacher	Emma Marshall

### 2.2 PGS Office personnel

#### 2.2.1 Singapore

PGS Marine acquisition Office, Singapore +65 6735 6411 (Switchboard)  
+65 6735 6413 (Fax)

Operations Manager: Leif-Inge Iversen +65 6838 1947 (Office) +65 6275 2144 (Home)  
e-mail: leif-inge.iversen@pgs.com +65 9627 2765 (Mob)

Acquisition Manager: Johnny Leknes +65 6838 1944 (Office) +65 6836 6305 (Home)  
e-mail: johnny.leknes@pgs.com +65 9636 1898 (Mob)

Senior Project Manager:  
Anthony van der Wal + 65 6838 1154 (Office) + 65 9640 9881(Mob)  
e-mail: anthony.van.der.wal@pgs.com

Regional HSE&Q Manager - AP:  
Capt. Tony Robertsen +65 6838 1936(Office) +65 9711 3177 (Mob)  
e-mail: tony.robertsen@pgs.com

Crew Administrator: Cathy Chng +65 6838 1945 (Office) +65 9722 5870 (Mob)  
e-mail: cathy.chng@pgs.com

## 2.2.2 Norway

PGS Marine Acquisition Office (Lysaker)	+47 6752 6400 (Switchboard)	
	+47 6752 6464 (Fax)	
Marine Acquisition HSE&Q Manager:		
Joanna Oustad	+47 675 14 053 (Office)	+47 480 33 319 (Mob)
e-mail: joanna.oustad@pgs.com		
Navigation Supervisor: Roar Nilsen	+47 6751 4045 (Office)	+47 901 49 306 (Mob)
e-mail: roar.nilsen@pgs.com		
Navigation Processing Vessel Coordinator:		
Damian Wood	+47 675 14 285 (Office)	+47 913 80 031 (Mob)
e-mail: damian.e.wood@pgs.com		
Seismic Supervisor: John MacIver	+ 47 675 142 12 (Office)	+47 948 08 748 (Mob)
e-mail: john.maciver@pgs.com		
Mechanical Supervisor: Per Øyvind Lund	+47 675 14 210(Office)	+47 994 12 345 (Mob)
e-mail: per.oivin.lund@pgs.com		
Crew Coordinator: Alise Beate Olsen	+47 675 14 073 (Office)	+47 918 38 905 (Mob)
e-mail: alise.beate.olsen@pgs.com		
SEG-Y Coordinator: Sarah Carter		+44 7958 707701(Mob)
e-mail: sarah.carter@pgs.com		

## 2.3 Origin Energy Contacts

The main shore based interface with the Origin Energy's HSE functions will be through Mr. Neil Millar based in Brisbane. The onboard Client Representatives will liaise with the Client onshore.

### Primary Contact

Manager Exploration Operations: Neil Millar +61 7 3858 0667 (Office) +61 409 891 391 (Mob)  
e-mail: neil.millar@originenergy.com.au +61 7 3369 7840 (Fax)

### Secondary Contact

Principal Exploration QHSE Advisor:

Bob Meagher +61 7 3867 0095 (Office) +61 457 539 035 (Mob)  
e-mail: robert.meagher@originenergy.com.au

### Tertiary Contact

Chief Geophysicist: Randall Taylor +61 7 3858 0605 (Office) +61 419 804 105 (Mob)  
e-mail: randall.taylor@originenergy.com.au +61 7 3858 0248 (Fax)

## 2.4 Onboard Representatives

**Origin Onboard Staff Representative** : **Bob Meagher (pre 23<sup>rd</sup> Feb)/Neil Millar (post 23<sup>rd</sup> Feb)**

Acquisition QC : **Drew Murray**  
e-mail: steseisclient@pgs.com

Navigation QC : **Ray Doughty**  
e-mail: stonavclient@pgs.com

**Principal MMO** : **Fiona Macknight**

RAMFORM STERLING Onboard Clients : +47 675 15 573 (Client office)

## 2.5 Vessel

**M/V RAMFORM STERLING (CALL SIGN: C6YE5, IMO No: 9413303)**

Inmarsat (Bridge) +870 764 903 851

Bridge +47 675 15 550

Captain +47 675 15 560  
e-mail: STEcaptain@pgs.com

Party Chief +47 675 15 575  
e-mail: STEpc@pgs.com

Instrument room (Seismic desk) +47 675 15 568

## 2.6 Support / Chase Vessels

**M/V OCEAN DYNASTY (CALL SIGN: VKV 7187, IMO No: 9524619)**

+870 764 882 396 (Sat) +61 400 521 162 (Mob)  
e-mail: od138@delmark.net.au

**M/V WESTERN LIGHT (Victorian/Tasmanian Fishing Registration XKU,  
Australian Shipping Register No.855225)**

+870 147 142 710 (Sat) +61 428 682 686 (Mob)  
e-mail: westcapefisheries@bigpond.com

## 2.7 Vessel Management Companies

### 2.7.1 PGS Geophysical AS

(Maritime Management - M/V RAMFORM STERLING)

Head Office:	+47 675 26 400 (Office)	
Strandveien 4, N-1326 Lysaker, Norway	+47 675 26 464 (Fax)	
Emergency Phone 24/7	+ 47 994 51 401	
Designated person: Marie Henøen Maritime Compliance Manager e-mail: marie.henoen@pgs.com	+47 675 14 443 (Office)	+47 907 31 588 (Mobile)
Deputy Designated person: Samuel Alshager - Fleet Manager e-mail: samuel.alshager@pgs.com	+47 675 14 109 (Office)	+47 900 45 244 (Mobile)
Jan-Erik Larsson - Marine Superintendent e-mail: jan-erik.larsson@pgs.com	+47 675 14 258 (Office)	+47 975 80 557 (Mobile)
Runar Bråthen - Senior Superintendent e-mail: runar.brathen@pgs.com	+47 675 14 322 (Office)	+47 906 12 434 (Mobile)
Harald Sundby - Maritime Manager e-mail: harald.sundby@pgs.com	+47 675 14 048 (Office)	+47 902 24 549 (Mobile)

### 2.7.2 Delmark Consulting Pty Ltd

(Owner/Support Vessel Management - M/V OCEAN DYNASTY)

Office: Swan Reach, Victoria, Australia 3903	+61 351 562 580 (Office)	
	+61 351 562 744 (Fax)	
Main Contact: Arno Blank e-mail: delmcons@bigpond.net.au; delmark@delmark.net.au and shipadmin@delmark.net.au		+61 429 843 309 (Mobile)

### 2.7.3 West Cape Fisheries Pty Ltd

(Owner/Chase Vessel Management - M/V WESTERN LIGHT)

Office: Killarney, Victoria, Australia 3283	+61 355 687 215 (Office)
Main Contact: Daneel and Gary Robinson e-mail: westcapefisheries@bigpond.com	

## 2.8 Agent

### NT Shipping

Darwin, Northern Territory, Australia +61 8 89 472 570  
+61 8 89 472 640 (Fax)

#### Main Contact:

Robbie Robertson

e-mail: robbie@ntshipping.com

+61 4 17 819 593 (Mobile)

+61 8 89 324 042 (Home)

Oliver Barz

e-mail: oliver@ntshipping.com

+ 61 418 894359 (Mobile)

**Address:** East Arm Wharf  
Berrimah Rd  
P.O.Box 443 - GPO Berrimah  
Berrimah 0828  
NT Australia

## 2.9 Others

### 2.9.1 Australian Maritime Crew Management

#### Offshore Marine Services (Management for Australian Crew on M/V RAMFORM STERLING)

Marine House, Applecross, WA 6153 +61 8 6310 5600 (Phone)  
e-mail: info@omsau.com +61 8 6310 5666 (Fax)

Business Development Manager: Peter Richards +61 418 166 592 (Mobile)  
e-mail: peter.richards@omsau.com

Marine Co-ordinator: Larry Thorstensen +61 8 6310 5611 (Office) +61 419 240 167 (Mobile)  
e-mail: larry.thorstensen@omsau.com

### 2.9.2 Fugro Survey

Fugro-Survey AS, Head Office Oslo +47 2213 4600 (Office)  
+47 2213 4646 (Fax)

Duty officer +47 9110 9620 (Mobile)

Fugro-Survey AS Bergen +47 5534 9400 (Office)  
+47 5534 9450 (Fax)

Duty Officer +47 9525 6082 (Mobile)

Point of contact Arne Sleire +47 5534 9421 (Office) +47 9131 5825 (Mobile)  
e-mail: arne.sleire@fugro-survey.no

Fugro Geodetic Pte Ltd Singapore +65 6543 0200 (Office)  
+65 6543 0500 (Fax)

All questions regarding StarFix, SkyFix, and RGPS should be forwarded to Arne Sleire at Fugro-Survey AS in Bergen.

### 2.9.3 Weather Forecasts

#### Buoy Weather

<http://www.buoyweather.com/>

#### Australian Bureau of Meteorology

<http://www.bom.gov.au/marine/>

### **3 EMERGENCY PROCEDURES**

#### **3.1 EMERGENCY NUMBERS**

##### **MEDICAL ADVICE**

##### **ISOS Medical Support (Sydney)**

**+61 2 9372 2468 (24-Hours)**

##### **MEDEVAC / EMERGENCIES**

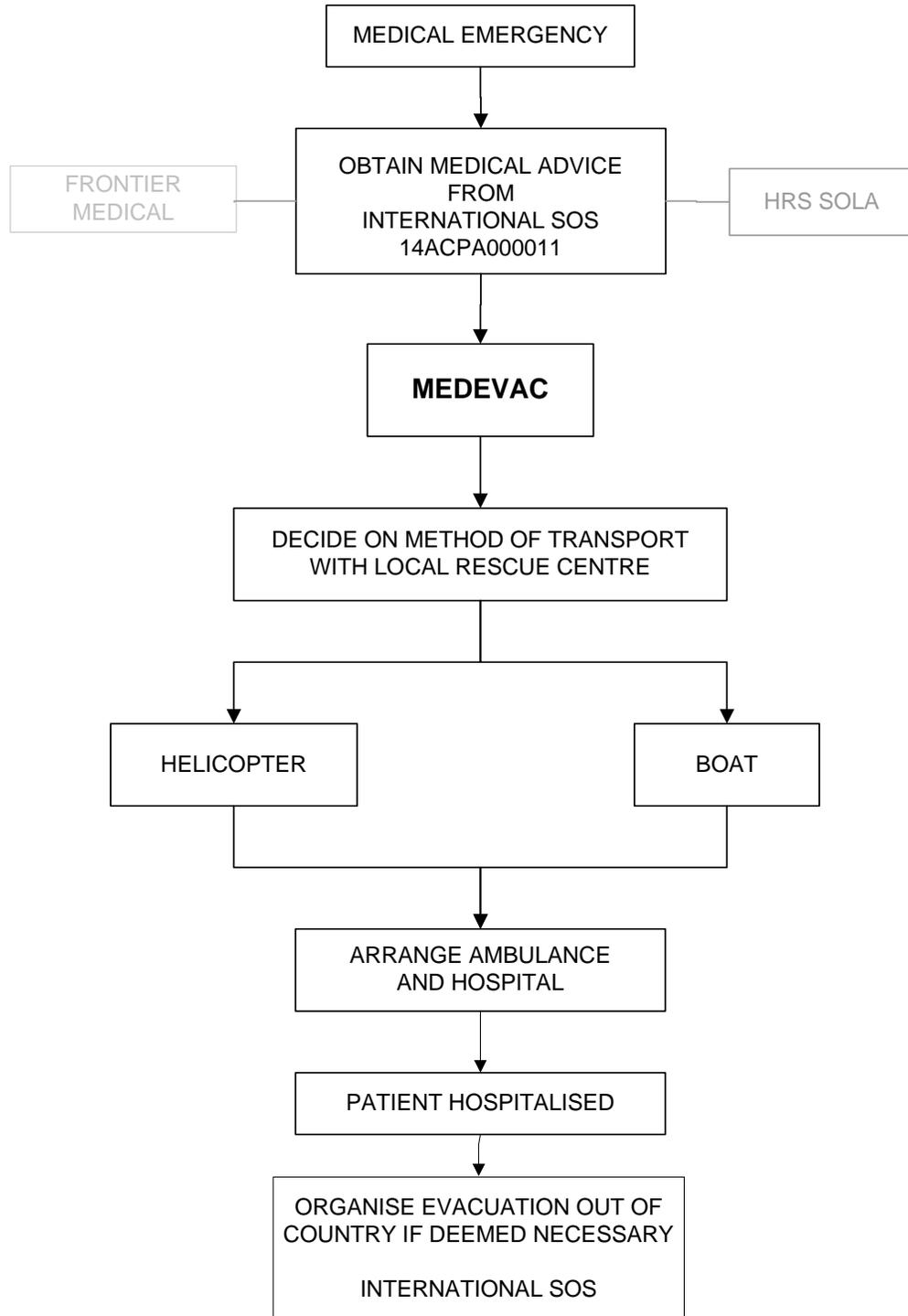
##### **Air Ambulance Victoria**

**+61 1300 883 200 (24 Hours)**

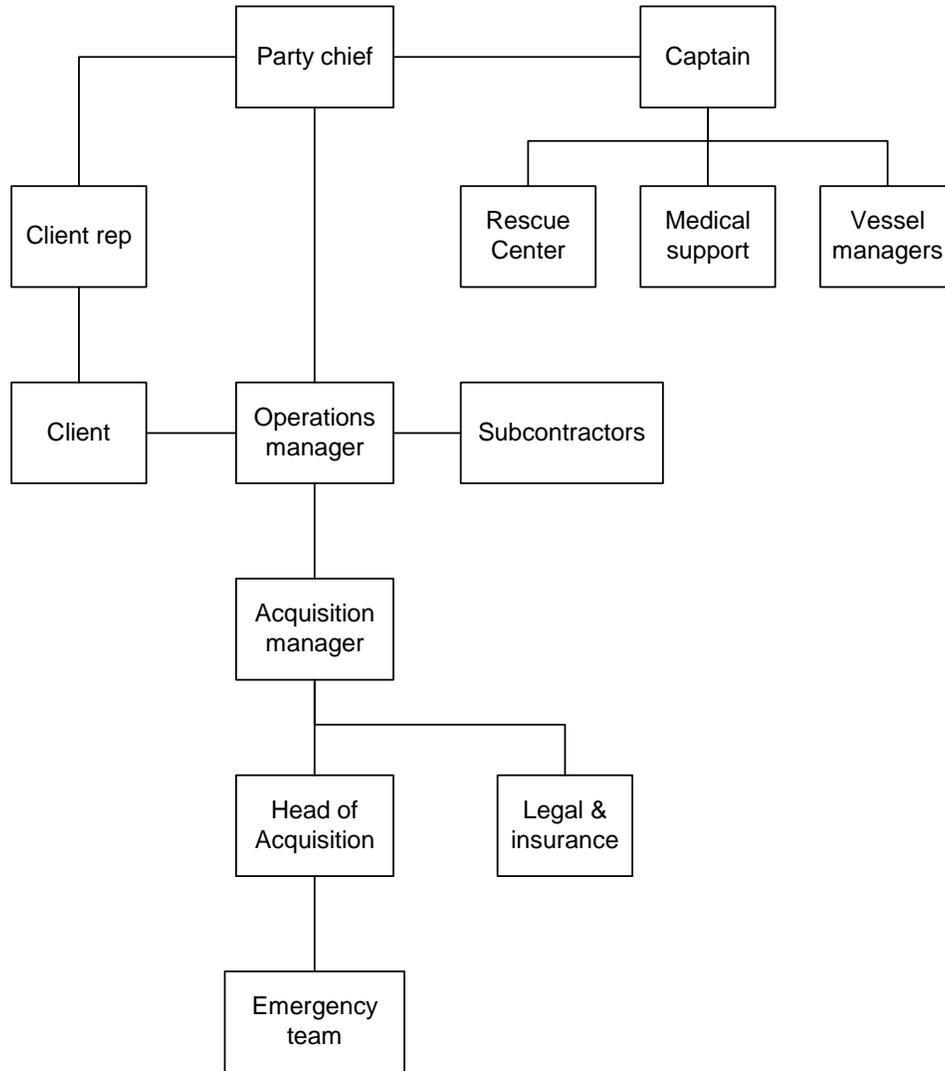
### 3.2 Contingency contacts

International SOS, Sydney Alarm centre International SOS No: <b>14ACPA000011</b>	+61 2 9372 2468	e-mail: sydopsmed@internationalsos.com
<b>Air Ambulance Victoria</b>	+61 1300 883 100	e-mail: <a href="mailto:air.ambulance@mas.vic.gov.au">air.ambulance@mas.vic.gov.au</a> Internet: <a href="http://www.ambulance.vic.gov.au/index.html">http://www.ambulance.vic.gov.au/index.html</a>
International SOS, Singapore	+65 6338 7800	+65 6338 7611 (fax) e-mail: sin.medical@internationalsos.com
MRCC - Australia (Maritime Rescue Coordination Centre)	+61 2 6230 6811 (24 hours)	+61 2 6230 6811 (Main Switchboard) <a href="http://www.amsa.gov.au/Search_and_rescue/">http://www.amsa.gov.au/Search_and_rescue/</a>
HRS Sola (MRCC Southern Norway)	+47 5151 70 00	e-mail: post@rcc-stavanger.no

### 3.3 MEDEVAC Flow Chart



### 3.4 Accident and Incident Communication Flow Chart



## 4 TECHNICAL INFORMATION

### 4.1 Data Acquisition Parameters

#### Survey definition

Acquisition Mode	:	3D - Dual Source
Shot interval	:	18.75m
Line orientation	:	331.100°
<b>Inline offset</b>	:	<b>As short as possible, but around 150 m expected</b>

#### Energy Source

Source type	:	Bolt LLXT
Number of sources	:	2
Air pressure	:	2000 psi $\pm$ 10%
Volume	:	3090 in <sup>3</sup>
Source separation	:	50m
Number of sub-arrays	:	2 x 3
<b>Sub-array separation</b>	:	<b>10m <math>\pm</math>10%</b>
Source length	:	14m
Source depth	:	7m $\pm$ 1m
Gun synchronisation	:	$\pm$ 1.0 ms*
Source modeling	:	Refer to Appendix 9.1
Drop-out specification	:	Refer to Appendix 9.2

\*Source delta errors of 1.1-1.5ms to be flagged as warnings instead of edits. Shots with Source Spread errors larger than 2.2ms to be edits.

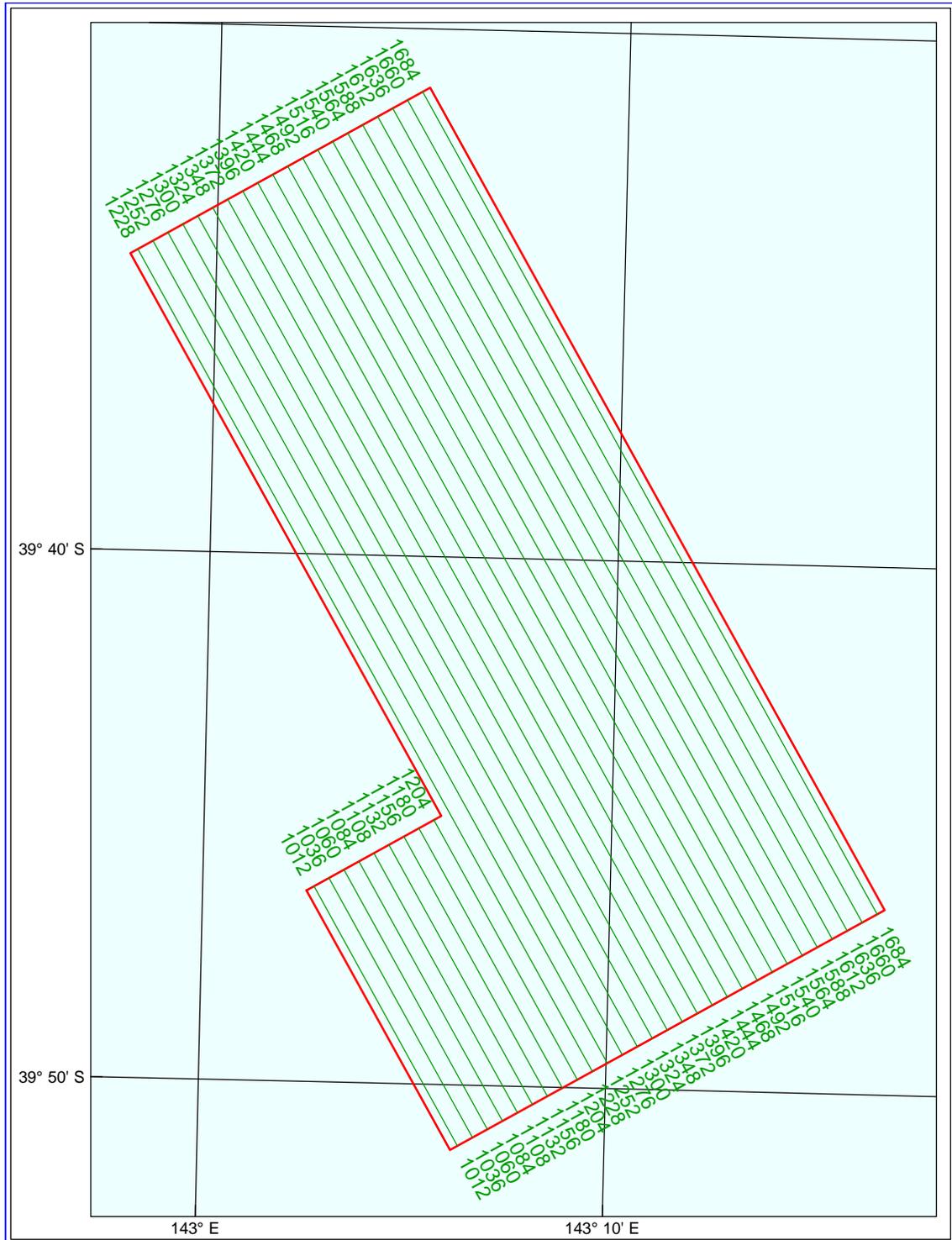
#### Streamer

Number of Streamer	:	12
Streamer length	:	5100m
Streamer separation	:	100m
Streamer depth	:	8m $\pm$ 1m
Number of Channels per Streamer	:	408
Group length	:	12.5m

#### Data Recording

Record length	:	6 s
Sampling rate	:	2 ms
Lo-cut filter - Hydrophone	:	4.6 Hz @ 6 dB per octave
Hi-cut filter - Hydrophone	:	206 Hz @ 276 dB per octave
Format	:	SEGD - 8036 (Revision 2.1) on 3592 Cartridges

### 4.2 Miniature of Preplot



### 4.3 Line Names

Each Sail Line has a unique number. The Sail Line Numbering System is designed as follows:

**AAAAAAAXXXXZYSSS**

where

AAAAAAA	Survey identifier - <b>OEOBE11</b>
XXXX	four digit line number
Z	type of line, P for Prime, F for infill, R for Reshoot
Y	pass number
SSS	three digit sequence number

Each type of pass will be numbered from one; e.g. P1, P2, P3 and F1, F2, F3. So the first infill on a line will be F1.

The number: OEOBE111008R2023 shows that it is the second pass on Sail Line 1008, it is a Reshoot and the sequence number is 23.

Columns covered by a specific line will be from line no. -11 to line no. +12.

Example: sail line 1012 covers CMP columns 1001 to 1024.

### 4.4 Shot Numbering

The Shot Point is defined as the nominal CMP for the first group.

### 4.5 Tape numbering

All tape labels should include the PGS survey number (2010184) and the sequence number and should clearly show the following:

- Client name
- Date
- Line name
- File range
- Shot point range

Seismic data tapes will be numbered sequentially. Numbering for the second set of tapes will follow the convention set up in the Technical Procedures Manual.

P1/90 tape numbering will follow the conventions as set up in the Standard Instructions to Post-processors.

## 5 Deliverables

### Seismic

Data tapes set 1	:	3592
Data tapes set 2 (or copy tapes)	:	3592
Observer logs on CD ROM	:	two copies, one with each set of data tapes
Navigation merged SEG-Y (raw)	:	one set, 3592 (see Appendix 9.3 for the format)
QC brute stack for each line	:	one set SEG-Y tapes
Archive of common offset cube	:	one set SEG-Y tapes

### Navigation

Two copies of the following will be produced for delivery from the vessel, with each set of data tapes:

- Processed data (Final P1/90)	:	3592
- Raw data (Final P2/94)	:	3592

The following will be produced for delivery from the office:

- Shotpoint loc. map, vessel positions	:	CD ROM
- Vessel position tape	:	CD ROM
- Bathymetry tape	:	P1/90, draft, tide and velocity corrected
- Bathymetry data and map	:	CD ROM
- <b>Bathymetry map (Contour)</b>	:	<b>In .pdf format on CD ROM</b>

## **5.1 Data shipment details**

### **TBN**

## 6 POSITIONING

### 6.1 Geodetic Reference

#### 6.1.1 Datums

Survey Datum	:	GDA94
Ellipsoid	:	GRS 80
Semi Major Axis	:	6378137 m
1/Flattening	:	298.257222101
<i>GPS Datum</i>	:	<i>WGS84</i>
<i>Ellipsoid</i>	:	<i>WGS84</i>
<i>Semi Major Axis</i>	:	<i>6378137 m</i>
<i>1/Flattening</i>	:	<i>298.257223563</i>
Geoid height	:	-5.00 m (min. -5.79 m, max. -4.20 m)

#### 6.1.2 Datum Shift from GDA94 to WGS84

The datum shift parameters below are based on the GEOSCIENCE AUSTRALIA document 'International Terrestrial Reference Frame (ITRF) to GDA94 Coordinate Transformations' by John Dawson and Jim Steed (See Appendix 9.7).

The values are derived from Appendix A 14 Parameter Transformation, Table A1. The numbers have been calculated to year 2011.5 using the initial value and /year tabulated values.

Orca uses the shift parameters Local -> GPS84. We use method a) in section 2 of the mentioned document, while the tables are based on method b).

That gives the following values for input to Orca.

X-Translation	:	-0.0504 m
Y-Translation	:	0.0619 m
Z-Translation	:	0.1557 m
X-Axis Rotation *	:	0.02066"
Y-Axis Rotation *	:	0.01708"
Z-Axis Rotation *	:	0.02127"
Scale Correction	:	-0.001748 ppm

\* Bursa-Wolf sign convention

#### Test Point

Datum	Latitude	Longitude	Height
GDA94	40° 00' 00.0313" S	144° 59' 59.9856" E	0.06 m
WGS84	40° 00' 00.0000" S	145° 00' 00.0000" E	0.00 m

### 6.1.3 Map Projection

Projection	:	Transverse Mercator
Projection System	:	UTM
Central Meridian	:	141° East
Scale Factor on Central Meridian	:	0.9996
Latitude of Origin	:	0°
False Northing	:	10000000 m
False Easting	:	500000 m

## 6.2 Surface positioning

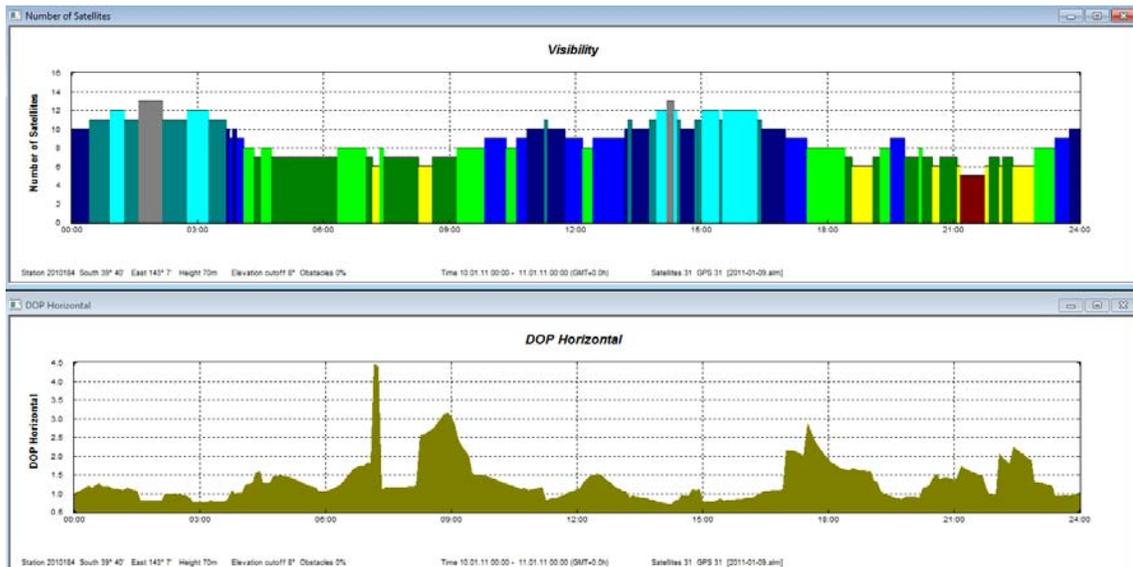
### 6.2.1 System I

System	:	SkyFix.XP
Differential Corrections via	:	SPOT / NTRIP
Reference Stations at	:	N/A, global orbit and clock corrections
Subcontractor	:	Fugro Survey

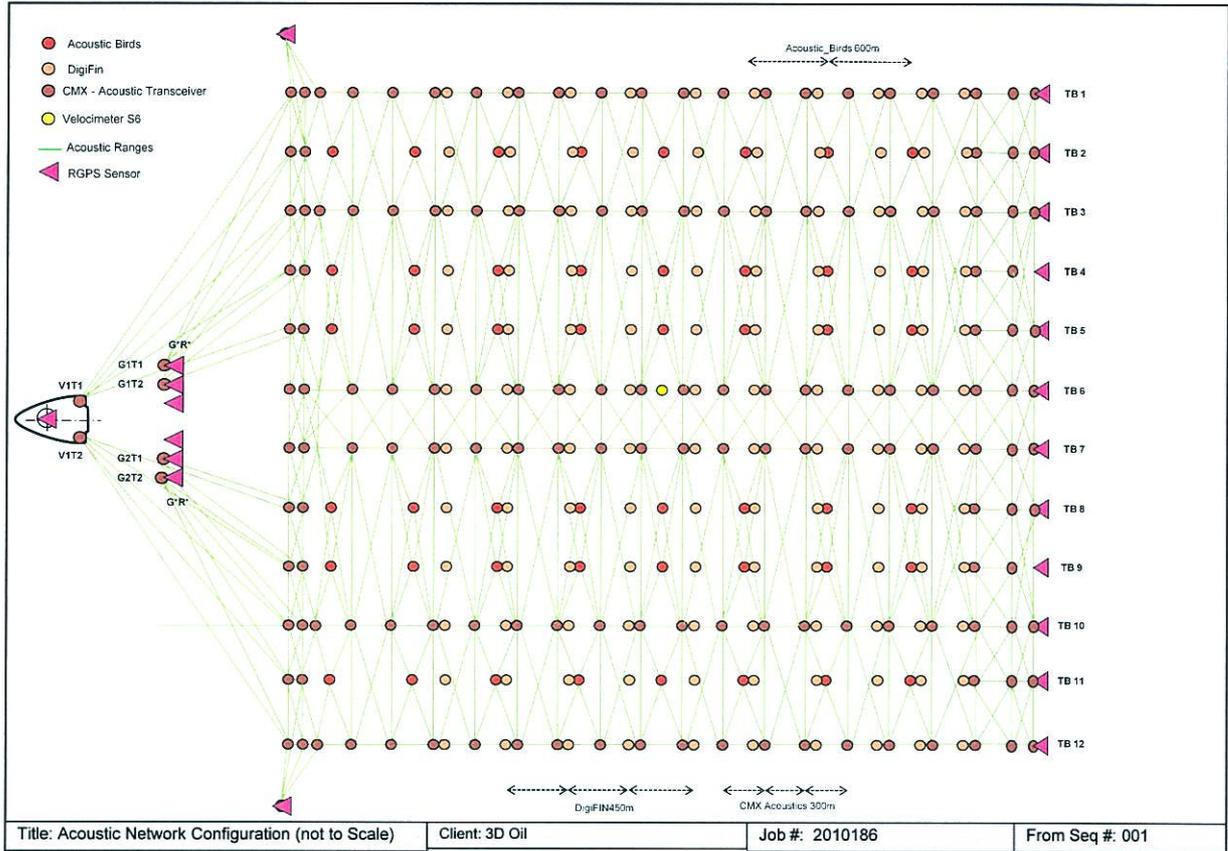
### 6.2.2 System II

System	:	StarFix.HP
Differential Corrections via	:	SPOT / NTRIP
Reference Stations at	:	Melbourne      250 km distant Bathurst        900 km distant Ceduna         1200 km distant Brisbane       1625 km distant
Subcontractor	:	Fugro Survey

## 6.3 GPS Coverage



### 6.4 Acoustic Network



Local conditions might make modifications to this network desirable.

Any major change should be discussed with the office.

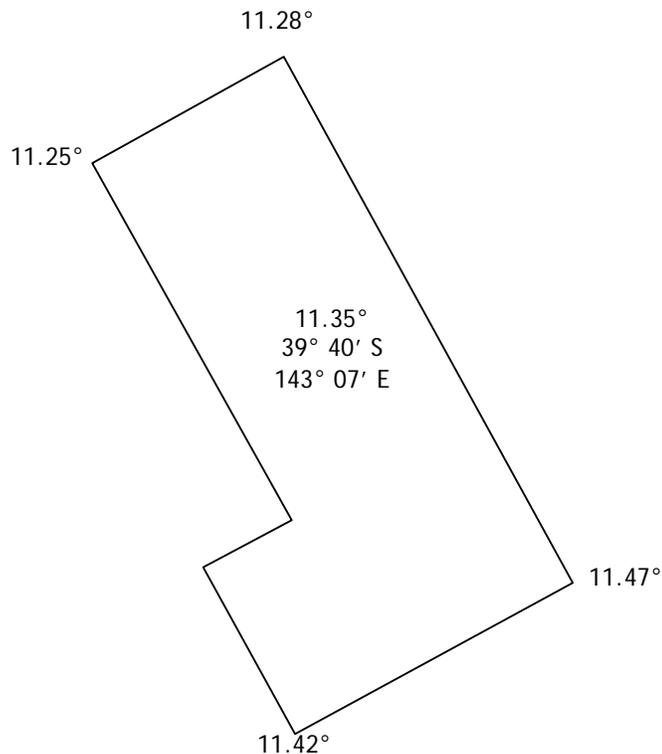
## 6.5 Magnetic Compasses

Number	:	20 on streamers 1, 3, 6, 7, 10 and 12; 12 on the remaining streamers (alternating compass birds and acoustic birds)
Location	:	0, 75, 300, , 4800, 5025, 5100 (m)
Filtering	:	2 seconds output interval, 14 seconds filtering period

### Magnetic Variation

Recommended value : 11.36°

Derived from the IGRF11 (2010) model on 31st January 2011.



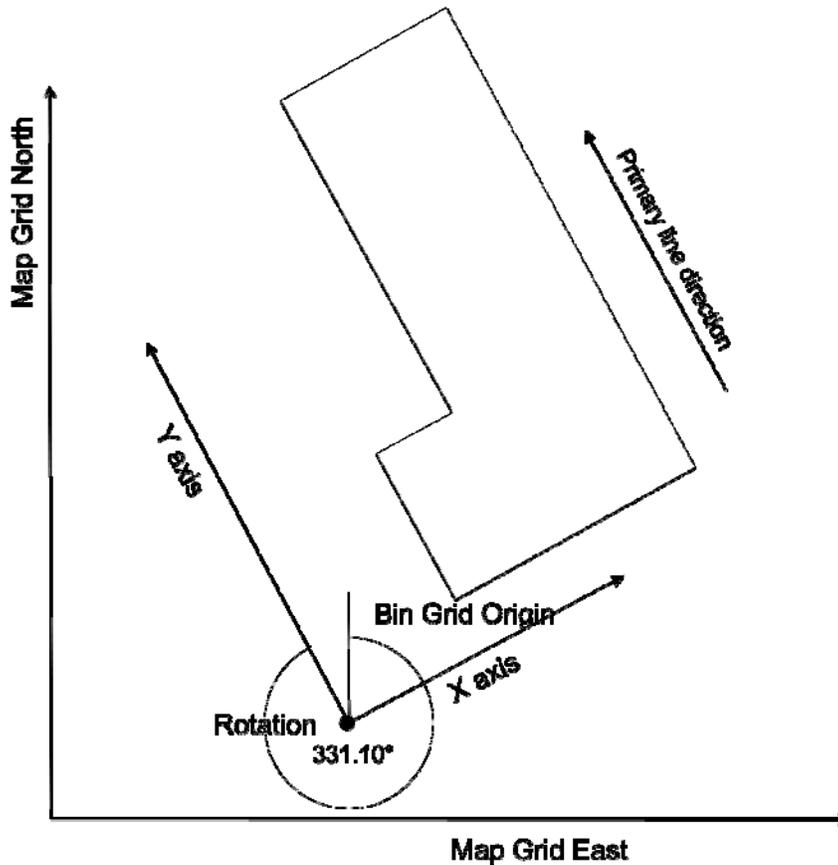
## 6.6 Sound Propagation Velocity measurements

A real-time velocimeter shall be mounted on a streamer, and the data recorded for use in post-processing. The results should be compared with the readings from the CT-probe.

A full water column velocity profile should be taken once a week or more frequently if the results show rapid variations.

## 7 Binning Grid

### 7.1 Grid Definition



Reference is made to the Preplots and Line Listings provided.

Orientation	:	331.1°
In-line Cell Length	:	6.25 m
Cross Line Cell Width	:	25 m

The origin should be chosen in the south-west corner.

Bin numbering should be chosen so that Row and Column numbers are identical to Shotpoint Numbers and CMP Line Numbers.

## 7.2 3D Bin Coverage Specifications

3D Seismic Survey Proposed Flex Bining Parameters								
	Nears		Near Mids		Far Mids		Fars	
Channels	1	102	103	204	205	306	307	408
Offsets (metres)	0	1262.5	1275	2537.5	2550	3812.5	3825	5087.5
Nominal Fold	17		17		17		17	
Min Fold Percent	80%		73%		67%		60%	
Min Fold with Flex applied	14		12		11		10	
Flex Binning Technique	Linear taper		Linear taper		Linear taper		Linear taper	
Static Bin Width	25 metres		25 metres		25 metres		25 metres	
Percentage Flex at beginning of Segment	100%		150%		200%		250%	
Percentage Flex at end of Segment	150%		200%		250%		400%	
Flexed Bin Width (metres)	50 to 62.5m		62.5 to 75m		75 to 87.5m		87.5 to 125m	
		Inputs						
Number of Channels	408							
Group Interval	12.5	m						
Source Interval (on CMP line)	37.5	m						
COS to CNG	0	m						
Xline Bin Size	25	m						
Inline Bin Size	12.5	m	after ATS					

- Steering for the Nears;
- The edge of the new full Nears coverage is one bin across from the adjacent edge of the previous sail line’s full Nears coverage. This is in part due to the flex parameters that we are using, which allow the slight separation of the full fold swaths.

## **8 ACQUISITION QC**

### **8.1 Acquisition QC sequence**

The standard PGS acquisition QC sequence will be used for this survey.

### **8.2 Additional requirements**

A set of navigation merged SEG-Y tapes will be created using the PGS standard navmerged SEG-Y format shown in Appendix 9.3.

If anything extra or variations from normal procedures are required this will be discussed during the start-up meeting.

## **9 APPENDIX**

9.1 Source modeling

9.2 Source Drop-out Specifications

9.3 PGS Standard Navmerged SEG-Y Format

9.4 Australian Cetacean Monitoring Guidelines

9.5 International SOS - Medical Emergency Response Plan

9.6 Bridging Document

9.7 International Terrestrial Reference Frame (ITRF) to GDA94 Coordinate Transformations

## 9.1 Source modelling

### SIGNATURES FROM MARINE AIRGUN SOURCE LIBRARY

NUCLEUS+ 2.0.0 - Marine Source Modeling 1.4.0

Modeling by Ashish Misra, approved by \_\_\_\_\_,

PGS Technology - Geophysical Support, January 2011

Survey name	:	Bellerive 3D - Origin Energy
PGS project No	:	2010184
Survey area	:	Otway Basin
Vessel	:	MV RAMFORM STERLING
Array	:	3090T__070_2000_100
Source type	:	Bolt 1900 LLXT
Source volume	:	3090 cu.in.
Air pressure	:	2000 psi
Source depth	:	7.0 m
Subarray separation	:	10.0 m
Recording filter	:	Hydroscience, 4.6(6)-206(276) Hz (dB/oct.)
Receiver depth	:	8.0 m
Hydrophone group length	:	12.5 m
Full system response* filter name	:	Hydroscience, 4.6(6)-206(276) Hz (dB/oct.)
Sea temperature	:	15.0 ° C

#### Enclosed are:

Figure 1: Array configuration top view, i.e. positive Y denotes starboard.

Figure 2: Modeled far-field signature and amplitude spectrum with Hydroscience recording filter (without receiver ghost).

Figure 3: Modeled far-field signature and amplitude spectrum with DFS-V recording filter (without receiver ghost).

Figure 4: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (without receiver ghost).

Figure 5: Far-field signature listing with 2 ms sampling interval (without receiver ghost).

Figure 6: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (with receiver ghost).

Figure 7: Far-field signature listing with 2 ms sampling interval (with receiver ghost).

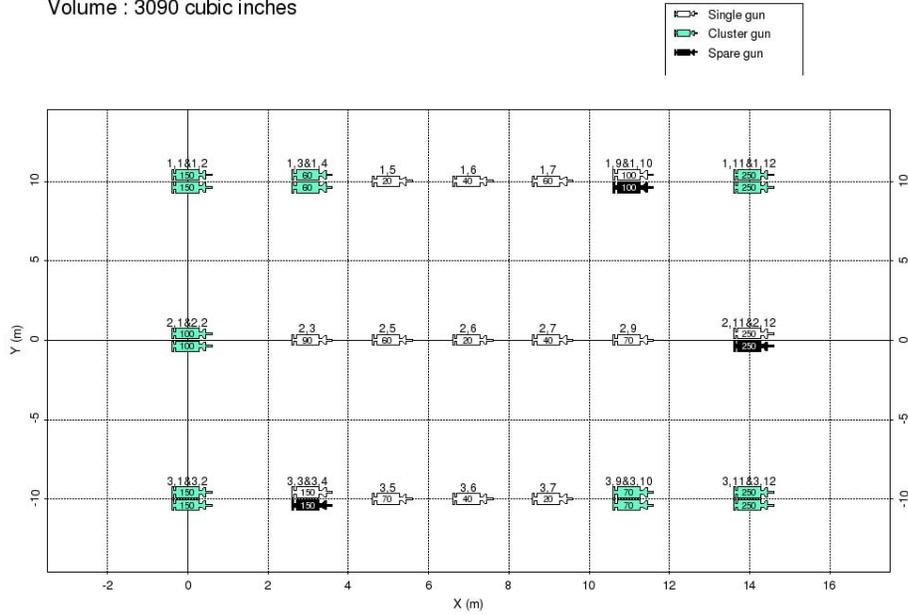
Figure 8: Directivity plot for constant azimuth of 0° and 90°.

---

\* The full system response filter includes the effect of connecting the hydrophones to the modules in addition to the recording system filter setting. Therefore the resulting signature includes all phase effects arising from streamer electronics, and should be used for designature filter design.

Array : 3090T\_\_070\_2000\_100

Volume : 3090 cubic inches



Plotted by Nucleus+ (2.0.0), Masomo+ (1.4.0), Date :2011/11/11 13:50

Figure 1: Array configuration top view, i.e. positive Y denotes starboard.

**SOURCE ARRAY PARAMETERS:**

Project : Origin-Energy  
 Dataset : 3090T\_\_070\_2000\_100  
 Number of subarrays : 3  
 Total number of guns : 31  
 Total chamber volume : 3590.0  
 Effective volume : 3090.0  
 Subarray number : 1  
 Subarray name : 1140T\_\_040\_2000\_SUB  
 Number of guns : 11  
 Subarray volume : 1240.0  
 Effective volume : 1140.0

2010184

GUN	TYPE	X (m)	Y (m)	Z (m)	Volume	Pressure	Delay	CluNo	Activ	Group
1	Bolt 1900 LLXT airgun	0.00	10.40	7.00	150.0	2000.0	0.0	1	1	1
2	Bolt 1900 LLXT airgun	0.00	9.60	7.00	150.0	2000.0	0.0	1	1	1
3	Bolt 1900 LLXT airgun	3.00	10.40	7.00	60.0	2000.0	0.0	2	1	1
4	Bolt 1900 LLXT airgun	3.00	9.60	7.00	60.0	2000.0	0.0	2	1	1
5	Bolt 1900 LLXT airgun	5.00	10.00	7.00	20.0	2000.0	0.0	0	1	1
6	Bolt 1900 LLXT airgun	7.00	10.00	7.00	40.0	2000.0	0.0	0	1	1
7	Bolt 1900 LLXT airgun	9.00	10.00	7.00	60.0	2000.0	0.0	0	1	1
9	Bolt 1900 LLXT airgun	11.00	10.40	7.00	100.0	2000.0	0.0	0	1	1
10	Bolt 1900 LLXT airgun	11.00	9.60	7.00	100.0	2000.0	0.0	0	0	1
11	Bolt 1900 LLXT airgun	14.00	10.40	7.00	250.0	2000.0	0.0	3	1	1
12	Bolt 1900 LLXT airgun	14.00	9.60	7.00	250.0	2000.0	0.0	3	1	1

Subarray number : 2  
 Subarray name : 0730T\_\_040\_2000\_SUB  
 Number of guns : 9  
 Subarray volume : 980.0  
 Effective volume : 730.0

GUN	TYPE	X (m)	Y (m)	Z (m)	Volume	Pressure	Delay	CluNo	Activ	Group
1	Bolt 1900 LLXT airgun	0.00	0.40	7.00	100.0	2000.0	0.0	4	1	1
2	Bolt 1900 LLXT airgun	0.00	-0.40	7.00	100.0	2000.0	0.0	4	1	1
3	Bolt 1900 LLXT airgun	3.00	0.00	7.00	90.0	2000.0	0.0	0	1	1
5	Bolt 1900 LLXT airgun	5.00	0.00	7.00	60.0	2000.0	0.0	0	1	1
6	Bolt 1900 LLXT airgun	7.00	0.00	7.00	20.0	2000.0	0.0	0	1	1
7	Bolt 1900 LLXT airgun	9.00	0.00	7.00	40.0	2000.0	0.0	0	1	1
9	Bolt 1900 LLXT airgun	11.00	0.00	7.00	70.0	2000.0	0.0	0	1	1
11	Bolt 1900 LLXT airgun	14.00	0.40	7.00	250.0	2000.0	0.0	0	1	1
12	Bolt 1900 LLXT airgun	14.00	-0.40	7.00	250.0	2000.0	0.0	0	0	1

Subarray number : 3  
 Subarray name : 1220T\_\_040\_2000\_SUB  
 Number of guns : 11  
 Subarray volume : 1370.0  
 Effective volume : 1220.0

GUN	TYPE	X (m)	Y (m)	Z (m)	Volume	Pressure	Delay	CluNo	Activ	Group
1	Bolt 1900 LLXT airgun	0.00	-9.60	7.00	150.0	2000.0	0.0	5	1	1
2	Bolt 1900 LLXT airgun	0.00	-10.40	7.00	150.0	2000.0	0.0	5	1	1
3	Bolt 1900 LLXT airgun	3.00	-9.60	7.00	150.0	2000.0	0.0	0	1	1
4	Bolt 1900 LLXT airgun	3.00	-10.40	7.00	150.0	2000.0	0.0	0	0	1
5	Bolt 1900 LLXT airgun	5.00	-10.00	7.00	70.0	2000.0	0.0	0	1	1
6	Bolt 1900 LLXT airgun	7.00	-10.00	7.00	40.0	2000.0	0.0	0	1	1
7	Bolt 1900 LLXT airgun	9.00	-10.00	7.00	20.0	2000.0	0.0	0	1	1
9	Bolt 1900 LLXT airgun	11.00	-9.60	7.00	70.0	2000.0	0.0	6	1	1
10	Bolt 1900 LLXT airgun	11.00	-10.40	7.00	70.0	2000.0	0.0	6	1	1
11	Bolt 1900 LLXT airgun	14.00	-9.60	7.00	250.0	2000.0	0.0	7	1	1
12	Bolt 1900 LLXT airgun	14.00	-10.40	7.00	250.0	2000.0	0.0	7	1	1

Gun types used :

Bolt 1900 LLXT airgun

Units:

Coordinates : meter

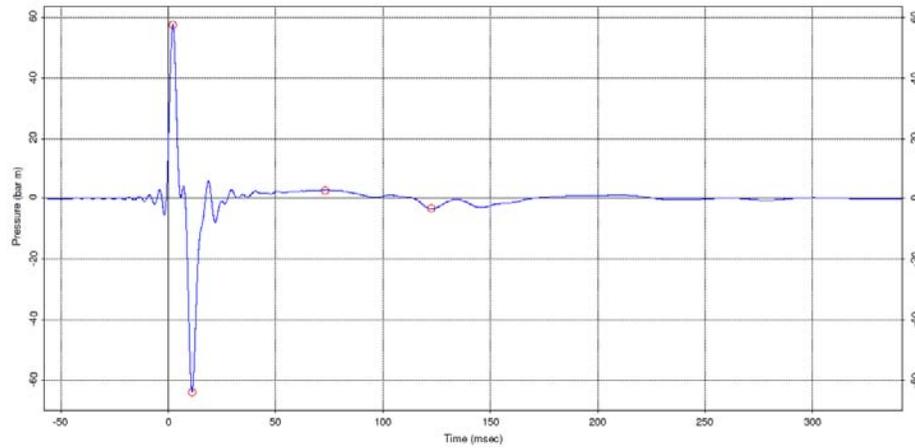
Chamber volume : cubic inch

Chamber pressure : psi

Firing delay : ms

Farfield signature : 3090T\_070\_2000\_100

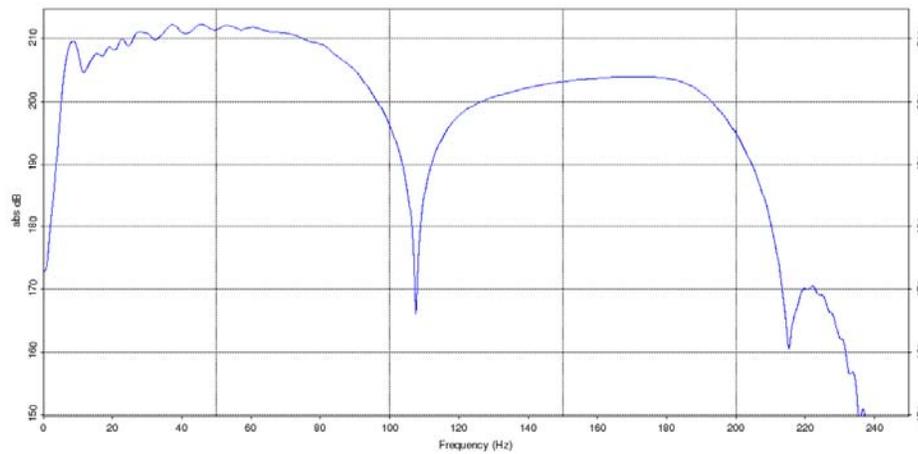
Distance: 9000 m	P/B ratio: 20.1	Pressure: 2000 psi	Water temp.: 15.00 C	Water velocity: 1506.9 m/s
Dip: 0 deg	Geom. spr: 2.00	Primary: 57.7 bar m	Ghost strength: -1.00	Period (+/-): 70.8/111.6 msec
Azimuth: 0 deg	Volume: 3090 cu.in	Source depth: 7.00 m	Peak-peak: 121.5 bar m	Filter: Hydrosience_4.6/6-206/276



Printed by Nariusu (2000) Microsoft (1.4.0) Date: 2011/11/11 13:52

Farfield signature : 3090T\_070\_2000\_100

Distance: 9000 m  
Dip: 0 deg  
Azimuth: 0 deg

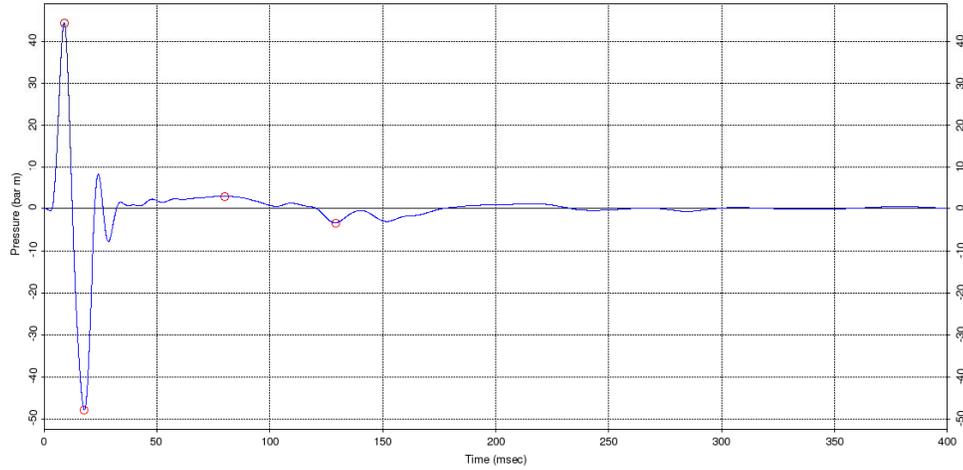


Printed by Nariusu (2000) Microsoft (1.4.0) Date: 2011/11/11 13:52

Figure 2: Modeled far-field signature and amplitude spectrum with Hydrosience recording filter (without receiver ghost).

Farfield signature : 3090T\_\_070\_2000\_100

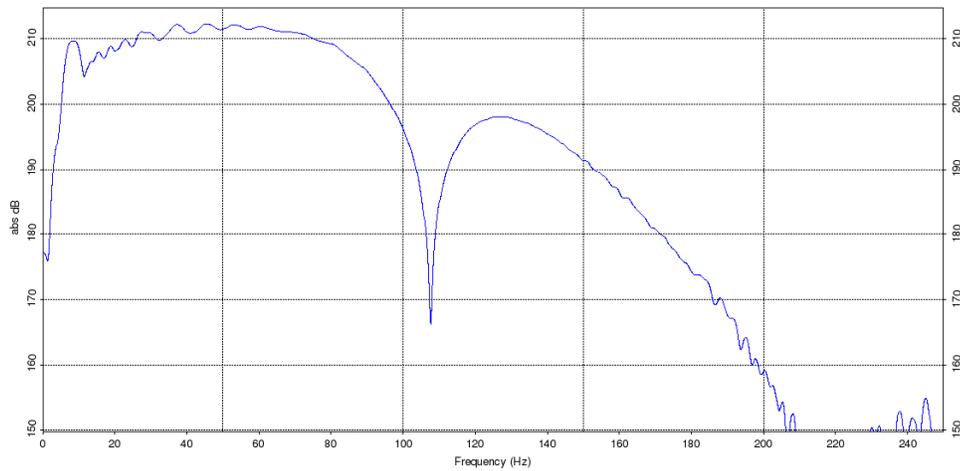
Distance : 9000 m	P/B ratio : 14.6	Pressure : 2000 psi	Water temp. : 15.00 C	Filter : DFS_V_Out-128/72
Dip: 0 deg	Geom. spr. : 2.00	Primary : 44.4 bar m	Peak-peak : 92.3 bar m	Water velocity : 1506.9 m/s
Azimuth: 0 deg	Volume : 3090 cu.in	Source depth : 7.00 m	Ghost strength : -1.00	Period (+/-) : 71.1/111.1 msec



Printed by Nucleus (2.0.0) Mesonova (1.4.0) Date: 2011/1/11 13:51

Farfield signature : 3090T\_\_070\_2000\_100

Distance: 9000 m  
 Dip: 0 deg  
 Azimuth: 0 deg



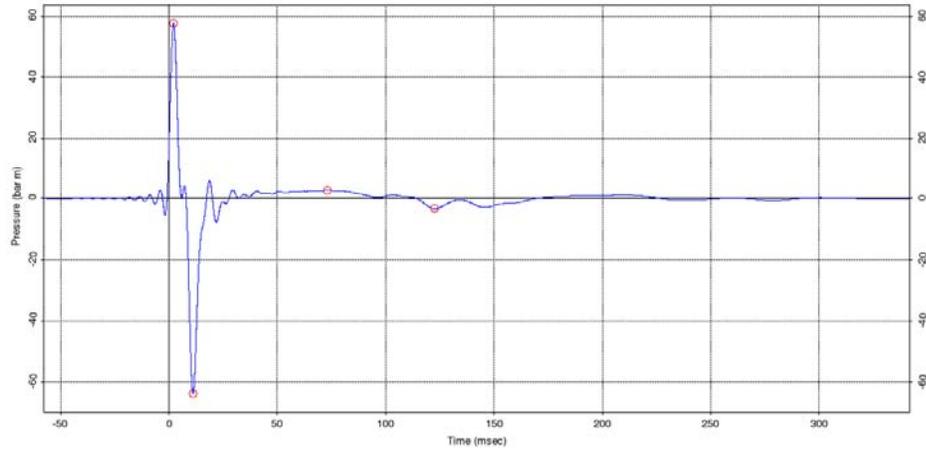
Printed by Nucleus (2.0.0) Mesonova (1.4.0) Date: 2011/1/11 13:51

Figure 3: Modeled far-field signature and amplitude spectrum with DFS-V recording filter (without receiver ghost).

### Full system response with source ghost only

Farfield signature : 3090T\_\_070\_2000\_100

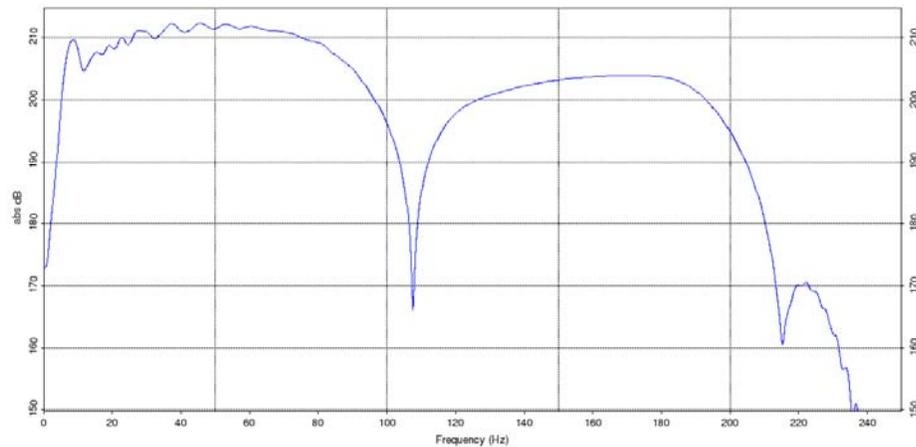
Distance: 9000 m	P/B ratio: 20.1	Pressure: 2000 psi	Water temp.: 15.00 C	Water velocity: 1506.9 m/s
Dip: 0 deg	Geom. spr.: 2.00	Primary: 57.7 bar m	Ghost strength: -1.00	Period (+/-): 70.8/111.6 msec
Azimuth: 0 deg	Volume: 3090 cu.in	Source depth: 7.00 m	Peak-peak: 121.5 bar m	Filter: Hydrosience_4.6/6-206/276



Printed by Nucleus v (2.0.0) Microsoft (1.4.0) Date: 2011/11/11 13:53

Farfield signature : 3090T\_\_070\_2000\_100

Distance: 9000 m  
Dip: 0 deg  
Azimuth: 0 deg



Printed by Nucleus v (2.0.0) Microsoft (1.4.0) Date: 2011/11/11 13:53

Figure 4: Modeled far-field signature and amplitude spectrum with full system response filter effect applied (without receiver ghost).

## Full system response with source ghost only

### FARFIELD SIGNATURE LISTING

Farfield signature was generated by Nucleus+ version 2.0.0

Farfield signature was generated by Marine source modelling version 1.4.0

Name of farfield dataset : 3090T\_\_070\_2000\_100

Source array name : 3090T\_\_070\_2000\_100

Total array volume (cu.in.) : 3090.0

Source average depth (m) : 7.0

Average pressure (psi) : 2000.0

Ghost strength : -1.00

Primary amplitude (bar m) : 57.72

Peak-peak amplitude (bar m) : 121.51

Pulse/Bubble ratio : 20.06

Bubble period (+) (ms) : 70.75

Bubble period (-) (ms) : 111.62

Geometrical spreading : 2.00

Sea water temperature (C) : 15.0

Sea water velocity (m/s) : 1506.9

Filter parameters

Filter type : Hydroscience\_4.6/6-206/276

Low cut frequency (Hz) : 4.6

High cut frequency (Hz) : 206.0

Low cut slope (dB/oct) : 6.0

High cut slope (dB/oct) : 276.0

Start time (ms) : -58.0

Index of time zero : 117

Sample interval (ms) : 0.5

Farfield position

Farfield distance (m) : 9000.0

Dip angle (degrees) : 0.0

Azimuth angle (degrees) : 0.0

Amplitudes are in bar m

Time is increasing horizontally

2010184

---

-0.000	-0.002	-0.005	-0.010	-0.013	-0.017	-0.019
-0.021	-0.022	-0.023	-0.023	-0.023	-0.023	-0.023
-0.022	-0.022	-0.021	-0.021	-0.021	-0.021	-0.020
-0.018	-0.017	-0.016	-0.016	-0.015	-0.012	-0.008
-0.003	0.004	0.008	0.010	0.008	0.002	-0.006
-0.012	-0.013	-0.007	0.006	0.022	0.035	0.040
0.032	0.013	-0.010	-0.029	-0.035	-0.022	0.007
0.042	0.069	0.073	0.050	0.004	-0.047	-0.083
-0.084	-0.044	0.025	0.097	0.141	0.134	0.071
-0.028	-0.123	-0.172	-0.147	-0.048	0.088	0.207
0.252	0.194	0.044	-0.142	-0.285	-0.317	-0.210
0.006	0.245	0.405	0.404	0.224	-0.075	-0.372
-0.534	-0.471	-0.186	0.221	0.579	0.722	0.560
0.128	-0.410	-0.824	-0.908	-0.583	0.059	0.767
1.223	1.181	0.585	-0.377	-1.314	-1.781	-1.473
-0.383	1.127	2.417	2.799	1.835	-0.393	-3.162
-5.204	-5.030	-1.391	6.244	17.378	30.449	43.119
52.833	57.496	56.066	48.883	37.609	24.789	13.150
4.837	0.814	0.620	2.542	4.168	3.140	-2.101
-11.827	-24.913	-39.141	-51.822	-60.539	-63.785	-61.322
-54.162	-44.199	-33.626	-24.328	-17.426	-13.108	-10.757
-9.323	-7.765	-5.445	-2.318	1.107	4.008	5.591
5.397	3.477	0.378	-3.044	-5.900	-7.543	-7.738
-6.690	-4.924	-3.075	-1.670	-0.972	-0.935	-1.271
-1.591	-1.567	-1.047	-0.094	1.051	2.074	2.706
2.810	2.420	1.714	0.943	0.342	0.057	0.115
0.428	0.842	1.195	1.370	1.330	1.120	0.841
0.610	0.527	0.636	0.926	1.333	1.763	2.125
2.353	2.420	2.343	2.172	1.972	1.801	1.697
1.671	1.704	1.759	1.799	1.797	1.747	1.665
1.584	1.541	1.563	1.658	1.812	1.993	2.160
2.276	2.320	2.290	2.207	2.101	2.009	1.955
1.951	1.992	2.060	2.131	2.185	2.209	2.205
2.182	2.157	2.147	2.160	2.198	2.252	2.312
2.362	2.396	2.409	2.407	2.401	2.400	2.413
2.444	2.489	2.540	2.588	2.624	2.642	2.642
2.630	2.613	2.599	2.594	2.602	2.621	2.647
2.673	2.694	2.706	2.709	2.705	2.696	2.685
2.677	2.670	2.665	2.658	2.649	2.634	2.614
2.587	2.557	2.523	2.488	2.452	2.415	2.375
2.331	2.283	2.229	2.170	2.108	2.043	1.978
1.914	1.849	1.784	1.717	1.647	1.573	1.494
1.411	1.324	1.234	1.143	1.052	0.960	0.869
0.779	0.692	0.609	0.533	0.466	0.411	0.373
0.351	0.349	0.365	0.401	0.453	0.520	0.599
0.685	0.776	0.866	0.950	1.025	1.086	1.130
1.154	1.158	1.143	1.111	1.064	1.007	0.942
0.875	0.809	0.747	0.691	0.643	0.604	0.573
0.547	0.524	0.500	0.471	0.431	0.378	0.308
0.217	0.104	-0.032	-0.193	-0.379	-0.590	-0.825
-1.081	-1.354	-1.638	-1.926	-2.209	-2.477	-2.720
-2.930	-3.101	-3.228	-3.310	-3.345	-3.337	-3.289
-3.204	-3.088	-2.944	-2.778	-2.595	-2.399	-2.196
-1.990	-1.785	-1.585	-1.394	-1.215	-1.049	-0.899
-0.766	-0.650	-0.554	-0.476	-0.419	-0.381	-0.363
-0.365	-0.386	-0.427	-0.487	-0.566	-0.665	-0.784
-0.922	-1.076	-1.244	-1.422	-1.605	-1.790	-1.970
-2.141	-2.300	-2.445	-2.572	-2.681	-2.770	-2.838
-2.885	-2.909	-2.910	-2.888	-2.844	-2.779	-2.697

---

2010184

---

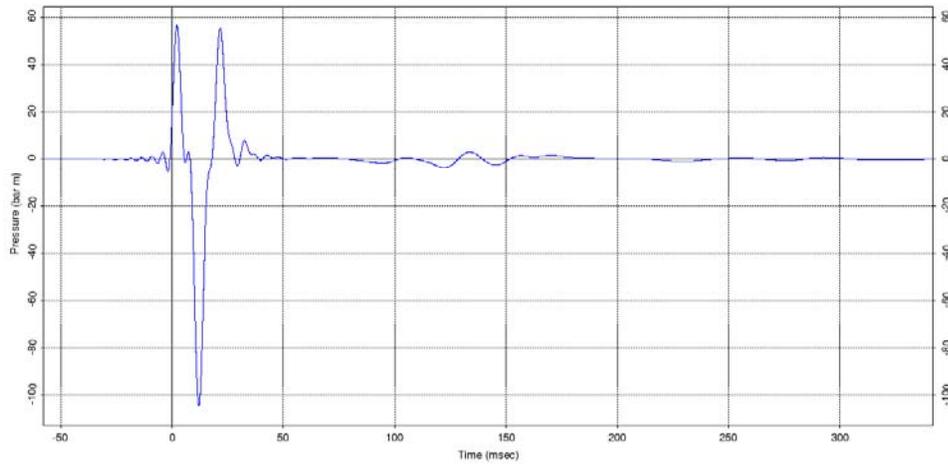
-2.600	-2.492	-2.380	-2.266	-2.156	-2.053	-1.959
-1.877	-1.806	-1.747	-1.698	-1.657	-1.624	-1.597
-1.574	-1.553	-1.534	-1.516	-1.497	-1.476	-1.451
-1.422	-1.387	-1.345	-1.296	-1.238	-1.173	-1.101
-1.024	-0.942	-0.857	-0.772	-0.686	-0.602	-0.520
-0.441	-0.365	-0.294	-0.226	-0.163	-0.103	-0.048
0.004	0.052	0.096	0.138	0.177	0.214	0.249
0.283	0.315	0.346	0.377	0.407	0.436	0.463
0.489	0.513	0.535	0.556	0.574	0.591	0.608
0.625	0.642	0.660	0.678	0.697	0.716	0.734
0.751	0.767	0.781	0.794	0.806	0.817	0.827
0.837	0.846	0.854	0.862	0.869	0.875	0.880
0.883	0.885	0.886	0.887	0.887	0.887	0.887
0.887	0.886	0.886	0.887	0.888	0.889	0.892
0.896	0.901	0.907	0.916	0.925	0.936	0.947
0.960	0.972	0.986	1.000	1.014	1.028	1.043
1.058	1.072	1.085	1.098	1.109	1.119	1.128
1.134	1.139	1.143	1.144	1.144	1.141	1.136
1.129	1.120	1.109	1.095	1.079	1.062	1.043
1.021	0.998	0.973	0.945	0.915	0.883	0.848
0.811	0.773	0.732	0.690	0.646	0.600	0.553
0.505	0.456	0.405	0.354	0.302	0.249	0.196
0.144	0.091	0.039	-0.012	-0.062	-0.110	-0.157
-0.202	-0.243	-0.282	-0.317	-0.349	-0.377	-0.401
-0.422	-0.439	-0.453	-0.464	-0.472	-0.478	-0.482
-0.485	-0.486	-0.486	-0.486	-0.485	-0.483	-0.481
-0.478	-0.475	-0.471	-0.467	-0.462	-0.457	-0.451
-0.444	-0.436	-0.427	-0.417	-0.405	-0.391	-0.375
-0.358	-0.338	-0.317	-0.294	-0.270	-0.246	-0.222
-0.198	-0.174	-0.150	-0.128	-0.105	-0.084	-0.062
-0.042	-0.022	-0.003	0.015	0.031	0.046	0.060
0.072	0.082	0.091	0.099	0.105	0.110	0.113
0.115	0.114	0.112	0.108	0.101	0.093	0.082
0.070	0.055	0.040	0.022	0.003	-0.018	-0.041
-0.065	-0.092	-0.121	-0.152	-0.184	-0.218	-0.254
-0.290	-0.326	-0.363	-0.398	-0.433	-0.466	-0.497
-0.527	-0.554	-0.578	-0.600	-0.618	-0.632	-0.643
-0.650	-0.652	-0.651	-0.645	-0.636	-0.623	-0.606
-0.586	-0.564	-0.538	-0.511	-0.482	-0.451	-0.419
-0.386	-0.353	-0.320	-0.287	-0.253	-0.220	-0.187
-0.155	-0.123	-0.092	-0.062	-0.033	-0.005	0.022
0.047	0.072	0.095	0.116	0.137	0.155	0.172
0.187	0.200	0.212	0.222	0.231	0.239	0.246
0.252	0.256	0.259	0.260	0.259	0.257	0.253
0.248	0.242	0.235	0.227	0.218	0.209	0.199
0.188	0.177	0.165	0.153	0.141	0.129	0.117
0.106	0.096	0.086	0.076	0.067	0.058	0.049
0.041	0.033	0.025	0.018	0.011	0.006	0.001
-0.004	-0.008	-0.012	-0.017	-0.021	-0.026	-0.031
-0.036	-0.040	-0.045	-0.049	-0.054	-0.058	-0.063
-0.067	-0.072	-0.078	-0.083	-0.089	-0.095	-0.101
-0.107	-0.113	-0.120	-0.126	-0.132	-0.138	-0.145
-0.151	-0.156	-0.161	-0.166	-0.170	-0.173	-0.176
-0.178	-0.180	-0.182	-0.183	-0.184	-0.184	-0.184
-0.183	-0.182	-0.180	-0.177	-0.174	-0.171	-0.167
-0.162	-0.157	-0.152				

Figure 5: Far-field signature listing with 2 ms sampling interval (without receiver ghost).

### Full system response with source and receiver ghost

Farfield signature : 3090T\_070\_2000\_100

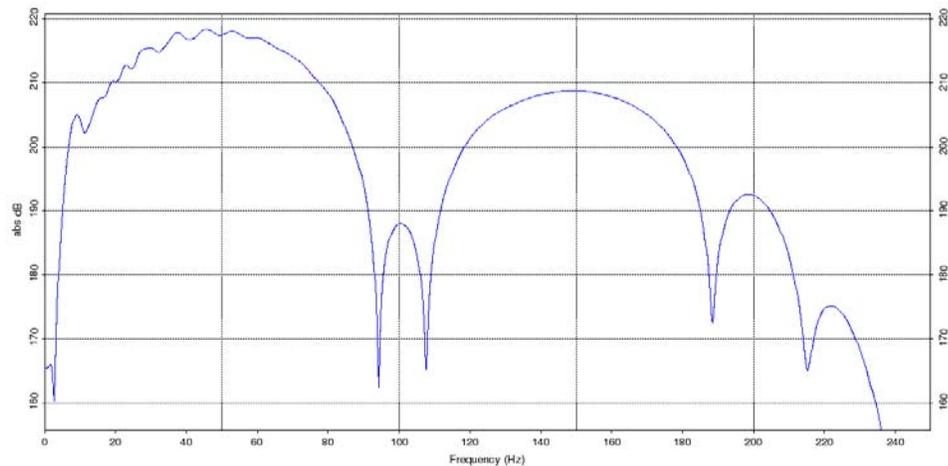
Distance: 9000 m    P/B ratio: 23.9    Pressure: 2000 psi    Water temp.: 15.00 C    Streamer depth: 8.00 m    Filter: Hydrosience\_4.6/6.206/276  
Dip: 0 deg    Geom. spr.: 2.00    Primary: 56.6 bar m    Ghost strength: -1.00    Water velocity: 1506.9 m/s  
Azimuth: 0 deg    Volume: 3090 cu.in    Source depth: 7.00 m    Peak-peak: 161.2 bar m    Period (+/-): 131.5/110.2 msec



Plotted by Nacinus+ (2.0.0), Missions+ (1.4.0), Date: 2011/11/15 15:43

Farfield signature : 3090T\_070\_2000\_100

Distance: 9000 m  
Dip: 0 deg  
Azimuth: 0 deg



Plotted by Nacinus+ (2.0.0), Missions+ (1.4.0), Date: 2011/11/11 13:54

Figure 6: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (with receiver ghost).

---

## Full system response with source and receiver ghost

### FARFIELD SIGNATURE LISTING

Farfield signature was generated by Nucleus+ version 2.0.0

Farfield signature was generated by Marine source modelling version 1.4.0

Name of farfield dataset	:	3090T__070_2000_100
Source array name	:	3090T__070_2000_100
Total array volume (cu.in.)	:	3090.0
Source average depth (m)	:	7.0
Streamer depth (m)	:	8.0
Streamer group length (m)	:	12.5
Average pressure (psi)	:	2000.0
Ghost strength	:	-1.00
Primary amplitude (bar m)	:	56.60
Peak-peak amplitude (bar m)	:	161.21
Pulse/Bubble ratio	:	23.90
Bubble period (+) (ms)	:	131.50
Bubble period (-) (ms)	:	110.25
Geometrical spreading	:	2.00
Sea water temperature (C)	:	15.0
Sea water velocity (m/s)	:	1506.9
Filter parameters		
Filter type	:	Hydroscience_4.6/6-206/276
Low cut frequency (Hz)	:	4.6
High cut frequency (Hz)	:	206.0
Low cut slope (dB/oct)	:	6.0
High cut slope (dB/oct)	:	276.0
Start time (ms)	:	-58.0
Index of time zero	:	117
Sample interval (ms)	:	0.5
Farfield position		
Farfield distance (m)	:	9000.0
Dip angle (degrees)	:	0.0
Azimuth angle (degrees)	:	0.0

Amplitudes are in bar m

Time is increasing horizontally

2010184

-0.000	-0.002	-0.005	-0.010	-0.013	-0.017	-0.019
-0.021	-0.022	-0.023	-0.023	-0.023	-0.023	-0.023
-0.022	-0.022	-0.021	-0.021	-0.021	-0.021	-0.020
-0.018	-0.016	-0.012	-0.007	-0.002	0.003	0.010
0.018	0.025	0.031	0.033	0.031	0.025	0.017
0.010	0.008	0.014	0.027	0.043	0.056	0.060
0.051	0.031	0.006	-0.013	-0.020	-0.009	0.016
0.046	0.067	0.066	0.040	-0.004	-0.050	-0.078
-0.073	-0.031	0.033	0.094	0.123	0.102	0.033
-0.061	-0.141	-0.167	-0.122	-0.015	0.113	0.207
0.218	0.131	-0.028	-0.197	-0.300	-0.282	-0.135
0.089	0.299	0.397	0.324	0.094	-0.210	-0.458
-0.529	-0.371	-0.026	0.373	0.650	0.666	0.381
-0.112	-0.617	-0.902	-0.811	-0.332	0.368	1.001
1.268	0.993	0.219	-0.779	-1.579	-1.777	-1.172
0.111	1.611	2.669	2.675	1.342	-1.079	-3.757
-5.433	-4.748	-0.670	7.124	18.028	30.531	42.510
51.712	56.303	55.343	49.038	38.708	26.467	14.702
5.483	0.049	-1.488	-0.163	2.107	3.007	0.405
-7.107	-19.840	-36.881	-56.241	-75.249	-91.090	-101.373
-104.612	-100.499	-89.939	-74.829	-57.637	-40.884	-26.635
-16.116	-9.529	-6.111	-4.404	-2.672	0.628	6.449
14.906	25.256	36.091	45.693	52.474	55.363	54.057
49.066	41.548	32.987	24.810	18.053	13.170	10.023
8.054	6.552	4.936	2.958	0.754	-1.242	-2.502
-2.624	-1.504	0.605	3.174	5.557	7.198	7.793
7.354	6.175	4.701	3.369	2.465	2.062	2.030
2.123	2.097	1.804	1.245	0.553	-0.067	-0.427
-0.428	-0.088	0.465	1.049	1.489	1.677	1.597
1.318	0.961	0.650	0.474	0.460	0.579	0.760
0.920	0.995	0.953	0.801	0.578	0.335	0.125
-0.018	-0.080	-0.067	-0.002	0.086	0.171	0.236
0.276	0.299	0.317	0.345	0.390	0.454	0.524
0.582	0.609	0.592	0.528	0.425	0.305	0.195
0.118	0.090	0.116	0.185	0.278	0.373	0.449
0.495	0.510	0.500	0.478	0.456	0.442	0.440
0.446	0.453	0.453	0.441	0.417	0.386	0.353
0.327	0.310	0.305	0.306	0.307	0.300	0.280
0.244	0.196	0.141	0.086	0.038	0.001	-0.024
-0.041	-0.055	-0.074	-0.103	-0.144	-0.197	-0.261
-0.330	-0.401	-0.470	-0.534	-0.594	-0.650	-0.705
-0.760	-0.817	-0.877	-0.938	-0.999	-1.060	-1.120
-1.178	-1.236	-1.292	-1.349	-1.405	-1.459	-1.511
-1.558	-1.598	-1.629	-1.647	-1.653	-1.643	-1.618
-1.574	-1.513	-1.431	-1.329	-1.208	-1.068	-0.911
-0.743	-0.566	-0.387	-0.212	-0.046	0.106	0.241
0.355	0.447	0.516	0.562	0.584	0.583	0.561
0.520	0.460	0.386	0.299	0.204	0.101	-0.006
-0.116	-0.229	-0.343	-0.458	-0.574	-0.691	-0.809
-0.929	-1.051	-1.177	-1.310	-1.453	-1.609	-1.781
-1.970	-2.177	-2.398	-2.629	-2.862	-3.089	-3.299
-3.482	-3.630	-3.733	-3.786	-3.785	-3.727	-3.613
-3.443	-3.219	-2.945	-2.624	-2.261	-1.860	-1.428
-0.971	-0.498	-0.017	0.460	0.923	1.359	1.758
2.109	2.405	2.639	2.808	2.912	2.952	2.931
2.853	2.723	2.546	2.326	2.068	1.776	1.456
1.113	0.754	0.386	0.015	-0.350	-0.703	-1.036

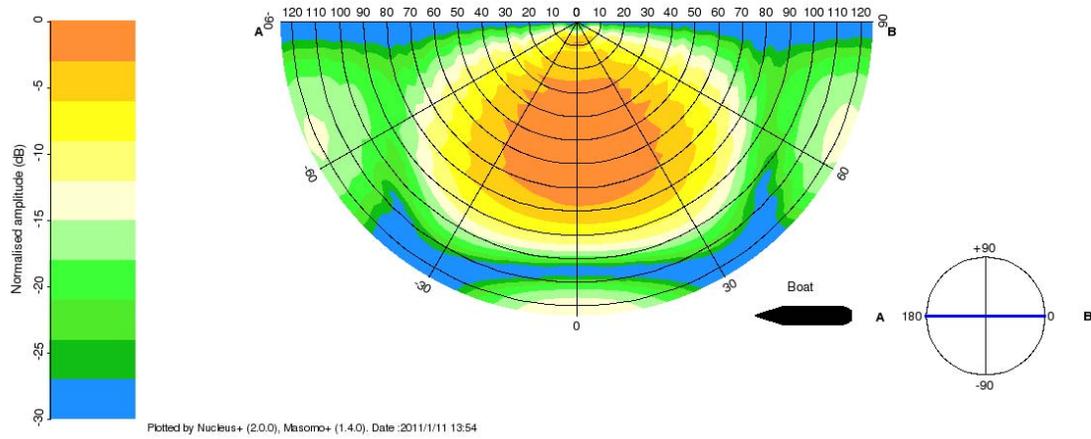
2010184

-1.345	-1.624	-1.869	-2.078	-2.249	-2.381	-2.471
-2.521	-2.529	-2.494	-2.417	-2.298	-2.139	-1.942
-1.712	-1.455	-1.178	-0.889	-0.597	-0.310	-0.036
0.220	0.452	0.659	0.840	0.993	1.120	1.220
1.295	1.345	1.370	1.372	1.353	1.314	1.260
1.196	1.126	1.057	0.993	0.940	0.900	0.877
0.869	0.878	0.900	0.934	0.978	1.028	1.081
1.136	1.190	1.243	1.292	1.336	1.375	1.406
1.430	1.445	1.449	1.443	1.427	1.400	1.365
1.323	1.275	1.222	1.168	1.112	1.056	1.001
0.948	0.896	0.845	0.797	0.751	0.709	0.669
0.633	0.602	0.574	0.550	0.529	0.511	0.493
0.477	0.460	0.443	0.425	0.407	0.389	0.371
0.355	0.339	0.325	0.313	0.301	0.289	0.276
0.263	0.248	0.232	0.214	0.196	0.177	0.159
0.141	0.125	0.110	0.097	0.086	0.076	0.069
0.063	0.059	0.056	0.057	0.059	0.063	0.070
0.079	0.089	0.101	0.114	0.128	0.143	0.158
0.172	0.187	0.200	0.213	0.223	0.232	0.238
0.241	0.242	0.239	0.232	0.223	0.210	0.194
0.174	0.152	0.128	0.100	0.071	0.039	0.005
-0.031	-0.068	-0.107	-0.148	-0.189	-0.232	-0.275
-0.319	-0.364	-0.408	-0.452	-0.496	-0.539	-0.582
-0.624	-0.665	-0.704	-0.743	-0.780	-0.815	-0.849
-0.881	-0.911	-0.938	-0.962	-0.982	-0.999	-1.012
-1.020	-1.024	-1.022	-1.016	-1.004	-0.987	-0.965
-0.937	-0.905	-0.869	-0.829	-0.785	-0.739	-0.691
-0.641	-0.590	-0.538	-0.486	-0.435	-0.384	-0.335
-0.287	-0.242	-0.199	-0.159	-0.121	-0.087	-0.056
-0.028	-0.002	0.021	0.043	0.064	0.085	0.105
0.126	0.147	0.169	0.191	0.213	0.236	0.258
0.280	0.301	0.321	0.340	0.357	0.374	0.389
0.403	0.415	0.426	0.433	0.438	0.440	0.438
0.433	0.424	0.412	0.398	0.380	0.361	0.340
0.318	0.293	0.268	0.240	0.212	0.181	0.149
0.116	0.082	0.047	0.012	-0.024	-0.061	-0.097
-0.134	-0.171	-0.210	-0.248	-0.287	-0.327	-0.366
-0.404	-0.440	-0.475	-0.507	-0.535	-0.560	-0.582
-0.599	-0.613	-0.622	-0.626	-0.625	-0.620	-0.608
-0.590	-0.567	-0.537	-0.501	-0.460	-0.413	-0.361
-0.305	-0.246	-0.185	-0.122	-0.058	0.006	0.070
0.132	0.193	0.251	0.307	0.359	0.408	0.452
0.492	0.527	0.558	0.583	0.604	0.620	0.631
0.637	0.639	0.638	0.633	0.624	0.612	0.597
0.580	0.560	0.539	0.516	0.492	0.467	0.441
0.414	0.386	0.358	0.329	0.299	0.269	0.238
0.207	0.176	0.146	0.116	0.086	0.058	0.031
0.005	-0.020	-0.044	-0.066	-0.088	-0.108	-0.127
-0.144	-0.159	-0.172	-0.183	-0.192	-0.199	-0.205
-0.208	-0.210	-0.211	-0.210	-0.208	-0.205	-0.200
-0.194	-0.187	-0.180	-0.172	-0.164	-0.157	-0.150
-0.144	-0.138	-0.133	-0.128	-0.123	-0.118	-0.114
-0.110	-0.107	-0.104	-0.103	-0.102	-0.102	-0.103
-0.105	-0.106	-0.108	-0.110	-0.112	-0.114	-0.115
-0.116	-0.117	-0.118	-0.118	-0.117	-0.116	-0.114
-0.112	-0.109	-0.105	-0.101	-0.096	-0.090	-0.084
-0.078	-0.070	-0.062	-0.053	-0.044	-0.034	-0.024
-0.013	-0.003	0.008				

Figure 7: Far-field signature listing with 2 ms sampling interval (with receiver ghost).

Source directivity : 3090T\_\_070\_2000\_100

Azimuth : 0 deg



Source directivity : 3090T\_\_070\_2000\_100

Azimuth : 90 deg

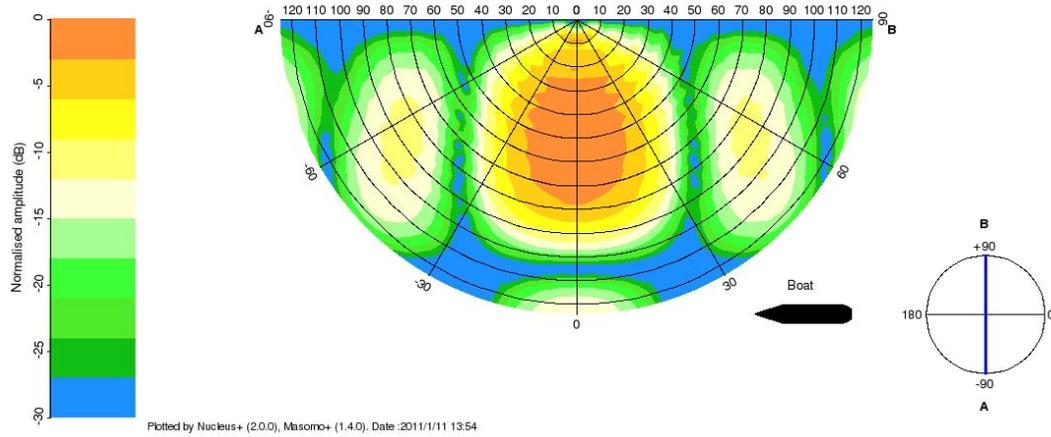


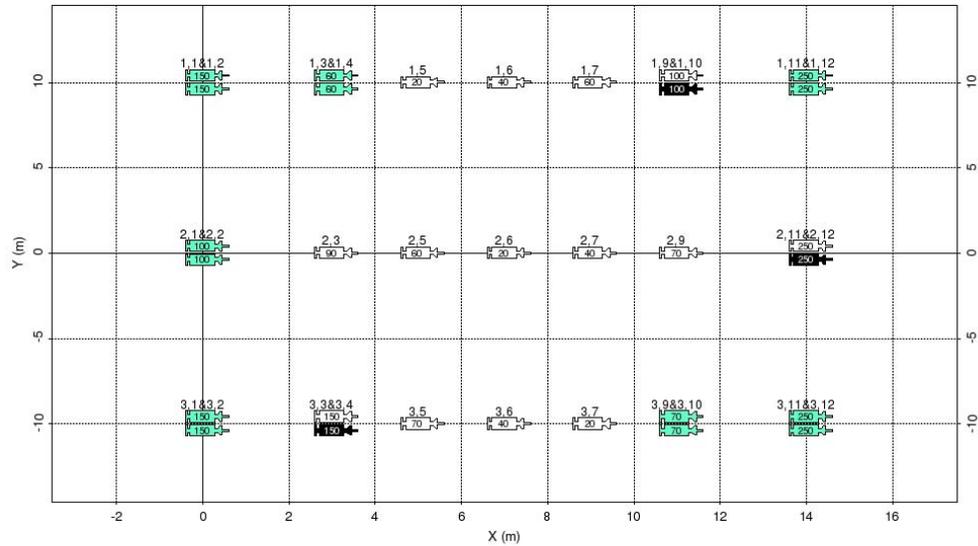
Figure 8: Directivity plot for constant azimuth of 0° and 90°.

## 9.2 Source Drop-out Specifications

Array : 3090T\_\_070\_2000\_100

Volume : 3090 cubic inches

 Single gun  
 Cluster gun  
 Spare gun



Plotted by Nucleus+ (2.0.0), Masomo+ (1.4.0), Date :2011/1/11 14:46

Drop-out specification of array:

3090T\_\_070\_2000\_100

Bolt 1900 LLXT guns, 3090 cu.in. array,

7.0 m depth, 2000 psi pressure,

10.0 m subarray spacing

JANUARY 2011

The drop-out specification covered by this report was performed with NUCLEUS v.2.0.0 (masomo v.1.4.0) modeling software by Ashish Misra, approved by \_\_\_\_\_ PGS Geoscience & Engineering - Research & Geophysical Support.

A Hydroscience\_4.6/6-206/276 Hz (dB/oct.) filter is used for the modeling.

An explanation of the dropout matrix can be found at:

<http://ge.pgs.com/res/sourcemod/ExplanationOfTheDropoutMatrix.ppt>

The drop-out specification enclosed is given for the following criteria:

- ✓ Pulse/bubble ratio value  $\leq 15.00$
- ✓ Cross correlation coeff.  $\leq 0.99800$
- ✓ Average spectrum deviation  $\geq 1.20$  dB
- ✓ Maximum spectrum deviation  $\geq 3.00$  dB

**APPENDIX A: ARRAY DESCRIPTION**

**APPENDIX B: DROP-OUT SPECIFICATION**

**APPENDIX C: DROP-OUT RESULTS FROM THE MODELING**

## APPENDIX A: ARRAY DESCRIPTION

### SOURCE ARRAY PARAMETERS

Project : Origin-Energy  
 Dataset : 3090T\_\_070\_2000\_100  
  
 Number of subarrays : 3  
 Total number of guns : 31  
 Total chamber volume : 3590.0  
 Effective volume : 3090.0  
  
 Subarray number : 1  
 Subarray name : 1140T\_\_040\_2000\_SUB  
 Number of guns : 11  
 Subarray volume : 1240.0  
 Effective volume : 1140.0

GUN	TYPE	X (m)	Y (m)	Z (m)	Volume	Pressure	Delay	CluNo	Activ	Group
1	Bolt 1900 LLXT airgun	0.00	10.40	7.00	150.0	2000.0	0.0	1	1	1
2	Bolt 1900 LLXT airgun	0.00	9.60	7.00	150.0	2000.0	0.0	1	1	1
3	Bolt 1900 LLXT airgun	3.00	10.40	7.00	60.0	2000.0	0.0	2	1	1
4	Bolt 1900 LLXT airgun	3.00	9.60	7.00	60.0	2000.0	0.0	2	1	1
5	Bolt 1900 LLXT airgun	5.00	10.00	7.00	20.0	2000.0	0.0	0	1	1
6	Bolt 1900 LLXT airgun	7.00	10.00	7.00	40.0	2000.0	0.0	0	1	1
7	Bolt 1900 LLXT airgun	9.00	10.00	7.00	60.0	2000.0	0.0	0	1	1
9	Bolt 1900 LLXT airgun	11.00	10.40	7.00	100.0	2000.0	0.0	0	1	1
10	Bolt 1900 LLXT airgun	11.00	9.60	7.00	100.0	2000.0	0.0	0	0	1
11	Bolt 1900 LLXT airgun	14.00	10.40	7.00	250.0	2000.0	0.0	3	1	1
12	Bolt 1900 LLXT airgun	14.00	9.60	7.00	250.0	2000.0	0.0	3	1	1

Subarray number : 2  
 Subarray name : 0730T\_\_040\_2000\_SUB  
 Number of guns : 9  
 Subarray volume : 980.0  
 Effective volume : 730.0

GUN	TYPE	X (m)	Y (m)	Z (m)	Volume	Pressure	Delay	CluNo	Activ	Group
1	Bolt 1900 LLXT airgun	0.00	0.40	7.00	100.0	2000.0	0.0	4	1	1
2	Bolt 1900 LLXT airgun	0.00	-0.40	7.00	100.0	2000.0	0.0	4	1	1
3	Bolt 1900 LLXT airgun	3.00	0.00	7.00	90.0	2000.0	0.0	0	1	1
5	Bolt 1900 LLXT airgun	5.00	0.00	7.00	60.0	2000.0	0.0	0	1	1
6	Bolt 1900 LLXT airgun	7.00	0.00	7.00	20.0	2000.0	0.0	0	1	1
7	Bolt 1900 LLXT airgun	9.00	0.00	7.00	40.0	2000.0	0.0	0	1	1
9	Bolt 1900 LLXT airgun	11.00	0.00	7.00	70.0	2000.0	0.0	0	1	1
11	Bolt 1900 LLXT airgun	14.00	0.40	7.00	250.0	2000.0	0.0	0	1	1
12	Bolt 1900 LLXT airgun	14.00	-0.40	7.00	250.0	2000.0	0.0	0	0	1

2010184

Subarray number : 3  
 Subarray name : 1220T\_\_040\_2000\_SUB  
 Number of guns : 11  
 Subarray volume : 1370.0  
 Effective volume : 1220.0

GUN	TYPE	X (m)	Y (m)	Z (m)	Volume	Pressure	Delay	CluNo	Activ	Group
1	Bolt 1900 LLXT airgun	0.00	-9.60	7.00	150.0	2000.0	0.0	5	1	1
2	Bolt 1900 LLXT airgun	0.00	-10.40	7.00	150.0	2000.0	0.0	5	1	1
3	Bolt 1900 LLXT airgun	3.00	-9.60	7.00	150.0	2000.0	0.0	0	1	1
4	Bolt 1900 LLXT airgun	3.00	-10.40	7.00	150.0	2000.0	0.0	0	0	1
5	Bolt 1900 LLXT airgun	5.00	-10.00	7.00	70.0	2000.0	0.0	0	1	1
6	Bolt 1900 LLXT airgun	7.00	-10.00	7.00	40.0	2000.0	0.0	0	1	1
7	Bolt 1900 LLXT airgun	9.00	-10.00	7.00	20.0	2000.0	0.0	0	1	1
9	Bolt 1900 LLXT airgun	11.00	-9.60	7.00	70.0	2000.0	0.0	6	1	1
10	Bolt 1900 LLXT airgun	11.00	-10.40	7.00	70.0	2000.0	0.0	6	1	1
11	Bolt 1900 LLXT airgun	14.00	-9.60	7.00	250.0	2000.0	0.0	7	1	1
12	Bolt 1900 LLXT airgun	14.00	-10.40	7.00	250.0	2000.0	0.0	7	1	1

Gun types used :

Bolt 1900 LLXT airgun

Units :

Coordinates : meter

Chamber volume : cubic inch

Chamber pressure : psi

Firing delay : ms

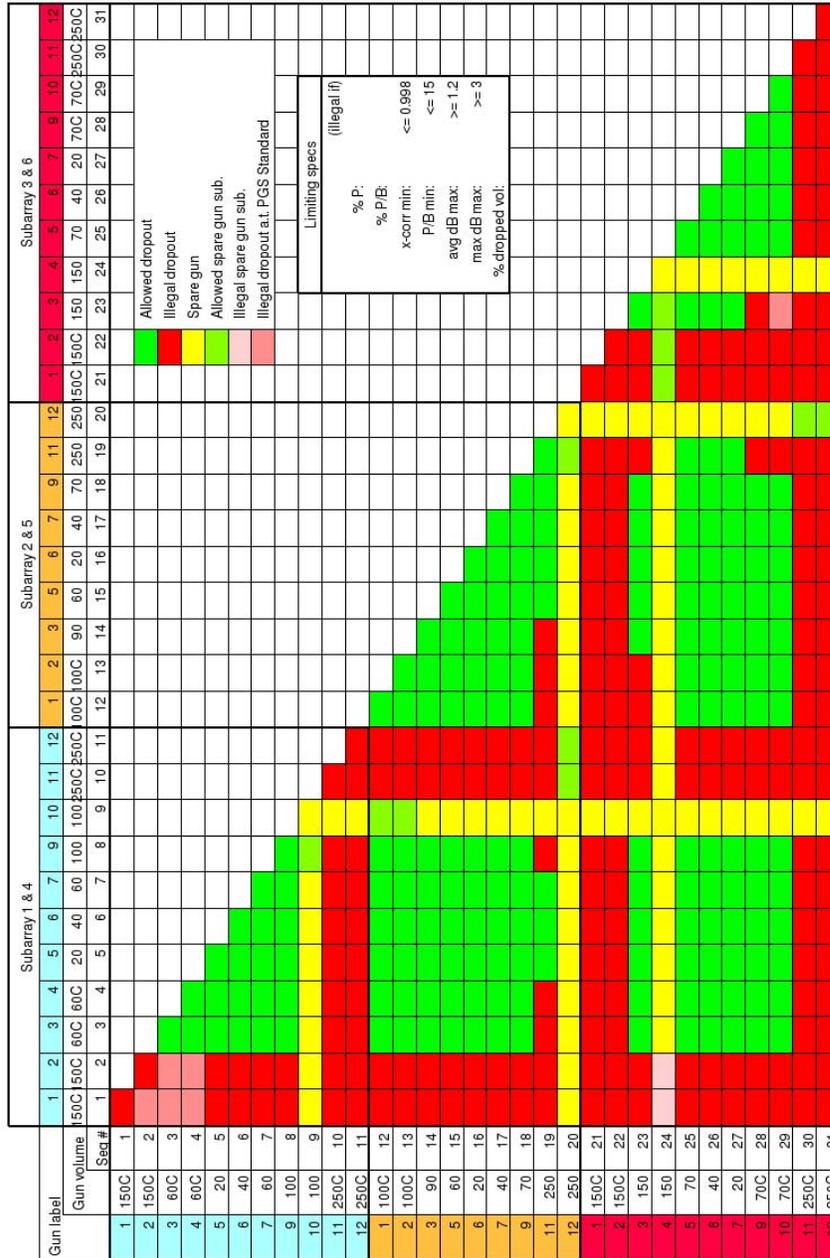
**APPENDIX B: DROP-OUT SPECIFICATIONS**

The array contains the following active elements:

Number of elements	Name	Type	Total volume (cu. in.)	Number of guns in element
2	2x250C	Cluster	500	2
2	2x150C	Cluster	300	2
1	2x100C	Cluster	200	2
1	2x70C	Cluster	140	2
1	2x60C	Cluster	120	2
1	250	Single gun	250	1
1	150	Single gun	150	1
1	100	Single gun	100	1
1	90	Single gun	90	1
2	70	Single gun	70	1
2	60	Single gun	60	1
3	40	Single gun	40	1
3	20	Single gun	20	1

# Dropout specification for array: 3090T\_\_070\_2000\_100

## Hydroscience\_4.6/6-206/276, 15 deg C



Created by Nucleus+ (2.0.0), Masomo+ (1.4.0), Date 2011/1/11 14:50

Figure 1: Single (on diagonal) and two gun drop-out diagram. Illegal combinations denoted in red. According to PGS standard, if a single gun drop-out is not allowed, no combination with that gun - even if otherwise acceptable - is allowed. Similarly, if a drop-out combination including a cluster gun is illegal, all other similar combinations including other guns in the same cluster are also illegal. These combinations are marked in light red.

**Generalized drop-out specification for 3090T\_\_070\_2000\_100****(Bolt 1900 LLXT gun / 3090 cu.in. / 7.0 m / 2000 psi / Hydrosience\_4.6/6-206/276 / 15 °C)**

The drop-out specification is given for the following criteria:

- ✓ Pulse/bubble ratio value  $\leq 15.00$
- ✓ Cross correlation coeff.  $\leq 0.99800$
- ✓ Average spectrum deviation  $\geq 1.20$  dB
- ✓ Maximum spectrum deviation  $\geq 3.00$  dB

All direct spare gun substitutions are legal (i.e. a 250cu.in. for a 250cu.in., a 150cu.in. for a 150cu.in., or a 100cu.in. for a 100cu.in.) except:

The 150 cu.in. gun at Subs 3&6 pos 4 may not replace Subs 1&4 pos 1, 2

Any single gun can be dropped except:

Subs 1&4 pos 1, 2, 11, 12

Subs 3&6 pos 1, 2, 11, 12

Any 2-gun drop-out combination is acceptable except\*:

Subs 1&4 pos 1, 2, 11, 12 with any other gun

Subs 3&6 pos 1, 2, 11, 12 with any other gun

Subs 2&5 pos 11 with Subs 1&4 pos 3, 4, 9

Subs 2&5 pos 11 with Subs 2&5 pos 1, 2, 3

Subs 3&6 pos 3 with Subs 2&5 pos 1, 2, 11

Subs 3&6 pos 9, 10 with Subs 2&5 pos 11

Subs 3&6 pos 9, 10 with Subs 3&6 pos 3

More than 2 guns is not analyzed and cannot be dropped.

\*. Previously stated illegal combinations are not repeated

**APPENDIX C: DROP-OUT RESULTS FROM THE MODELING**

Dropout array	:	3090T__070_2000_100
Gun type	:	Bolt 1900 LLXT gun
Volume	:	3090 cu.in.
Depth	:	7.0 m
Air pressure	:	2000 psi
Subarrayseparation	:	10.0 m
Reference array	:	3090T__070_2000_100
Filter	:	Hydroscience_4.6/6-206/276 Hz (dB/oct.)
Sea temperature	:	15 °C
Water velocity	:	1506.89 m/s
Reflection coefficient	:	-1.00
Primary window	:	-58 - 30 ms
Bubble window	:	50 - 200 ms
Amplitude option	:	Positive peak amplitude.
Frequency option	:	Average absolute spectral deviation.
Analysis bandwidth	:	10 - 70 Hz

Abbreviations in the table below:

Peak	=	Primary positive peak amplitude (barm)
%ch	=	Percentage change
P/B	=	Primary-to-bubble ratio
X-cor	=	Normalized cross correlation coefficient
AvgdB	=	Average absolute deviation (dB) in analyzed frequency domain
MaxdB	=	Maximum deviation (dB) in analyzed frequency domain

(Negative gun number means activated spare gun)

**Drop-out combinations:**

Dropped	gun numbers	Gun volumes	Peak	%ch	P/B	%ch	X-cor	AvgdB	MaxdB				
0	0	0	57.7	0.0	20.1	0.0	1.0000	0.00	0.0				
1	1	150	55.9	-3.1	21.6	7.5	0.9977	0.50	-2.8				
1	2	150	55.9	-3.1	21.6	7.5	0.9976	0.50	-2.9				
1	3	60	56.4	-2.2	20.2	0.7	0.9996	0.23	0.9				
1	4	60	56.4	-2.2	20.2	0.7	0.9996	0.23	-0.9				
1	5	20	57.1	-1.1	19.9	-0.7	0.9999	0.04	0.1				
1	6	40	56.4	-2.2	19.7	-1.7	0.9998	0.12	0.3				
1	7	60	56.1	-2.8	20.0	-0.1	0.9997	0.18	0.8				
1	9	100	55.6	-3.7	19.2	-4.3	0.9996	0.30	1.3				
1	11	250	55.5	-3.9	13.1	-34.8	0.9955	0.62	3.2				
1	12	250	55.5	-3.9	13.1	-34.5	0.9954	0.62	3.2				
2	1	100	56.1	-2.8	19.5	-3.0	0.9990	0.37	-1.8				
2	2	100	56.1	-2.8	19.4	-3.0	0.9990	0.37	-1.8				
2	3	90	55.7	-3.5	19.8	-1.1	0.9994	0.26	0.8				
2	5	60	56.1	-2.8	20.3	1.1	0.9996	0.14	0.6				
2	6	20	57.0	-1.3	19.9	-0.7	0.9998	0.03	0.1				
2	7	40	56.4	-2.3	19.9	-0.9	0.9997	0.10	0.3				
2	9	70	55.8	-3.3	20.5	2.4	0.9996	0.22	0.6				
2	11	250	54.5	-5.6	19.8	-1.3	0.9984	0.59	1.8				
3	1	150	55.9	-3.2	21.2	5.7	0.9965	0.57	-2.3				
3	2	150	55.9	-3.2	21.1	5.3	0.9966	0.57	-2.2				
3	3	150	55.3	-4.2	19.4	-3.1	0.9993	0.37	-1.1				
3	5	70	56.0	-3.0	19.8	-1.4	0.9997	0.18	0.4				
3	6	40	56.4	-2.2	19.7	-1.9	0.9998	0.11	0.3				
3	7	20	57.1	-1.1	19.9	-0.6	0.9999	0.03	0.1				
3	9	70	56.4	-2.3	19.1	-4.9	0.9996	0.23	-1.0				
3	10	70	56.4	-2.3	19.1	-4.7	0.9996	0.23	-1.0				
3	11	250	55.5	-3.8	12.5	-37.9	0.9950	0.65	3.4				
3	12	250	55.5	-3.8	12.4	-38.2	0.9950	0.65	3.4				
1	1	1	2	150	150	53.2	-7.9	20.6	2.7	0.9987	0.74	1.9	
1	1	1	3	150	60	54.6	-5.4	20.0	-0.2	0.9981	0.55	-2.4	
1	1	1	4	150	60	54.6	-5.4	20.0	-0.3	0.9981	0.54	-2.4	
1	1	1	5	150	20	55.3	-4.2	21.4	6.9	0.9976	0.52	-2.8	
1	1	1	6	150	40	54.6	-5.3	20.8	3.8	0.9975	0.58	-2.6	
1	1	1	7	150	60	54.3	-5.9	21.3	6.0	0.9977	0.60	-2.5	
1	1	1	9	150	100	53.8	-6.8	19.5	-2.6	0.9977	0.68	-2.4	
1	1	1	11	150	250	53.7	-7.0	13.4	-33.4	0.9951	0.83	3.3	
1	1	1	12	150	250	53.7	-7.0	13.4	-33.4	0.9949	0.84	3.3	
1	1	1	2	1	150	100	54.3	-5.9	20.3	1.0	0.9966	0.70	-3.2
1	1	1	2	2	150	100	54.3	-5.9	20.2	0.9	0.9966	0.70	-3.2
1	1	1	2	3	150	90	53.9	-6.7	20.1	0.4	0.9973	0.63	-2.5
1	1	1	2	5	150	60	54.3	-5.9	21.5	7.2	0.9974	0.58	-2.6
1	1	1	2	6	150	20	55.2	-4.4	21.5	7.2	0.9975	0.51	-2.8
1	1	1	2	7	150	40	54.6	-5.4	21.0	4.5	0.9973	0.57	-2.7
1	1	1	2	9	150	70	54.0	-6.4	22.5	12.4	0.9973	0.65	-2.7
1	1	1	2	11	150	250	52.7	-8.7	19.4	-3.1	0.9932	1.01	-3.3
1	1	1	3	1	150	150	54.1	-6.3	14.6	-27.3	0.9885	1.05	-4.1
1	1	1	3	2	150	150	54.1	-6.3	14.8	-26.4	0.9888	1.04	-4.0
1	1	1	3	3	150	150	53.5	-7.3	19.4	-3.5	0.9969	0.71	2.5
1	1	1	3	5	150	70	54.2	-6.1	21.9	9.1	0.9973	0.62	-2.6
1	1	1	3	6	150	40	54.6	-5.3	20.7	3.1	0.9974	0.59	-2.7
1	1	1	3	7	150	20	55.3	-4.2	21.4	6.9	0.9976	0.52	-2.8
1	1	1	3	9	150	70	54.6	-5.4	19.1	-4.8	0.9975	0.62	-2.3
1	1	1	3	10	150	70	54.6	-5.4	19.2	-4.5	0.9975	0.62	-2.3
1	1	1	3	11	150	250	53.7	-7.0	12.8	-36.0	0.9950	0.83	3.5

2010184

1	1	3	12	150	250	53.7	-7.0	12.8	-36.1	0.9950	0.83	3.5
1	2	1	3	150	60	54.6	-5.4	20.0	-0.4	0.9981	0.54	-2.4
1	2	1	4	150	60	54.6	-5.4	20.0	-0.1	0.9981	0.54	-2.4
1	2	1	5	150	20	55.3	-4.2	21.4	6.8	0.9975	0.52	-2.8
1	2	1	6	150	40	54.6	-5.3	20.8	3.8	0.9974	0.58	-2.7
1	2	1	7	150	60	54.3	-5.9	21.2	5.9	0.9976	0.60	-2.5
1	2	1	9	150	100	53.8	-6.8	19.6	-2.5	0.9976	0.67	-2.4
1	2	1	11	150	250	53.7	-7.0	13.4	-33.4	0.9951	0.83	3.3
1	2	1	12	150	250	53.7	-7.0	13.4	-33.3	0.9949	0.83	3.3
1	2	2	1	150	100	54.3	-5.9	20.2	0.9	0.9965	0.70	-3.2
1	2	2	2	150	100	54.3	-5.9	20.2	0.8	0.9965	0.70	-3.2
1	2	2	3	150	90	53.9	-6.6	20.1	0.4	0.9972	0.63	-2.6
1	2	2	5	150	60	54.3	-5.9	21.5	7.0	0.9973	0.58	-2.6
1	2	2	6	150	20	55.2	-4.4	21.5	7.1	0.9974	0.51	-2.9
1	2	2	7	150	40	54.6	-5.4	20.9	4.4	0.9972	0.57	-2.8
1	2	2	9	150	70	54.0	-6.4	22.6	12.6	0.9972	0.65	-2.7
1	2	2	11	150	250	52.7	-8.7	19.5	-2.8	0.9931	1.01	-3.3
1	2	3	1	150	150	54.1	-6.3	14.6	-27.1	0.9884	1.05	-4.2
1	2	3	2	150	150	54.1	-6.3	14.8	-26.3	0.9887	1.04	-4.1
1	2	3	3	150	150	53.5	-7.3	19.4	-3.5	0.9968	0.71	2.5
1	2	3	5	150	70	54.2	-6.1	21.9	9.2	0.9972	0.62	-2.6
1	2	3	6	150	40	54.6	-5.3	20.7	3.1	0.9973	0.59	-2.8
1	2	3	7	150	20	55.3	-4.2	21.4	6.8	0.9975	0.52	-2.8
1	2	3	9	150	70	54.6	-5.4	19.1	-4.8	0.9974	0.62	-2.4
1	2	3	10	150	70	54.6	-5.4	19.2	-4.5	0.9974	0.62	-2.4
1	2	3	11	150	250	53.7	-6.9	12.8	-36.0	0.9950	0.83	3.5
1	2	3	12	150	250	53.7	-6.9	12.8	-36.1	0.9950	0.83	3.4
1	3	1	4	60	60	54.7	-5.3	20.2	0.7	0.9994	0.36	1.3
1	3	1	5	60	20	55.7	-3.6	20.1	0.1	0.9994	0.27	0.9
1	3	1	6	60	40	55.1	-4.5	19.9	-1.0	0.9993	0.32	1.2
1	3	1	7	60	60	54.9	-5.0	21.3	6.2	0.9992	0.38	1.7
1	3	1	9	60	100	54.3	-5.9	17.3	-13.9	0.9983	0.55	2.7
1	3	1	11	60	250	54.2	-6.1	13.3	-33.9	0.9954	0.73	2.5
1	3	1	12	60	250	54.2	-6.1	13.3	-33.7	0.9953	0.73	2.5
1	3	2	1	60	100	54.8	-5.0	19.7	-1.6	0.9988	0.50	1.6
1	3	2	2	60	100	54.8	-5.0	19.7	-1.6	0.9988	0.50	1.7
1	3	2	3	60	90	54.4	-5.8	18.4	-8.3	0.9982	0.50	1.9
1	3	2	5	60	60	54.8	-5.0	20.0	-0.3	0.9989	0.36	1.5
1	3	2	6	60	20	55.7	-3.5	20.0	-0.4	0.9992	0.26	0.9
1	3	2	7	60	40	55.1	-4.5	19.9	-1.0	0.9990	0.33	1.1
1	3	2	9	60	70	54.6	-5.5	20.6	2.8	0.9989	0.41	1.3
1	3	2	11	60	250	53.2	-7.8	18.5	-7.8	0.9977	0.74	1.9
1	3	3	1	60	150	54.6	-5.4	20.2	0.6	0.9961	0.67	-2.2
1	3	3	2	60	150	54.6	-5.4	20.2	0.5	0.9962	0.67	-2.2
1	3	3	3	60	150	54.0	-6.4	18.2	-9.4	0.9986	0.54	1.3
1	3	3	5	60	70	54.7	-5.2	20.1	0.4	0.9993	0.36	0.9
1	3	3	6	60	40	55.2	-4.4	19.6	-2.1	0.9993	0.31	1.0
1	3	3	7	60	20	55.8	-3.3	20.1	0.2	0.9994	0.26	0.9
1	3	3	9	60	70	55.1	-4.5	17.9	-10.7	0.9987	0.43	2.0
1	3	3	10	60	70	55.1	-4.5	17.9	-10.5	0.9988	0.43	2.0
1	3	3	11	60	250	54.2	-6.0	12.5	-37.7	0.9950	0.75	2.6
1	3	3	12	60	250	54.2	-6.1	12.5	-37.9	0.9951	0.75	2.6
1	4	1	5	60	20	55.7	-3.6	20.0	-0.1	0.9993	0.27	0.9
1	4	1	6	60	40	55.1	-4.5	19.9	-0.7	0.9993	0.32	1.2
1	4	1	7	60	60	54.9	-5.0	21.3	6.4	0.9992	0.37	1.7
1	4	1	9	60	100	54.3	-5.9	17.2	-14.3	0.9982	0.54	2.7
1	4	1	11	60	250	54.2	-6.1	13.3	-33.7	0.9955	0.72	2.5
1	4	1	12	60	250	54.2	-6.1	13.3	-33.5	0.9953	0.72	2.5
1	4	2	1	60	100	54.8	-5.0	19.8	-1.5	0.9988	0.49	1.7

2010184

1	4	2	2	60	100	54.8	-5.0	19.8	-1.5	0.9988	0.50	1.7
1	4	2	3	60	90	54.4	-5.7	18.3	-8.6	0.9981	0.50	1.9
1	4	2	5	60	60	54.8	-5.0	20.0	-0.5	0.9988	0.36	1.5
1	4	2	6	60	20	55.7	-3.5	19.9	-0.7	0.9992	0.26	0.9
1	4	2	7	60	40	55.1	-4.5	19.9	-1.0	0.9990	0.32	1.1
1	4	2	9	60	70	54.6	-5.5	20.6	2.6	0.9989	0.41	1.3
1	4	2	11	60	250	53.2	-7.8	18.5	-7.8	0.9976	0.73	1.9
1	4	3	1	60	150	54.6	-5.4	20.2	0.7	0.9961	0.67	-2.2
1	4	3	2	60	150	54.6	-5.4	20.2	0.6	0.9962	0.67	-2.2
1	4	3	3	60	150	54.0	-6.4	18.2	-9.4	0.9985	0.54	1.3
1	4	3	5	60	70	54.7	-5.2	20.2	0.7	0.9993	0.35	0.9
1	4	3	6	60	40	55.2	-4.4	19.7	-2.0	0.9992	0.31	1.0
1	4	3	7	60	20	55.8	-3.3	20.0	-0.1	0.9993	0.25	-0.9
1	4	3	9	60	70	55.1	-4.5	17.9	-10.8	0.9987	0.43	2.0
1	4	3	10	60	70	55.1	-4.5	17.9	-10.5	0.9988	0.43	2.0
1	4	3	11	60	250	54.2	-6.0	12.5	-37.5	0.9950	0.74	2.6
1	4	3	12	60	250	54.2	-6.0	12.5	-37.7	0.9951	0.74	2.6
1	5	1	6	20	40	55.6	-3.7	19.4	-3.1	0.9994	0.17	0.4
1	5	1	7	20	60	55.5	-3.9	19.7	-1.7	0.9993	0.22	0.8
1	5	1	9	20	100	54.9	-4.8	19.0	-5.2	0.9992	0.34	1.4
1	5	1	11	20	250	54.8	-5.0	13.0	-35.4	0.9954	0.65	3.1
1	5	1	12	20	250	54.8	-5.1	13.0	-35.1	0.9953	0.65	3.1
1	5	2	1	20	100	55.5	-3.9	19.3	-4.0	0.9988	0.40	-1.7
1	5	2	2	20	100	55.5	-3.9	19.3	-4.0	0.9988	0.40	-1.8
1	5	2	3	20	90	55.0	-4.7	19.6	-2.2	0.9990	0.30	0.9
1	5	2	5	20	60	55.5	-3.9	20.1	0.0	0.9992	0.18	0.6
1	5	2	6	20	20	56.3	-2.4	19.7	-1.7	0.9994	0.06	0.1
1	5	2	7	20	40	55.8	-3.4	19.7	-1.7	0.9992	0.14	0.3
1	5	2	9	20	70	55.2	-4.4	20.4	1.5	0.9991	0.25	0.5
1	5	2	11	20	250	53.8	-6.7	19.7	-1.8	0.9983	0.62	1.8
1	5	3	1	20	150	55.2	-4.3	21.0	4.8	0.9964	0.59	-2.3
1	5	3	2	20	150	55.2	-4.3	21.0	4.4	0.9966	0.59	-2.2
1	5	3	3	20	150	54.7	-5.3	19.3	-3.6	0.9990	0.40	-1.1
1	5	3	5	20	70	55.4	-4.1	19.6	-2.4	0.9994	0.21	0.4
1	5	3	6	20	40	55.8	-3.4	19.5	-2.7	0.9994	0.14	0.3
1	5	3	7	20	20	56.4	-2.3	19.8	-1.4	0.9995	0.06	0.1
1	5	3	9	20	70	55.7	-3.4	19.0	-5.4	0.9993	0.26	-1.1
1	5	3	10	20	70	55.7	-3.5	19.0	-5.2	0.9994	0.26	-1.0
1	5	3	11	20	250	54.9	-5.0	12.3	-38.5	0.9949	0.67	3.3
1	5	3	12	20	250	54.9	-5.0	12.3	-38.7	0.9949	0.67	3.3
1	6	1	7	40	60	54.6	-5.5	19.3	-3.7	0.9992	0.32	1.0
1	6	1	9	40	100	54.3	-6.0	19.1	-4.6	0.9991	0.42	1.6
1	6	1	11	40	250	54.2	-6.1	12.9	-35.9	0.9954	0.72	3.3
1	6	1	12	40	250	54.2	-6.1	12.9	-35.6	0.9953	0.71	3.3
1	6	2	1	40	100	54.8	-5.0	19.2	-4.5	0.9988	0.45	1.6
1	6	2	2	40	100	54.8	-5.0	19.1	-4.6	0.9988	0.45	1.6
1	6	2	3	40	90	54.4	-5.8	19.6	-2.5	0.9989	0.36	1.2
1	6	2	5	40	60	54.8	-5.0	20.2	0.7	0.9990	0.26	0.9
1	6	2	6	40	20	55.7	-3.5	19.6	-2.4	0.9993	0.14	0.4
1	6	2	7	40	40	55.1	-4.5	19.5	-2.8	0.9991	0.22	0.6
1	6	2	9	40	70	54.5	-5.5	20.7	3.2	0.9990	0.33	0.7
1	6	2	11	40	250	53.2	-7.8	19.2	-4.5	0.9983	0.68	1.9
1	6	3	1	40	150	54.6	-5.4	20.7	3.3	0.9963	0.66	-2.2
1	6	3	2	40	150	54.6	-5.4	20.6	2.9	0.9964	0.65	-2.2
1	6	3	3	40	150	54.0	-6.4	18.8	-6.1	0.9989	0.46	1.2
1	6	3	5	40	70	54.7	-5.2	19.7	-1.8	0.9993	0.29	0.5
1	6	3	6	40	40	55.2	-4.5	19.3	-3.7	0.9993	0.22	0.4

2010184

1	6	3	7	40	20	55.8	-3.4	19.6	-2.3	0.9994	0.14	0.3
1	6	3	9	40	70	55.1	-4.5	18.5	-7.6	0.9992	0.33	1.4
1	6	3	10	40	70	55.1	-4.5	18.6	-7.4	0.9993	0.33	1.3
1	6	3	11	40	250	54.2	-6.1	12.2	-39.2	0.9948	0.73	3.5
1	6	3	12	40	250	54.2	-6.1	12.2	-39.3	0.9948	0.73	3.5
1	7	1	9	60	100	53.7	-7.0	19.6	-2.2	0.9991	0.51	1.9
1	7	1	11	60	250	53.9	-6.6	13.0	-35.4	0.9949	0.80	3.1
1	7	1	12	60	250	53.9	-6.7	13.0	-35.1	0.9948	0.80	3.1
1	7	2	1	60	100	54.5	-5.5	18.8	-6.1	0.9988	0.46	1.6
1	7	2	2	60	100	54.5	-5.5	18.8	-6.1	0.9988	0.46	1.6
1	7	2	3	60	90	54.1	-6.3	20.1	0.3	0.9988	0.42	1.7
1	7	2	5	60	60	54.5	-5.5	19.8	-1.5	0.9989	0.33	1.4
1	7	2	6	60	20	55.4	-4.1	19.9	-0.7	0.9992	0.21	0.8
1	7	2	7	60	40	54.8	-5.0	20.0	-0.4	0.9990	0.28	1.0
1	7	2	9	60	70	54.2	-6.0	20.1	0.1	0.9988	0.40	1.2
1	7	2	11	60	250	52.9	-8.3	21.0	4.5	0.9986	0.71	1.5
1	7	3	1	60	150	54.3	-5.9	20.7	3.2	0.9964	0.68	-2.2
1	7	3	2	60	150	54.3	-6.0	20.7	3.0	0.9965	0.68	-2.2
1	7	3	3	60	150	53.7	-6.9	20.1	0.1	0.9990	0.50	1.5
1	7	3	5	60	70	54.4	-5.7	19.5	-3.0	0.9991	0.37	0.8
1	7	3	6	60	40	54.8	-5.0	19.6	-2.5	0.9993	0.28	0.9
1	7	3	7	60	20	55.5	-3.9	19.9	-1.0	0.9993	0.21	0.8
1	7	3	9	60	70	54.8	-5.1	19.8	-1.2	0.9991	0.38	1.8
1	7	3	10	60	70	54.8	-5.1	19.8	-1.3	0.9991	0.39	1.8
1	7	3	11	60	250	53.9	-6.6	12.3	-38.9	0.9941	0.80	3.3
1	7	3	12	60	250	53.9	-6.6	12.2	-39.1	0.9942	0.81	3.3
1	9	1	11	100	250	53.3	-7.7	13.3	-33.9	0.9954	0.86	2.5
1	9	1	12	100	250	53.3	-7.7	13.3	-33.5	0.9953	0.85	2.5
1	9	2	1	100	100	54.0	-6.5	19.0	-5.2	0.9988	0.55	1.6
1	9	2	2	100	100	54.0	-6.5	19.0	-5.2	0.9988	0.55	1.6
1	9	2	3	100	90	53.5	-7.2	17.4	-13.1	0.9981	0.57	2.3
1	9	2	5	100	60	54.0	-6.5	18.9	-5.7	0.9987	0.45	2.0
1	9	2	6	100	20	54.8	-5.0	18.9	-5.7	0.9990	0.33	1.3
1	9	2	7	100	40	54.3	-6.0	19.0	-5.3	0.9989	0.40	1.6
1	9	2	9	100	70	53.7	-7.0	19.5	-2.8	0.9987	0.51	1.7
1	9	2	11	100	250	52.4	-9.3	17.6	-12.2	0.9979	0.84	1.8
1	9	3	1	100	150	53.8	-6.9	19.3	-3.8	0.9962	0.75	-2.2
1	9	3	2	100	150	53.7	-6.9	19.3	-3.9	0.9963	0.76	-2.2
1	9	3	3	100	150	53.2	-7.9	17.4	-13.4	0.9985	0.64	1.7
1	9	3	5	100	70	53.9	-6.7	19.2	-4.3	0.9991	0.46	1.2
1	9	3	6	100	40	54.3	-5.9	18.8	-6.2	0.9991	0.39	1.4
1	9	3	7	100	20	54.9	-4.8	19.0	-5.1	0.9992	0.33	1.3
1	9	3	9	100	70	54.2	-6.0	17.0	-15.0	0.9984	0.52	2.4
1	9	3	10	100	70	54.2	-6.0	17.1	-14.7	0.9985	0.52	2.4
1	9	3	11	100	250	53.4	-7.5	12.2	-39.3	0.9946	0.86	2.4
1	9	3	12	100	250	53.4	-7.5	12.1	-39.5	0.9946	0.86	2.4
1	11	1	12	250	250	52.2	-9.5	15.9	-20.6	0.9974	0.92	2.4
1	11	2	1	250	100	53.9	-6.7	12.6	-37.4	0.9944	0.80	3.5
1	11	2	2	250	100	53.9	-6.7	12.5	-37.5	0.9944	0.80	3.5
1	11	2	3	250	90	53.4	-7.4	12.9	-35.8	0.9954	0.79	2.6
1	11	2	5	250	60	53.9	-6.7	13.2	-34.4	0.9952	0.73	3.1
1	11	2	6	250	20	54.7	-5.2	13.0	-35.4	0.9954	0.64	3.2
1	11	2	7	250	40	54.2	-6.1	12.9	-35.7	0.9953	0.70	3.4
1	11	2	9	250	70	53.6	-7.2	13.3	-33.8	0.9948	0.80	4.0
1	11	2	11	250	250	52.3	-9.5	15.7	-21.5	0.9974	0.91	2.4
1	11	3	1	250	150	53.6	-7.1	12.9	-35.8	0.9941	0.84	4.1

2010184

1	11	3	2	250	150	53.6	-7.1	12.9	-35.9	0.9940	0.85	4.1
1	11	3	3	250	150	53.1	-8.1	12.5	-37.8	0.9953	0.79	2.1
1	11	3	5	250	70	53.8	-6.9	12.9	-35.7	0.9950	0.76	3.6
1	11	3	6	250	40	54.2	-6.1	12.8	-36.3	0.9955	0.70	3.4
1	11	3	7	250	20	54.8	-5.0	13.0	-35.3	0.9955	0.65	3.2
1	11	3	9	250	70	54.1	-6.2	13.0	-35.3	0.9955	0.75	1.9
1	11	3	10	250	70	54.1	-6.2	13.0	-35.4	0.9955	0.75	2.0
1	11	3	11	250	250	53.3	-7.7	8.8	-56.1	0.9795	1.29	8.4
1	11	3	12	250	250	53.3	-7.7	8.8	-56.2	0.9796	1.30	8.4
1	12	2	1	250	100	53.9	-6.7	12.6	-37.2	0.9944	0.80	3.5
1	12	2	2	250	100	53.9	-6.7	12.6	-37.2	0.9944	0.80	3.5
1	12	2	3	250	90	53.4	-7.5	12.9	-35.5	0.9952	0.79	2.7
1	12	2	5	250	60	53.9	-6.7	13.2	-34.1	0.9951	0.73	3.2
1	12	2	6	250	20	54.7	-5.2	13.0	-35.1	0.9953	0.64	3.2
1	12	2	7	250	40	54.2	-6.2	12.9	-35.5	0.9952	0.70	3.5
1	12	2	9	250	70	53.6	-7.2	13.4	-33.3	0.9947	0.80	4.0
1	12	2	11	250	250	52.2	-9.5	15.7	-21.6	0.9973	0.91	2.4
1	12	3	1	250	150	53.6	-7.1	12.9	-35.8	0.9938	0.85	4.1
1	12	3	2	250	150	53.6	-7.1	12.8	-35.9	0.9938	0.86	4.2
1	12	3	3	250	150	53.1	-8.1	12.5	-37.7	0.9952	0.79	2.2
1	12	3	5	250	70	53.7	-6.9	13.0	-35.4	0.9949	0.76	3.6
1	12	3	6	250	40	54.2	-6.1	12.8	-36.0	0.9954	0.70	3.5
1	12	3	7	250	20	54.8	-5.0	13.0	-35.0	0.9954	0.64	3.2
1	12	3	9	250	70	54.1	-6.2	13.0	-35.0	0.9954	0.74	2.0
1	12	3	10	250	70	54.1	-6.2	13.0	-35.1	0.9954	0.75	2.0
1	12	3	11	250	250	53.2	-7.8	8.8	-55.9	0.9795	1.29	8.4
1	12	3	12	250	250	53.2	-7.8	8.8	-55.9	0.9796	1.29	8.4
2	1	2	2	100	100	53.6	-7.1	19.1	-4.9	0.9990	0.63	1.8
2	1	2	3	100	90	54.0	-6.5	19.3	-3.6	0.9988	0.54	1.8
2	1	2	5	100	60	54.5	-5.6	19.5	-2.9	0.9988	0.44	1.7
2	1	2	6	100	20	55.4	-4.1	19.3	-3.7	0.9987	0.39	-1.8
2	1	2	7	100	40	54.8	-5.0	19.2	-4.2	0.9986	0.44	1.6
2	1	2	9	100	70	54.2	-6.1	20.4	1.8	0.9988	0.50	1.7
2	1	2	11	100	250	52.9	-8.4	19.6	-2.3	0.9965	0.92	2.8
2	1	3	1	100	150	54.3	-6.0	20.3	1.0	0.9965	0.71	2.6
2	1	3	2	100	150	54.3	-6.0	20.2	0.9	0.9967	0.70	2.5
2	1	3	3	100	150	53.7	-6.9	19.0	-5.5	0.9970	0.72	2.8
2	1	3	5	100	70	54.4	-5.8	19.2	-4.1	0.9986	0.51	2.0
2	1	3	6	100	40	54.8	-5.0	18.9	-5.6	0.9987	0.46	-1.7
2	1	3	7	100	20	55.5	-3.9	19.3	-3.8	0.9988	0.40	-1.8
2	1	3	9	100	70	54.8	-5.1	18.8	-6.3	0.9985	0.52	1.6
2	1	3	10	100	70	54.8	-5.1	18.8	-6.2	0.9986	0.52	1.6
2	1	3	11	100	250	53.9	-6.6	12.0	-40.3	0.9939	0.82	3.7
2	1	3	12	100	250	53.9	-6.6	11.9	-40.5	0.9939	0.83	3.7
2	2	2	3	100	90	54.0	-6.5	19.3	-3.6	0.9988	0.54	1.8
2	2	2	5	100	60	54.5	-5.6	19.4	-3.1	0.9988	0.44	1.7
2	2	2	6	100	20	55.4	-4.1	19.3	-3.7	0.9987	0.39	-1.8
2	2	2	7	100	40	54.8	-5.0	19.2	-4.2	0.9986	0.44	1.6
2	2	2	9	100	70	54.2	-6.1	20.4	1.7	0.9988	0.50	1.7
2	2	2	11	100	250	52.9	-8.4	19.6	-2.3	0.9965	0.92	2.8
2	2	3	1	100	150	54.3	-6.0	20.3	1.1	0.9965	0.71	2.6
2	2	3	2	100	150	54.3	-6.0	20.2	0.9	0.9966	0.71	2.5
2	2	3	3	100	150	53.7	-6.9	18.9	-5.6	0.9970	0.72	2.8
2	2	3	5	100	70	54.4	-5.8	19.2	-4.1	0.9986	0.51	2.1
2	2	3	6	100	40	54.8	-5.0	18.9	-5.7	0.9987	0.46	-1.7
2	2	3	7	100	20	55.5	-3.9	19.3	-3.9	0.9987	0.40	-1.8
2	2	3	9	100	70	54.8	-5.1	18.8	-6.4	0.9985	0.52	1.6

2010184

2	2	3	10	100	70	54.8	-5.1	18.8	-6.2	0.9986	0.52	1.6
2	2	3	11	100	250	53.9	-6.6	12.0	-40.3	0.9939	0.82	3.8
2	2	3	12	100	250	53.9	-6.6	11.9	-40.5	0.9939	0.83	3.7
2	3	2	5	90	60	53.7	-6.9	19.8	-1.1	0.9984	0.42	1.2
2	3	2	6	90	20	54.9	-4.9	19.5	-3.0	0.9987	0.30	0.8
2	3	2	7	90	40	54.4	-5.8	19.9	-0.6	0.9985	0.37	1.0
2	3	2	9	90	70	53.8	-6.8	20.4	1.9	0.9982	0.48	1.2
2	3	2	11	90	250	52.5	-9.1	18.0	-10.2	0.9974	0.80	1.7
2	3	3	1	90	150	53.8	-6.7	20.1	0.2	0.9959	0.73	-2.0
2	3	3	2	90	150	53.8	-6.7	20.1	0.2	0.9960	0.73	-1.9
2	3	3	3	90	150	53.3	-7.7	17.8	-11.1	0.9982	0.60	1.5
2	3	3	5	90	70	54.0	-6.5	19.4	-3.3	0.9987	0.41	0.8
2	3	3	6	90	40	54.4	-5.8	19.6	-2.3	0.9989	0.36	0.9
2	3	3	7	90	20	55.0	-4.7	19.7	-2.0	0.9990	0.29	0.8
2	3	3	9	90	70	54.3	-5.9	17.6	-12.5	0.9985	0.48	1.9
2	3	3	10	90	70	54.3	-5.9	17.6	-12.1	0.9985	0.48	1.9
2	3	3	11	90	250	53.5	-7.4	12.3	-38.8	0.9947	0.80	2.8
2	3	3	12	90	250	53.5	-7.4	12.2	-39.1	0.9948	0.80	2.8
2	5	2	6	60	20	55.1	-4.5	19.8	-1.1	0.9987	0.19	0.6
2	5	2	7	60	40	54.8	-5.1	20.1	0.3	0.9987	0.26	0.8
2	5	2	9	60	70	54.2	-6.0	20.2	0.7	0.9985	0.38	1.0
2	5	2	11	60	250	52.9	-8.4	19.5	-2.7	0.9981	0.70	1.6
2	5	3	1	60	150	54.3	-6.0	21.5	7.2	0.9961	0.66	-2.1
2	5	3	2	60	150	54.3	-6.0	21.5	7.0	0.9962	0.66	-2.1
2	5	3	3	60	150	53.7	-6.9	19.5	-2.9	0.9987	0.49	1.4
2	5	3	5	60	70	54.4	-5.8	19.8	-1.3	0.9989	0.33	0.7
2	5	3	6	60	40	54.8	-5.0	20.0	-0.1	0.9990	0.25	0.6
2	5	3	7	60	20	55.5	-3.9	20.1	0.3	0.9992	0.17	0.5
2	5	3	9	60	70	54.8	-5.1	18.9	-5.6	0.9989	0.36	1.7
2	5	3	10	60	70	54.8	-5.1	19.0	-5.4	0.9990	0.36	1.7
2	5	3	11	60	250	53.9	-6.6	12.5	-37.7	0.9946	0.74	3.3
2	5	3	12	60	250	53.9	-6.6	12.5	-37.9	0.9947	0.75	3.3
2	6	2	7	20	40	55.5	-3.9	19.6	-2.3	0.9988	0.15	0.3
2	6	2	9	20	70	55.1	-4.6	20.2	0.6	0.9988	0.26	0.6
2	6	2	11	20	250	53.8	-6.9	19.6	-2.2	0.9982	0.62	1.8
2	6	3	1	20	150	55.1	-4.5	21.1	5.1	0.9963	0.59	-2.2
2	6	3	2	20	150	55.1	-4.5	21.0	4.6	0.9965	0.59	-2.2
2	6	3	3	20	150	54.6	-5.5	19.3	-3.7	0.9989	0.39	-1.0
2	6	3	5	20	70	55.3	-4.3	19.5	-3.0	0.9992	0.21	0.4
2	6	3	6	20	40	55.7	-3.5	19.5	-2.6	0.9993	0.13	0.3
2	6	3	7	20	20	56.3	-2.4	19.8	-1.5	0.9994	0.06	0.1
2	6	3	9	20	70	55.6	-3.6	19.0	-5.5	0.9992	0.25	-1.1
2	6	3	10	20	70	55.6	-3.6	19.0	-5.2	0.9993	0.26	1.0
2	6	3	11	20	250	54.8	-5.1	12.3	-38.5	0.9948	0.66	3.4
2	6	3	12	20	250	54.8	-5.1	12.3	-38.7	0.9949	0.67	3.3
2	7	2	9	40	70	54.2	-6.0	20.3	1.2	0.9985	0.36	0.8
2	7	2	11	40	250	53.2	-7.8	19.0	-5.5	0.9981	0.68	1.9
2	7	3	1	40	150	54.6	-5.4	20.9	4.0	0.9961	0.65	-2.2
2	7	3	2	40	150	54.6	-5.5	20.8	3.6	0.9962	0.65	-2.2
2	7	3	3	40	150	54.0	-6.4	18.9	-5.6	0.9988	0.45	1.1
2	7	3	5	40	70	54.7	-5.2	19.8	-1.3	0.9991	0.28	0.5
2	7	3	6	40	40	55.1	-4.5	19.4	-3.2	0.9991	0.21	0.4
2	7	3	7	40	20	55.8	-3.4	19.8	-1.5	0.9992	0.13	0.3
2	7	3	9	40	70	55.1	-4.6	18.6	-7.2	0.9991	0.32	1.3
2	7	3	10	40	70	55.1	-4.6	18.7	-6.9	0.9992	0.32	1.3
2	7	3	11	40	250	54.2	-6.1	12.3	-38.7	0.9948	0.71	3.6
2	7	3	12	40	250	54.2	-6.1	12.3	-38.9	0.9948	0.71	3.6
2	9	2	11	70	250	52.5	-9.1	21.8	8.4	0.9984	0.77	1.5
2	9	3	1	70	150	54.0	-6.4	22.1	9.9	0.9959	0.73	-2.2

2010184

2	9	3	2	70	150	54.0	-6.5	21.9	9.3	0.9960	0.74	-2.1
2	9	3	3	70	150	53.4	-7.4	20.1	0.3	0.9990	0.52	1.2
2	9	3	5	70	70	54.1	-6.2	19.7	-1.8	0.9989	0.41	0.9
2	9	3	6	70	40	54.5	-5.5	20.6	2.7	0.9990	0.32	0.8
2	9	3	7	70	20	55.2	-4.4	20.4	1.7	0.9991	0.25	0.5
2	9	3	9	70	70	54.5	-5.6	19.4	-3.1	0.9991	0.40	1.5
2	9	3	10	70	70	54.5	-5.6	19.4	-3.2	0.9992	0.40	1.5
2	9	3	11	70	250	53.6	-7.1	12.6	-37.2	0.9942	0.81	4.2
2	9	3	12	70	250	53.6	-7.1	12.5	-37.6	0.9943	0.81	4.2
2	11	3	1	250	150	52.7	-8.7	15.7	-21.6	0.9916	1.09	3.8
2	11	3	2	250	150	52.7	-8.8	15.8	-21.3	0.9918	1.09	3.8
2	11	3	3	250	150	52.1	-9.7	18.0	-10.4	0.9967	0.95	2.8
2	11	3	5	250	70	52.8	-8.6	20.5	2.4	0.9983	0.74	1.7
2	11	3	6	250	40	53.2	-7.8	19.2	-4.4	0.9982	0.68	2.1
2	11	3	7	250	20	53.9	-6.7	19.7	-1.6	0.9983	0.62	1.8
2	11	3	9	250	70	53.2	-7.9	17.5	-13.0	0.9977	0.76	2.2
2	11	3	10	250	70	53.2	-7.9	17.5	-12.7	0.9977	0.77	2.2
2	11	3	11	250	250	52.3	-9.4	14.5	-27.8	0.9974	0.90	2.5
2	11	3	12	250	250	52.3	-9.4	14.4	-28.0	0.9974	0.90	2.5
3	1	3	2	150	150	53.1	-8.1	20.6	2.9	0.9975	0.79	2.3
3	1	3	3	150	150	53.4	-7.5	19.4	-3.1	0.9970	0.73	2.5
3	1	3	5	150	70	54.2	-6.1	21.7	8.1	0.9963	0.68	2.0
3	1	3	6	150	40	54.6	-5.4	20.7	3.0	0.9962	0.66	-2.1
3	1	3	7	150	20	55.2	-4.3	21.1	5.1	0.9964	0.60	-2.2
3	1	3	9	150	70	54.6	-5.5	19.4	-3.4	0.9963	0.67	-2.2
3	1	3	10	150	70	54.6	-5.5	19.4	-3.2	0.9964	0.68	-2.2
3	1	3	11	150	250	53.7	-7.0	12.4	-38.3	0.9936	0.83	3.9
3	1	3	12	150	250	53.7	-7.0	12.4	-38.2	0.9937	0.83	3.9
3	2	3	3	150	150	53.4	-7.5	19.4	-3.1	0.9971	0.73	2.5
3	2	3	5	150	70	54.2	-6.2	21.6	7.6	0.9965	0.68	1.9
3	2	3	6	150	40	54.6	-5.4	20.7	3.0	0.9963	0.66	-2.1
3	2	3	7	150	20	55.2	-4.3	21.0	4.7	0.9966	0.59	-2.2
3	2	3	9	150	70	54.5	-5.5	19.3	-3.6	0.9964	0.67	-2.2
3	2	3	10	150	70	54.5	-5.5	19.4	-3.3	0.9965	0.68	-2.2
3	2	3	11	150	250	53.7	-7.0	12.4	-38.4	0.9936	0.84	4.0
3	2	3	12	150	250	53.7	-7.0	12.4	-38.3	0.9937	0.84	3.9
3	3	3	5	150	70	53.3	-7.7	19.8	-1.2	0.9992	0.55	1.4
3	3	3	6	150	40	54.0	-6.4	18.9	-5.8	0.9990	0.47	1.1
3	3	3	7	150	20	54.7	-5.3	19.3	-3.7	0.9990	0.40	-1.1
3	3	3	9	150	70	54.0	-6.5	16.9	-15.9	0.9980	0.60	2.2
3	3	3	10	150	70	54.0	-6.5	16.9	-15.7	0.9981	0.60	2.2
3	3	3	11	150	250	53.1	-8.0	12.0	-40.0	0.9947	0.81	2.2
3	3	3	12	150	250	53.1	-8.0	12.0	-40.1	0.9948	0.81	2.2
3	5	3	6	70	40	54.4	-5.7	19.4	-3.5	0.9993	0.33	0.5
3	5	3	7	70	20	55.3	-4.1	19.6	-2.1	0.9994	0.22	0.4
3	5	3	9	70	70	54.7	-5.3	19.3	-3.9	0.9993	0.37	1.0
3	5	3	10	70	70	54.7	-5.3	19.4	-3.5	0.9994	0.38	1.0
3	5	3	11	70	250	53.8	-6.8	12.3	-38.9	0.9943	0.77	3.7
3	5	3	12	70	250	53.8	-6.8	12.2	-39.1	0.9944	0.78	3.7
3	6	3	7	40	20	55.6	-3.7	19.4	-3.1	0.9994	0.16	0.3
3	6	3	9	40	70	55.1	-4.6	18.3	-8.9	0.9993	0.33	1.1
3	6	3	10	40	70	55.1	-4.6	18.3	-8.7	0.9993	0.33	1.1
3	6	3	11	40	250	54.2	-6.1	12.2	-39.0	0.9949	0.71	3.6
3	6	3	12	40	250	54.2	-6.1	12.2	-39.2	0.9950	0.71	3.6
3	7	3	9	20	70	55.6	-3.7	18.8	-6.2	0.9993	0.27	-1.0
3	7	3	10	20	70	55.6	-3.7	18.9	-5.9	0.9994	0.28	1.0
3	7	3	11	20	250	54.9	-5.0	12.4	-38.4	0.9949	0.67	3.4
3	7	3	12	20	250	54.9	-5.0	12.3	-38.7	0.9950	0.67	3.3
3	9	3	10	70	70	54.5	-5.6	19.9	-1.0	0.9994	0.41	1.4

2010184

---

3	9	3	11	70	250	54.1	-6.2	13.4	-33.3	0.9957	0.72	2.0
3	9	3	12	70	250	54.1	-6.2	13.3	-33.6	0.9958	0.72	1.9
3	10	3	11	70	250	54.1	-6.2	13.3	-33.5	0.9957	0.72	2.0
3	10	3	12	70	250	54.1	-6.2	13.3	-33.8	0.9957	0.73	2.0
3	11	3	12	250	250	52.4	-9.3	15.9	-20.8	0.9975	0.93	2.6
1	9	1	-10	100	100	57.7	-0.0	20.0	-0.1	1.0000	0.01	0.0
2	1	1	-10	100	100	57.5	-0.4	19.5	-3.0	0.9994	0.22	0.7
2	2	1	-10	100	100	57.5	-0.4	19.5	-3.0	0.9994	0.22	0.7
1	11	2	-12	250	250	57.7	0.0	19.9	-0.7	0.9994	0.21	0.9
1	12	2	-12	250	250	57.7	-0.0	20.0	-0.5	0.9994	0.22	1.0
2	11	2	-12	250	250	57.7	-0.0	20.0	-0.1	1.0000	0.00	0.0
3	11	2	-12	250	250	57.8	0.1	18.4	-8.1	0.9996	0.19	0.8
3	12	2	-12	250	250	57.8	0.1	18.4	-8.2	0.9995	0.19	0.8
1	1	3	-4	150	150	57.5	-0.3	20.3	1.2	0.9964	0.47	2.0
1	2	3	-4	150	150	57.5	-0.3	20.3	1.2	0.9963	0.48	2.0
3	1	3	-4	150	150	57.5	-0.3	21.5	7.2	0.9997	0.16	0.6
3	2	3	-4	150	150	57.5	-0.3	21.5	7.1	0.9997	0.15	0.6
3	3	3	-4	150	150	57.7	0.0	20.1	0.1	1.0000	0.01	-0.1

### 9.3 PGS Standard Navmerged SEG-Y Format

The PGS Navmerged SEG-Y format follows the SEG revision 0 standard as defined in "Recommended Standard for Digital Tape Formats" by K. M. Barry, D. A. Cavers and C. W. Kneale, Geophysics, v. 40, no. 2 (April 1975), pp. 344 - 352. However, both binary header and trace header byte locations (1-196 only) follow the SEG standard as defined by revision 1.

#### The EBCDIC and Binary Headers:

The first data written to tape is a 3200 byte EBCDIC reel header. This header is defined as 40 lines of text, each having 80 characters per line, including blank spaces.

Here follows an example EBCDIC header:

```

C1 CLIENT:##### COMPANY:PGS GEOPHYSICAL
C 2 VESSEL:Atlantic Explorer AREA:##### PGS PROJECT NO:2009043
C 3 LINE:LN09022830P2002 DATE SHOT:094 19:13:13 2009 SPS:1640-4552 DIR:47.00
C 4 =====ACQUISITION & RECORDING PARAMETERS=====
C 5 ACQUISITION SYSTEM: Seis/Enet RECORDING DELAY: 69.2ms
C 6 RECORDING FORMAT: SEG-D REV 1.0-8036 TRCS/RECORD: 4896 AUX TRCS/RECORD: 0048
C 7 RECORD LENGTH: 5120ms SAMPLE INTERVAL: 2.0000ms SAMPLES/TRACE: 2560
C 8 FILTERS: LO 4.40Hz/12.00dB/OCT HI 214.0Hz/341.0dB/OCT SRC TYPE: Bolt
C 9 VOLUME: 3090.0 cu in SHOT INT: 25.00m (FLIP/FLOP) PRESSURE: 2000.0 psi
C10 DEPTH: 6.0m SEPN: 50.0m NBR OF ARRAYS: 02 ACTIVE SRC : 1=STBD, 2=PORT
C11 NBR OF STRS: 06 NBR OF GROUPS: 0480 GROUP INTERVAL: 12.50m NBR COMP: 2
C12 STR SEPARATION: 100.0m STR DEPTH: 7.0m STR LENGTH: 6000.0m CDP/SHOT:4/1
C13 CDP FOLD: 102 INLINE OFFSET: 135m POLARITY: COMPRESSION=NEGATIVE VALUE
C14 NAV SYSTEM:Orca 1.6.1 DGPS1:Skyfix XP DGPS2:Starfix HP
C15 =====PROCESSING PARAMETERS=====
C16 PROCESSED BY PGS GEOPHYSICAL USING VIPER V.4.4.0 ONBOARD Atlantic Explorer
C17 01. REFORMAT FROM SEG-D WITH SKEW CORRECTION APPLIED
C18 02. RECORDING DELAY OF -69.2ms *NOT* REMOVED (DATA NEED TO BE SHIFTED UP)
C19 03. BAD CH/SHOTS EDITS FLAG trid=2, REVERSE CH FLAG trid=-1, SEIS/NAV MERGE
C20 04. OUTPUT TO 32-BIT SEG-Y REV. 0 FORMAT (TIME DOMAIN) TO 3592 TAPE
C21 ALL DEPTHS ARE RAW WITH NO CORRECTIONS AS P190 NAVIGATION DATA
C22 ALL CO-ORDINATES & ELEVATIONS IN DECIMETRES, ALL TRACE VALUES IN MILLIVOLTS
C23 AUXILIARY TRACES NOT INCLUDED IN SEG-Y TAPES
C24 TRACE HEADER BYTE POSITIONS 1-196 ACCORDING TO SEG-Y FORMAT REV. 1
C25 NON STANDARD SEG-Y HEADER BYTE POSITIONS: DESCRIPTION/LOCATION/FORMAT/LENGTH
C26 ACQSEQNO, 197, I2; SVID, 199, I2; CABLE, 201, I2; GRND_STA, 203, I2;
C27 SENSOR, 205, I2; ARR_FIRE, 207, I2; ARR_VOL, 209, I2; DROPOUT1, 211, I2;
C28 W_DEPTH, 213, I4; VCMG, 217, I2; AZIMUTH, 219, F4; VSPEED, 223, F4; SPID, 227, I2
C29 =====GEODETTIC REFERENCE & PROC. GRID DEFINITION=====
C30 SURVEY DATUM: ED50 ELLIPSOID: International 1924
C31 SEMIMAJOR AXIS: 6378388 PROJECTION: TM
C32 SCALE FACTOR: 0.9996 CENTRAL MERIDIAN: 3 East
C33 LAT. OF ORIGIN: 0 deg FALSE NORTHING: 0 m FALSE EASTING: 500000 m
C34 GRID ORIGIN: X: 426168.3 Y: 6516616.2 XL: 778 SL: 921
C35 CORNER 2: X: 467990.0 Y: 6555547.4 XL: 9920 SL: 921
C36 CORNER 3: X: 501972.8 Y: 6519041.5 XL: 9920 SL: 2916
C37 CORNER 4: X: 460151.1 Y: 6480110.3 XL: 778 SL: 2916
C38 SL NUMBER INCREMENT: 1 XL NUMBER INCREMENT: 1
C39 SL BIN SIZE: 25m XL BIN SIZE: 6.25m AZIMUTH: 47.05deg
C40 END EBCDIC

```

The next data on tape is the 400 byte binary reel header and consists of the following:

Bytes	Description
-----	-----
3201-3204	Job identification number
3205-3208	Line number
3209-3212	Reel number
3213-3214	Number of data traces per record
3215-3216	Number of auxiliary traces per record
3217-3218	Sample interval in $\mu$ sec
3219-3220	Sample interval in $\mu$ sec (original)
3221-3222	Number of samples per data trace
3223-3224	Number of samples per data trace (original)
3225-3226	Data sample format code (1=floating point)
3227-3228	Ensemble Fold
3229-3230	Sort order (1=as recorded)
3231-3232	Vertical Sum (1=none)
3233-3234	Sweep freq at start (N/A)
3235-3236	Sweep freq at end (N/A)
3237-3238	Sweep length (N/A)
3239-3240	Sweep type code (N/A)
3241-3242	Trc No of sweep channel (N/A)
3243-3244	Sweep trc taper length start (N/A)
3245-3246	Sweep trc taper length end (N/A)
3247-3248	Taper Type (0=not set)
3249-3250	Correlated Data Traces (0=not set)
3251-3252	Binary Gain Recovered (1=yes)
3253-3254	Amplitude Recovery (1=none)
3255-3256	Measurement System (1=metres)
3257-3258	Impulsive Signal Polarity (1=inc press neg number)
3259-3260	Vibrator Polarity (N/A)
3501-3502	SEG-Y revision number (0=rev. 0)
3503-3504	Fixed trace length flag (1=all traces have same sample interval and number of samples)
3505-3506	Number of 3200-byte Extended Textual File Header (N/A)

This is followed by the actual seismic data. The data values themselves will be written as 32-bit IBM short floating point. There is a double end of file mark at the end of each tape to signal end of tape.

#### The Trace Headers:

The following trace headers will be written to default positions within the SEG-Y trace headers according to SEG-Y rev. 1:

2010184

Bytes	Type	Description
-----	-----	-----
1-4	I	Trace Sequence Number within the Line. (tracI)
5-8	I	Trace Sequence Number within the Tape. (tracr)
9-12	I	Field Record Number. (fldr).
13-16	I	Trace Number within the Field Record. (tracf).
17-20	I	Energy Source Point Number. (ep).
21-24	I	Common Depth Point ensemble Number. (cdp).
25-28	I	Trace Number within the CDP ensemble. (cdpt).
29-30	S	Trace Ident Code. "1"-Seismic Data, "2"-Dead, "3"-Dummy, "-1"-Reversed. (trid)
31-32	S	Number of Vertically Stacked traces. (nvs).
33-34	S	Number of Horizontally Stacked traces. (nhs)
35-36	S	Data use. "1"-Production, "2"-Test. (duse)
37-40	I	Distance of Source Point to Receiver Group. (offset).
41-44	I	Receiver Group Elevation. (gelev).
45-48	I	Surface Elevation at Shot. (selev).
49-52	I	Source Depth Below Surface. Positive. (sdepth).
53-56	I	Datum Elevation at Receiver Group. (gdel).
57-60	I	Datum Elevation at Source. (sdel).
61-64	I	Water Depth at Source. (swdep).
65-68	I	Water Depth at Receiver Group. (gwdep).
69-70	S	Elevation & Depth Scalar Exponent (scaleI)
71-72	S	Coordinate scalar Exponent (scalco).
73-76	I	Source Coordinate - X. (sx).
77-80	I	Source Coordinate - Y. (sy).
81-84	I	Receiver Coordinate - X. (gx)
85-88	I	Receiver Coordinate - Y. (gy).
89-90	S	Units; "1"-Meters; Feet, "2"- Seconds of Arc. (count).
91-92	S	Weathering Velocity. (wevel)
93-94	S	Subweathering Velocity. (swevel)
95-96	S	Uphole Time at Source. (sut).
97-98	S	Uphole Time at Group. (gut).
99-100	S	Source Static Correction. (sstat).
101-102	S	Group Static Correction. (gstat).
103-104	S	Total Static Applied. (tstat).
105-106	S	Lag Time A. (laga)
107-108	S	Lab Time B. (lagb)
109-110	S	Delay Recording Time. (delrt)
111-112	S	Mute Time - Start. (muts).
113-114	S	Mute Time - End. (mute).
115-116	-	Number of samples in this trace. (ns) unsigned short format
117-118	-	Sample Interval, in microsecs. (dt) unsigned short format
119-120	S	Gain of Field Instruments. "1"Fixed, "2"Binary, "3"Float. (gain)
121-122	S	Instrument Gain Constant. (igc)
123-124	S	Instrument Early or Initial Gain. (igi)
125-126	S	Correlated? "1"-No, "2"-Yes. (corr)
127-128	S	Sweep Frequency Start. (sfs)
129-130	S	Sweep Frequency End. (sfe)
131-132	S	Sweep Length, in msec. (slen)
133-134	S	Sweep Type. "1"-Linear, "2"-Parabolic, "3"-Exponential. (styp)
135-136	S	Sweep Trace Taper Length at Start, in msec. (stas)

2010184

---

137-138	S	Sweep Trace Taper Length at End, in msec. (stae)
139-140	S	Taper Type. "1"-Linear,"2"-cos**2,"3"-Other. (tatyp)
141-142	S	Alias Filter Frequency, if used. (afilf)
143-144	S	Alias Filter Slope, in dB/oct. (afilsl)
145-146	S	Notch Filter Frequency, if used. (nofilf)
147-148	S	Notch Filter Slope, in dB/oct. (nofilsl)
149-150	S	Low Cut Frequency, if used; in hertz. (lcf)
151-152	S	High Cut Frequency, if used; in hertz. (hcf)
153-154	S	Low Cut Slope, in dB/oct. (lcs)
155-156	S	High Cut Slope, in dB/oct. (hcs)
157-158	S	Year Data Recorded. (year).
159-160	S	Julian Day of Year. (day).
161-162	S	Hour of Day, 24 hour clock. (hour).
163-164	S	Minute of Hour. (minute).
165-166	S	Second of Minute. (sec).
167-168	S	Time Basis Code. "1"-Local,"2"-GMT,"3"-Other. (timbas).
169-170	S	Trace Weight Factor. (trwf)
171-172	S	Geophone Group Number of Roll Switch Position One. (grnors)
173-174	S	Geophone Group Number of Trace One in Field Record. (grnofr)
175-176	S	Geophone Group Number of Last Trace in Field Record. (grnlof)
177-178	S	Gap Size. Total Groups Dropped. (gaps)
179-180	S	Over Travel Associated with taper, start or end of Line.(otrav)
181-184	I	CDP coordinate - X (cdp-x)
185-188	I	CDP coordinate - Y (cdp-y)
189-192	I	3D in line number. (subline)
193-196	I	3D cross line number. (xline)

However, in addition to the standard headers described above, PGS recommends saving the following marine acquisition headers which completely deviate from those recommended in SEG-Y rev. 1:

197-198	S	Acquisition Sequence Number (acqseqno)
199-200	S	Device/Trace Identifier (for multi vessel operations only) (svid)
201-202	S	Physical cable or streamer number (cable)
203-204	S	Ground station (grnd_sta)
205-206	S	Sensor type (sensor) (1=hydrophone, 2=vertical velocity sensor)
207-208	S	Gun type (1=stbd, 2=port) (arr_fire)
209-210	S	Volume actually fired (arrvol)
211-212	S	Source pressure (dropout1)
213-216	I	Water depth at binned midpoint position (w_depth)
217-218	S	Course made good (vcmg)
219-222	F	Source/receiver azimuth (azimuth)
223-226	F	Vessel speed (in knots) (vspeed)
227-228	S	Shotpoint Ident Code (0=good, 1=bad trace, 2=bad shot, 3=bad trace within a bad shot, 9=dummy trace (for Syntrek vessels only)) (spid)

## TYPES:

S = 2 byte Integer

I = 4 byte Integer

F = IEEE Floating point

## 9.4 Australian Cetacean Monitoring Guidelines



**Australian Government**

**Department of the Environment, Water, Heritage and the Arts**

**EPBC Act  
Policy Statements**

### **EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales**

**Australian Government**

**Department of the Environment, Water, Heritage and the Arts**

September 2008

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

## 1. AIM

The aim of this Policy Statement is to:

1. provide practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations;
2. provide a framework that minimises the risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours; and
3. provide guidance to both proponents of seismic surveys and operators conducting seismic surveys about their legal responsibilities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)<sup>1</sup>.

This Policy Statement updates and replaces the previous Guidelines (May 2007). This Policy Statement should be read in conjunction with the associated [Background Paper](#).

## 2. INTRODUCTION

Seismic surveying is widely used in the marine environment to define and analyse subsurface geological structures, mainly by the oil and gas exploration and production industry. Seismic surveying utilises a technique that directs acoustic energy (sound) into the rock beneath the sea floor from equipment towed behind a purpose-built seismic vessel. The loudest sound sources used in seismic survey operations are produced by air-guns which generate short, intense pulses of sound directed at the seafloor. The pulses are broad band, but most energy is concentrated in the 10 – 200 Hertz (Hz) frequency range, with lower energy levels in the 200 – 1000 Hz range. The air-guns are fired repeatedly as the ship traverses an area of interest. In a typical survey the sound levels from the air-gun array are in the range of 200 – 250 dB<sub>rms</sub> re 1µPa at 1m. When acoustic energy reaches the different layers of rock under the sea bed, it may be reflected back to the surface of the water where waterproof microphones (hydrophones) can receive and record the reflected energy signals. The hydrophones capture the different sound waves which have been reflected back by the rock beneath the sea bed enabling a map to be made of these layers. The signals can then be processed into cross-sections and maps showing the geological structures below the sea floor. These can then be used to identify potential areas where oil and gas deposits may occur.

The effects of human made sound in the marine environment is a concern for marine life, particularly whales and dolphins that may be sensitive to certain sound levels, potentially resulting in physical and/or behavioral impacts. As the effects of seismic surveying on whales are not fully understood, precautionary mitigation measures aimed at preventing injury and minimising the risk of biologically significant behavioral changes should be applied to ensure their protection. Extensive research efforts over many years have been undertaken by the oil and gas industry, governments and other institutions to understand the possible effects from seismic exploration activities. This information has helped in preparing this Policy Statement. Gaps in knowledge still exist, highlighting the need for further research in this area and this Policy Statement may need to be amended as further information becomes available.

This Policy Statement has been written with the goal of minimising the likelihood of injury or hearing impairment of whales based on current scientific understanding. Calculations are primarily based on received sound energy levels that are estimated to lead to a temporary threshold shift (TTS) in baleen whale hearing. This Policy Statement is not intended to prevent all behavioral changes, which might occur in response to detectable, but non-traumatic sound levels. In fact, it is likely that whales in the vicinity of seismic surveying will avoid the immediate area due to an aversive response to the sound. This aversion is relied upon as a form of mitigation to prevent whales from approaching or being approached closely enough to cause acoustic injury from intense or prolonged sound exposure. At the scale of a seismic survey, such temporary displacements are unlikely to result in any real biological cost to the animals unless the interaction occurs during critical behaviours (e.g. breeding, feeding and resting), or in important areas such as narrow migratory corridors. In these biologically important habitats (defined in Section 4 below), where the displacement of whales may have a more significant or biologically relevant effect, the proponent is encouraged to conduct the survey at different times of year to avoid overlap with the presence of whales. If you propose to undertake a survey in an important habitat area you should refer the proposal to the Department. Such referrals will be considered on a case by case basis to assess the degree to which there is likely to be a significant adverse impact on whales.

<sup>1</sup> For the purpose of this policy statement, 'proponent' means the party responsible for the seismic survey, and 'operator' means the party conducting the seismic survey.

September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales

### 3. SCOPE OF THE POLICY STATEMENT

Under the EPBC Act, a number of whale species are listed as threatened and/or migratory species and are, subsequently, protected under the Act as matters of national environmental significance (NES). Whale species are also part of the Commonwealth marine environment, another matter of NES.

Whales and other cetaceans also have additional protections in the *Australian Whale Sanctuary*. The EPBC Act provides for offences for certain actions that adversely affect whales in the Australian Whale Sanctuary. The Act also provides for permits to be obtained in relation to actions affecting whales in the Australian Whale Sanctuary. Further information on legislative responsibilities regarding whales is provided in Section 5.

A full list of whale species known to occur in Australian waters can be found on the Department's web site at: [www.environment.gov.au/whales](http://www.environment.gov.au/whales).

#### 3.1 Applicable Species

Not all whales hear the same acoustic frequencies. Seismic survey sound sources are generally focussed at frequencies below 200Hz. Based on the best available scientific information, it is generally understood that baleen whales and some toothed whales are likely to be sensitive to sounds in this lower frequency range.

Due to the difficulties in identifying whales to the species level, particularly at distance, appropriate management procedures (as recommended in Part A Standard Management Procedures and Part B Additional Management Procedures, below) should be applied whenever whales are, or might be, encountered. 'Whales' includes baleen whales and larger toothed whales, such as, sperm whales, killer whales, false killer whales, pilot whales and beaked whales.

Smaller dolphins and porpoises that have peak sensitivities in the higher frequency ranges are likely to be less disturbed by these lower frequency sounds and less vulnerable to acoustic trauma. Accordingly, this Policy Statement does not apply to encounters with the smaller dolphins and porpoises.

#### 3.2 Limitations of this Policy Statement

This Policy Statement does not provide definitive advice on avoiding significant impacts on whales for proposed seismic surveys, as different surveys may have unique consequences. The particular circumstances of each seismic survey have to be considered when decisions are made under the EPBC Act. This Policy Statement does not in any way limit the discretion or responsibilities of the Australian Government Environment Minister under the EPBC Act.

This Policy Statement does not address legal obligations under the *Offshore Petroleum Act 2006* or other relevant Australian Government, state or territory legislation. The person proposing to undertake a seismic survey is advised to contact the relevant authorities to address those obligations prior to undertaking seismic surveys.

The impact of sound from seismic acoustic sources is the subject of ongoing research in many parts of the world, including Australia. Updates and amendments to this Policy Statement and to the application of the EPBC Act as it relates to seismic survey activities will occur as our knowledge of whales and the impacts of sound improve.

### 4. POTENTIAL IMPACTS TO BE CONSIDERED

When planning a seismic survey, you should obtain as much information about the area in which you intend to survey and consider the timing, duration and intensity of the survey. One of the most important aspects of assessing the likelihood of potential impacts on whales, is determining whether the proposed survey will have a low likelihood or a moderate to high likelihood of encountering whales:

Low likelihood: Spatially and temporally outside aggregation areas, migratory pathways and areas considered to provide biologically important habitat.

Moderate to high likelihood: Spatially and/or temporally proximate to aggregation areas, migratory pathways and/or areas considered to provide biologically important habitat.

The likelihood of encountering whales in a given location must be examined on a case-by-case basis, and will provide guidance regarding the management procedures (as outlined in Section 6) that should be implemented to minimise the risk of impacts on whales.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

In addition, it is necessary to identify whether the proposed survey will occur in a **biologically important habitat** of a whale species, defined as breeding, calving, or resting areas, or confined migratory routes or feeding areas. In such habitats, displacement from areas or activities that are important to whale survival or recovery may have a greater impact than elsewhere.

If information on the area or the likely impacts is unavailable, proponents may need to consider conducting research into the likely presence of whales in the area and the potential impacts that the proposed activity may have on whales (as defined in Section 3) and other matters of national environmental significance (see Section 5.1).

Limited information is currently available for a number of species, habitat areas and migration paths. Specific research activities are underway to improve our knowledge for a number of species and areas. Additionally, information from ongoing marine industries encountering whales (including the oil and gas exploration activities) will assist in improving our knowledge.

Proponents are encouraged to seek advice about the likelihood of surveys interacting with whales from the Department. Currently accessible information on whale distributions, migration times and conservation status is available on the web site at: [www.environment.gov.au/whales](http://www.environment.gov.au/whales).

In addition, local communities, conservation organisations, researchers, environmental consultants, state and territory governments, universities and museums are important sources of information on whale distribution, ecology and management.

**Useful Resources**

Species information: <http://www.environment.gov.au/coasts/species/cetaceans/species.html>

SPRAT – detailed species information: <http://www.environment.gov.au/sprat>

Humpback Whale Recovery Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/recovery/m-novaeangliae/index.html>

Southern Right Whale Recovery Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/recovery/e-australis/index.html>

Blue, Fin and Sei Whale Recovery Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/recovery/balaenoptera-sp/index.html>

**5. LEGISLATIVE RESPONSIBILITIES**

Under the EPBC Act there are two obligations that proponents must consider. The first is the obligation to refer proposals that have or are likely to have a significant impact on a matter of national environmental significance, for a decision about whether assessment and approval is needed (Parts 7 to 9 of the EPBC Act). Actions which may have such impacts are defined under the EPBC Act as ‘controlled actions’. The second obligation is the need to apply for a permit (Part 13, Div 3, Subdivision F, of the EPBC Act), if the action may kill, injure, take or interfere with a cetacean in the Australian Whale Sanctuary. There are offence provisions for breaching these obligations.

**5.1 Referrals**

If a proposed seismic survey has or is likely to have a significant impact on a matter of national environmental significance, which includes listed threatened and migratory species, the action should be referred to the Australian Government Environment Minister under the EPBC Act (Part 7). An action taken in the Commonwealth marine area must also be referred if it is likely to have a significant impact on the ‘environment’, which may include impacts on whales and other species.

A referral may be determined by the Minister to be:

- Not a controlled action (*Further approval is not required if the action is undertaken in accordance with the referral*);
- Not a controlled action, provided the action is undertaken in a particular manner (*Further approval is not required provided that the action is performed in a particular way, specified in the decision notice*); or
- A controlled action (*the action is subject to the assessment and approval processes under the EPBC Act*).

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

To date, the majority of seismic surveys referred under the EPBC Act have been determined not controlled actions provided they are undertaken in a particular manner.

The proponent should consider the adoption of appropriate mitigation measures before making a referral, as this may influence the decision on whether the proposed survey is determined to be a controlled action. If a seismic survey is determined to be a *controlled action*, it will require further assessment and approval under Part 8 and 9 of the Act. Further information on the assessment and approval process and timeframes is available at: <http://www.environment.gov.au/epbc/assessments/index.html>

If the likelihood of encountering whales is low, the chance of a seismic survey having a significant impact on a whale species should be minimal, provided that the proponent and the operator of the seismic survey adopt the measures outlined in Part A Standard Management Procedures (see Section 6.2).

While Part A Standard Management Procedures may be sufficient in locations where the likelihood of encounters with whales is low, the proponent may need to consider additional avoidance and mitigation measures for areas and/or seasons where the likelihood of encountering whales is moderate to high. In these circumstances, the proponent should not only apply Part A Standard Management Procedures, but should also consider measures like those outlined in Part B Additional Management Procedures (see Section 6.2).

In situations involving **biologically important habitats**, explicit justification for why the proposed survey should take place should be provided. It will be necessary to implement more extensive measures, such as greater precaution zones and additional marine mammal observer coverage. Such measures should be identified in the planning stage of a seismic survey. Accordingly, it is strongly suggested that the proponent discuss these situations with the Department in the planning stages. The appropriateness of any additional measures to be applied will be considered on a case by case basis.

A referral under the EPBC Act for a seismic survey should include all relevant and available information. This includes:

- Specific details on the location and timing of the survey (including maps with the survey route and bathymetry clearly marked);
- Specific details on the seismic sound sources to be used (i.e. airgun number, volume, pressure), and their operational characteristics like size, spacing (x,y,z) and depth of the seismic array, along with calculated operational source levels and sound propagation characteristics, if known. This information can be used to assess introduced sound energy and sound propagation;
- Details of whale species likely to occur in the area and any information known on the likelihood of encountering whales during the survey;
- Specific information on the management measures to be employed to detect whales and avoid interference or significant impacts;
- Details of any professional or trained observers to be employed in the application of the management measures;
- A copy of any environment management plans for the survey; and
- Details of any whale or other environmental research being conducted in association with the survey.

Matters of National Environmental Significance

In addition to considering impacts on whales, the proponent must also consider whether the survey operation is likely to have a significant impact on matters of national environmental significance, particularly:

- other listed threatened and migratory species;
- World and National Heritage areas; and
- The environment as a whole (including in relation to whales), if the action is in the Commonwealth marine area.

This Policy Statement should be read in conjunction with other relevant EPBC Act Policy Statements, in particular, the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (May 2006), which is a general source of guidance as to whether an action is likely to have a significant impact on a matter of national environmental significance.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

This Policy Statement is one of a range of EPBC Act Policy Statements which provide more detailed guidance in relation to specific industry sectors and activities or specific places, species, or ecological communities which are protected under the EPBC Act. EPBC Act Policy Statements can be obtained from the Department's Community Information Unit on 1800 803 772 or can be downloaded from the web site at: [www.environment.gov.au/epbc/policy/index.html](http://www.environment.gov.au/epbc/policy/index.html)

## 5.2 Permits

An action that will kill, injure, take or interfere (among other things) with a whale or dolphin within the Australian Whale Sanctuary and, for Australian nationals and companies, the waters beyond the outer limits of the Australian Whale Sanctuary, is an offence under Part 13 of the EPBC Act.

However, an action will not be an offence if:

- the proponent has referred the proposed action to the Minister, and the Minister has considered impacts on the Commonwealth marine area and approved the action under Part 9 of the EPBC Act; or
- a permit has been granted.

Permits will only be granted to injure, take or kill a whale or other cetacean in extremely limited circumstances. Accordingly, these circumstances are not discussed further in this Policy Statement.

The proponent must consider whether a permit is required. Permits issued in relation to seismic surveys in the circumstances relevant to this Policy Statement, would generally relate to interference with a whale or dolphin. 'Interference' is defined in the Act to include "to harass, chase, herd, tag, mark or brand" a whale or dolphin. Seismic surveys in Commonwealth waters have the potential to affect some aspects of whale behaviour, particularly if they are to be conducted at times and places when encounters with whales are likely.

A seismic survey will generally not interfere with whales if the survey is undertaken in an area and time where the likelihood of encountering whales is low and the appropriate measures outlined in Part A Standard Management Procedures and Part B Additional Management Procedures are undertaken.

If the seismic survey is within an area declared as a Commonwealth Marine Reserve and a management plan is not in operation, approval (under s359B(2) of the EPBC Act) from the Director of National Parks may also be required.

Further information on the permit system and process under the EPBC Act is available at: <http://www.environment.gov.au/epbc/permits/index.html>

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

## 6. MANAGEMENT MEASURES FOR ORGANISATIONS/VESSELS CONDUCTING SEISMIC SURVEYS IN AUSTRALIAN WATERS

The management measures are divided into two areas:

**Precaution Zones:** defines the *Observation*, *Low power* and *Shut-down* zones to be used based on the likely sound levels surrounding the seismic sound source(s). These precaution zones are to be used in the operational procedures that follow.

**Management Procedures:** defines the operational procedures which should be used when planning and carrying out seismic surveys. These include:

**Part A: Standard Management Procedures,** which should be followed by all vessels conducting seismic surveys in Australian waters, irrespective of location and time of year, so as to avoid interfering with or having a significant impact on whale species. These procedures should be sufficient in areas that can be demonstrated, by available evidence, to have a **low likelihood** of encountering whales.

**Part B: Additional Management Procedures,** which are designed to further minimise any possible impacts on individual animals or populations. These procedures may be employed in areas and/or seasons which have a **moderate to high likelihood** of encountering whales. These procedures are of particular importance in considering a seismic survey proposed to take place in a biologically important habitat.

Guidance for assessing the likelihood of encountering whales during a seismic survey is provided in Section 4.

### 6.1 Precaution Zones

Different seismic surveys will have varying acoustic propagation characteristics depending on many characteristics including the seismic array used, bathymetry of the survey area and temperature profile of the water column. Precaution zones should be delineated based on the sound levels whales are likely to receive. For example, a seismic air-gun array operating in shallow water will likely have much quicker attenuation of sound energy compared to a similar array operating in deep water. Accordingly, a survey producing lower sound levels as one ranges further from the seismic vessel should be able to operate with smaller precaution zones than a survey that produces higher levels at similar ranges.

For proposed seismic surveys that can demonstrate through sound modelling or empirical measurements that the received sound exposure level for each shot will not likely exceed 160dB re 1µPa<sup>2</sup>s, for 95% of seismic shots at 1km range, the following precaution zones are recommended:

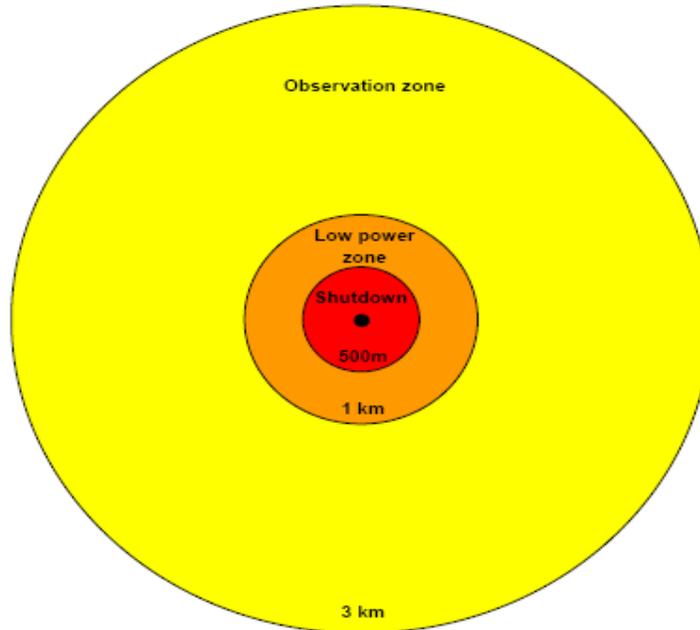
- *Observation* zone: 3+ km horizontal radius from the acoustic source.
- *Low power* zone: 1 km horizontal radius from the acoustic source.
- *Shut-down* zone: 500m horizontal radius from the acoustic source.

For all other proposed seismic surveys:

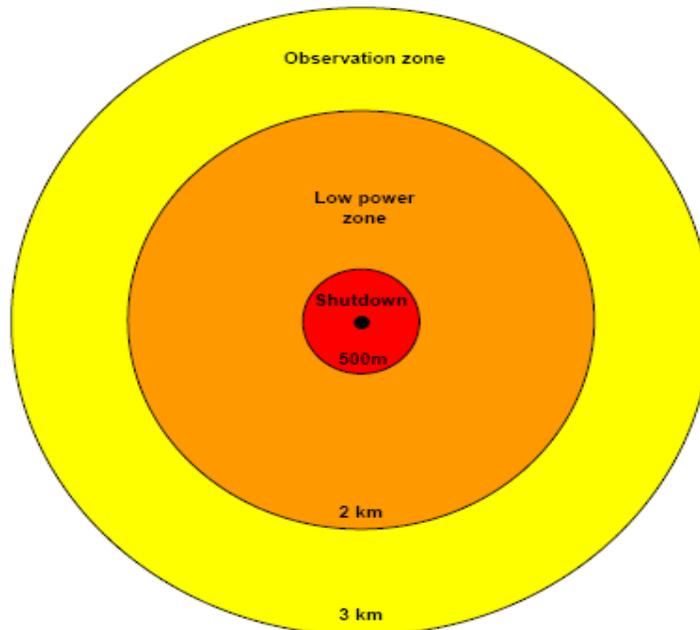
- *Observation* zone: 3+ km horizontal radius from the acoustic source.
- *Low power* zone: 2 km horizontal radius from the acoustic source.
- *Shut-down* zone: 500m horizontal radius from the acoustic source.

See Diagrams 1 and 2 below for an illustration of these zones. In the *observation* zone whales and their movements should be monitored to determine whether they are approaching or entering the *low power* zone. When a whale is sighted within, or is about to enter, the *low power* zone, the acoustic source should immediately be powered down to the lowest possible setting. When a whale is sighted within, or is about to enter, the *shut-down* zone, the acoustic source must immediately be shut down completely. Use the above values for application of both Part A Standard Management Procedures and Part B Additional Management Procedures outlined below.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*



**Diagram 1:** Precaution zones surrounding the acoustic source for surveys that meet the criteria for a 1km low power zone.



**Diagram 2:** Precaution zones surrounding the acoustic source for all other surveys (2km low power zone)

September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales

## 6.2 Management procedures

### PART A. STANDARD MANAGEMENT PROCEDURES

These procedures should be followed by all seismic vessels conducting surveys in Australian waters irrespective of location and time of year.

**Applicable Species:** Due to the difficulties in identifying whales to the species level, particularly at distance, the following Standard Management Procedures should be applied whenever whales are encountered. 'Whales' includes baleen whales and larger toothed whales, such as, sperm whales, killer whales, false killer whales, pilot whales and beaked whales. Other (smaller) dolphins and porpoises that have peak sensitivities in the higher frequency ranges are likely to be less disturbed by these lower frequency sounds and less vulnerable to acoustic trauma. Accordingly, these Standard Management Procedures do not apply to encounters with the smaller dolphins and porpoises. If there is doubt regarding the identification of the species, precaution should be shown and the procedures outlined below should be applied.

#### A.1. PRE-SURVEY PLANNING

Do not program seismic surveys in areas where and when whales are likely to be breeding, calving, resting or feeding. If proposed, these surveys and associated mitigation measures will need careful consideration and may require further assessment under the EPBC Act.

Example: The endangered Southern Right whale breeds and calves at particular sites along the coast of southern Australia, such as the Head of the Bight, SA and near Warmambool, Vic, in the winter months. Seismic surveys should be planned to avoid such areas and times, or at a minimum demonstrate that the measures to be employed will not have an impact on animals at important times, this may include application of all or some of the measures outlined in the Part B Additional Management Procedures. The *Recovery Plans for Australia's Threatened Whales (Humpback, Southern Right, Blue, Fin and Sei) 2005-2010* contain detailed information on important habitat areas.

When planning seismic surveys, avoid where possible areas where and when whales are known or are likely to be migrating. Should it be necessary to conduct seismic surveys in areas where and when whales are known or are likely to be migrating then additional measures (see Part B Additional Management Procedures) to ensure that impacts and interference are avoided and/or minimised are necessary. Details of the measures to be applied should be included in any referral submitted under the EPBC Act.

Further environmental assessment of potential impacts may also be necessary if multiple seismic sources (e.g. two vessels on one project or multiple, adjacent projects) are to be operated in the same general area. Where a seismic survey is proposed, the proponent should liaise with government and industry bodies to ensure that surveys do not unnecessarily coincide or overlap.

The proponent should prepare an environmental management plan for the survey that details the management and operational measures that will apply throughout the survey to detect whales and avoid interference or significant impacts. The plan and measures employed should be based on the likelihood of encountering whales during the survey.

If during the operation of the survey the number of sightings/power-downs of whales are higher than were anticipated during the planning of the survey or the timing of the survey alters, the proponent should contact the Department to discuss any proposed additional management measures.

#### A.2. TRAINED CREW

The organisation conducting the survey should ensure that there is sufficient trained crew to fulfil the basic requirements outlined below. The trained crew members must have proven experience in whale observation, distance estimation and reporting.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

A briefing should be provided to all crew on board the survey vessel (and any supporting craft) on environmental matters, including information on this Policy Statement, whale identification and the environmental legal obligations for companies operating in Australian waters.

Where possible, provide reference material, including this Policy Statement, the Department's Whale and Dolphin sighting report form and the APPEA CD Guide *Search Australian Whales and Dolphins* and provide appropriate visual aids, such as binoculars, on board the vessel to aid in the identification and reporting of any whales sighted.

### **A.3. DURING SURVEYS**

All seismic survey vessels operating in Australian waters must undertake the following basic procedures during surveys irrespective of location and time of year of survey:

- Pre start-up visual observation
- Soft start
- Start-up delay
- Operations
- Power- down and Stop work

These procedures are defined and described in greater detail below.

#### **A.3.1 Pre Start-up-Visual Observation**

During daylight hours, visual observations (using binoculars and the naked eye from the bridge on the survey vessel or preferably a higher vantage point) for the presence of whales should be undertaken by a suitably trained crew member for at least 30 minutes before the commencement of the Soft Start Procedure (see A.3.2). Observations should, where visibility allows, extend to 3+ km (the *Observation zone*) from the vessel but with particular focus on the *Low power* and *Shut-down* zones around the acoustic source (see Diagrams 1 and 2).

During these 30 minute observations, the observer should make observations around the whole of the vessel (360°) and towed array out to a 3km distance and, if possible, beyond 3kms.

#### **A.3.2 Soft Start Procedure (also known as ramp-up)**

If no whales have been sighted within the *Low power* and *Shut-down* zones during the pre start-up procedure, the soft start procedure outlined below may commence.

Soft start procedures should be used each time the acoustic sources are initiated, gradually increasing power over a 30-minute period. Initiate soft start procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output and volume. Additional acoustic source components should gradually be added in sequence until operating level is achieved. The full power operating level should be the minimum acoustic energy output that is necessary to achieve the survey's objectives.

A sequential ramp-up of the acoustic source is considered to be industry best practice, and is known as a 'soft start'. The slow increase in acoustic energy may alert whales in the area to the presence of the seismic array and enable animals to move and avoid (or stand off) at distances where injury is unlikely.

During daylight hours, visual observations by trained crew should be maintained continuously during soft starts to identify any whales within the precaution zones.

#### **A.3.3 Start-up Delay Procedure**

If a whale is sighted within the 3km observation zone during the soft start an additional trained crew member or marine mammal observer should also be brought to the bridge to continuously monitor the whale whilst in sight. If a whale is sighted within or is about to enter the *Low power* zone, the acoustic source should be powered down to the lowest possible setting (e.g. a single gun). If a whale is sighted within or is about to enter the *Shut-down* zone, the acoustic source should be shut down completely.

Soft start procedures should only resume after the whale has been observed to move outside the *Low power* zone, or when 30 minutes have lapsed since the last whale sighting.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

#### **A.3.4 Operations Procedure**

During daylight hours, trained crew should undertake visual observations continuously during survey operations.

Operators should power down the acoustic source to the lowest possible setting when not collecting data, or undertaking soft start procedures (e.g. during line turns or when moving to another part of the survey area).

The firing of a single gun during turns is an industry standard and is generally considered a reasonable precaution. This sound source may alert whales in the area to the presence of the seismic array and reduce chances of entanglement or contact.

If the array is completely shut down or reduced to low power (e.g. for operational reasons or during line turns), observations for whales should continue. To restart the array the following procedures should take place:

- If no whales are sighted during the shut-down/low power period then start-up may commence using A.3.2 Soft Start Procedure and A.3.3 Start-up Delay Procedure.
- If whales are sighted during the shut down/low power period, or if observations for whales ceased, then start-up should not begin until pre start-up visual observations have been conducted, as outlined in A.3.1. Start-up may then commence using A.3.2 Soft Start Procedure and A.3.3 Start-up Delay Procedure.

#### **A.3.5 Stop Work Procedure**

If a whale is sighted within the 3km observation zone an additional trained crew member or marine mammal observer should also be brought to the bridge to continuously monitor the whale whilst in sight.

If a whale is sighted within or is about to enter the *Low power* zone, the acoustic source should be powered down to the lowest possible setting. If a whale is sighted or is about to enter the *Shut-down* zone, the acoustic source should be shut down completely.

Power-up of the acoustic source with soft-start procedures should only occur after the whale has been observed to move outside the *Low power zone*, or when 30 minutes have lapsed since the last whale sighting.

#### **A.3.6 Night-time and Low Visibility Procedures**

At night-time or at other times of low-visibility (when observations cannot extend to 3km from the acoustic source, e.g. during fog or periods of high winds), the following measures apply for start up and operations:

Start up may be commenced according to A.3.2 Soft-Start Procedure:

- provided that there have not been 3 or more whale instigated power-down or shut-down situations during the preceding 24 hour period; or
- if operations were not previously underway during the preceding 24 hours, the vessel (and/or a spotter vessel or aircraft) has been in the vicinity (approximately 10km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted.

Operations may proceed provided that there have not been 3 or more whale instigated power-down or shut-down situations during the preceding 24 hour period.

During low visibility, where conditions allow, continuous observations to spot whales should be maintained with a particular focus on the *Low power* and *Shut-down* zones. If whales are detected then the procedures outlined in A.3.5 Stop Work Procedures should apply.

If sightings of whales have been frequent or are higher than were anticipated during the planning of the survey, the proponent should contact the Department to discuss appropriate night-time provisions and whether additional management measures should be employed for day and/or night-time operations.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales***A.4 COMPLIANCE AND SIGHTING REPORTS**

It is the responsibility of the proponent to maintain a record of procedures employed during operations. Such records should be auditable and account for aspects of the operation that relate to legislative approvals and regulations. Additionally, information on any whales (or other species) sighted during the survey may be useful in the planning and assessment of future marine industry activities.

A report on the conduct of the survey, and any whale interactions, should be provided to the Department within two months of survey completion. The report should, at a minimum, contain:

- the location, date and start time of the survey;
- name, qualifications and experience of any Marine Mammal Observers (or research scientists) involved in the survey;
- the location, times and reasons when observations were hampered by poor visibility or high winds;
- the location and time of any start-up delays, power downs or stop work procedures instigated as a result of whale sightings;
- the location, time and distance of any whale sighting including species where possible; and
- the date and time of survey completion.

Any whale sightings should be recorded on a sightings form. An example reporting form for cetaceans sightings is available online at <http://www.environment.gov.au/epbc/publications/seismic.html>

The Report and completed sighting forms should be emailed to [portsandmarine@environment.gov.au](mailto:portsandmarine@environment.gov.au) or posted to:

Director  
Ports & Marine Section  
Approvals and Wildlife Division  
Department of the Environment, Water, Heritage and the Arts  
GPO Box 787  
CANBERRA ACT 2601

## **PART B. ADDITIONAL MANAGEMENT PROCEDURES**

For seismic surveys operating in areas where the likelihood of encountering whales is **moderate to high**, the application of additional measures, to ensure that impacts and interference are avoided and/or minimised, are necessary. The following measures are recommended, however, application of all these measures may not be necessary, applicable or possible for all seismic survey operations. In planning a seismic survey, the proponent should consider which of these measures best apply to their circumstances. Details of the measures to be applied should be included in any referral submitted under the EPBC Act. The proponent is strongly encouraged to seek advice from the Department about the likelihood of surveys interacting with whales and the management measures that may be necessary.

### **B.1 Marine Mammal Observers (MMO)**

As the likelihood of encountering whales increases, the proponent should engage MMOs. MMOs should be trained and experienced in whale identification and behaviour, distance estimation, and be capable of making accurate identifications and observations of whales in Australian waters. The MMOs should assist other observers (e.g. trained crew) and be available to provide advice, should whales be encountered.

### **B.2 Night-time/Poor visibility**

For surveys in areas where whales are expected to be encountered, the proponent should include appropriate management measures to detect (or predict) whale presence and apply measures to reduce the likelihood of encounters. Depending on the situation a range of measures may be appropriate, possible measures include:

- Limiting initiation of soft start procedures to conditions that allow visual inspection of the precaution zone;
- Daylight spotter vessel or aircraft searches of the night-time survey area to determine if whales are present; and
- Pre survey research (including surveys) to detect and identify likely whale concentration areas, such as: peak migration paths and times, key feeding sites (e.g. shelf breaks, sea mounts and trenches), or other aggregation areas.

### **B.3 Spotter Vessel(s) and Aircraft**

Where the likelihood of encountering whales is high, spotter vessels/aircraft could be used to assist in detecting the presence of whales. Spotter vessels and aircraft may be usefully employed to determine the presence and likelihood of encountering whales during day and night-time operations; information that can then be used to re-design the survey or tracks to be run to avoid whales that are in the vicinity. Spotter vessels/aircraft should maintain continuous contact with the seismic survey vessel. An MMO should be employed on board both the survey vessel and the spotter vessel/aircraft.

### **B.4 Increased Precaution zones and Buffer zones**

In some locations and circumstances it may be advisable to apply increased distances for the instigation of power-down procedures from those outlined in Part A Standard Management Procedures. For important habitats, such as feeding areas, when concentrations of food and whales are likely to occur, an increased low power zone (e.g. 3km) may be appropriate to ensure that disturbance or displacement of whales does not occur. Such a measure may not need to apply for the whole of the survey (time and area) but may be advisable for particular specific locations (e.g. along the shelf edge where food sources are most likely to occur).

For surveys being undertaken in the broad vicinity of known breeding or resting areas, a buffer (exclusion) zone should be established to ensure that operating survey vessels do not enter the vicinity where whales may be present. The size of the buffer zone should be established on a precautionary basis. Where available, scientific evidence and/or acoustic propagation modelling should be used to determine and justify the buffer zone.

### **B.5 Passive Acoustic Monitoring**

Passive acoustic monitoring (PAM) is an emerging technology that has some limitations. Deployment of PAM with appropriate technologies and programs to detect whales in real time may provide an additional method of detecting and avoiding whales during surveys and may be particularly useful during night-time and low visibility operations. The use of PAM as a detection tool should be considered by the proponent and, if deployed, details should be provided on their intended use as part of any referral under the EPBC Act.

*September 2008: EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*

**B.6 Adaptive Management**

Where a survey is proposed in an area that is spatially and temporally on the edge of areas considered to provide biologically important habitat, the proponent may consider implementing adaptive management procedures to manage the potential increased likelihood of encountering whales. For example, they may cease all night time surveying if there are three consecutive days on which operators experience three or more whale-instigated shut down/power down situations. Adaptive management may also be used in conjunction with other measures described in Part B. For example, if aerial surveys identify whales in the region, increased buffer zones are implemented.

## 9.5 Bridging Document

### ORIGIN – PGS 2011 OTWAY AND BASS BASINS 3D SEISMIC PROGRAM BRIDGING DOCUMENT

This document explains the interaction between the Legislation, the Parties, the Policies, Systems & Procedures and the Project Management Documents to ensure an effective 3D seismic survey operation.

#### A) LEGISLATION

1. The laws of the States of Tasmania and Victoria
2. The laws of the Commonwealth Government of Australia
3. International legislation where relevant
4. Other laws where specified in the Project management Documents

#### B) PARTIES:

5. Origin Energy including supervision contractors (Operator)
6. PGS (Contractor)

#### B) POLICIES, SYSTEMS & PROCEDURES:

1. Origin Energy HSE Policy and HSE Management System
2. PGS HSE Management and Operational Systems including Standard Operating Procedures

#### C) PROJECT MANAGEMENT DOCUMENTS:

1. Project Manual, including the following sections:
  - a. Project Plan
  - b. Environmental Plan
2. Contract between Origin Energy and PGS

Origin Energy is the Operator of Exploration permits in the Bass Strait and the Otway basin within which the proposed work will be conducted. PGS is contracted to Origin to provide the seismic acquisition services. Origin must ensure that all work is conducted in accordance with the relevant legislation and Origin's HSE Management Policy and System. Origin must ensure that Contractors' own systems adhere to Origin's systems and policies before the contractors are selected and during the operation by use of onboard supervisors. Origin must ensure that the Project Manual adheres to Origin's HSE Policy and System and in accordance with legislation and industry best practice.

Contractors must ensure that they follow their own Systems and procedures and the Project Manual. Contractors must follow the instructions of Origin where Origin demonstrates that they have deviated from the Project Manual or their own systems and procedures. Contractors must ensure that their work is in accordance with best industry practice.

All personnel must follow a duty of care to protect the safety of all personnel and the environment.

## **9.6 International SOS - Medical Emergency Response Plan**

# MEDICAL EMERGENCY RESPONSE PLAN (MERP)

***PGS / Ramform Sterling / Seismic Acquisition  
Offshore Australia***

***Latitude: 39° 15' S; Longitude: 143° 03' E***

***Latitude: 39° 41' S; Longitude: 143° 08' E***

***Latitude: 39° 47' S; Longitude: 145° 34' E***

***Latitude: 40° 05' S; Longitude: 146° 34' E***

<b><u>Version No.</u></b>	<b><u>Drafted By</u></b>	<b><u>Reviewed By</u></b>	<b><u>Date</u></b>
Version 1.1	Global Knowledge Support Center	SYD MERP Team	14.01.2011
Version 1.2	Global Knowledge Support Center	-	19.01.2011



# Table of Contents

- 1 Medical Emergency Response Plan (MERP) Summary**
- 2 Background Information**
  - 2.1 Geographic Location*
  - 2.2 Medical Infrastructure*
  - 2.3 Vessel Transportation Facilities and Procedures*
- 3 Evacuation Staging**
  - 3.1 Alert and Stabilization*
  - 3.2 Authorization*
  - 3.3 Evacuation*
  - 3.4 Responsibilities and Duties*
    - 3.4.1 Vessel Team's Duties
    - 3.4.2 International SOS' Duties
- 4 Evacuation Support Logistics**
  - 4.1 Phase One: Primary Evacuation*
    - 4.1.1 Facility Destination – Preferred Health Providers for Emergency Care
    - 4.1.2 Transportation
      - 4.1.2.1 Air: Rotary Wing
      - 4.1.2.2 Sea: Vessel
      - 4.1.2.3 Ground
    - 4.1.3 Other
      - 4.1.3.1 Airport Information
      - 4.1.3.2 Port Information
  - 4.2 Phase Two: Secondary Evacuation*
    - 4.2.1 Facility Destination – Preferred Health Providers for Emergency Care
    - 4.2.2 Transportation
      - 4.2.2.1 Air: Fixed Wing
      - 4.2.2.2 Air: Commercial Carrier
      - 4.2.2.3 Ground
    - 4.2.3 Other
      - 4.2.3.1 Airport Information – Airports of Entry
      - 4.2.3.2 Logistics, Immigration and Health Authority Requirements
- 5 Main Organizational Contact Details**
  - 5.1 PGS (Petroleum Geo-Services)*
    - 5.1.1 Authorized Person (AP)
    - 5.1.2 Other Company Contacts
  - 5.2 International SOS*
    - 5.2.1 Operational Escalation
    - 5.2.2 Account Management
- 6 Appendix I – Medical Report Form**
- 7 Appendix II – Medical Inventory**

## 1. MEDICAL EMERGENCY RESPONSE PLAN (MERP) SUMMARY

**Injury or illness** occurs and results in need for medical advice, urgent medical referral or emergency medical evacuation.

Ramform Sterling medical staff activates local primary Emergency Response Plan (ERP) as required and contacts the International SOS Alarm Center.

International SOS Coordinating Doctor (CD), vessel medical staff and Ramform Sterling Authorized Person (AP) discuss case and decide on Plan of Action.

### Emergency Evacuation



1. Patient to be brought to nearest designated local medical facility for initial stabilization by locally available means of transport. (Captain or shipmaster to request assistance from applicable MRCC as required for offshore retrieval; International SOS will medically assist primary retrieval on best effort base and support client with available transport logistics).
2. International SOS to organize onward mode of transport by ground or air ambulance from port or airport to nearest hospital for stabilization or continued care.
3. Travel necessities (passport visa documents, clothing etc) to be organized by local site management.
4. International SOS to liaise with local providers to facilitate admission under most appropriate specialist and immediate care facility.
5. International SOS to guarantee upon request of patient's AP the payment at hospital/s to expedite admission.
6. International SOS to monitor care and update PGS management on condition of patient and next medical steps as required.

### Urgent Referral



1. Patient will stay on vessel until appropriate transfer can be arranged.
2. Company to move patient by next available transport to nearest appropriate medical facility.
3. Travel necessities (passport, visa, documents, clothing etc) to be organized by local site management.
4. **Inpatient admission required;**
  - a) International SOS to organize and liaise with local providers to facilitate admission and further care.
  - b) International SOS to arrange guarantee of payment at hospital if required.
  - c) International SOS to monitor Care and update PGS management as required.
- Outpatient assessment**
  - a) International SOS to organize and liaise with appropriate medical provider to facilitate assessment.
  - b) International SOS to guarantee payment to the doctor / clinic as authorized by PGS.
  - c) International SOS to monitor care and update PGS management on fitness to return to work or sick leave required as appropriate.

Primary Intl. SOS 24/7 Alarm Centre Contact Details:-  
**Sydney** (Ask to speak to the Coordinator doctor on duty)  
 Tel: +61 29372 2468  
 Email: [sydopsmed@internationalsos.com](mailto:sydopsmed@internationalsos.com)

Secondary Intl.SOS 24/7 Alarm Centre Contact Details:-  
**Singapore**  
 Tel: +65 6338 7800  
 Email: [sin.medical@internationalsos.com](mailto:sin.medical@internationalsos.com)

**Client Name: PGS (Petroleum Geo-Services)**  
**Membership No: 14ACPA000011**  
**Membership Type: Comprehensive Membership - Access**

### Project Details

**Medical Staffing:** Frontier Medics  
**Name:** James Gallacher / Emma Marshall  
**Direct contact number:** +47 6751 5558 / 7106  
**Vessel Population:** approx. 50 pax  
**Helipad:** dimension: 19.5 meters; capability: Super Puma  
**Support Assets:** Yes, vessel (Ocean Dynasty)  
**Vessel Contact Numbers:**  
**Tel:** +870 764948712 or 715  
**Radio:** VHF MARINE CH 16  
**Call Sign:** C6YE5  
**Vessel Description:** Seismic Acquisition

### Authorized Person (AP) Contact Details

**AP1 Leif-Inge Iversen, Operations Manager**  
**Work:** +65 6838 1947  
**Mobile:** +65 9627 2765  
**Email:** [leif-inge.iversen@pgs.com](mailto:leif-inge.iversen@pgs.com)

**AP2 Johnny Leknes, Acquisition Manager**  
**Work:** +65 6735 6411  
**Mobile:** +65 9636 1898  
**Email:** [johnny.leknes@pgs.com](mailto:johnny.leknes@pgs.com)

**Vessel Manager:** Neil Jackson / Phil Shriner  
**Tel:** +47 6751 5575

**Nearest Port:** Melbourne / Burnie / Devonport

### Responsibilities of Ramform Sterling staff

1. Provide / assist medic with immediate emergency care.
2. Define problem / request assistance to Intl SOS.
3. Complete Medical Report Forms.
4. Follow up call with verbal and written updates.
5. Provide patient escort if clinically necessary.
6. Contact MRCC (*shipmaster's responsibility*).

### Responsibilities of PGS

1. Provide caller's name, location, contact telephone, coordinates (and course and speed as relevant).
2. Provide patient name, nationality and passport details and facilitate transmission of doctor report.
3. Prepare passport and travel docs as necessary.
4. Advise next of kin (NOK) as appropriate.
5. Facilitate International SOS access to medical records and insurance cover where appropriate.
6. Make local transport assets / boats, helicopters etc. under company's control available for first stage of evacuation.
7. Prepare and maintain vessel Emergency Response Plan.

### Responsibilities of International SOS

1. Give immediate medical advice on clinical management over the phone if appropriate.
2. Assess the situation and recommend whether the patient should be treated on vessel or be evacuated to nearest hospital.
3. Ensure any ground transfer arrangements are in place and confirmed.
4. Organize immediate medical attention in the appropriate medical facility.
5. Organize onward evacuation if required.
6. Keep Authorized Persons updated on the case.

**Note: Intl SOS will provide Evacuation support once Frontier has confirmed medically that Evacuation is required.**

## 2. BACKGROUND INFORMATION

### 2.1 GEOGRAPHIC LOCATION

Ramform Sterling is a seismic vessel owned by PGS Falcon AS and is currently operating seismic acquisition offshore Australia. There are approximately 50 personnel working onboard.

#### Survey Area Geographical Coordinates:

##### Astrolabe 3D

Latitude: 39° 15' S; Longitude: 143° 03' E  
125 nautical miles to Melbourne

##### Bellerive 3D

Latitude: 39° 41' S; Longitude: 143° 08' E  
140 nautical miles to Melbourne

##### Chappell 3D

Latitude: 39° 47' S; Longitude: 145° 34' E  
122 nautical miles to Melbourne

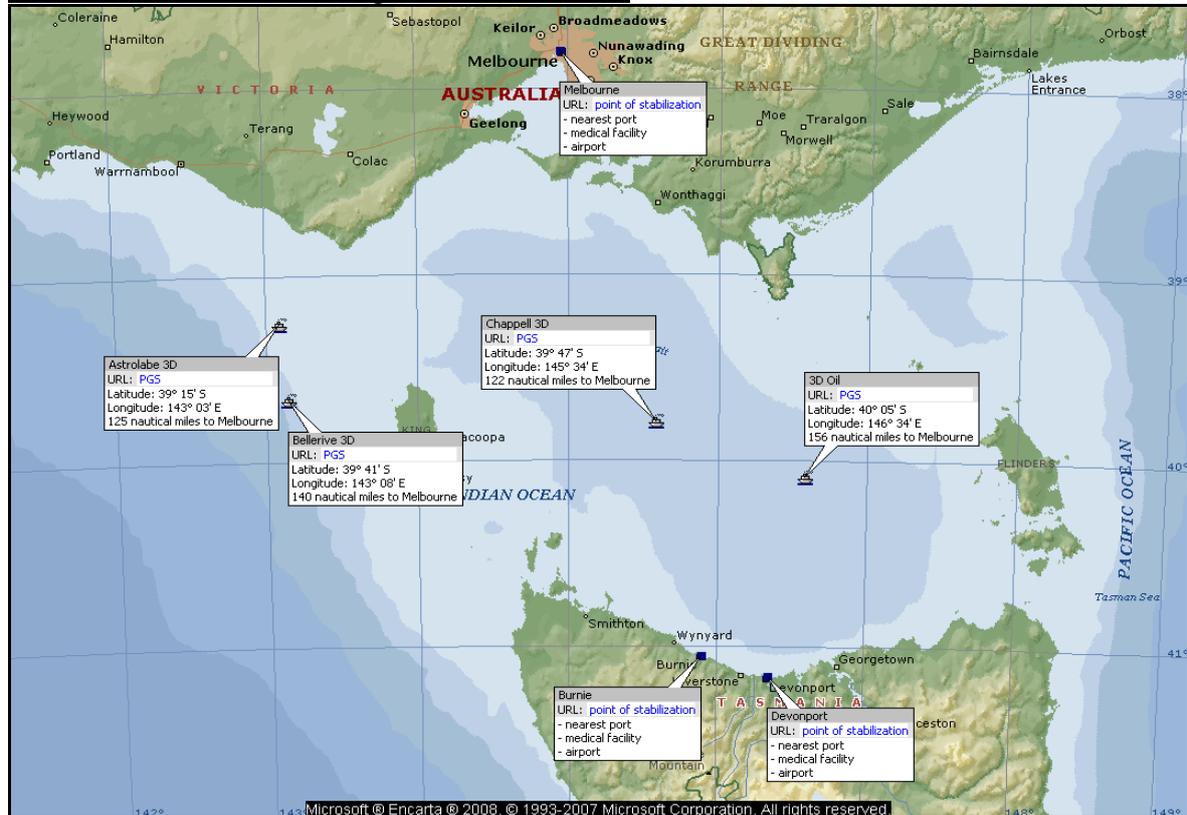
##### 3D Oil

Latitude: 40° 05' S; Longitude: 146° 34' E  
156 nautical miles to Melbourne

#### Picture of Ramform Sterling



#### Local View: Ramform Sterling, offshore Australia



## 2.2 MEDICAL INFRASTRUCTURE

Medical services on board are provided by the Frontier Medic. There is stretcher and it can be winched.

Name of the medic(s): James Gallacher / Emma Marshall  
Direct contact number: +47 6751 5888 / 7106  
Fax number: +870 764 903 852

The onboard clinic is equipped with defibrillator, oxygen, basket stretcher, vacuum mattress, oxyviva, pneumosplint, laerdal suction, hare traction, suture set, sterilizator, emergency bag, emergency drug and also adequate medical supplies.

**Note: Intl SOS will provide Evacuation support once Frontier has confirmed medically that Evacuation is required.**

*Please refer to Appendix II for a list of medical equipments and medicines available onboard.*

## 2.3 VESSEL TRANSPORTATION FACILITIES AND PROCEDURES

Support vessel (Ocean Dynasty) is available with PGS for evacuating the patient from vessel location to the nearest port.

Helideck is present onboard with dimension 19.5 meters and capable of landing helicopters up to Super Puma helicopters. Night landing is said to be possible and Aviation Navigational Beacon (NDB) is present. Operating frequency is 410 KHz.

*Please refer to section 4.1.2 for more details.*

## 3. EVACUATION STAGING

### 3.1 ALERT AND STABILIZATION

#### 3.1.1 WHO TO ALERT

<b>Primary International SOS 24/7 Alarm Center supporting vessel:</b> <b>Sydney Alarm Center:</b>	Tel: +61 29372 2468 Fax: +61 29372 2455 Email: sydopsmed@internationalsos.com
<b>Secondary International SOS 24/7 Alarm Center supporting vessel:</b> <b>Singapore Alarm Center:</b>	Tel: +65 6338 7800 Fax: +65 6338 7611 E-mail: sin.medical@internationalsos.com

Immediately call International SOS Sydney Alarm Center in the event of serious illness or injury. If for any reason, contact cannot be made with International SOS Sydney Alarm Center, the secondary International SOS Alarm Center can be contacted (or any other International SOS Alarm Center as necessary). Your message will be passed to the appropriate Alarm Center. Note: Due to the progressively worsening nature of some medical conditions and the logistical complexities of remote vessel operations, call EARLY.

At the time of the first call, a two-week travel history on the patient must be communicated, especially but not only if the patient has a febrile or respiratory tract illness.

### **3.1.2 HOW TO ALERT**

Communication by telephone, and confirmation by fax or email. Information to be provided:

- Name and location of the caller – incl. GPS coordinates.
- Name of the patient (and the company the patient works for if not PGS).
- Nationality of the patient and location of patient's passport).
- Comprehensive description of the medical problem both verbally and in writing.

NOTE: Use Appendix 1 'Medical Report Form' and fax or mail to International SOS.

### **3.1.3 STABILIZATION ON VESSEL**

The International SOS Alarm Center Coordinating Doctor (CD) will advise on how to stabilize patient and to prepare them for medical evacuation if required. Vessel medical staff must manage the patient for the duration prior to movement off site. This period will depend on the available rescue logistics. A recommendation regarding the need, mode and destination of evacuation will be undertaken by the International SOS Coordinating Doctor (CD) in conjunction and will be based on patient's condition, location and local logistics.

## **3.2 AUTHORIZATION**

PGS Authorized Person (AP) must confirm their agreement and authorize any cost that may be incurred for the evacuation and for any subsequent hospitalization costs.

Refer to Authorized Person (AP) listing in Section 5.1.

## **3.3 EVACUATION**

Evacuation will occur in one or two phases:

### **Phase One: Primary Evacuation**

- If evacuation is recommended, the patient should be transferred by locally available transport using the vessel medical team to the nearest port or medical facility accessible by the primary mode of transport (air or sea offshore retrieval).
- If there is no primary mode of transport available to the project, the shipmaster may need to activate the responsible MRCC (Maritime Rescue Coordination Centre – see below). International SOS will also liaise with the MRCC and provide the medical justification for such emergency mobilization.
- If the primary transport is not to a port with a direct accessible medical facility at or near the port, International SOS to be notified as soon as possible so arrangements for domestic ground or air transfer can be made prior to the patient's arrival in port.
- The nearest medical facility may not be – and in remote areas usually will not be – the medical facility best suited for the patient's definitive treatment.
- Intl SOS may have administrative agreements with these hospitals and providers to assist with the admission of patients and guarantee of payments but this does not mean these hospitals are credentialed by International SOS to international standards or the standards of International SOS.
- International SOS members are always strongly advised to contact the Intl SOS designated Alarm Centre as early as possible so the most appropriate medical facility for both first care and definitive care can be advised on a case by case basis.
- Medical facilities recommended only for initial admission and stabilization prior to onward transfer for the more serious cases may be appropriate for definitive care of less serious cases but in any case only represent the best locally available option. Onward referral to a regional centre of medical excellence will be recommended on a case by case basis by the International SOS Medical Team.
- International SOS is not in a position to direct local hospitals regarding the treatment of the patient, but will make all efforts to secure understanding and cooperation from the local medical team.

### **Phase Two: Secondary Evacuation**

Secondary evacuation is the movement from the primary receiving facility to a medical facility in another location for the purposes of providing definitive care. The most common modes of secondary evacuation depend on medical and logistical criteria as well as resources available:

#### **1) Air Ambulance:**

- Air ambulance directly to nearest center of medical excellence if recommended by the International SOS Coordinating Doctor (CD). This option will be recommended for serious medical condition if adequate medical care cannot be provided at local facility.

#### **2) Commercial Carrier:**

- Patient transfer on a scheduled flight if available and if patient fit to fly (to be decided by the International SOS Coordinating Doctor (CD) and the Treating Doctor).
- International SOS will facilitate the travel arrangements, including airline medical clearance and medical escort as necessary.

#### **NOTES:**

- In a medical emergency, International SOS may not be able to move patients across an international border if valid travel documents (passport and entry / exit visa) are not available. According to international law, immigration authorities will usually not permit cross-border travel without valid travel documents. It is imperative that a patient always carries his passport with him (if the patient is incapacitated, someone else on board needs to know where to find the passport in case of an emergency).
- Even in a medical emergency, a country may not allow a patient entry if the country immigration regulations do not grant emergency visas for certain nationalities.
- All emergency responses are on a best effort basis; if an aircraft is not available, if the weather not allow safe flying or a safe voyage, if an airport is closed due to runway maintenance, absence of lighting, staffing restrictions, or if a particular aircraft is not available because the pilots have exceeded their safe flying time, there may be unavoidable delays.
- Government health regulations / laws must be followed; if a patient is sick with an infectious disease and health authorities do not allow the transport of the patient either locally, regionally or internationally, then the inability to transfer the patient would be considered as force majeure.
- Secondary medical evacuation to a place where the patient's language is spoken or where he is culturally more comfortable can be arranged upon request if this is considered medically safe.
- Arrangement of repatriation to the patient's home country following an initial evacuation to a centre of medical excellence depends on the patient's fitness to fly as well as the medical clearance of the patient by the airline commercial airline medical department.

## **3.4 RESPONSIBILITIES AND DUTIES**

### **3.4.1 VESSEL TEAM'S DUTIES**

- To alert and inform the International SOS Alarm Center as early as possible.
- To make local transport assets available for the primary transfer.
- To activate the MRCC if needed.
- To prepare patient's travel documents (passport, visa if required, etc).

### **3.4.2 INTERNATIONAL SOS' DUTIES**

- Provide medical advice and assistance over the phone.
- Recommend whether patient should be treated on vessel or be evacuated directly to the nearest suitable location.
- Liaise with PGS to monitor the situation and coordinate the medical evacuation.

- Confirm to PGS the estimated mission timings, organize medical assessment / admission in the appropriate medical facility and to guarantee all payments on behalf of PGS based on approval from Authorized Person (AP).
- Continue to medically monitor and update PGS at each stage.

## **4. EVACUATION SUPPORT LOGISTICS**

### **4.1 PHASE ONE: PRIMARY EVACUATION**

#### **4.1.1 FACILITY DESTINATION – PREFERRED HEALTH PROVIDERS FOR EMERGENCY CARE**

<b>Provider Name:</b>	Epworth Hospital
<b>Provider Address:</b>	89 Bridge Road Richmond Melbourne VIC Australia 3121
<b>Switchboard Details:</b>	+61 3 9426 6666
<b>Fax Number:</b>	+61 3 9427 0353

<b>Provider Name:</b>	Royal Melbourne Hospital
<b>Provider Address:</b>	Grattan Street, Parkville Melbourne VIC Australia 3052
<b>Switchboard Details:</b>	+61 3 9342 7000
<b>Fax Number:</b>	+61 3 9342 8813

<b>Provider Name:</b>	North West Regional Hospital
<b>Provider Address:</b>	Brickport Road Burnie Tasmania Australia 7320
<b>Switchboard Details:</b>	+61 3 6430 6666
<b>Fax Number:</b>	+61 3 6430 6684

<b>Provider Name:</b>	Mersey Community Hospital
<b>Provider Address:</b>	Mersey Community Hospital, Bass Highway, Latrobe TAS 7307
<b>Switchboard Details:</b>	+61 3 6426 5111

## 4.1.2 TRANSPORTATION

*Notes:*

1. This section includes local transport assets based on or near the site under the control of the client(s) or subcontractors, as well as transport options available through third-party providers which International SOS considers feasible options. Client to please provide necessary detail on how and where transport assets under the client's control or that the client is aware of, can be mobilized to support patients' movement to shore, as well as the capacity of a particular helicopter or boat for a patient or patients.

2. Such options and information must always include details of how, and how often, crew changes and resupply trips are effected, as well as the casualty capacity of the boat or helicopter, their port(s) of origin and destination, their 24-hour access, and whether in the case of a helicopter the cabin dimensions allow for the placement of a victim of illness or injury in an industry-standard Ferno basket stretcher:

Stretcher weight	23 lbs	10 Kg
Stretcher Load Limit	600 lbs	272 Kg
Stretcher Width	24 in	61 cm
Height ( <i>without patient inside</i> )	8 in	19 cm
Stretcher Length	86 in	218 cm

### 4.1.2.1 AIR: ROTARY WING

<b>Aircraft Type / Make / Model:</b>	1x Bell 412 / 1 x Dolphin
<b>Provider Name:</b>	Royal Flying Doctor Service Australia (Melbourne)
<b>Asset Location:</b>	Melbourne
<b>Activation Time(Approximately):</b>	Dependant on if they have other cases on as they are primarily dedicated to public medicine in Australia.  Generally activation time of 2 hours.
<b>Availability (Day / Night Operations):</b>	24/7
<b>Point of Contact:</b>	Sydney Alarm Center
<b>Contact Details:</b>	Tel : +61 2 9372 2468  E-mail: sydopsmed@internationalsos.com

**4.1.2.2 SEA: VESSEL**

<b>Vessel Type:</b>	Support vessel
<b>Name of the Vessel:</b>	Ocean Dynasty
<b>Asset Location:</b>	With Ramform Sterling
<b>Speed:</b>	10 knots
<b>Medical Configuration:</b>	Fit to a stretcher
<b>Capacity:</b>	Approx. 13 persons
<b>Range:</b>	Unlimited
<b>Point of Contact:</b>	Ramform Sterling

**4.1.2.3 GROUND**

Ground ambulance will be arranged for bringing the patient from port to the nearest medical facility.

**4.1.3 OTHER**

**4.1.3.1 AIRPORT INFORMATION**

<b>Airport Name:</b>	Melbourne International Airport
<b>Country:</b>	Australia
<b>ICAO Identification:</b>	YMML
<b>Time Zone (UTC):</b>	UTC+10(+11DT)
<b>Operating Hours:</b>	24 hour operation
<b>Contact Number:</b>	+61 3 9297 1600
<b>Customs and Immigration Hours:</b>	08:45-17:00 (24 hours on request)
<b>Fuel Availability:</b>	Jet A1, without icing inhibitor. 100/130 MIL Spec, low lead, aviation gasoline (BLUE)
<b>Nearest City:</b>	Melbourne
<b>International Clearance Status:</b>	Airport of Entry
<b>Communications:</b>	TWR                      120.5 GND                        121.7

**MEDICAL EMERGENCY RESPONSE PLAN**  
**PGS (PETROLEUM GEO-SERVICES) / RAMFORM STERLING**

	<p>DEP 118.9 129.4 118.9 rte 264 rad N to 092. 129.4 rte 263 rad S to 093</p> <p>CLNC DEL 127.2</p> <p>ATIS 114.1 132.7</p> <p>APP 132.0</p>
<b>Runways:</b>	<p>ID: 09/27, Dimensions: 7500 x 148 feet, Surface: Asphalt, PCN: 079FCWU, ILS: Yes</p> <p>ID: 16/34, Dimensions: 11998 x 148 feet, Surface: Asphalt, PCN: 079FCWU, ILS: Yes</p>

<b>Airport Name:</b>	Melbourne Essendon Airport	Melbourne Moorabbin Airport
<b>Country:</b>	Australia	Australia
<b>ICAO Identification:</b>	YMEN	YMMB
<b>Time Zone (UTC):</b>	UTC+10(+11DT)	UTC+10(+11DT)
<b>Operating Hours:</b>	Not operational 24 hours	Not operational 24 hours
<b>Contact Number:</b>	+61 3 9948 9300	+61 3 9587 3666
<b>Fuel Availability:</b>	Jet A1, without icing inhibitor. 100/130 MIL Spec, low lead, aviation gasoline (BLUE)	Jet A1, without icing inhibitor. 100/130 MIL Spec, low lead, aviation gasoline (BLUE)
<b>Nearest City:</b>	Melbourne	Melbourne
<b>International Clearance Status:</b>	Airport of Entry	Not an Airport of Entry
<b>Communications:</b>	<p>TWR Mon-Fri 2015-1200, Sat. 2100-1200, Sun. 2200-1200. 125.1</p> <p>GND 121.9</p> <p>DEP 118.9 129.4 118.9 rte 264 rad N to 092.</p>	<p>TWR Opr 2200-0800Z++ Thu-118.1 Mon, 2200-123.0 1100Z++ Tue-Wed.</p> <p>GND 119.9</p> <p>MOORABBIN CNTR 120.0</p>

**MEDICAL EMERGENCY RESPONSE PLAN**  
**PGS (PETROLEUM GEO-SERVICES) / RAMFORM STERLING**

	<p>129.4 rte 263 rad S to 093.</p> <p>ATIS 119.8 356.0</p> <p>APP 132.0</p>	<p>CTAF <i>Outside twr 118.1 hrs.</i></p> <p>ATIS <i>Opr 2200- 0800Z++ Thu- 120.9 Mon, 2200- 398.0 1100Z++ Tue- Wed.</i></p>
<b>Runways:</b>	<p>ID: 08/26, Dimensions: 6302 x 148 feet, Surface: Asphalt, PCN: 025FCXT, ILS: Yes</p> <p>ID: 17/35, Dimensions: 4311 x 148 feet, Surface: Asphalt, PCN: 029RCXT, ILS: No</p>	<p>ID: 04/22, Dimensions: 1873 x 60 feet, Surface: Asphalt, PCN: N/A, ILS: No</p> <p>ID: 13R/31L, Dimensions: 3478 x 60 feet, Surface: Asphalt, PCN: N/A, ILS: No</p> <p>ID: 13L/31R, Dimensions: 3783 x 98 feet, Surface: Asphalt, PCN: N/A, ILS: No</p> <p>ID: 17R/35L, Dimensions: 4069 x 60 feet, Surface: Asphalt, PCN: N/A, ILS: No</p> <p>ID: 17L/35R, Dimensions: 4383 x 98 feet, Surface: Asphalt, PCN: N/A, ILS: No</p>

<b>Airport Name:</b>	Burnie-Wynyard Airport	Devonport Airport
<b>Country:</b>	Australia	Australia
<b>ICAO Identification:</b>	YWYY	YDPO
<b>Time Zone (UTC):</b>	UTC+10(+11DT)	UTC+10(+11DT)
<b>Operating Hours:</b>	Not operational 24 hours	Not operational 24 hours
<b>Fuel Availability:</b>	Jet A1, without icing inhibitor. 100/130 MIL Spec, low lead, aviation gasoline (BLUE)	Jet A1, without icing inhibitor. 100/130 MIL Spec, low lead, aviation gasoline (BLUE)
<b>Nearest City:</b>	Burnie	Devonport
<b>International Clearance Status:</b>	Not an Airport of Entry	Not an Airport of Entry
<b>Communications:</b>	MELBOURNE 122.6 CNTR	MELBOURNE 120.7 CNTR

	CTAF 126.9	CTAF 126.9
<b>Runways:</b>	ID: 05/23, Dimensions: 2516 x 98 feet, Surface: Gravel, PCN: 009FAYT, ILS: No  ID: 09/27, Dimensions: 5413 x 98 feet, Surface: Asphalt, PCN: 020FAXT, ILS: No	ID: 06/24, Dimensions: 6030 x 148 feet, Surface: Asphalt, PCN: 029FCXT, ILS: No  ID: 14/32, Dimensions: 2887 x 98 feet, Surface: GRASS OR EARTH NOT GRADED OR ROLLED., PCN: N/A, ILS: No

#### 4.1.3.2 PORT INFORMATION

##### **Port of Melbourne**

Port of Melbourne Corporation  
 Tel: +61 3 9628 7555  
 Fax: +61 3 9628 7550  
 Email: information@portofmelbourne.com

##### **Port of Burnie**

Tasmanian Ports Corporation Pty Ltd  
 Tel: +61 3 6434 7300  
 Fax: +61 3 6434 7373  
 Email: burnie@tasports.com.au

##### **Port of Devonport**

Tasmanian Ports Corporation Pty Ltd  
 Tel: +61 3 6421 4911  
 Fax: +61 3 6421 4988  
 Email: secretary@tasports.com.au

By international consent, a network of Maritime Rescue Coordination Centres is allocated the local responsibility to manage offshore emergencies. Resources that can be deployed may (but do not always) include helicopters (and very occasionally sea-planes), fast rescue craft, and coastguard or naval vessels either in the vicinity or based at the nearest port. The MRCC commander will not usually accept a call from any land-based organization; they require a call to be initiated by the vessel's master, and they reserve the right to define what assistance if any they can or will provide. In some cases they will first ask the caller to exhaust civilian response possibilities, before they will agree to deploy their assets or assets under their control.

## 4.2 PHASE TWO: SECONDARY EVACUATION

### 4.2.1 FACILITY DESTINATION – PREFERRED HEALTH PROVIDERS FOR EMERGENCY CARE

<b>Provider Name:</b>	Royal Hobart Hospital
<b>Provider Address:</b>	48 Liverpool Street Hobart Tas Australia 7000
<b>Switchboard Details:</b>	+61 3 6222 8308

**MEDICAL EMERGENCY RESPONSE PLAN**  
**PGS (PETROLEUM GEO-SERVICES) / RAMFORM STERLING**

<b>Fax Number:</b>	+61 3 6231 3520
--------------------	-----------------

<b>Provider Name:</b>	Launceston General Hospital
<b>Provider Address:</b>	287 - 291 Charles St Launceston AUS
<b>Switchboard Details:</b>	+61 3 6348 7111 +61 3 6348 7886 (Accounts)

**Regional centers of medical excellence:**

<b>Provider Name:</b>	Cairns Base Hospital
<b>Provider Address:</b>	The Esplanade, Cairns QLD, Australia 4870
<b>Switchboard Detail:</b>	+61 7 4050 6333
<b>Fax Number:</b>	+61 7 4050 6767

<b>Provider Name:</b>	Cairns Private Hospital
<b>Provider Address:</b>	1 Upward Street, Cairns QLD, Australia 4870
<b>Switchboard Detail:</b>	+61 74052 5200
<b>Fax Number:</b>	+61 74051 6009

<b>Provider Name:</b>	Townsville Hospital
<b>Provider Address:</b>	100 Angus Smith Drive, Douglas, Townsville QLD, Australia 4810
<b>Switchboard Detail:</b>	+61 7 4796 1111
<b>Fax Number:</b>	+61 7 4796 1231

<b>Provider Name:</b>	Mater Misericordiae Private Hospital
<b>Provider Address:</b>	21 - 37, Fulham Rd, Townsville, Australia 4812
<b>Switchboard Detail:</b>	+61 7 4727 4444

<b>Fax Number:</b>	+61 7 4725 1034
--------------------	-----------------

<b>Provider Name:</b>	Royal Brisbane & Women's Hospital
<b>Provider Address:</b>	Butterfield Street Herston Brisbane Australia 4029
<b>Switchboard Details:</b>	+61 7 3636 8111
<b>Fax Number:</b>	+61 7 3257 1765

<b>Provider Name:</b>	The Wesley Hospital
<b>Provider Address:</b>	451 Coronation Drive Auchenflower Brisbane Australia 4066
<b>Switchboard Details:</b>	+61 7 3232 7000
<b>Fax Number:</b>	+61 7 3371 6834

## 4.2.2 TRANSPORTATION

### 4.2.2.1 AIR: FIXED WING

Below is a detailed overview of available fixed wing assets.

<b>Aircraft Type / Make / Model:</b>	Lear 45 and Lear 36
<b>Asset Location:</b>	Gold Coast and Townsville
<b>Medical Configuration and Medical Team Detail:</b>	One stretcher patient, 2 medical crew and 3 other escorts (or seated patients).
<b>Activation Time(Approximately):</b>	1 – 2 hours
<b>Availability (Day / Night Operations)</b>	Notified at the time of request
<b>Operator:</b>	Careflight QLD
<b>Point of Contact:</b>	Sydney Alarm Center
<b>Contact Details:</b>	Tel: +61 2 9372 2468 Fax: +61 2 9372 2455 E-mail: sydopsmed@internationalsos.com

<b>Aircraft Type / Make / Model:</b>	Dash 8
--------------------------------------	--------

<b>Asset Location:</b>	Cairns
<b>Medical Configuration and Medical Team Detail:</b>	All aircraft have been configured to meet medical requirements.
<b>Activation Time(Approximately):</b>	2 hours or more
<b>Availability (Day / Night Operations):</b>	Notified at the time of request
<b>Provider:</b>	Careflight International (Dash 8 is operated by Skytrans)
<b>Point of Contact:</b>	Sydney Alarm Center
<b>Contact Details:</b>	Tel: +61 2 9372 2468 Fax: +61 2 9372 2455 E-mail: sydopsmed@internationalsos.com

<b>Aircraft Type / Make / Model:</b>	Beechcraft 400
<b>Asset Location:</b>	Darwin
<b>Medical Configuration:</b>	1-2 stretchers
<b>Activation Time(Approximately):</b>	2 – 3 Hours
<b>Availability (Day / Night Operations):</b>	Availability is confirmed at time of request
<b>Operator:</b>	Careflight International
<b>Point of Contact:</b>	Sydney Alarm Center
<b>Contact Details:</b>	Tel: +61 2 9372 2468 Fax: +61 2 9372 2455 E-mail: sydopsmed@internationalsos.com

#### **4.2.2.2 COMMERCIAL CARRIER**

Commercial flights may be used for secondary evacuation if the patient's condition and airline acceptance permit.

Note: Details can be obtained from the relevant International SOS Alarm Center.

#### **4.2.2.3 GROUND**

<b>Vehicle:</b>	Ground Ambulance
<b>Asset Location:</b>	Cairns

<b>Provider Name:</b>	Queensland Ambulance Services (Cairns)
<b>Provider Location:</b>	Cairns
<b>Point of Contact:</b>	Sydney Alarm Center
<b>Contact Details:</b>	Tel : +61 2 9372 2468 Fax : +61 2 9372 2455 E-mail: sydopsmed@internationalsos.com

#### 4.2.3 OTHER:

##### 4.2.3.1 AIRPORT INFORMATION – AIRPORTS OF ENTRY

<b>Name of Airport:</b>	Hobart International Airport
<b>Country:</b>	Australia
<b>ICAO Identification:</b>	YMHB
<b>Time Zone (UTC):</b>	UTC+10(+11DT)
<b>Operating Hours:</b>	24 hour operations
<b>Tower Contact Number:</b>	+61 3 6216 1600
<b>Customs and Immigration Hours:</b>	On request, by prior notice
<b>Fuel Availability:</b>	Jet A1, without icing inhibitor. 100/130 MIL Spec, low lead, aviation gasoline (BLUE)
<b>Nearest City:</b>	Hobart
<b>International Clearance Status:</b>	Airport of Entry
<b>Communications:</b>	TWR 118.1 MELBOURNE CNTR 125.55 <i>Outside twr hrs.</i> CTAF 118.1 <i>Outside twr hrs.</i> ATIS 112.7 128.45
<b>Runways:</b>	ID: 12/30, Dimensions: 7385 x 148 feet,

	Surface: Asphalt, PCN: 063FDWT, ILS: Yes
--	--

<b>Airport:</b>	Cairns International Airport	Townsville International Airport																																										
<b>Country:</b>	Australia	Australia																																										
<b>ICAO Identification:</b>	YBCS	YBTL																																										
<b>Time Zone (UTC):</b>	UTC+10	UTC+10																																										
<b>Operating Hours</b>	24 hour operation	24 hour operation																																										
<b>Contact Number:</b>	+61 7 4080 6703	+61 7 4727 3211																																										
<b>Fuel Availability:</b>	AVGAS Jet	AVGAS Jet																																										
<b>Nearest City:</b>	Cairns	Townsville																																										
<b>International Clearance Status:</b>	Airport of Entry	Airport of Entry																																										
<b>Communications:</b>	<table border="1"> <thead> <tr> <th>Name</th> <th>Type</th> <th>Frequencies</th> </tr> </thead> <tbody> <tr> <td>APP/DE P</td> <td>A/D</td> <td>118.4 126.1</td> </tr> <tr> <td>ATIS</td> <td>ATIS</td> <td>113 131.1</td> </tr> <tr> <td>CLNC DEL</td> <td>CLD</td> <td>121.7</td> </tr> <tr> <td>GND</td> <td>GND</td> <td>121.7</td> </tr> <tr> <td>TWR</td> <td>TWR</td> <td>124.9</td> </tr> </tbody> </table>	Name	Type	Frequencies	APP/DE P	A/D	118.4 126.1	ATIS	ATIS	113 131.1	CLNC DEL	CLD	121.7	GND	GND	121.7	TWR	TWR	124.9	<table border="1"> <thead> <tr> <th>Name</th> <th>Type</th> <th>Frequencies</th> </tr> </thead> <tbody> <tr> <td>APP/DE P</td> <td>A/D</td> <td>126.8 276 307.8 335.8 282.4 Opr 1930-1200Z Mon-Fri; 2000-1200Z Sat, Sun and Hol.</td> </tr> <tr> <td colspan="3">Remarks: Acft rqr to remain on APP CON freq til instr to ctc twr.</td> </tr> <tr> <td>ATIS</td> <td>ATIS</td> <td>133.5 114.1 276</td> </tr> <tr> <td>CLNC DEL</td> <td>CLD</td> <td>128.1 236.1</td> </tr> <tr> <td>BRISBA NE CNTR</td> <td>FSS</td> <td>120.55 Outside twr hrs</td> </tr> <tr> <td colspan="3">Remarks: (on gnd, outside Twr Hrs.)</td> </tr> <tr> <td>GND</td> <td>GND</td> <td>121.8 264.6</td> </tr> </tbody> </table>	Name	Type	Frequencies	APP/DE P	A/D	126.8 276 307.8 335.8 282.4 Opr 1930-1200Z Mon-Fri; 2000-1200Z Sat, Sun and Hol.	Remarks: Acft rqr to remain on APP CON freq til instr to ctc twr.			ATIS	ATIS	133.5 114.1 276	CLNC DEL	CLD	128.1 236.1	BRISBA NE CNTR	FSS	120.55 Outside twr hrs	Remarks: (on gnd, outside Twr Hrs.)			GND	GND	121.8 264.6
Name	Type	Frequencies																																										
APP/DE P	A/D	118.4 126.1																																										
ATIS	ATIS	113 131.1																																										
CLNC DEL	CLD	121.7																																										
GND	GND	121.7																																										
TWR	TWR	124.9																																										
Name	Type	Frequencies																																										
APP/DE P	A/D	126.8 276 307.8 335.8 282.4 Opr 1930-1200Z Mon-Fri; 2000-1200Z Sat, Sun and Hol.																																										
Remarks: Acft rqr to remain on APP CON freq til instr to ctc twr.																																												
ATIS	ATIS	133.5 114.1 276																																										
CLNC DEL	CLD	128.1 236.1																																										
BRISBA NE CNTR	FSS	120.55 Outside twr hrs																																										
Remarks: (on gnd, outside Twr Hrs.)																																												
GND	GND	121.8 264.6																																										

**MEDICAL EMERGENCY RESPONSE PLAN**  
**PGS (PETROLEUM GEO-SERVICES) / RAMFORM STERLING**

		<table border="1"> <tr> <td></td> <td></td> <td>119.45</td> </tr> <tr> <td>MTAF</td> <td>MISC</td> <td>118.3 outside Twr Hrs</td> </tr> <tr> <td colspan="3">Remarks: (nstd to 4500')</td> </tr> <tr> <td>RAAF AIR OPS</td> <td>OPS</td> <td>8974 11235 13206 3032 5687</td> </tr> <tr> <td colspan="3">Remarks: 8974 11235 13206 Opr 2100-0900Z. 3032 5687 8974 Opr 0900-2100Z</td> </tr> <tr> <td>TWR</td> <td>TWR</td> <td>118.3 257.8 276 Opr 1930- 1200Z Mon-Fri; 2000- 1200Z Sat, Sun and Hol.</td> </tr> </table>			119.45	MTAF	MISC	118.3 outside Twr Hrs	Remarks: (nstd to 4500')			RAAF AIR OPS	OPS	8974 11235 13206 3032 5687	Remarks: 8974 11235 13206 Opr 2100-0900Z. 3032 5687 8974 Opr 0900-2100Z			TWR	TWR	118.3 257.8 276 Opr 1930- 1200Z Mon-Fri; 2000- 1200Z Sat, Sun and Hol.
		119.45																		
MTAF	MISC	118.3 outside Twr Hrs																		
Remarks: (nstd to 4500')																				
RAAF AIR OPS	OPS	8974 11235 13206 3032 5687																		
Remarks: 8974 11235 13206 Opr 2100-0900Z. 3032 5687 8974 Opr 0900-2100Z																				
TWR	TWR	118.3 257.8 276 Opr 1930- 1200Z Mon-Fri; 2000- 1200Z Sat, Sun and Hol.																		
<b>Runways:</b>	<p>ID:12/30, Dimensions: 3035 x 60 feet, Surface: ASP, PCN: N/A, ILS: NO</p> <p>ID: 15/33, Dimensions: 10489 x 148 feet, Surface: ASP, PCN: 090FDWU, ILS: YES</p>	<p>ID: 01/19, Dimensions: 7999 x 148 feet, Surface: ASP071FDWT, ILS: YES</p> <p>ID: 07/25, Dimensions: 3609 x 98 feet, Surface: ASP, PCN: 018FAZU, ILS: NO</p>																		

<b>Airport:</b>	Brisbane International Airport
<b>Country:</b>	Australia
<b>ICAO Identification:</b>	YBBN
<b>Time Zone (UTC):</b>	UTC+10
<b>Operating Hours:</b>	24 hour operation
<b>Contact Number:</b>	+61 7 3406 3000
<b>Customs and Immigration Hours:</b>	--
<b>Fuel Availability:</b>	AVGAS Jet
<b>Nearest City:</b>	Brisbane
<b>International Clearance Status:</b>	Airport of Entry

<b>Communications:</b>	APP/DEP	A/D	124.35 124.7 125.6
	Remarks: (124.35 124.7 within 30 NM of Brisbane NW of extn Rwy 01-19 cntrln) (125.6 within 30 NM of Brisbane SE of extn rwy 01-19 cntrln).		
	ATIS	ATIS	113.2 125.5
	CLNC DEL	CLD	118.6
	RADAR	FSS	125.7
	GND	GND	121.7
	TWR	TWR	120.5
<b>Runways:</b>	ID: 01/19, Dimensions: 11680 x 148 feet, Surface: Asphalt, PCN: 108FDWU, ILS: Yes		
	ID: 14/32, Dimensions: 5577 x 98 feet, Surface: Asphalt, PCN: 015FAYT, ILS: No		

#### 4.2.3.2 LOGISTICS, IMMIGRATION AND HEALTH AUTHORITY REQUIREMENTS

It is client's responsibility to prepare patient's travel documents (passport, visa if required, etc.)

## 5. MAIN ORGANIZATIONAL CONTACT DETAILS

### 5.1 PGS (Petroleum Geo-Services)

#### 5.1.1 AUTHORIZED PERSON (AP)

Name:	Job Title:	Primary Numbers:	Secondary Number:	Email Address:
Leif-Inge Iversen	Operations Manager	+65 9627 2765 +65 6735 6413 (F)	+65 6838 1947	leif-inge.iversen@pgs.com
Johnny Leknes	Acquisition Manager	+65 9636 1898 +65 6735 6413 (F)	+65 6735 6411	johnny.leknes@pgs.com
Tony Robertsen	HSE Manager	+65 9711 3177 +65 6735 6413 (F)	+65 6735 6411	tony.robertsen@pgs.com

The company / caller will need to decide and inform Intl SOS at the time of any emergency call EITHER whether the company wish to wait until the company's insurers give authorization for costs

to be incurred in assisting the patient OR whether the company will give direct authorization to Intl SOS: to ensure there is no delay caused by waiting for insurance approvals.

**5.1.2 OTHER COMPANY CONTACTS:**

<b>Office Contact Details</b>	
<b>Head office telephone number:</b>	+47 6752 6400
<b>Head office facsimile number:</b>	+47 6752 6464
<b>Regional office telephone number:</b>	+65 6735 6411
<b>Regional office facsimile number:</b>	+65 6735 6413
<b>Vessel Contact Details</b>	
<b>Vessel contact numbers:</b>	+870 764 948 712 or 715 Radio: VHF MARINE CH 16 Call Sign: C6YE5 Vessel Manager: Neil Jackson / Phil Shriner Tel: +47 6751 5575
<b>Vessel facsimile number:</b>	+870 764 903 852
<b>Vessel Email Address:</b>	stepc@pgs.com

**5.2 International SOS**

**5.2.1 OPERATIONAL ESCALATION:**

<b>Name</b>	<b>Contact Details</b>
<b>Regional Medical Director on Duty:</b>	+61 2 9372 2468

**5.2.2 ACCOUNT MANAGEMENT:**

<b>Name</b>	<b>Contact Details</b>
<b>Emma Graeme – Coutts, Primary Account Manager:</b>	Tel: +44 1224 218557 Mob: +44 7725 960400 Fax: +44 1224 218517 After hours: +44 20 8762 8008 Email: <a href="mailto:emma.graeme-coutts@internationalsos.com">emma.graeme-coutts@internationalsos.com</a>

## 6. APPENDIX I

# MEDICAL REPORT FORM: PGS (Petroleum Geo-Services)

Send to +61 2 9372 2455

**SITE NAME:** \_\_\_\_\_ **LOCATION / HEADING / COORDINATES:** \_\_\_\_\_

**PATIENT PASSPORT No.:** \_\_\_\_\_ **NATIONALITY:** \_\_\_\_\_ **BIRTH DATE:** \_\_\_\_\_

\_\_\_\_\_

**ALLERGIES:** \_\_\_\_\_ **PAST ILLNESS:** \_\_\_\_\_ **PAST SURGERY:** \_\_\_\_\_

## CASUALTY ASSESSMENT FORM

Surname	:	
First Name	:	
Company	:	
Sex	:	
Date of Birth	:	
Date	:	
Onset Time	:	

PRIMARY SURVEY		Time:
Airway	Clear	Obstructed
Breathing	Spontaneous	Difficulty
C. Spine	Normal	Possible Injury
Circulation/ Haemorrhage	External None/Slight Moderate Severe	Internal Possible
Disability respond to	Alert Visual Stimuli	Pain Unresponsive

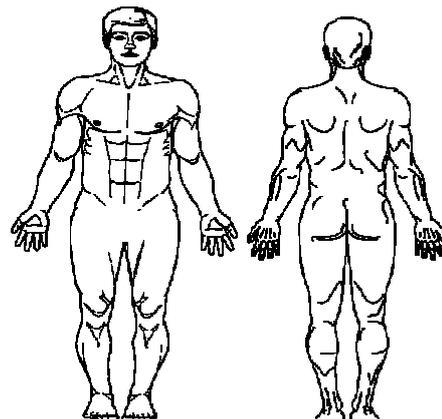
PRIMARY MANAGEMENT		
Airway	Oropharyngeal C/Thyrotomy Oxygen	Nasal ET Tube Suction
Breathing	Ventilated	Chest Drain
C. Spine	Sand Bags	Stiff Neck
Circulation	Cannula Size: Rt.....	Lt. ....
IV Fluid	Ringers / Saline Colloid	Vol. Time ..... .....

SECONDARY SURVEY - Glasgow Coma Scale		
Eye Opening	Spontaneous	4
	To voice	3
	To pain	2
	None	1
Best Verbal Response	Oriented	5
	Confused	4
	Inappropriate	3
	Incomprehensible	2
	None	1
Motor Response	Obeys command	6
	Localises pain	5
	Withdrawal (pain)	4
	Flexion (pain)	3
	Extension (pain)	2
	None	1

Pupils	React	R	L
	Constricted	R	L
	Normal	R	L
	None	R	L
Coma Score	Time: ..... Score: .....		
Comments			
SECONDARY MANAGEMENT			
Analgesia	Drug	Dose	Time
		.....	.....
Splinting	Franc Straps	KED	
	Traction	Inflatable	
	Box	Others (specify)	

OBSERVATIONS	Time:
Respiratory Rate:	
Oxygen Saturation (Sa O <sub>2</sub> ):	
Blood Pressure (mmHg):	
Pulse Rate (per min):	
Body Temperature (deg F or deg C):	

### EXPOSURE / INJURY



Notes:

C\* = Closed Fracture

B = Burn (shade the area)

L = Laceration

E = Eccymosis (bruising)

O\* = Open Fracture

F = Foreign Body

A = Abrasion

**Medic's Working Diagnosis:** \_\_\_\_\_

**ESCORT REQUIRES MEDICAL ESCORT** YES / NO

**PATIENT REQUIRES WHEELCHAIR** YES / NO

**PATIENT REQUIRES STRETCHER** YES / NO

**PATIENT INSURED WITH INTL.SOS** YES / NO

**OTHER INSURANCE NAME:** \_\_\_\_\_

## **9.7 International Terrestrial Reference Frame (ITRF) to GDA94 Coordinate Transformations**



## **International Terrestrial Reference Frame (ITRF) to GDA94 Coordinate Transformations**

*John Dawson and Jim Steed*

*Geodesy Program  
Division of National Mapping  
Geoscience Australia*

**version 02.12.2002**

### **1. Overview**

This document provides a practical solution to the transformation of International Terrestrial Reference Frame (ITRF) coordinates into GDA94 coordinates. GDA94 is coordinate datum based on ITRF92 at the fixed epoch of 1994.0. ITRF coordinates will in general differ from GDA94 coordinates for two main reasons, namely tectonic motion of the Australian landmass and reference frame differences. Tectonic motion of the Australian landmass is approximately 7cm/year in the NNE direction. Differences between the ITRF92 coordinate reference frame and the ITRF2000 are at the several cm in magnitude. A standard 7-parameter transformation can adequately model these differences at the cm level, provided the 7-parameter transformation parameters are regularly updated to reflect the tectonic motion. A slightly more complex 14-parameter transformation (7-parameters + their rates) can be used as a better long-term practical solution to these coordinate transformations. A 14 parameter transformation parameter allow users to map a 7 parameter transformation to any epoch of interest.

Users of IGS products please note the following. Since 2 December 2001 all International GPS Service (IGS) Products are aligned to ITRF2000. Users transforming coordinates derived from IGS products after 2 December 2001 are provided with additional high quality transformation parameters that referred to as ITRF2000(IGS).

This document provides the 14-Parameter transformations from ITRF2000, ITRF2000(IGS), ITRF97 and ITRF96 to GDA94. This document supersedes version 31.08.2001 of the same title.

## 2. Important Note

There are two different ways of applying the sign conventions for the rotations. In both cases the sign convention is the same (a positive rotation is an anti-clockwise rotation, when viewed along the positive axis towards the origin) but:

- a) the International Earth Rotation Service (IERS) assumes the rotations to be of the position around the coordinate axes, while
- b) the method historically used in Australia assumes the rotations to be of the coordinate axes.

The only difference in the transformation formula is a change in the signs of the angles (and angle rates) in the rotation matrix. If the sign of the rotation parameters and the formulae used are consistent the correct results will be obtained. In this document the method historically used in Australia (b) is adopted.

## 3. The 7-Parameter Transformation

The 7-Parameter transformation between an input set of ITRF coordinates and GDA94 can be described by equation (1). Where  $\begin{bmatrix} x_{GDA94} & y_{GDA94} & z_{GDA94} \end{bmatrix}^T$  are the transformed GDA94 Earth centred cartesian coordinates (metres),  $\begin{bmatrix} x_{ITRF} & y_{ITRF} & z_{ITRF} \end{bmatrix}^T$  are the input ITRF Earth centred Cartesian coordinates (metres),  $d_x$ ,  $d_y$ ,  $d_z$  are translations (metres),  $r_x$ ,  $r_y$ ,  $r_z$  are rotations (radians) and  $S_c$  is a scale.

$$\begin{bmatrix} x_{GDA94} \\ y_{GDA94} \\ z_{GDA94} \end{bmatrix} = \begin{bmatrix} d_x \\ d_y \\ d_z \end{bmatrix} + (1 + s_c) \times \begin{bmatrix} 1 & r_x & -r_y \\ -r_x & 1 & r_z \\ r_y & -r_z & 1 \end{bmatrix} \begin{bmatrix} x_{ITRF} \\ y_{ITRF} \\ z_{ITRF} \end{bmatrix} \quad (1)$$

#### 4. The 14-Parameter Transformation

The 14-Parameter transformation between an input set of ITRF coordinates and GDA94 can be described by equation (2). Where  $\begin{bmatrix} x_{GDA94} & y_{GDA94} & z_{GDA94} \end{bmatrix}^T$  are the transformed GDA94 Earth centred cartesian coordinates (metres),  $\begin{bmatrix} x_{ITRF} & y_{ITRF} & z_{ITRF} \end{bmatrix}^T$  are the input ITRF Earth centred cartesian coordinates (metres),  $d_x, d_y, d_z, \dot{d}_x, \dot{d}_y, \dot{d}_z$  are translations and their rates (metres, metres/year),  $r_x, r_y, r_z, \dot{r}_x, \dot{r}_y, \dot{r}_z$  are rotations and their rates (radians, radians/year) and  $s_c, \dot{s}_c$  is a scale and its rate (/year). The parameter  $t_0$  (years) is the reference epoch which for this document is 2000.0,  $t$  (years) is the reference epoch of the input ITRF coordinates.

$$\begin{bmatrix} x_{GDA94} \\ y_{GDA94} \\ z_{GDA94} \end{bmatrix} = \begin{bmatrix} d_x + \dot{d}_x \times (t - t_0) \\ d_y + \dot{d}_y \times (t - t_0) \\ d_z + \dot{d}_z \times (t - t_0) \end{bmatrix} + \{1 + s_c + \dot{s}_c \times (t - t_0)\} \times \tilde{R} \times \begin{bmatrix} x_{ITRF} \\ y_{ITRF} \\ z_{ITRF} \end{bmatrix} \quad (2)$$

$$\tilde{R} = \begin{bmatrix} 1 & \{r_x + \dot{r}_x \times (t - t_0)\} & -\{r_y + \dot{r}_y \times (t - t_0)\} \\ -\{r_x + \dot{r}_x \times (t - t_0)\} & 1 & \{r_z + \dot{r}_z \times (t - t_0)\} \\ \{r_y + \dot{r}_y \times (t - t_0)\} & -\{r_z + \dot{r}_z \times (t - t_0)\} & 1 \end{bmatrix}$$

## Appendix A 14 Parameter Transformations

Table A.1 ITRF2000 to GDA94 using 14-Parameter transformation. Note unit changes from equation (1) and (2) for the rotations and scale parameters and their rates.

$t$ (years)	$d_x$ (metres)	$d_y$ (metres)	$d_z$ (metres)	$r_x$ (as)	$r_y$ (as)	$r_z$ (as)	$s_c$ (ppm)
2000.00	-0.0761	-0.0101	0.0444	0.008765	0.009361	0.009325	0.007935
/year	0.0110	-0.0045	-0.0174	0.001034	0.000671	0.001039	-0.000538

Table A.2 ITRF2000(IGS) to GDA94 using 14-Parameter transformation. Note unit changes from equation (1) and (2) for the rotations and scale parameters and their rates.

$t$ (years)	$d_x$ (metres)	$d_y$ (metres)	$d_z$ (metres)	$r_x$ (as)	$r_y$ (as)	$r_z$ (as)	$s_c$ (ppm)
2000.00	-0.0663	-0.0050	0.0426	0.008814	0.009127	0.009042	0.007936
/year	0.0049	0.0039	0.0049	0.001616	0.001200	0.001013	0.000096

Table A.3 ITRF97 to GDA94 using 14-Parameter transformation. Note unit changes from equation (1) and (2) for the rotations and scale parameters and their rates.

$t$ (years)	$d_x$ (metres)	$d_y$ (metres)	$d_z$ (metres)	$r_x$ (as)	$r_y$ (as)	$r_z$ (as)	$s_c$ (ppm)
2000.00	-0.2088	0.0119	0.1855	0.012059	0.013639	0.011825	0.004559
/year	-0.0220	0.0049	0.0169	0.002040	0.001782	0.001697	-0.001090

Table A.4 ITRF96 to GDA94 using 14-Parameter transformation. Note unit changes from equation (1) and (2) for the rotations and scale parameters and their rates.

$t$ (years)	$d_x$ (metres)	$d_y$ (metres)	$d_z$ (metres)	$r_x$ (as)	$r_y$ (as)	$r_z$ (as)	$s_c$ (ppm)
2000.00	-0.0140	0.0431	0.2010	0.012464	0.012013	0.006434	0.024607
/year	0.0411	0.0218	0.0383	0.002542	0.001431	-0.000234	0.005897

## Appendix B Sample Calculation

**INPUT** : ITRF2000 at 1 January 2002 (GRS80 ellipsoid) :-

Cartesian X, Y, Z	-4052052.048	4212836.105	-2545105.587
Longitude, Latitude, Height	133 53 7.8574	-23 40 12.4314	603.287

The computation can be undertaken using equation (2) and the parameters in Table A.1, where  $t_0 = 2000.0$  and  $t = 2002.0$ . Alternatively, using Table A.1 the 7-Parameter transformation parameters can be computed for epoch 2002.0 and equation (1) applied, for example :-

$$d_x = -0.0761 + (2002.0 - 2000.0) \times 0.0110 = -0.0541$$

$$d_y = -0.0101 + (2002.0 - 2000.0) \times -0.0045 = -0.0191$$

$$d_z = 0.0444 + (2002.0 - 2000.0) \times -0.0174 = 0.0096$$

$$r_x = 0.008765 + (2002.0 - 2000.0) \times 0.001034 = 0.010833$$

$$r_y = 0.009361 + (2002.0 - 2000.0) \times 0.000671 = 0.010703$$

$$r_z = 0.009325 + (2002.0 - 2000.0) \times 0.001039 = 0.011403$$

$$s_c = 0.007935 + (2002.0 - 2000.0) \times -0.000538 = 0.006859$$

$t$ (years)	$d_x$ (metres)	$d_y$ (metres)	$d_z$ (metres)	$r_x$ (as)	$r_y$ (as)	$r_z$ (as)	$s_c$ (ppm)
2002.00	-0.0541	-0.0191	0.0096	0.010833	0.010703	0.011403	0.006859

The rotation and scale units can be converted ready for equation (1) or (2) using the following :-

$$1 \text{ as} = 1 \text{ arc second} = 1 \times \frac{\pi}{60 \times 60 \times 180} \text{ radians} = 0.000004848 \text{ radians}$$

$$1 \text{ ppm} = 1 \text{ part per million} = 1 \times \frac{1}{1,000,000} \text{ parts} = 0.000001 \text{ parts}$$

**OUTPUT** : GDA94 (GRS80 ellipsoid) :-

Cartesian X, Y, Z	-4052051.765	4212836.205	-2545106.027
Longitude, Latitude, Height	133 53 7.8478	-23 40 12.4461	603.350