

rxt	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10010
	Date:	October 2010

Final Seismic QC Report

M/V Sanco Spirit & M/V Vikland

4D 4C OBC Seismic Survey

North Sea, Norway, Block 15/9

For



Project Number: ST10010 Volve



	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Prepared by:</td><td style="width: 50%;">RXT QC Department</td></tr> <tr> <td>Client:</td><td>Statoil</td></tr> <tr> <td>Project Number:</td><td>RXT10010</td></tr> <tr> <td>Date:</td><td>October 2010</td></tr> </table>	Prepared by:	RXT QC Department	Client:	Statoil	Project Number:	RXT10010	Date:	October 2010
Prepared by:	RXT QC Department								
Client:	Statoil								
Project Number:	RXT10010								
Date:	October 2010								

Table of Contents

FINAL SEISMIC QC REPORT	1
1 GENERAL INFORMATION	6
1.1 VESSEL AND PROCESSING SYSTEM SPECIFICATIONS	6
1.2 DEPARTMENT PERSONNEL	6
2 SURVEY DETAILS.....	7
2.1 START-UP RECORDING PARAMETER TEST.....	7
2.2 SURVEY LOCATION AND LAYOUT.....	7
2.3 SOURCE AND GROUND STATION NUMBERING	8
2.4 FFID, CHANNEL AND SENSOR NUMBERING	9
2.5 FIELD PARAMETERS	9
2.6 SOURCE DETAILS.....	11
2.7 FAR FIELD SIGNATURE	14
2.8 VSO SYSTEM IMPULSE RESPONSE	16
3 SEISMIC QC METHOD.....	18
3.1 OVERVIEW.....	18
3.2 FLOW DIAGRAM	18
4 VSO SENSOR ROTATION	19
4.1 INTRODUCTION.....	19
4.1.1 Glossary of Terms	19
4.1.2 The 3C Sensor.....	19
4.1.3 The Right Hand Rule	20
4.1.4 VSO Acquisition Overview.....	21
4.1.5 The Recording Buoy	21
4.1.6 The Data Bucket Unloader (DBU)	22
4.1.7 VSO Data Flow Summary.....	23
4.2 VSO ROTATION ATTRIBUTES.....	24
4.2.1 VOA	24
4.2.2 Vector Fidelity	24
4.2.3 HOR	25
4.2.4 HPR	26
4.3 VERTICAL ORIENTATION ROTATION.....	26
4.3.1 Frames of Reference	26
4.3.2 The VOR Transform Matrix.....	28
5 ONLINE QC	29
5.1 VSO QC	29
5.1.1 Level 1 VSOQC	30
5.1.2 Level 2 VSOQC	31
5.1.3 Level 3 VSOQC	32
5.2 SOURCE QC	33
5.2.1 Online Gun QC and Reporting.....	33
5.2.2 End of Line Near Field QC.....	34
5.2.3 Gun Volume Verification (Bubble Test)	36
5.3 INSTRUMENT TESTS	37
6 DBU PROCESS	38
6.1 RAW DATA RETRIEVAL/TRANSCRIPTION (DBU).....	38
7 OFFLINE QC	40
7.1 DBU (DATA BUCKET UNLOADER) DATA INPUT.....	40
7.2 DATA TRACE ACCOUNTING	40
7.2.1 Initial Trace Accounting	40

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

7.2.2	<i>Missing Shot Data Check</i>	41
7.3	QC DATA ANALYSIS	42
7.3.1	<i>Frequency Analysis</i>	42
7.3.2	<i>Bad Shot Identification.....</i>	43
7.3.3	<i>Bad Channel Identification.....</i>	44
7.3.4	<i>Polarity QC.....</i>	45
7.3.5	<i>Brute Stacks.....</i>	47
7.3.6	<i>RMS Decay.....</i>	49
7.4	GEOMETRY (SOURCE AND RECEIVER POSITIONS) AND GENERAL QC.....	50
7.4.1	<i>RL Quadrant Stack QC.....</i>	50
7.4.2	<i>Receiver Location Predictor.....</i>	52
7.4.3	<i>Source Position QC</i>	53
7.4.4	<i>Client final SEGY tapes</i>	54
7.4.5	<i>Client OBC SEGY Header Description.....</i>	54
7.4.6	<i>Navigation merge Flow</i>	54
7.4.7	<i>Client SEGY Tape Verification.....</i>	55
7.4.8	<i>Post Plot.....</i>	55
7.4.9	<i>Trace Accounting</i>	55
7.4.10	<i>Receiver line depth QC.....</i>	56
7.4.11	<i>Aerial Plot Water Depth QC (Source and receiver).....</i>	57
7.4.12	<i>Fold QC.....</i>	59
7.4.13	<i>Limited Offset 3D Cube</i>	60
8	SUMMARY OF SEISMIC QC DELIVERABLES	63
8.1	<i>FINAL NAVIGATION MERGED SEGY TAPES.....</i>	63
8.2	<i>ACQUISITION LOGS</i>	63
8.3	<i>SEGY LOG.....</i>	64
8.4	<i>TOC FILES</i>	64
8.5	<i>EDIT FILES.....</i>	64
8.6	<i>NEAR FIELD HYDROPHONE DATA.....</i>	64
8.7	<i>BRUTE STACKS (SEGY FORMAT)</i>	64
8.8	<i>SEISMIC QC DISPLAYS</i>	64
8.9	<i>NAVIGATION QC DISPLAYS.....</i>	65
8.10	<i>DATA COMPLETENESS QC DISPLAYS.....</i>	65
9	SEISMIC QC REVIEW	66
9.1	<i>SEISMIC INTERFERENCE</i>	66
9.2	<i>SUPPLY VESSEL NOISE</i>	68
9.3	<i>MAERSK INSPIRER AND NAVION SAGA NOISE</i>	69
9.4	<i>VIKLAND NOISE.....</i>	71
10	DATA SHIPMENTS	72
11	APPENDICES	72
11.1	<i>PROCESSING HARDWARE</i>	72
11.2	<i>FAR FIELD SIGNATURE LISTING.....</i>	73
11.3	<i>VSO SYSTEM IMPULSE RESPONSE LISTING</i>	76
11.4	<i>DBU SEGY HEADER</i>	92
11.5	<i>VOLVE OBC SEGY EBBCDIC HEADER – EXAMPLE.....</i>	93
11.6	<i>SEGY BINARY HEADER – EXAMPLE.....</i>	94
11.7	<i>VOLVE OBC SEGY OUTPUT TRACE HEADER.....</i>	94
11.8	<i>EXAMPLE ACQUISITION LOG</i>	96
11.10	<i>NAVMERGED SEGY TAPE LISTING.....</i>	98
11.11	<i>DELIVERABLES LIST</i>	98
11.12	<i>WATER DEPTHS AND TIDAL CORRECTIONS DIAGRAM (HEADER SPECIFICATIONS).....</i>	100
11.13	<i>SOURCE SPS FILE, HEADER EXAMPLE</i>	101
11.14	<i>RECEIVER SPS FILE, HEADER EXAMPLE</i>	103
11.15	<i>RELATIONAL SPS FILE, HEADER EXAMPLE.....</i>	105

11.16 SUMMARY OF NOISE AFFECTED LINES 107

List of Figures

FIGURE 1. SURVEY AREA	8
FIGURE 2. PROJECT LAYOUT.....	8
FIGURE 3. GUN ARRAY DIAGRAM	11
FIGURE 4. GUN ARRAY LISTING	12
FIGURE 5. SOURCE DIRECTIVITY PLOTS	14
FIGURE 6 FIELD SIGNATURE	15
FIGURE 7. FAR FIELD SIGNATURE AMPLITUDE SPECTRUM.....	15
FIGURE 8. DERIVATIVE FAR FIELD SIGNATURE.....	16
FIGURE 9. DERIVATIVE FAR FIELD SIGNATURE AMPLITUDE SPECTRUM	16
FIGURE 10. HYDROPHONE VSO SYSTEM IMPULSE RESPONSE	17
FIGURE 11. ACCELEROMETER VSO SYSTEM IMPULSE RESPONSE.....	17
FIGURE 12. VSO DATA FLOW	18
FIGURE 13. VSO 3C NODE ORIENTATION	19
FIGURE 14. THE RELATIVE ORIENTATION OF THE 3 SENSORS CORRESPONDING TO THE RIGHT HAND RULE.	20
FIGURE 15. VSO BUOY BASED ACQUISITION.....	21
FIGURE 16. VSO VESSEL-BUOY COMMUNICATION	22
FIGURE 17. VSO DATA FLOW SCHEMATIC.....	23
FIGURE 18. DEPICTION OF THE 3C SENSOR AND THE VOR PROCESS.....	24
FIGURE 19. VECTOR FIDELITY AS DEMONSTRATED BY VECTOR SUM.....	25
FIGURE 20. 3 ACQUISITION SCENARIOS REFERENCING ALL NODES IN THE CABLE FRAME.....	27
FIGURE 21. APPLICATION OF HPR: CABLE TO PROSPECT FRAME.....	27
FIGURE 22. REPRESENTATIONS OF PITCH ROLL AND YAW.....	28
FIGURE 23. LEVEL 1 ONLINE ATTRIBUTE ANALYSIS DISPLAY	31
FIGURE 24. ONLINE RMS ATTRIBUTE ANALYSIS DISPLAYS (SEQUENCE 0044).....	32
FIGURE 25. EXAMPLE LEVEL 3 RAW SHOT RECORD WITH LOW CUT FILTER AND TIME VARIANT GAIN.	33
FIGURE 26. BIG SHOT HYD REAL TIME SCREEN DISPLAY	34
FIGURE 27. SPLICED NEAR FIELD DISPLAY FOR AIR LEAK DETECTION, SEQUENCE 109 STRING3	35
FIGURE 28. AMPLITUDE COMPARISONS.	35
FIGURE 29. AUTO FIRE DETECTION DISPLAY, SEQUENCE 109. THE FIRST SHOT HAS NO PREVIOUS SHOT TO COMPARE.....	36
FIGURE 30. BUBBLE PERIOD VERSUS CUBE ROOT OF VOLUME FOR ALL GUNS.....	37
FIGURE 31. CONFIGURATION OF DATA RETRIEVAL SYSTEM	38
FIGURE 32. VOR CORRECTION	39
FIGURE 33. HOR CORRECTION	39
FIGURE 34. MISSING SHOT POINT DISPLAY.....	41
FIGURE 35. ZOOMED DISPLAY SHOWING MISSING SHOTS	42
FIGURE 36. COMMON RECEIVER FX DISPLAY OF HYDROPHONE AND VERTICAL ACCELEROMETER..	42
FIGURE 37. COMMON RECEIVER FX DISPLAY OF INLINE AND XLINE ACCELEROMETER	43
FIGURE 38. COMMON SHOT FX DISPLAY OF HYDROPHONE AND VERTICAL ACCELEROMETER	43
FIGURE 39. COMMON SHOT FX DISPLAY OF INLINE AND XLINE ACCELEROMETER	43
FIGURE 40. DECIMATED HYDROPHONE AND VERTICAL COMPONENT SHOT GATHERS. THE BAR GRAPH AT THE TOP OF THE DISPLAY IS USED TO INDICATE THE PRODUCTION RANGE (RED) AND FIRST OR LAST SHOTPOINT (GREEN). A BUOY TIMING ERROR CAN ALSO BE SEEN TOWARDS THE LEFT ON THE DISPLAY. EXAMPLE FROM RECEIVER LINE 1152220.	44
FIGURE 41. HYDROPHONE (TOP), FOLLOWED BY VERTICAL, IL AND XL COMPONENT RECEIVER GATHERS. A DEAD ACCELEROMETER NODE IS PRESENT, RL1150780.	45
FIGURE 42. POLARITY QC VIA RECEIVER STACK	46
FIGURE 43. HYDROPHONE COMPONENT BRUTE STACK. RECEIVER LINE 1150780.....	47
FIGURE 44. VERTICAL COMPONENT BRUTE STACK. RECEIVER LINE 1150780.	48
FIGURE 45. DUAL SENSOR (HY + VT) SUMMED BRUTE STACK. RECEIVER LINE 1150780.....	48

	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Prepared by:</td><td style="padding: 2px;">RXT QC Department</td></tr> <tr> <td style="padding: 2px;">Client:</td><td style="padding: 2px;">Statoil</td></tr> <tr> <td style="padding: 2px;">Project Number:</td><td style="padding: 2px;">RXT10010</td></tr> <tr> <td style="padding: 2px;">Date:</td><td style="padding: 2px;">October 2010</td></tr> </table>	Prepared by:	RXT QC Department	Client:	Statoil	Project Number:	RXT10010	Date:	October 2010
Prepared by:	RXT QC Department								
Client:	Statoil								
Project Number:	RXT10010								
Date:	October 2010								

FIGURE 46. INLINE CONVERTED WAVE BRUTE STACK. RECEIVER LINE 1150780.....	49
FIGURE 47. EXAMPLE RMS DECAY. THE DECAY DATA IS DISPLAYED ON THE LEFT AND THE RMS RUNNING AVERAGE FOR ALL FOUR COMPONENTS ARE ON THE RIGHT. THE LIGHT BLUE CURVE IS NODES 1-120, YELLOW IS NODES 121-240, DARK BLUE IS THE ENTIRE CABLE NODES 1-240... 50	
FIGURE 48. COMBINED RMS DECAY PLOT FOR ALL SEQUENCES.....	50
FIGURE 49. QUADRANT DEFINITION.....	51
FIGURE 50. QUADRANT STACK QC DISPLAY, RL1252700. INDICATED ERRORS ARE LESS THAN 1M.	52
FIGURE 51. OUTPUT FROM VISTA'S RLP TOOL FROM RL1252700. PREDICTED ERROR LESS THAN 1M. THE LEFT SIDE OF THE FIGURE IS A POST PLOT SHOWING DIRECTION OF ERROR ON A GROUND STATION BASIS AND THE RIGHT SIDE IS A BULL'S EYE DIAGRAM SHOWING OVERALL ERROR.....	52
FIGURE 52. SOURCE POSITION QC (NO SOURCE POSITION ERRORS)	53
FIGURE 53. SOURCE POSITION QC (INDICATING SOURCE POSITION ERROR).....	54
FIGURE 54. XY POST PLOT EXTRACTED FROM CLIENT SEGY TAPE HEADERS, RL1253980.....	55
FIGURE 55. RECEIVER WATER DEPTH QC, RL1253660.....	56
FIGURE 56. SOURCE DEPTH QC.....	57
FIGURE 57. SOURCE ELEVATION (TIDE) QC	58
FIGURE 58. WATER DEPTH AT SOURCE POSITION QC.....	58
FIGURE 59. RECEIVER ELEVATION QC	59
FIGURE 60. WATER DEPTH AT RECEIVER.....	59
FIGURE 61. FOLD DISPLAY	60
FIGURE 62. LIMITED OFFSET CUBE TIME SLICE – 2500MS	61
FIGURE 63. LIMITED OFFSET CUBE INLINE DISPLAY. INLINE 1141.....	61
FIGURE 64. LIMITED OFFSET CUBE CROSSLINE DISPLAY. CROSSLINE 5623.....	62
FIGURE 65. RMS DISPLAY SHOWING SEISMIC INTERFERENCE, SEQUENCE 86	66
FIGURE 66. SHOT RECORDS SHOWING SEISMIC INTERFERENCE, SEQUENCES 85 AND 86	67
FIGURE 67. RMS DISPLAY SHOWING SUPPLY VESSEL NOISE UP TO 60 μ B AFFECTING ALL CABLES... 68	
FIGURE 68. RMS DISPLAY SHOWING NOISE FROM MAERSK INSPIRER ON THE RIGHT OF THE DISPLAY	69
FIGURE 69. RMS DISPLAY SHOWING NOISE FROM NAVION SAGA ON THE LEFT OF THE DISPLAY.....	70
FIGURE 70. SHOT RECORDS SHOWING NOISE FROM NAVION SAGA	70
FIGURE 71. RMS DISPLAY SHOWING VESSEL NOISE FROM THE VIKLAND	71
FIGURE 72. EXAMPLE OVERVIEW SHEET, ACQUISITION LOG FOR SEQUENCE 0120.....	96
FIGURE 73. EXAMPLE LINE LOG SHEET, ACQUISITION LOG SEQUENCE 0120.....	97
FIGURE 74. EXAMPLE BAD CHANNEL LISTING, ACQUISITION LOG, SEQUENCE 0120.....	97

	Prepared by:	RXT QC Department
Client:	Statoil	
Project Number:	RXT10010	
Date:	October 2010	

1 GENERAL INFORMATION

1.1 Vessel and Processing System Specifications

Seismic data QC within RXT is handled in two phases, online QC and offline QC. Online QC is defined as that QC which happens during the recording phase or immediately after. This was handled by the Instrument department onboard the M/V Vikland. Offline QC begins upon retrieval of the data bucket and continues through final tape delivery to the client. The Seismic QC department onboard M/V Vikland handled the offline QC.

Seismic acquisition commenced on the Volvo 4D-4C survey on the 28th September 2010 after a transit from the previous survey for Statoil at the Njord field.

The Seismic QC Department was equipped with some of the best hardware and software technology available for this type of Ocean Bottom Cable acquisition. High capacity media devices were employed in order to meet the large volume of data acquired (Appendix 11.1). Bulk data handling was achieved using the Data Bucket Unloader or DBU (from Ion), while processing and geometry QC were accomplished using the Vista package from GEDCO.

1.2 Department Personnel

The Seismic QC Department consisted of one Chief and two to three QC Geophysicists per rotation. Seismic QC activities were ongoing 24 hours per day.

M/V Vikland

Rotation A		Rotation B	
Chief Seismic QC	David Woollatt	Chief Seismic QC	Kelly Redden
Chief Seismic QC	Chamam Zulkarnen	Chief Seismic QC	Alastair Fergusson
Senior Seismic QC	Atanas Vasilev	Senior Seismic QC	Ken Chapman
Seismic QC	Taylor Patterson		

Table 1. Seismic QC Personnel offshore

Onshore RXT QC and Marketing Geophysicist, Anthony Mathieson, liaised with the client in order to meet the survey's Geophysical objectives.

2 SURVEY DETAILS

2.1 Start-up Recording Parameter Test

The VSO hydrophone has an adjustable pre-Amp recording gain parameter that should be tested prior to the commencement of any survey. The dB gain settings available for this parameter vary every 6dB between 0db and 36dB. The pre-Amp gain setting controls the level of gain applied to the hydrophone prior to being recorded to disk. A pre-Amp gain setting too high will lead to the direct arrivals being overdriven which will severely impact the quality of the hydrophone – geophone summation testing. A pre-Amp gain setting too low will reduce the amplitude resolution attainable for the survey thereby impacting the overall seismic quality.

The hydrophone gain parameter was set at 6dB for the Volve survey after discussion with Statoil and after initial testing done on the previous Statoil survey in Njord.

2.2 Survey Location and Layout

The Volve survey was located in the Norwegian sector of the North Sea, in Block 15/9.

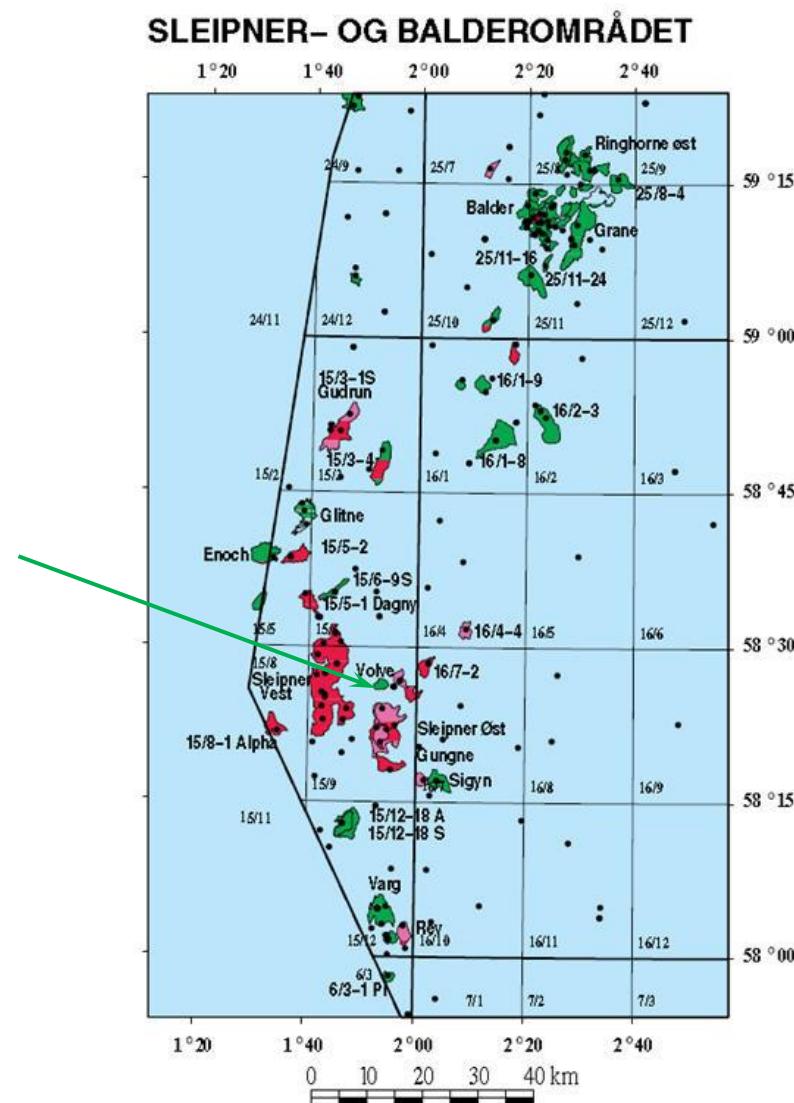


Figure 1. Survey Area

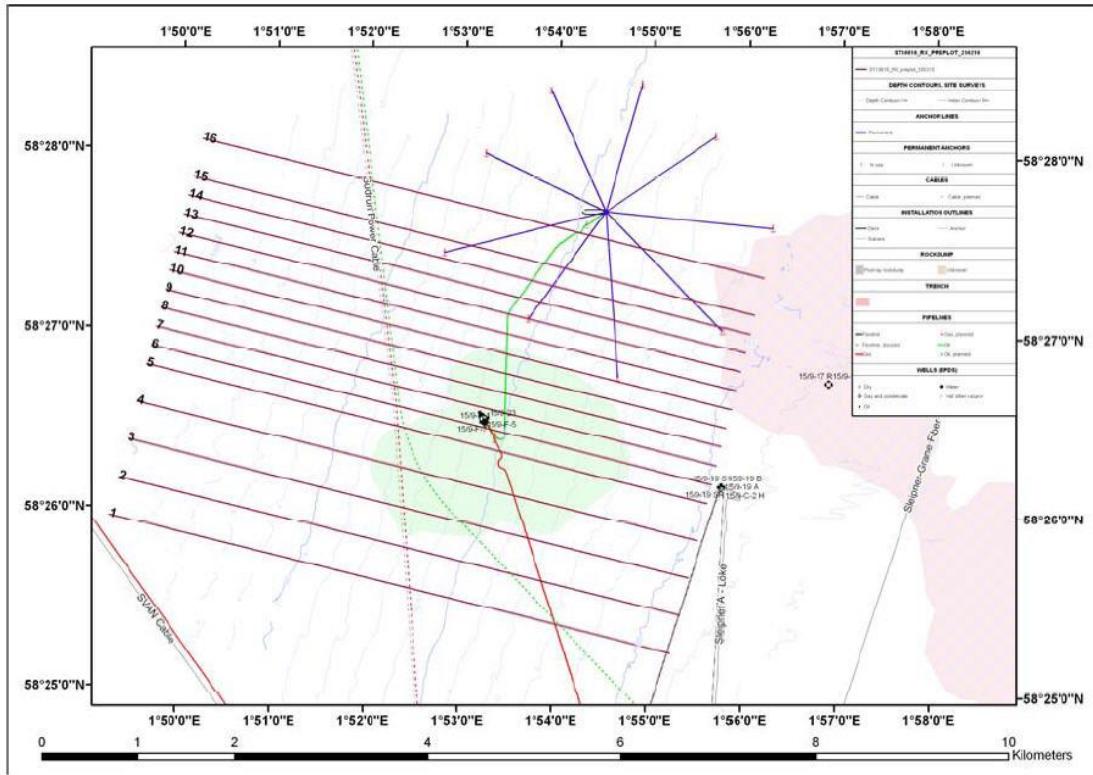


Figure 2. Project layout.

The survey comprised two static spread swaths of 8 x 6km receiver lines each. Swath 11 was designated as the southern 8 receiver lines (nominally numbered 1-8) and Swath 12 was designated as the northern 8 receiver lines (nominally numbered 9-16).

Sail-lines were acquired in each swath such that the required offsets of 3000m inline and 975m crossline were achieved into all receivers. A special case was made for receiver lines nominally numbered as RLs 10 and 11 in swath 12. These receiver lines were kept active for all sail-lines up to the northern boundary of the survey thus achieving a maximum crossline offset of 2375m.

Both receiver lines and sail-lines were oriented in the 104°/284° line direction.

2.3 Source and Ground Station Numbering

The line naming convention for this survey consisted of 8 digit shotline numbering, and 7 digit receiver line numbering. A shotline number was made from a 2 digit swath number, 1 digit Statoil direction code, 4 digit preplot line that incremented by 8 each line, and an attempt number which starts at "0" for the first prime shoot or first receiver line lay. Each receiver line then consisted of a 2 digit swath number, 4 digit preplot line, incrementing by either 16 or 32, and a 1 digit relay code. The relay code started at "0" and incremented by 1 for each subsequent cable deployment on the same location.

X = preplot line (4 digits)

D = direction code (1 digit) Sail line only, "1" this survey indicating inline swath shooting

P = swath (2 digits)

I = attempt number (1 digit) "0" indicates prime, "1" indicates first reshoot or relay

Shot Line

rxt	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10010
	Date:	October 2010

PPDXXXXI

Receiver Line

PPXXXXI

The final SEGY tapes were delivered with the above line naming conventions. The shot line numbering as recorded in the field was different in order to aid acquisition organizational convenience.

X = preplot line (4 digits)

I = attempt number (1 digit) "0" indicates prime, "1" indicates first reshoot

S = sequence number (4 digits) starting with "0001"

Shot Line

XXXXISSSS

All final deliverable products were manipulated such that the Statoil naming conventions were observed.

2.4 FFID, Channel and Sensor Numbering

The VSO system is integrated with the Gator database that contains the survey info. The native data headers in the recording buoy are survey related headers: source line, receiver line, shot point and station number. Also a time stamp is recorded for each file.

The channel number is assigned later on in the data flow by the DBU. Each 4C node comprises 4 consecutive channels that are ordered by 1) hydrophone, 2) Z component, 3) X component, 4) Y component. A 240-node cable will record 960 channels. Channel 1 is located at node 1 which IS at the buoy end of the cable, and channel 960 is at the tail end.

Node 1: channels 1 - 4 -----> Node 240: channels 957 -960

Because each buoy records data only for the cable that it is attached to, and accumulates shots over a number of sail lines, it is unlikely that assigning FFID by sequential numbering will result in consistency between receiver lines. FFID and channel are the primary headers in more dated recording systems, requiring relational info (via obs logs and/or SPS files) to assign the shot point and station headers required for processing. It is acknowledged here that VSO data does not have the same requirements. FFID is therefore assigned arbitrarily as the same as the shot point number to maintain consistency across receiver lines.

The DBU assigns the FFID and Channel headers in the data transcription stage. At this point the system creates an online SPS relational 'X' file that maps channel to station and FFID to shot point. The 'X' file also provides information on what data has passed through the transcription process and cross checks this with what data is expected according to the Gator system. Discrepancies are highlighted.

Sensor Numbering

HY (Hydrophone) component	: 1
Z (Vertical) component	: 6
X (In Line) component	: 7
Y (Cross Line) component	: 8

2.5 Field Parameters

Recording System:

Recording system	: ION 24-bit Vectorseis
System manufacturer	: Input/Output

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10010
	Date:	October 2010

Record length : 10 seconds
 Sample rate : 2 msec
 Low cut filter Hydrophone : Out
 Low cut filter MEMS : Out
 High cut filter @ 2 msec : Cut off freq: 176Hz (not selectable)
 Slope: 261dB/Oct (not selectable)
 Type of filter, (operator selectable) : Minimum Phase
 Hydrophone pre-amplifier gain (operator selectable) : 6 dB
 Hydrophone recording mode (operator selectable) : Differential
 Recording format : Proprietary
 Deliverable format : SEG Y
 Tape type : 3592 E05 500GB tapes

Cable System:

Cable : Vectorseis OBC
 Cable Manufacturer : Input/Output
 Number of Cables : 8 cables in use / 8 per deployment
 Cable Length : 5975 m each cable
 Hydrophone, p component : Type: HTI-97-DA
 Sensitivity: 24 Volt/Bar
 Accelerometer, z component : VectorSeis
 Accelerometer, x component : VectorSeis
 Accelerometer, y component : VectorSeis
 Receiver group length : 0 meters
 Receiver group interval : 25 meters
 Number of receivers : 240 each cable
 Lead-in cable(s) : 1000 meters

Source Parameters

Shot Interval : 25 meters
 Number of sources : 2 (Flip-Flop)
 Source Separation : 50 meters
 Source Depth : 6 meters
 Source Volume : 3990 cu. in.
 Source Pressure : 2000 psi
 Sub-Arrays/Strings : 6
 Sail Line Spacing : 100 meters

2.6 Source Details

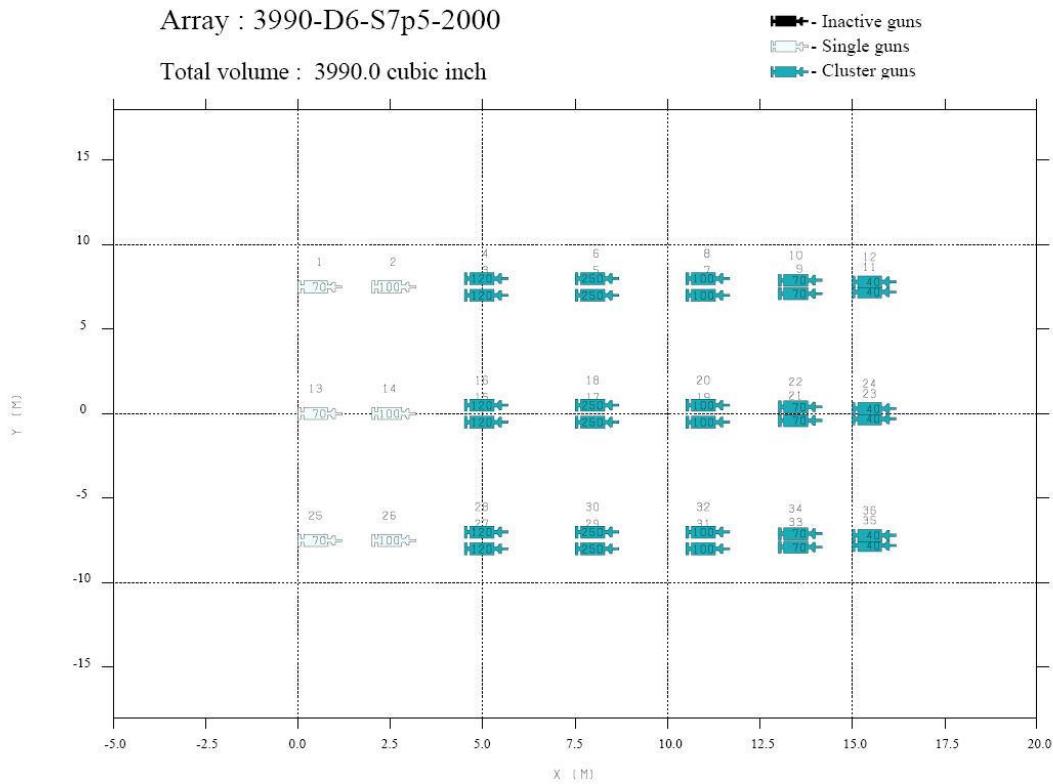


Figure 3. Gun Array Diagram



Prepared by:	RXT QC Department
Client:	Statoil
Project Number:	RXT10010
Date:	October 2010

SOURCE ARRAY LISTING

Source array name : 3990-D6-S7p5-2000

Array created by Nucleus version 6.5.4

Array created by Marine source modelling version 5.2.4

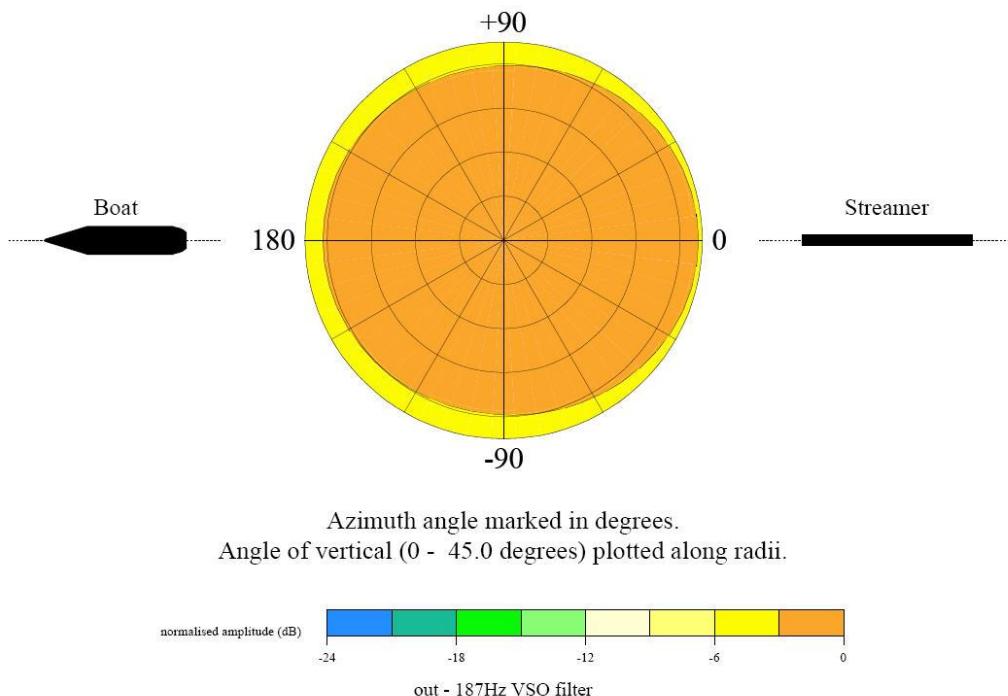
Number of active guns : 36
Total active volume : 3990 CU.IN.
Number of spare guns : 0

GUN #	GUN TYPE	X (m)	Y (m)	Z (m)	VOLUME (cu.in)	PRESSURE (psi)	DELAY (ms)	CLUSTER NUMBER
1	14	0.00	7.50	6.00	70	2000	0.00	0
2	14	2.00	7.50	6.00	100	2000	0.00	0
3	14	4.50	7.00	6.00	120	2000	0.00	1
4	14	4.50	8.00	6.00	120	2000	0.00	1
5	14	7.50	7.00	6.00	250	2000	0.00	2
6	14	7.50	8.00	6.00	250	2000	0.00	2
7	14	10.50	7.00	6.00	100	2000	0.00	3
8	14	10.50	8.00	6.00	100	2000	0.00	3
9	14	13.00	7.10	6.00	70	2000	0.00	4
10	14	13.00	7.90	6.00	70	2000	0.00	4
11	14	15.00	7.20	6.00	40	2000	0.00	5
12	14	15.00	7.80	6.00	40	2000	0.00	5
13	14	0.00	0.00	6.00	70	2000	0.00	0
14	14	2.00	0.00	6.00	100	2000	0.00	0
15	14	4.50	-0.50	6.00	120	2000	0.00	6
16	14	4.50	0.50	6.00	120	2000	0.00	6
17	14	7.50	-0.50	6.00	250	2000	0.00	7
18	14	7.50	0.50	6.00	250	2000	0.00	7
19	14	10.50	-0.50	6.00	100	2000	0.00	8
20	14	10.50	0.50	6.00	100	2000	0.00	8
21	14	13.00	-0.40	6.00	70	2000	0.00	9
22	14	13.00	0.40	6.00	70	2000	0.00	9
23	14	15.00	-0.30	6.00	40	2000	0.00	10
24	14	15.00	0.30	6.00	40	2000	0.00	10
25	14	0.00	-7.50	6.00	70	2000	0.00	0
26	14	2.00	-7.50	6.00	100	2000	0.00	0
27	14	4.50	-8.00	6.00	120	2000	0.00	11
28	14	4.50	-7.00	6.00	120	2000	0.00	11
29	14	7.50	-8.00	6.00	250	2000	0.00	12
30	14	7.50	-7.00	6.00	250	2000	0.00	12
31	14	10.50	-8.00	6.00	100	2000	0.00	13
32	14	10.50	-7.00	6.00	100	2000	0.00	13
33	14	13.00	-7.90	6.00	70	2000	0.00	14
34	14	13.00	-7.10	6.00	70	2000	0.00	14
35	14	15.00	-7.80	6.00	40	2000	0.00	15
36	14	15.00	-7.20	6.00	40	2000	0.00	15

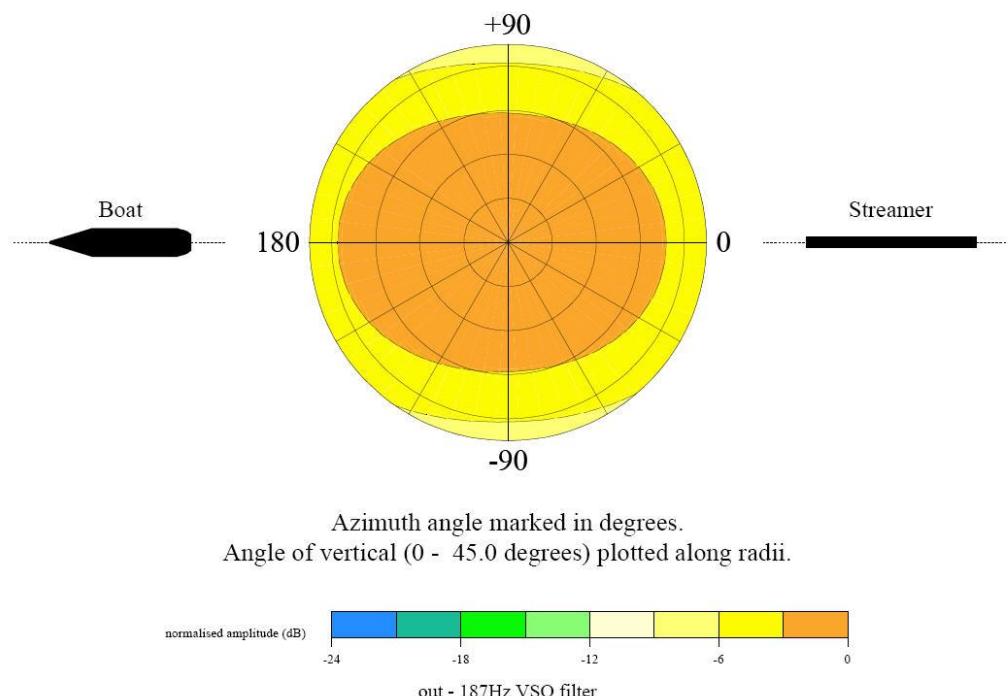
THE GUN TYPES ARE:
14: G-GUN

Figure 4. Gun Array Listing

Source Directivity Plot - frequency : 30.0 Hz. - array 3990-D6-S7p5-2000



Source Directivity Plot - frequency : 60.0 Hz. - array 3990-D6-S7p5-2000



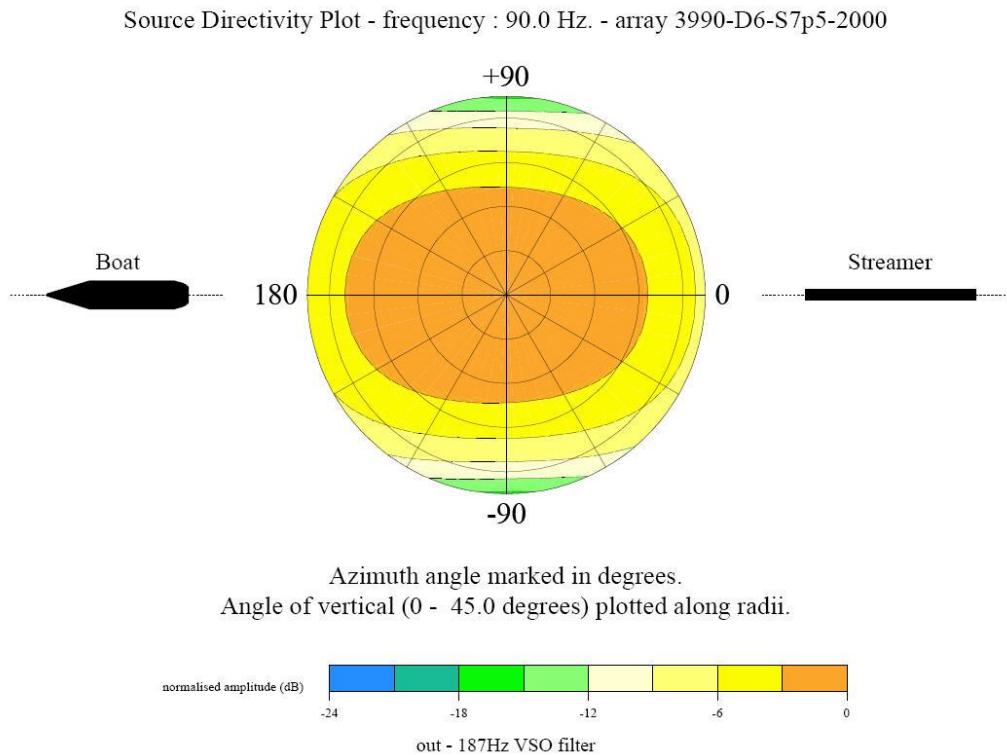


Figure 5. Source Directivity Plots

2.7 Far Field Signature

Far field signatures for the source described in the previous section are shown on the following page.

- Differential

This filter both differentiates and applies recording filter to the unfiltered source signature. If the Client chooses to deconvolve in the acceleration (differential) domain, this filter should be used for Deconvolution of the accelerometer data and hydrophone data in differentiated mode.

The far-field signature listing is provided in Appendix 11.2.

Farfield signature : 3990-D6-S7p5-2000

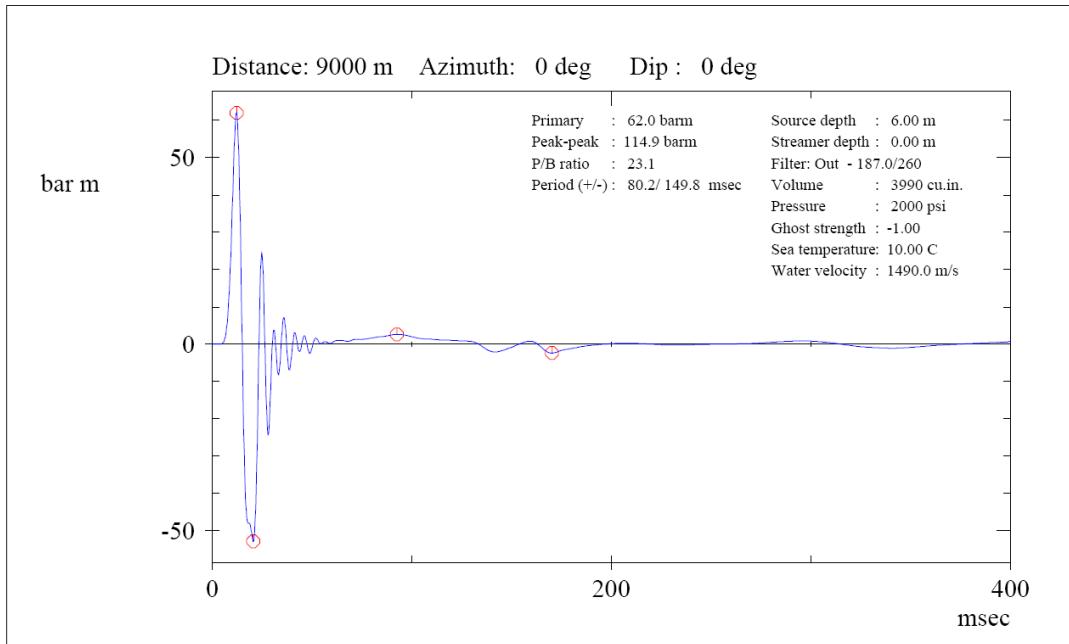


Figure 6 Field Signature

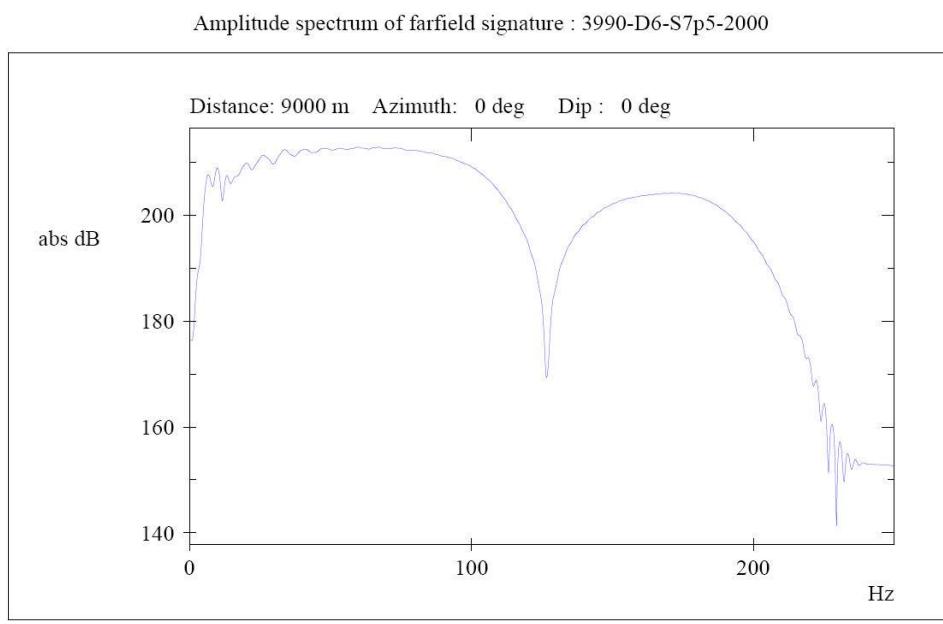


Figure 7. Far Field Signature Amplitude Spectrum

Farfield signature : 3990-D6-S7p5-2000

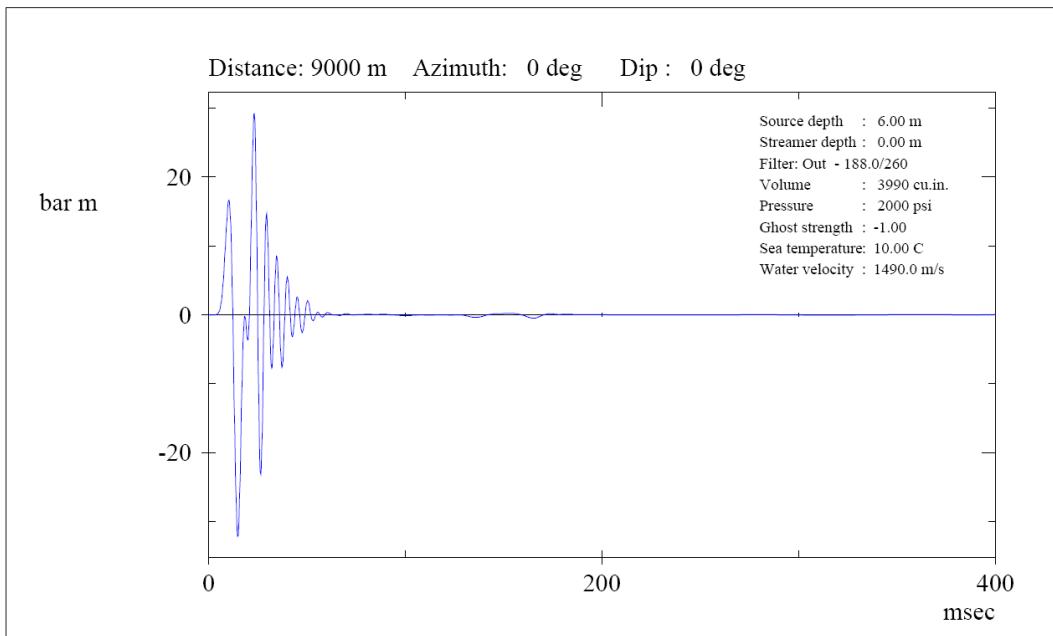


Figure 8. Derivative Far Field Signature

Figure 9. Derivative Far Field Signature Amplitude Spectrum

2.8 VSO System Impulse Response

Graphical displays are provided on the following pages which show the VSO system impulse response for the hydrophone and accelerometer sensors. The VSO system impulse response listings is provided in Section 11.3 (pressure response only as provided by ION). Note that the accelerometer impulse response is very similar to the P response except for a small difference at the low freq.

It should be apparent from looking at the displays that the system response (and therefore the far field signature) has a 10 ms delay. The correction for this delay was not done in the field.

The ringing in the impulse response is caused by the sharp anti-alias filter at $\frac{3}{4}$ Nyquist. The data processing contractor will want to use a more gradual slope for the anti-alias filter prior to re-sampling the data to 4ms.

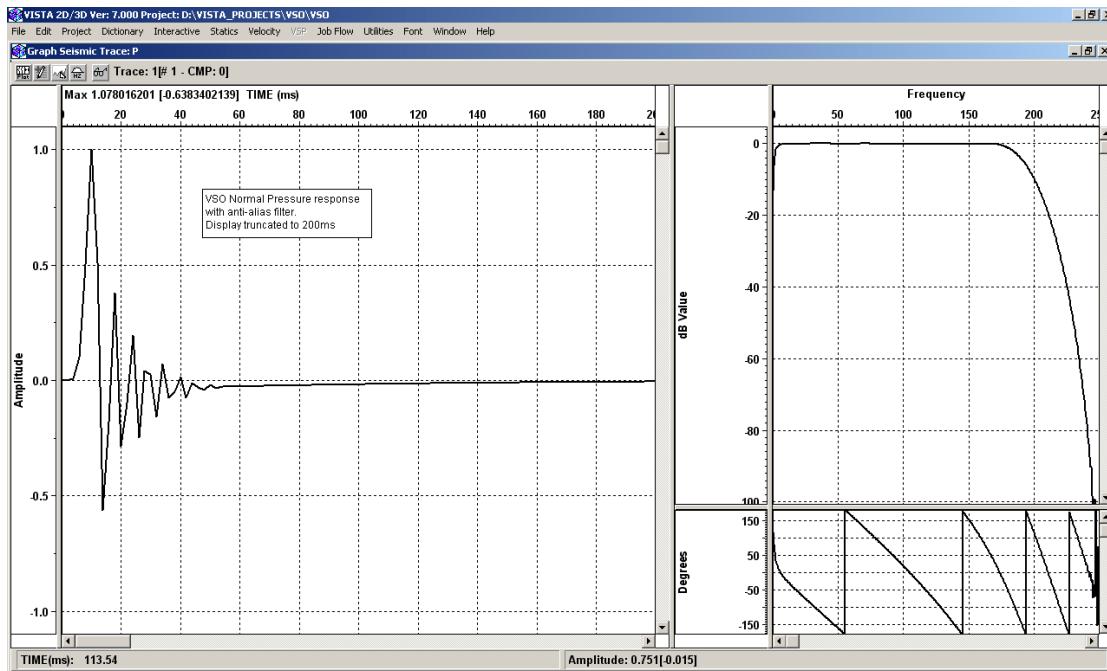


Figure 10. Hydrophone VSO System Impulse Response

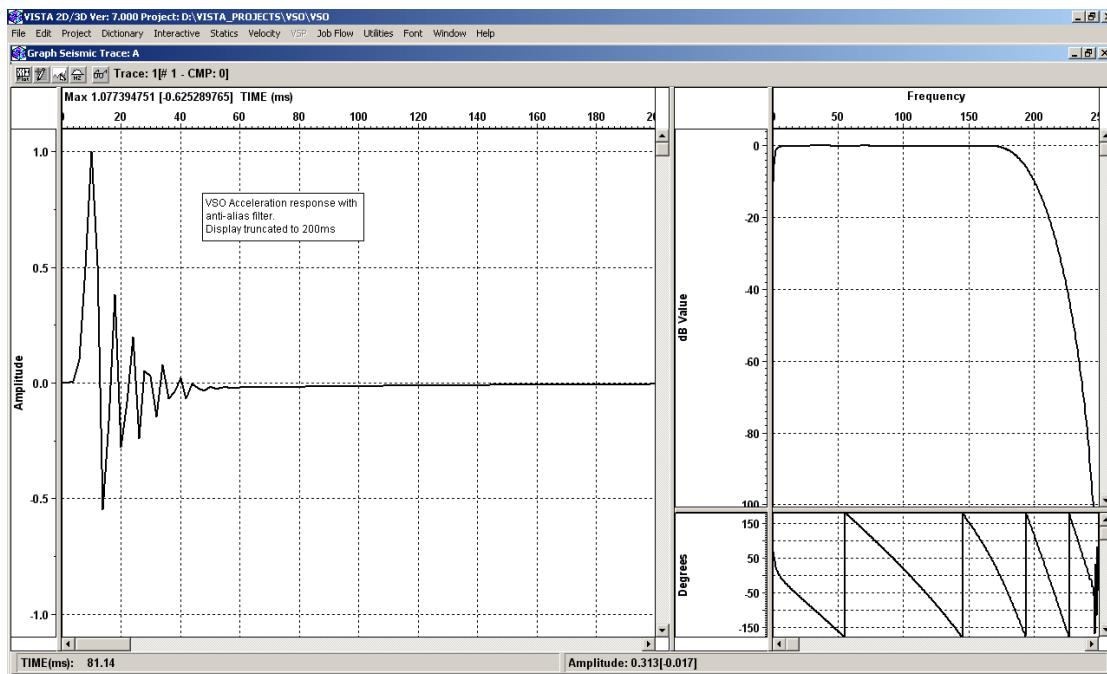


Figure 11. Accelerometer VSO System Impulse Response

3 SEISMIC QC METHOD

3.1 Overview

The Seismic QC method employed can be broken down into two essential stages; that which took place in real time or near real time, and that which took place after the data was retrieved from the buoy and loaded into the Vista offline QC system. Between these two stages, the data was transcribed using the ION/Concept DBU (Data Bucket Unloader) system. These various steps are described in detail in the following sections.

3.2 Flow Diagram

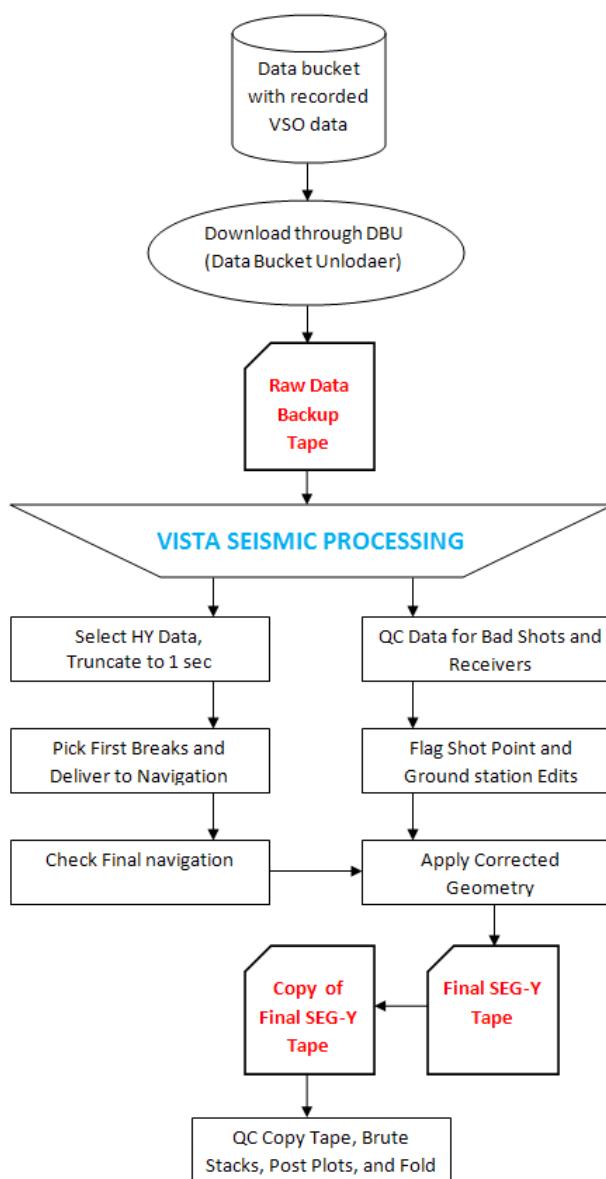


Figure 12. VSO Data Flow

4 VSO SENSOR ROTATION

4.1 Introduction

The objective is to highlight the key features of the VSO recording system, in particular the 'VOR' process of rotating the 3C sensor to 1 vertical and 2 horizontal axes.

This document is intended for external distribution. Acknowledgement is extended to ION Geophysical Corp. who assisted with displays and explanations.

4.1.1 Glossary of Terms

VSO	Vectorseis Ocean
VOA	Vertical Orientation Angle
VOR	Vertical Orientation Rotation
HOA	Horizontal Orientation Angle
HOR	Horizontal Orientation Rotation
HPR	Horizontal Polarity Reversal
NODE	The 4C module comprising 1 hydrophone + 3 MEMS accelerometers
MEMS	Micro Electrical Mechanical Systems
DBU	Data Bucket Unloader

4.1.2 The 3C Sensor

The VSO 4C node comprises a hydrophone and 3 MEMS linear accelerometers aligned orthogonally. The latter is referred to as the 3C sensor. Each accelerometer measures acceleration in units of gravity g. [1g is approximately 9.8 m/s²].

The sensors are mechanically fixed to the sensor package. One of the accelerometers (the 'X' sensor) is fixed along the cable axis parallel to the sensor housing. During deployment the other 2 accelerometers (the 'Y' and 'Z' sensors), being orthogonal to the cable axis, are oriented unpredictably at any particular station. Positive acceleration is recorded in the direction of the sensor axis.

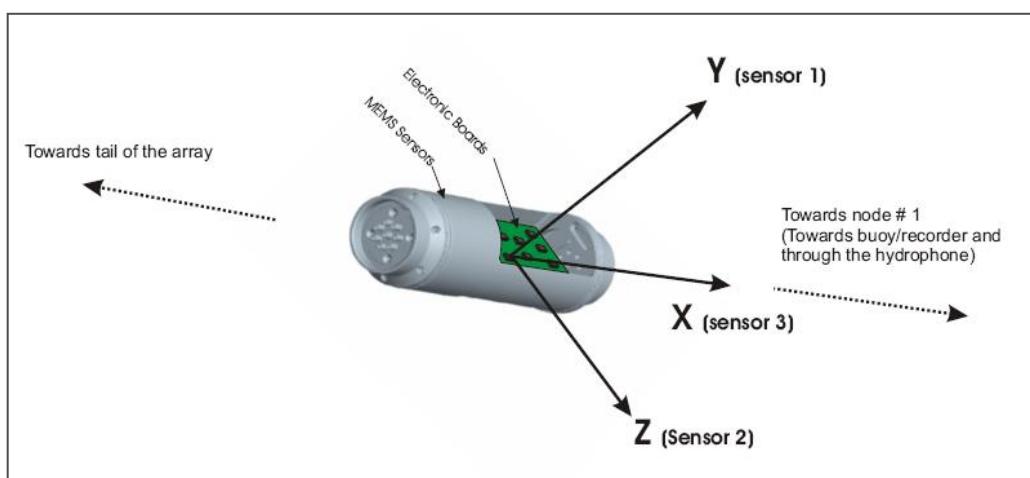


Figure 13. VSO 3C Node Orientation

The VSO system has self-contained functions to self-determine each sensor's orientation to vertical, and to automatically correct the sensor component data to a consistent orientation. The full rotation process includes three important coordinate frames that are discussed further in Section 3:

- 1) Sensor Frame
- 2) Cable Frame
- 3) Prospect Frame

The transform from sensor to cable frame is the VOR transform. This rotates the sensor frame to one axis true vertical and two axes true horizontal alignment. The rotation preserves the sensor heading with the axis of the cable.

The transform from cable to prospect frame is the HPR transform (or cable flip). This inverts the cable's coordinate frame whenever cables are placed back-to-back or in a serpentine fashion.

The prospect frame, representing the final state of all data rotations, is the basis upon which the Seismic Image data is output from the VSO system

4.1.3 The Right Hand Rule

The VSO node design follows the right hand rule as depicted below (ref. Sensor Frame). For a three dimensional Cartesian coordinate system, the relationship of positive axes of x, y, and z follows the thumb and next two fingers of the right hand respectively. For example, if positive Z is vertically down, then positive Y is always to the right while facing the direction of positive X.

The application of cable flip (ref. HPR) is equivalent to a 180 deg rotation about the vertical Z-axis; it is necessary to reverse the polarity of both X and Y sensors to preserve the right-hand rule.

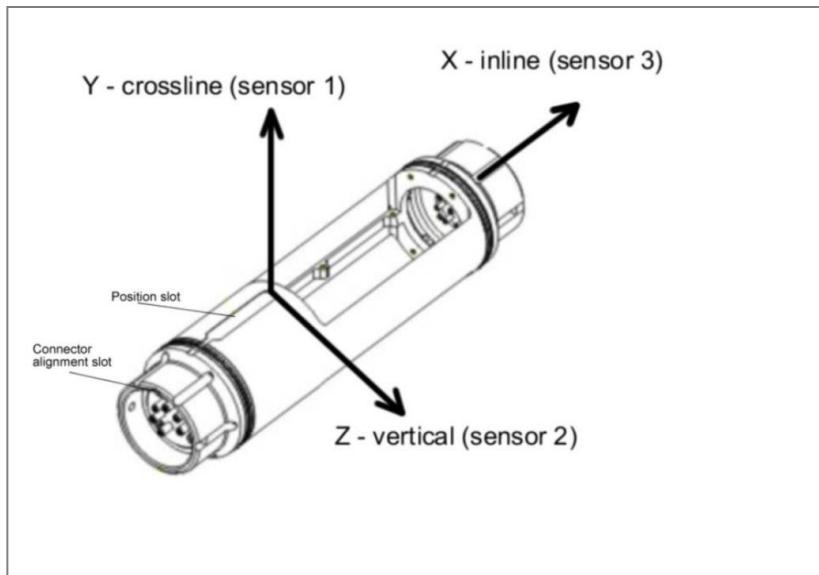


Figure 14. The relative orientation of the 3 sensors corresponding to the right hand rule.

4.1.4 VSO Acquisition Overview

Unlike other OBC recording systems, each VSO cable is attached to a recording buoy (figure 13). This allows flexibility in deploying cables, and the deployment itself can be in the forward or reverse direction (i.e.; the buoy sits at the start or end of a given preplot line). In normal operations a VSO cable comprises 240 nodes (or 960 channels of 4C data).

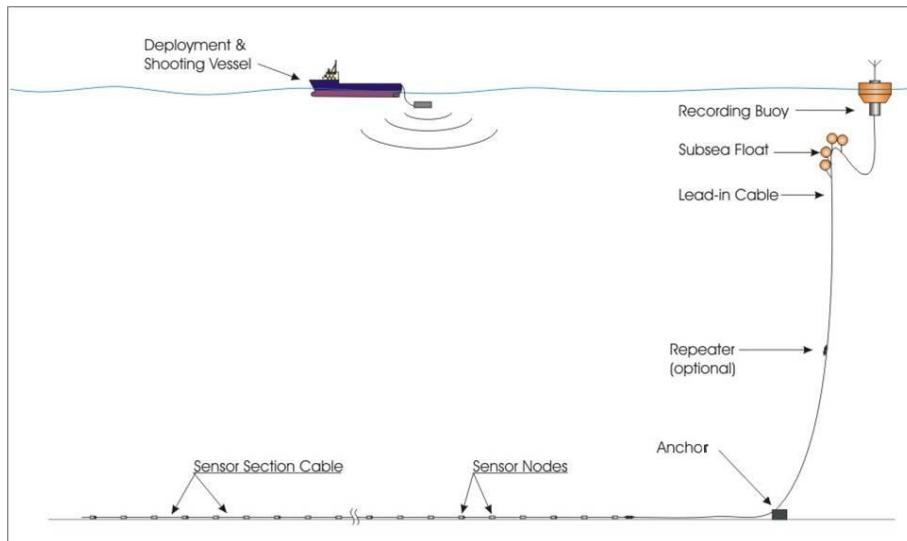


Figure 15. VSO buoy based acquisition

VSO is integrated with the Gator navigation system to define a relationship between node number (VSO) and station number (Gator). In the case of a cable looping over 2 or more preplot lines, Gator will also relate nodes to individual line number.

The recording buoy is always deployed after the cable and is retrieved before the cable. It is attached at the end of the cable where node 1 is, so that node 1 is the last to spool off the vessel. A lead-in cable connects the cable at node 1 to the buoy.

The cable is engineered so that the X sensor points toward the buoy (ie. the positive X direction is along the cable toward the buoy). A cable may be laid in the reverse direction (with respect to the prospect frame) for operational efficiency, such that a survey will ultimately comprise both forward and reverse laid cables, and therefore conflicting polarities of the horizontal components.

These acquisition features are coded in the VSO SEGY. At a later stage in the data flow the system establishes consistency in polarity of the horizontal components, effectively by orienting the cables to be all in the same direction (ref. HPR).

4.1.5 The Recording Buoy

Each recording buoy contains both a recorder and a QC computer. The raw VSO files are written to a redundant array of disks (variable size but usually 500Gb) that are connected to the recorder via daisy chained Firewire. These disks are contained in a rugged cylindrical data 'bucket' that can be readily detached (and re-attached) once the buoy has been taken onboard. Each buoy records the data for only one cable.

Immediately after recording a copy-convert process writes a copy of the data to the QC computer disk. These files on the QC computer form the basis of all real-time attributes

generated for QC. They also provide an independent secondary raw dataset in the event that the data cannot be read from the primary source.

There are 2 radios attached to the buoy that communicate with the master vessel. The higher bandwidth 2.4 GHz link allows for QC information to be relayed to the master vessel, including full attribute analysis, raw shots, etc. The 900 MHz radio allows the master vessel to communicate with each buoy / cable and synchronize recording. A limited amount of QC data, typically the RMS noise values for each trace, is also transferred over the 900 MHz link (figure 14).

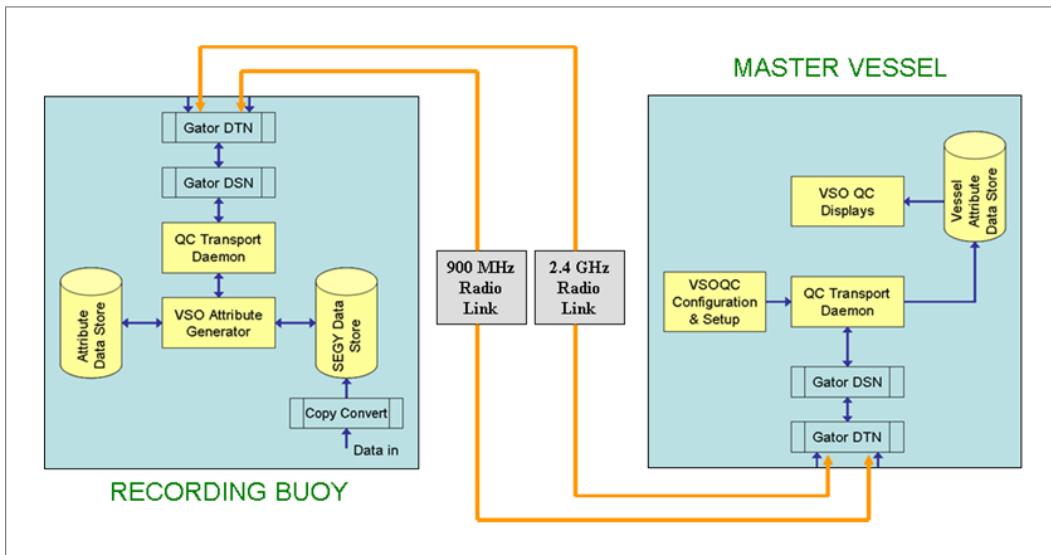


Figure 16. VSO Vessel-Buoy Communication

4.1.6 The Data Bucket Unloader (DBU)

The DBU is that part of the recording system that resides onboard. The functionality includes the following:

Transcribing. The DBU inputs raw VSO data from the buoy disks, or as a contingency it can read from the QC computer. Output is to SEGY on disk.

VOR rotation. Output is one axis true vertical and two axes true horizontal alignment.

HPR rotation. Reverse laid cables are flipped. The cable lay geometry is defined in Gator and the forward direction is defined by decreasing station number.

Header processing includes merging preliminary navigation data with the seismic, and header flags are created for several state-of-health checks performed by the system on itself (separate to instrument tests).

The DBU is integrated with the VSO Web Database that manages the bookkeeping for the survey, creates a relational SPS 'X' file, and cross-checks what has been acquired to what is expected to be acquired.

Note that data processing is limited to only VOR and HPR. These processes are reversible.

4.1.7 VSO Data Flow Summary

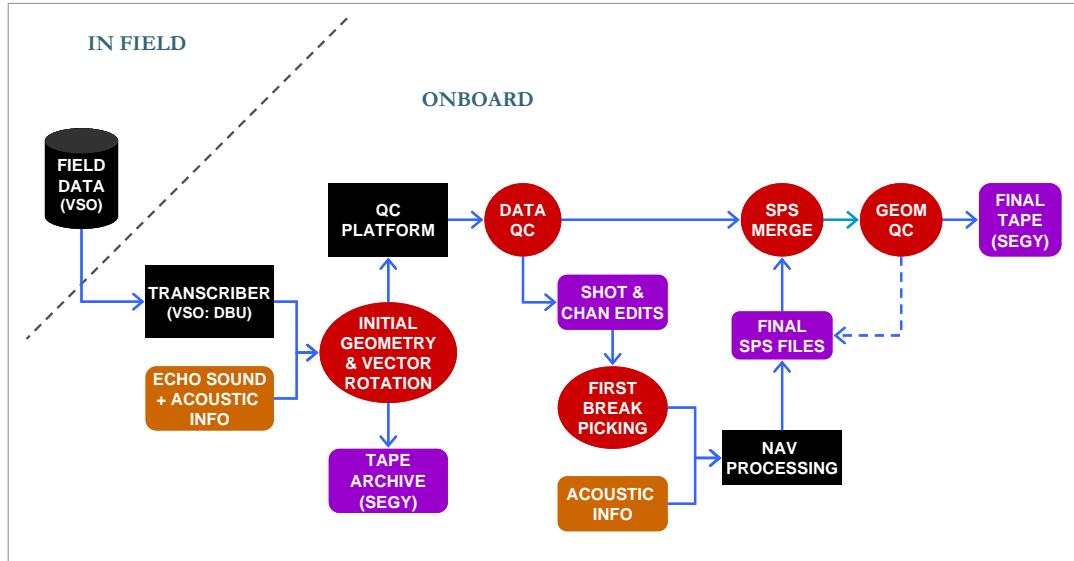


Figure 17. VSO Data Flow schematic

A generalized chronology of the VSO Data Flow is as follows.

#	STEP	DESCRIPTION
1.	Data Recording	Data is recorded in internal format to the multi-disk array inside the buoy.
2.	Online QC	Seismic attributes computed in the QC computer in the buoy are relayed to master vessel. Decisions made regarding line acceptability before cables are rolled.
3.	Data Transfer	After buoy retrieval, data is transferred from the buoy disks to computers onboard.
4.	Processing	VOR and HPR applied to trace data. Preliminary geometry uploaded to the seismic headers.
5.	VSO SEGY Output	Raw Data output in SEGY format to disk.
6.	Offline QC	Create final SPS data, data edits, and final obs logs
7.	SEGY Output	Final Data output in Client SEGY format to tape with final SPS info uploaded to data headers. Non-chargeable data (e.g. NTBP lines, etc.) removed from dataset.

In Step 3, data is transferred from the field to the vessel computers in two ways:

The buoy is recovered onboard the cable vessel where the QC processing is housed, the raid disks are removed from the buoy and hooked up directly to the DBU.

The buoy is recovered onboard a cable handler where the QC processing is not housed, a bit-bit copy of the raw data is made to separate disks that are dispatched to the main cable vessel.

Steps 3-5 are all carried out in the DBU. The DBU front-end software resides in the instrument room with the QC computers.

Step 7 is optional, in that it does not provide extra info to the deliverables created in steps 5 and 6.

4.2 VSO Rotation Attributes

4.2.1 VOA

The system intrinsically determines the vertical orientation angle (VOA) for each sensor via gravity measurements. With this information the system applies VOR, which is a rotation of the 3 axes digitally (i.e. via processing) so that the X and Y sensors are aligned horizontally and the Z sensor is aligned vertically down.

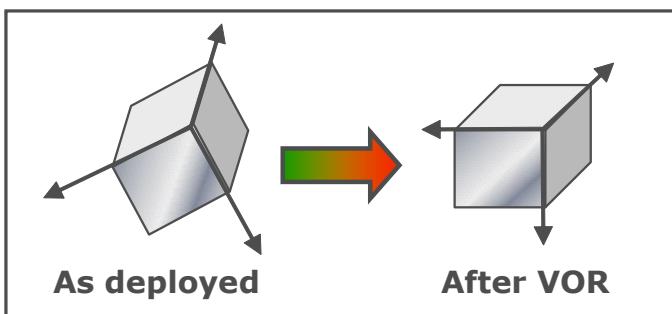


Figure 18. Depiction of the 3C sensor and the VOR process.

Note that the VOR process can be turned off in the Data Bucket Unloader (DBU) strictly for test purposes.

VOA is recorded by the system in units of radians * 10000 and is always positive (ranging 0 to 31416, zero being vertically up). In the VSO SEGY archive tape it is saved automatically as a short integer at bytes 205-206.

VOA(x) is the angle from vertical of the sensor aligned along the cable axis; it is generally close to 15708 (i.e. 90 degrees.) if the seafloor is flat. VOA(y) and VOA(z) vary unpredictably from node to node.

The as-laid sensor orientation from the vertical axis is determined along the following steps:

The system records a DC measurement for each accelerometer at every SP. This gives the projected (vertical) gravity in units of gravity g, ranging from -1 to 1.

The orientation angles are related to gravity according to the relations below:

$$g(x) = \cos(VOAx/10000)$$

$$g(y) = \cos(VOAy/10000)$$

$$g(z) = \cos(VOAz/10000)$$

where $g(x)$, $g(y)$, $g(z)$ are the components of gravity for each of the sensors.

4.2.2 Vector Fidelity

Vector fidelity infers that particle motion along the axis of one sensor registers a full wave recording at that sensor, and zero at the 2 orthogonal sensors. To achieve this, accurate VOR and sensor fidelity are required.

When VOR rotates to 3 components of 1 vertical + 2 horizontal, it infers that the vertical (Z) component registers only vertically propagating energy, and the horizontal (X and Y) components register only horizontally propagating energy.

Therefore a requirement for successful VOR, and therefore for vector fidelity, is to have accurately known as-laid orientation angles.

The accuracy of the as-laid sensor orientations is checked via the vector sum of the 3 components. Since the 3 sensors are orthogonal the vector sum of the 3 gravity readings (DC recording) should be 1.0.

$$\text{Gravity Sum} = \sqrt{g(x)^2 + g(y)^2 + g(z)^2}$$

The other requirement for vector fidelity is sensor fidelity. The process of analogue to digital conversion, from the field to the recorder, has to be consistent and within operating specs. If only 2 sensors are live, for example, then the entire 3C sensor (and arguably the 4C node) is not bona fide.

Below is an example gravity sum result over 120 nodes. According to the manufacturers specifications a gravity sum to within 3% of unity is considered acceptable; in all field cases the gravity sum is generally accurate to within a fraction of a percent.

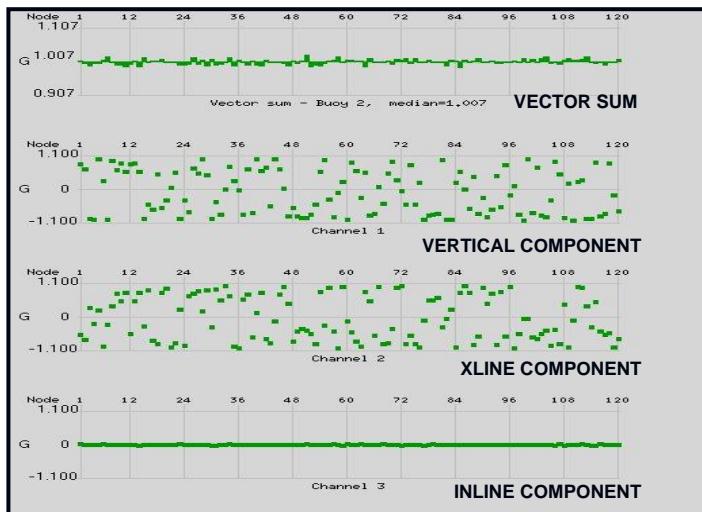


Figure 19. Vector Fidelity as demonstrated by vector sum.

4.2.3 HOR

During recording the X sensor is aligned in the direction of the node housing on the cable. The X-sensor axis is not the same as the X-axis because a) the sensor is not necessarily horizontal and b) the cable may not be deployed dead straight.

VOR is the process that rotates the X sensor to the horizontal plane, and HOR is the process that rotates the X sensor exactly along the X-axis (i.e. the inline direction), since there may be deviations during deployment.

The VSO system applies VOR but does not support HOR.

Other use of HOR is to rotate the horizontal data into radial and transverse components.

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

4.2.4 HPR

HPR is a means to establish a consistent polarity of the horizontal components across an entire survey.

HPR is effectively HOR limited to 0 or 180 degrees. It represents a polarity reversal of the horizontal X and Y components after the application of VOR.

4.3 Vertical Orientation Rotation

4.3.1 Frames of Reference

The process of VOR and HPR is explained via the movement between three frames of reference.

Sensor Frame

Refers to a frame of reference of the as-laid sensors. While each node is uniquely different, each 3C sensor follows the right-hand rule within the sensor frame.

Cable Frame

Refers to a frame of reference after rotation from the Sensor Frame, but before rotation due to deployed cable. Thus each 3C sensor has been rotated to 1 vertical + 2 horizontal to achieve consistency within each cable. Consistency between cables has not been attained at this stage.

The cable frame considers an entire group of nodes within a single cable. The node to node relation should be consistent and is achieved by the application of VOR. The output is a consistent set of nodes in which the principle axes of the 3 sensors have been redefined.

VSO sets these axes such that Z points vertically down, X points horizontally along the cable towards node 1 (ie. the buoy) and Y points horizontally to the right while facing the buoy.

In the diagram below 3 scenarios are presented for which each Cable Frame is consistent.

Prospect Frame

Refers to a frame of reference represented by the prospect coordinate system in which all data is rotated to for uniformity.

In the Prospect Frame the cable to cable relation should be consistent and is achieved by the application of HPR. This process inverts the cable's coordinate frame whenever cables are placed back-to-back or in a serpentine fashion. The output is a consistent set of cables within the prospect, in which a single lay direction is defined.

VSO by default sets the cable lay direction to be in the direction of decreasing station number. This is the direction of positive X; the seismogram therefore registers the first break as a negative loop for a compression wave.

The station numbering system is accessed in the Gator database. The process of HPR is equivalent to HOR limited to an HOA angle of 0 or 180 degrees; so if a cable is reversed by HPR the polarity of the X and Y components is simply flipped.

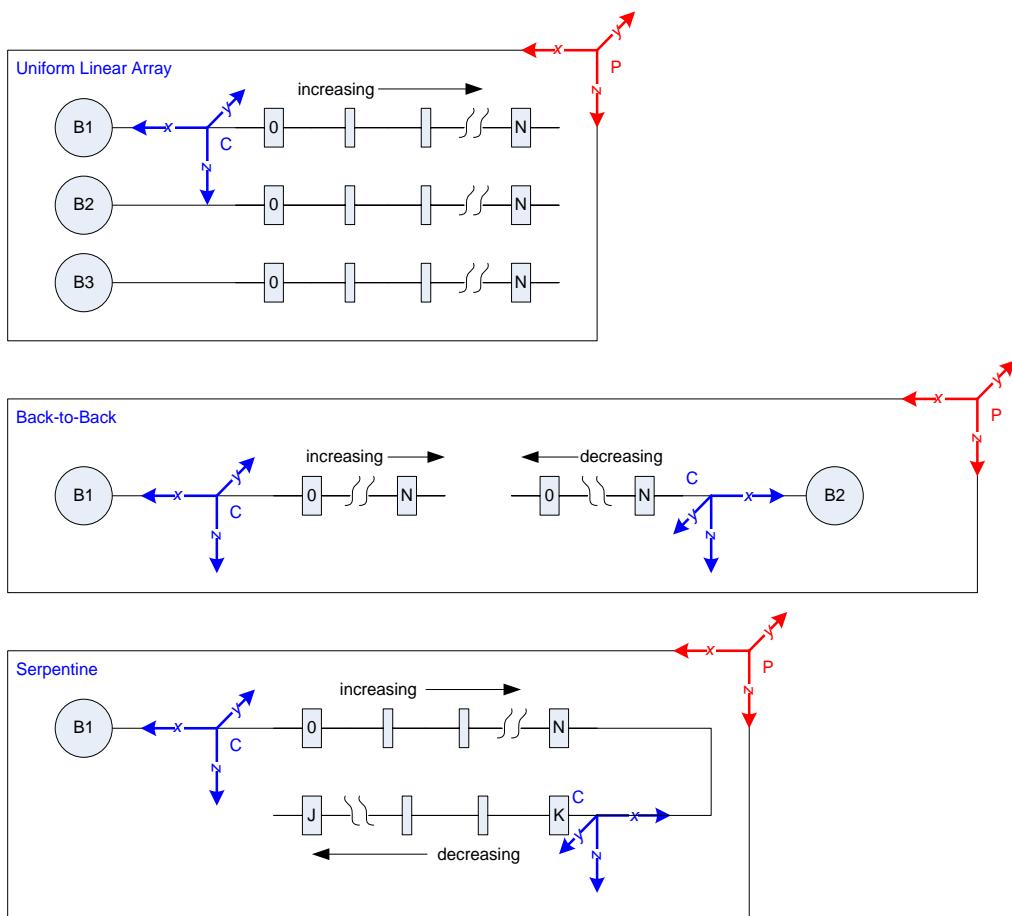


Figure 20. 3 acquisition scenarios referencing all nodes in the cable frame.

The cables can all be deployed in the same direction, or they can be laid back to back, or a single cable can be looped over one or more receiver lines.

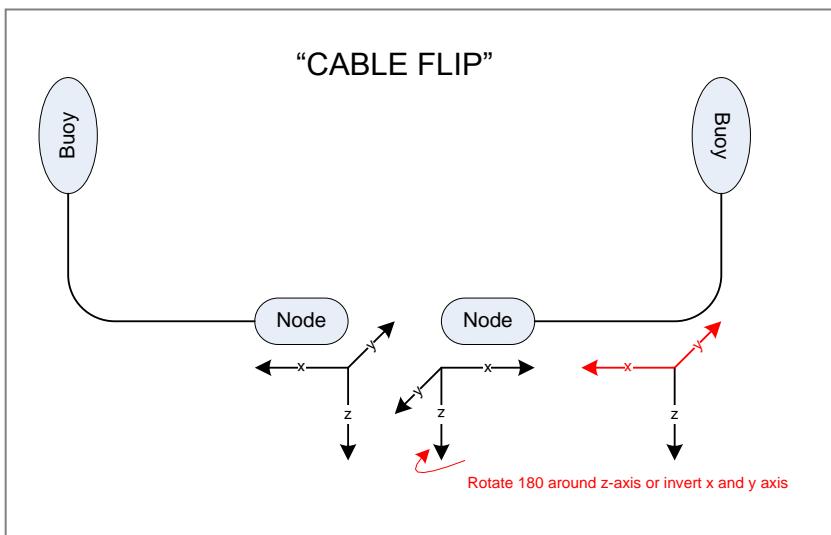


Figure 21. Application of HPR: cable to prospect frame.

4.3.2 The VOR Transform Matrix

The transform matrix is best represented using a Euler Angle approach where the angles pitch, roll and yaw are measured in the vertical plane.

AXIS	ANGLE	Symbol
Y	Pitch	θ
X	Roll	ψ
Z	Yaw	ϕ

The definitions of pitch, roll and yaw are illustrated below.

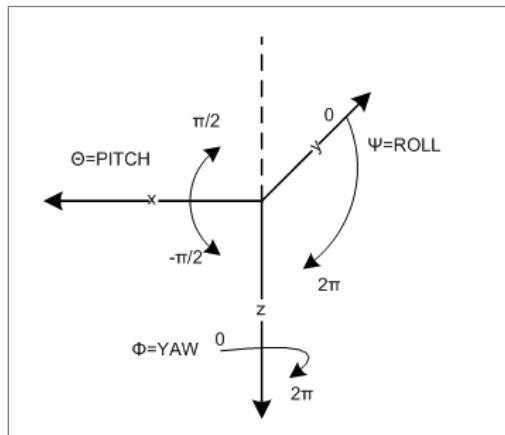


Figure 22. Representations of pitch roll and yaw.

The full 3D transform $[R]$ that rotates from the x-y-z axes to the ψ - θ - ϕ axes, as shown in the illustration, can be represented as a multiplication of 3 transform steps.

$$[R] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\psi & \sin\psi \\ 0 & -\sin\psi & \cos\psi \end{bmatrix} \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix} \begin{bmatrix} \cos\phi & \sin\phi & 0 \\ -\sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

These Euler angles can be related to VOA angles as follows:

$$\theta = \arcsin(\cos(VOA_x))$$

$$\psi = \text{atan2}\left(\frac{\cos(VOA_y)}{\cos(VOA_z)}\right) \quad \text{where } -\pi < \psi < +\pi$$

$$\phi = 0 \text{ or } \pi$$

rxt	Prepared by: Client: Project Number: Date:	RXT QC Department Statoil RXT10010 October 2010
------------	---	--

In the context of VOR application in the VSO system ϕ is limited to 0 or pi.

Note that the *atan2* function is a special case of arctangent where the output is limited to within +/- pi. The *atan* function has an output limited to +/- pi/2.

The matrix $[R]$ above is equivalent to the reverse VOR-HPR process since it is rotating from 2 horizontal + 1 vertical (x-y-z) to new axes defined by the Euler angles ($\psi-\theta-\phi$). The first 2 matrices define the reverse VOR process which can be rewritten as follows:

$$[\text{VOR}^{-1}] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\psi & \sin\psi \\ 0 & -\sin\psi & \cos\psi \end{bmatrix} \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix} = \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ \sin\psi.\sin\theta & \cos\psi & \sin\psi.\cos\theta \\ \cos\psi.\sin\theta & -\sin\psi & \cos\psi.\cos\theta \end{bmatrix}$$

The forward VOR application is the transpose of $[\text{VOR}^{-1}]$.

$$[\text{VOR}] = \begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\psi & -\sin\psi \\ 0 & \sin\psi & \cos\psi \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\psi.\sin\theta & \cos\psi.\sin\theta \\ 0 & \cos\psi & -\sin\psi \\ -\sin\theta & \sin\psi.\cos\theta & \cos\psi.\cos\theta \end{bmatrix}$$

If a 3C data sample before VOR is defined as $U(x,y,z)$, and after VOR as $V(x',y',z')$, then the output of VOR can be determined simply by the matrix multiplication $[V] = [\text{VOR}] \cdot [U]$

5 ONLINE QC

The purpose of online QC was to verify the performance of the guns, sensors, and the quality of the recorded data during acquisition of the survey. This QC can be broken down into the following stages:

- VSO QC
- Source QC
- Raw Shot Analysis
- Logging
- Instrument Tests

5.1 VSO QC

With the VectorSeis Ocean (VSO) buoy based recording system it can be some days from the time the data is shot until the complete seismic dataset is retrieved from the field. In order to assess line acceptability, a quick and accurate analysis of the data quality is required. This process, known as VSO QC, was developed by ION/Concept with specifications provided by RXT.

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

Onboard each recording buoy, a series of attributes is calculated from the raw seismic trace data as it is being acquired. The calculated attributes include:

- RMS Noise Displays
- General Shot Anomaly Detection
- General Node Anomaly Detection
- Count of the Number of Dead / Weak Traces
- Spike Detection
- Cable Rocking

Several of these attributes are still under development and as such were not used for line acceptance decisions on the RXT10010 survey. Efforts for this survey concentrated primarily on the use of the RMS Noise displays and the counts of the number of dead/weak traces in conjunction with Raw Shot data analysis and online logging of anomalies.

The VSO QC system operates via two radios. A 900 MHz radio system is used primarily for recording control, but is also used for Level 1 QC displays, a single RMS display (Hydrophone component for this survey), and data logging to ensure that we are never shooting blind. The remaining QC data was transferred over the broader band 2.4 GHz radio system. The operation of the recording system was not dependent on the 2.4 GHz radios to function properly.

The VSO QC information is broken up into three distinct "levels" that include:

- Level 1 consisted of an overall GOOD / BAD indicator for the entire shot / receiver line combination based on a number of test results for each shot-buoy ensemble. Level 1 also includes the RMS display of a single sensor, selected as the hydrophone component for this survey.
- Level 2 consisted of various seismic trace attributes, including RMS noise displays, of all of the 4 component sensors.
- Level 3 consisted of raw seismic trace data displayed by shot.

All Level 1 information, along with recording control data and data logging information is transmitted via the long wave radio (900 MHz) and thereby available at all times. Level 2 and Level 3 information is transmitted by the short wave radio (2.4 GHz) and therefore dependent on the proximity of the vessel to the buoy. For this survey it was found that during the normal course of acquisition, data was retrievable most of the time via the short wave radio.

5.1.1 Level 1 VSOQC

The Level 1 QC Display (figure 21) shows the shot quality indicator for each buoy/shot. The shot status (good, bad, missing) was colour coded with the most recent shot appearing at the right of the screen and rolling to the left as new shots were acquired.

The attributes calculated onboard the recording buoys are checked automatically against a set of user defined failure thresholds. Any shot / receiver combination which has more than a user defined number of individual trace failures for any of these attributes is flagged as bad. The reason for the failure and the number of affected sensors is shown on the right hand side of this "Level 1" QC display.

The Level 1 shot status was determined through a series of tests performed on the buoy's onboard QC computer, with each test designed to identify a particular problem.

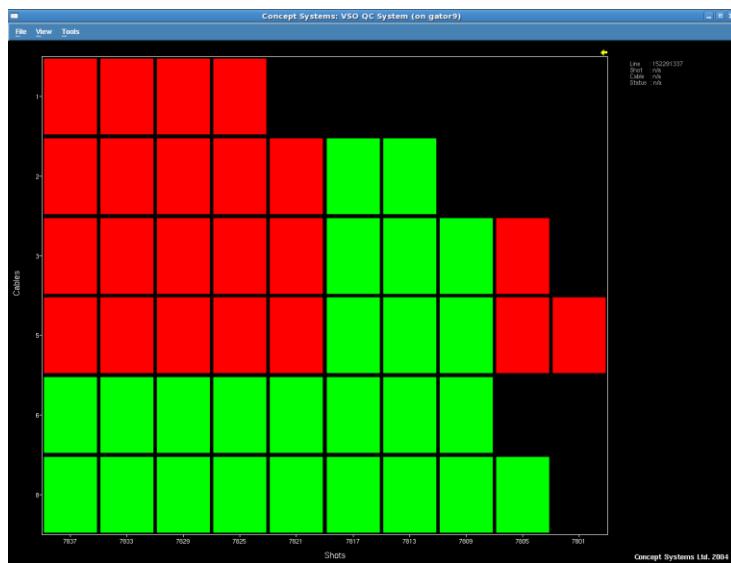
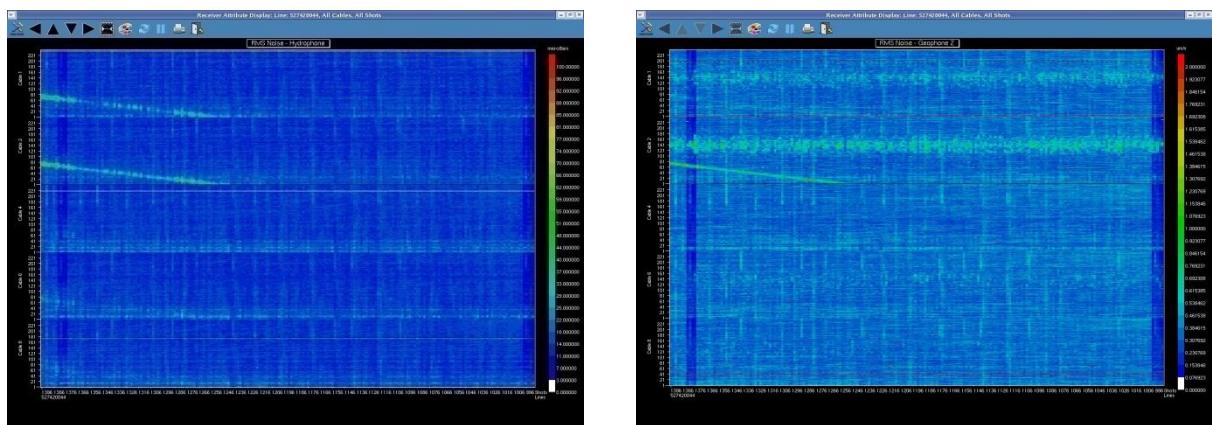


Figure 23. Level 1 online attribute analysis display

10 shots, 6 cables. In this example we see the 5 noise records taken at the end of line being flagged as "general shot anomalies"

5.1.2 Level 2 VSOQC

Level 2 VSOQC consisted of a dedicated online attribute display (figure 22). The VSOQC could display online any of the calculated attributes for each component (the cable rolling attribute has a single value per node). For the duration of this survey the RMS noise attributes for each component were displayed online for each sail sequence. The Y-axis shows the node number with distinction made for each cable, and X-axis is the different shots. The RMS level for each channel was shown by colour intensities. The RMS values were calculated in the recording buoys, and the results were stored onboard the shooting vessel in a database that could be interrogated after line completion. Several sequences of attribute data could be displayed in order to provide line to line comparisons against client defined benchmarks.



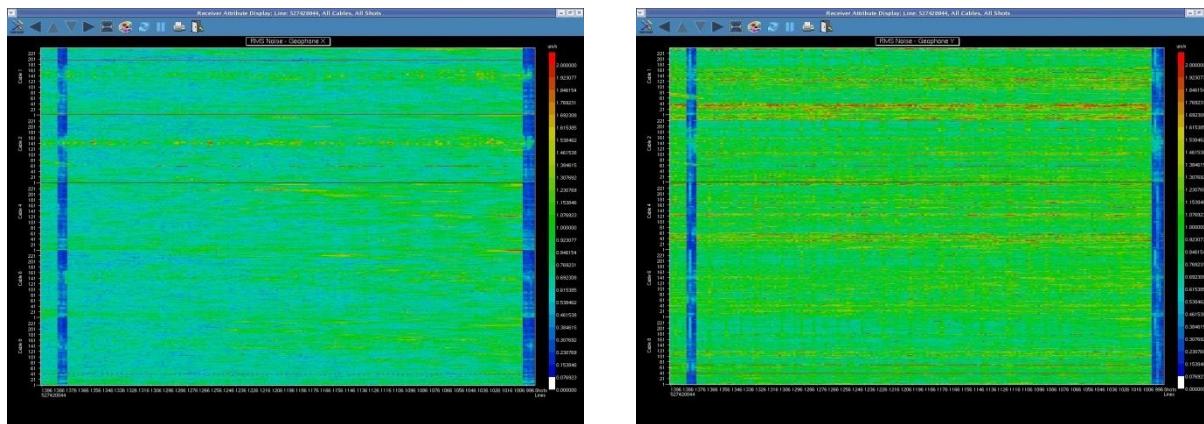


Figure 24. Online RMS attribute analysis displays (sequence 0044).

Hydrophone and vertical accelerometer top, Inline and Cross line components bottom. The scale for hydrophone is 0-100 μ Bar. Occasionally data was missing from the RMS displays due to slow data transmission displays. The vertical blue bar in each display are noise records.

5.1.3 Level 3 VSOQC

The level 3 VSOQC is the transfer of raw data across the radio link. A compressed shot record can be launched using a simple click from either the Level 1 or Level 2 QC displays (figure 23). This allows the user to see an 8-bit representation of the raw shot data for any cable / component.

Raw shot data was sometimes transferred on the 2.4GHz radio bandwidth from the buoy recorders to the master vessel for review when necessary to evaluate noise. This was routinely done in areas where excess environmental noise was present, especially in the zones around working production and/or storage platforms.

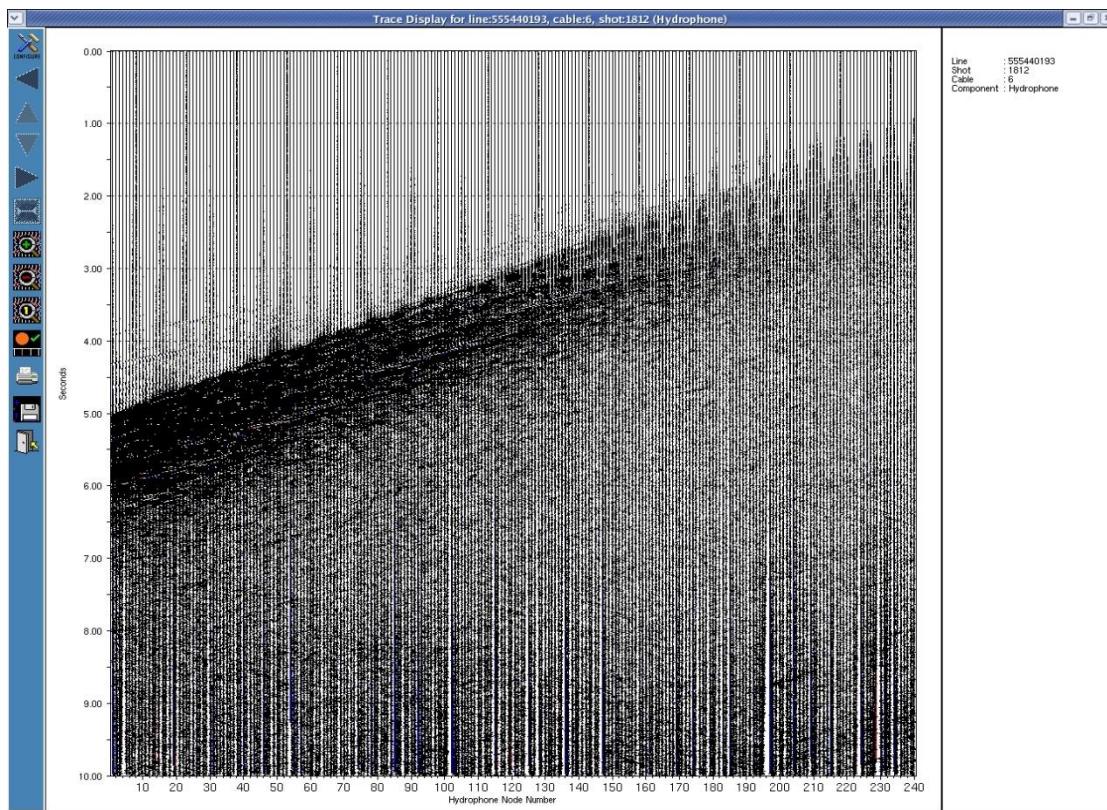


Figure 25. Example Level 3 Raw Shot Record with low cut filter and time variant gain.

5.2 Source QC

RXT employs the Big Shot gun controller system supplied by Real Time Systems.

5.2.1 Online Gun QC and Reporting

The gun controller provides volume and pressure information online, as well as automated reporting of misfires, autofires, delta errors, and other gun related errors.

A hydrophone is attached to each gun cluster and suspended approximately 1 meter above the gun ports. These sensors are referred to as the near field hydrophones. The near field hydrophone data is displayed in real time on the Big Shot HYD graphical interface as shown below. Discrepancies in gun volume, pressure, and timing are most easily observed in the character of the bubble.

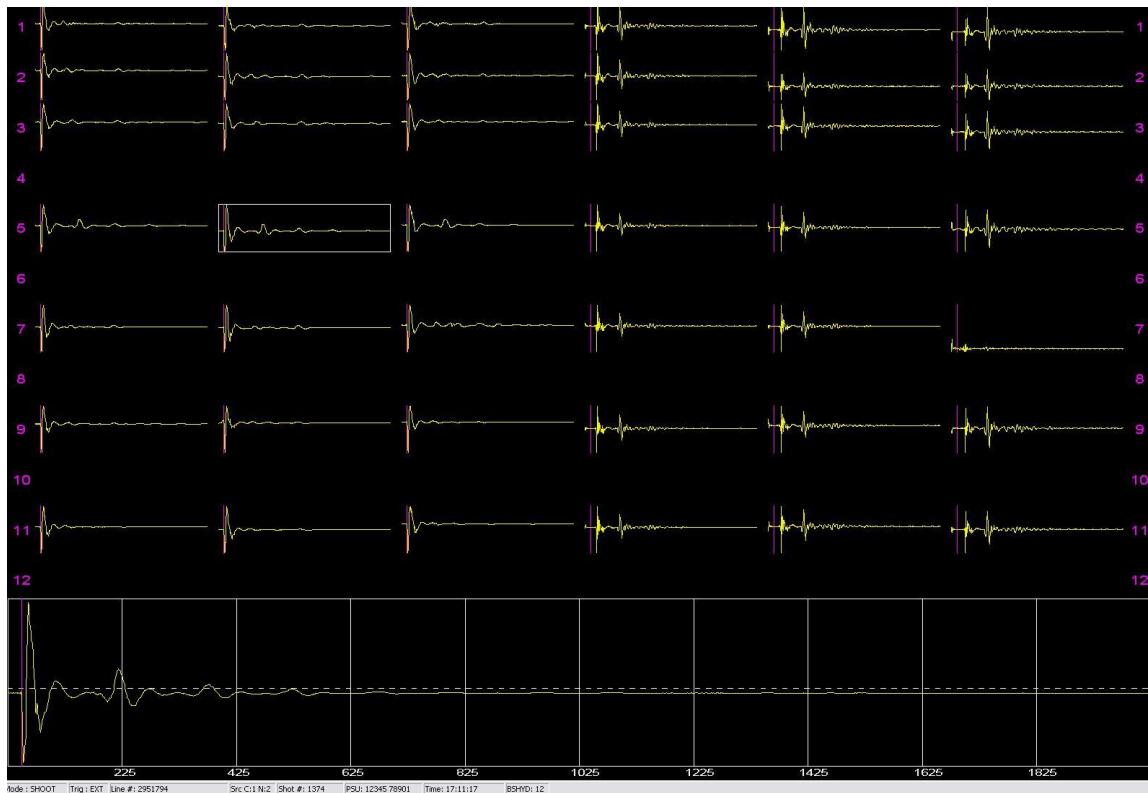


Figure 26. Big shot HYD real time screen display

5.2.2 End of Line Near Field QC

Near field hydrophones were used to check for any problems in the source output. Each hydrophone signature was displayed online on the Real Time Systems Big Shot HYD window. In addition a SEGY file was generated online and was analyzed at the end of each sequence, or during the line if required. The near field SEGY data was displayed in a manner such that source inconsistencies were clearly detected. Even those sequences that were not to be processed were checked in order to catch potential air leaks which will essentially carry on to the next line. The following is a list of the data analysis techniques performed at the end of each sequence.

Four different data analysis techniques were performed in order to detect possible source anomalies such as air leaks, timing errors, auto-fires, incorrect volume usage, pressure drops, and delta errors (Table 3).

Technique	Description	Primary Purpose	Display
Spliced Array	Individual channels spliced together for each array in order from front to back. One trace per shot.	Air Leak Detection, Volume changes.	Figure 25
Amplitude Comparison	Port array channels are spliced together with Starboard array channels.	Volume Control	Figure 26
Autofire detection	Stack of all the channels for each shot, one trace per shot. Display of 12 sec	Autofires	
Consecutive source stack	The previous shot is inverted and stacked with the current shot	Detection of autofires or misfires	Figure 27

Table 3. Near field source anomaly detection methods used on each sail sequence.

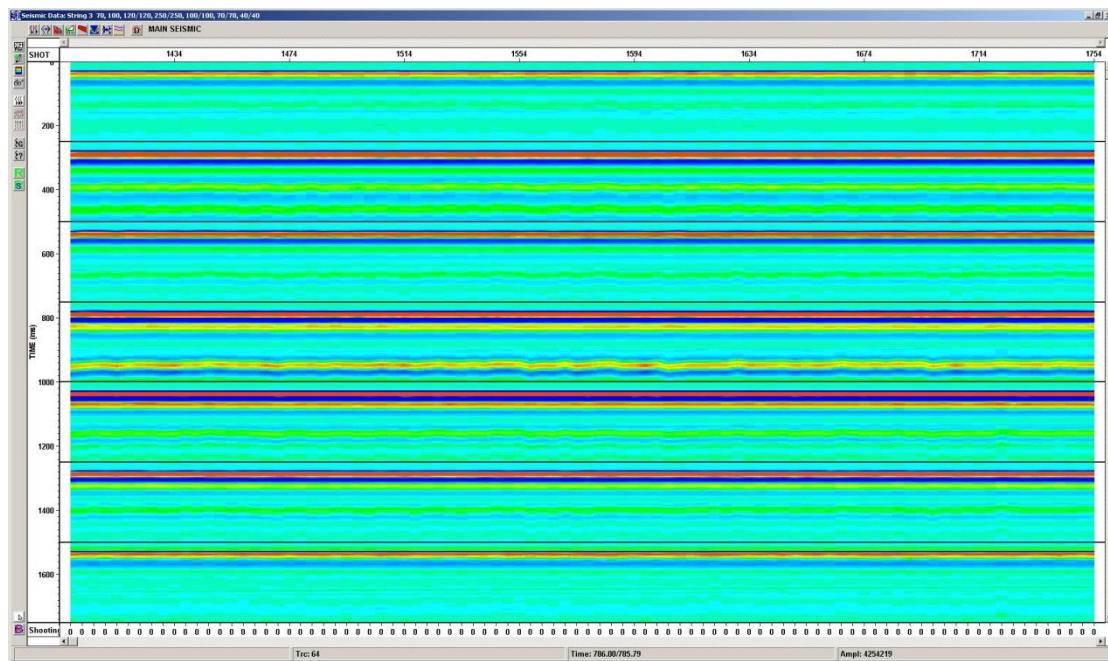


Figure 27. Spliced near field display for air leak detection, sequence 109 string3

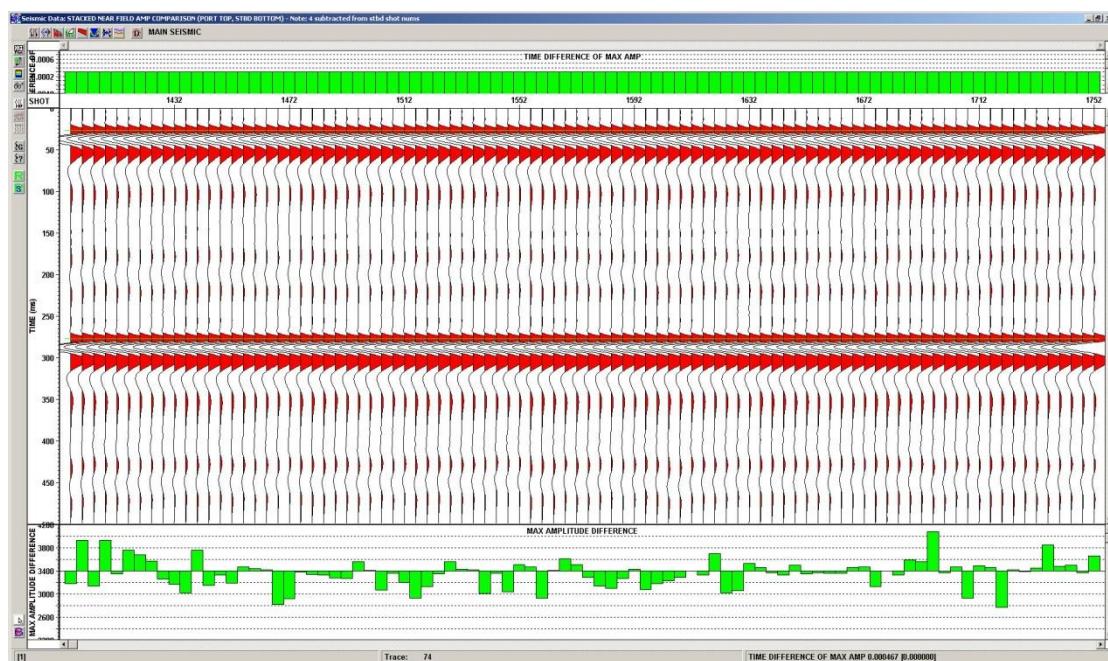


Figure 28. Amplitude comparisons.

Port Array is on top and Starboard Array is on the bottom, sequence 109.

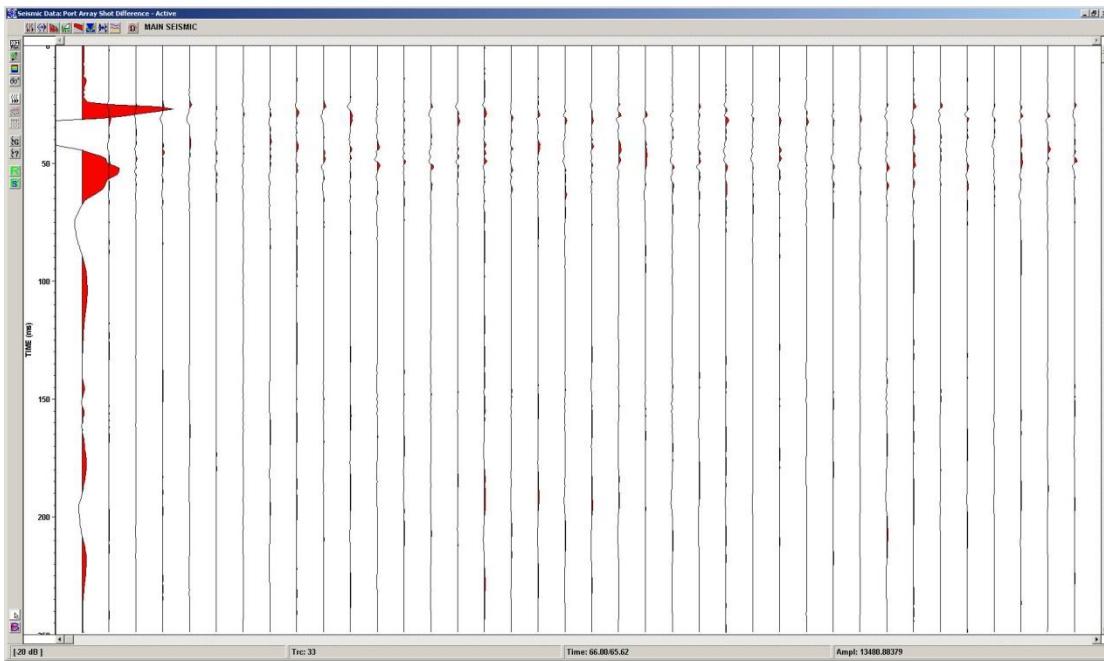


Figure 29. Auto fire detection display, sequence 109. The first shot has no previous shot to compare.

5.2.3 Gun Volume Verification (Bubble Test)

In addition to the online QC techniques, a ‘bubble test’ was performed at the beginning of the Njord survey completed just prior to shooting Volve. The test was run with a production cycle time of 12 seconds between the guns being fired. This test was performed in order to verify that the bubble period of each gun matched that expected using the Rayleigh-Willis Formula. This was achieved by firing each individual gun up to 5 times and calculating the average bubble period. The Rayleigh-Willis constant was calculated for each gun and compared against the average value for that particular volume throughout the array.

The period of each gun was plotted against the cubic root of the individual gun volume and a linear best fit was calculated (figure 28). For this project, it was found that no bubble periods deviated by more than 7.1% from the best line fit gradient value.

It is standard procedure to perform a new bubble test for every project. In this case though, the gun configurations were not altered between the Njord and Volve surveys and since the surveys were back to back, the client was comfortable with the bubble test results from Njord. Any time a gun was changed out due to failure, that particular gun was re-bubble tested to ensure conformity.

	Prepared by: Client: Project Number: Date:	RXT QC Department Statoil RXT10010 October 2010
---	---	--

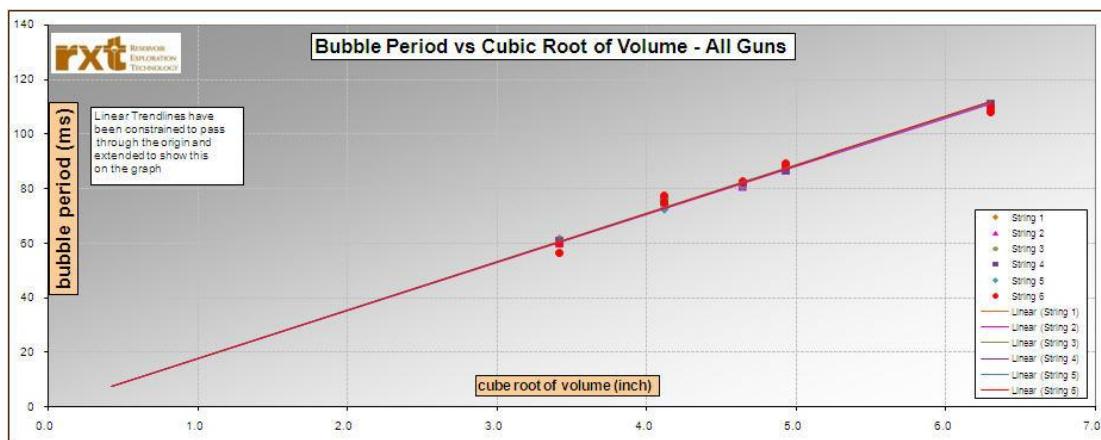


Figure 30. Bubble period versus cube root of volume for all guns.

5.3 Instrument Tests

Instrument tests were performed for each cable deployment. The following suite of tests was performed using VSO system:

- Accelerometer Gravity Sum Test
- Digital Loopback
- Hydrophone Channel Noise
- Hydrophone Channel Impulse (no sensor)
- Hydrophone Channel Impulse (with sensor)
- Sensor Noise (lo-cut 18Hz)
- Sensor Noise (lo-cut out)

The results from the instrument tests were analysed to ensure consistently failing hydrophones or nodes were identified and entered into the acquisition logs. Nodes or hydrophones that failed the same test over two different cable lays were changed out when feasible.

6 DBU PROCESS

The VSO Data Bucket Unloader (DBU) is a system for unloading, converting and reading seismic data (files) from the VSO buoys. The DBU transfers data from the data buckets to disk and applies de-multiplexing, scaling and vector rotation. It utilizes information from the VSO recording system and database and keeps track of any missing data.

After the data 'bucket' was recovered from the buoy, it was connected to one of the two Data Bucket Unloader (DBU) onboard the cable handling vessel. There the data was copied onto the DBU station's hard drive and converted to SEG-Y format. Once the data was read into Vista processing software and verified, a seismic data backup tape in SEG-Y format was output (referred to as the "raw" tape).

After creating the raw data backup tape, the data was deleted from the bucket and the bucket returned to the "available" bucket pool ready for redeployment.

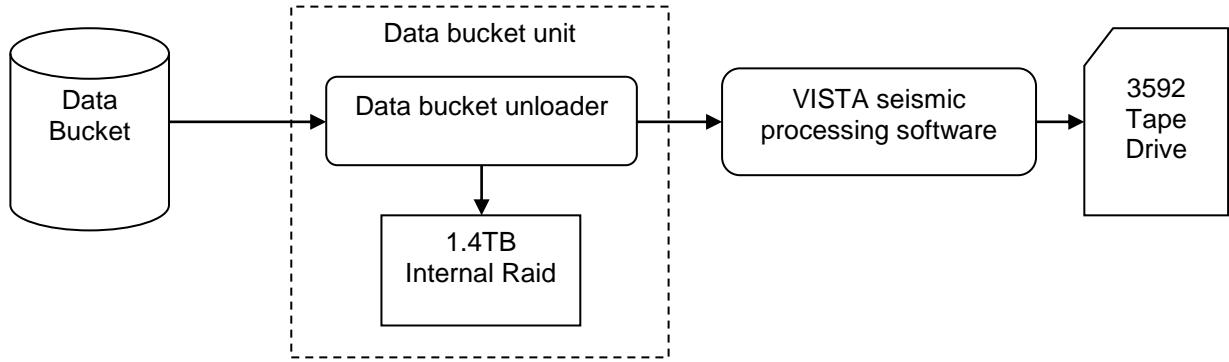


Figure 31. Configuration of data retrieval system

6.1 Raw data retrieval/transcription (DBU)

The primary function of the DBU process is as follows:

- Hardware/VSO database interface for retrieving buoy data and storing on RAID media
- Conversion from VSO buoy storage media format to SEGY format
- 3-C Data rotation (VOR) (figure 30)
- Horizontal Polarity reversal (HPR) (figure 31)
- Output of SEGY disk datasets for input to VISTA offline processing system

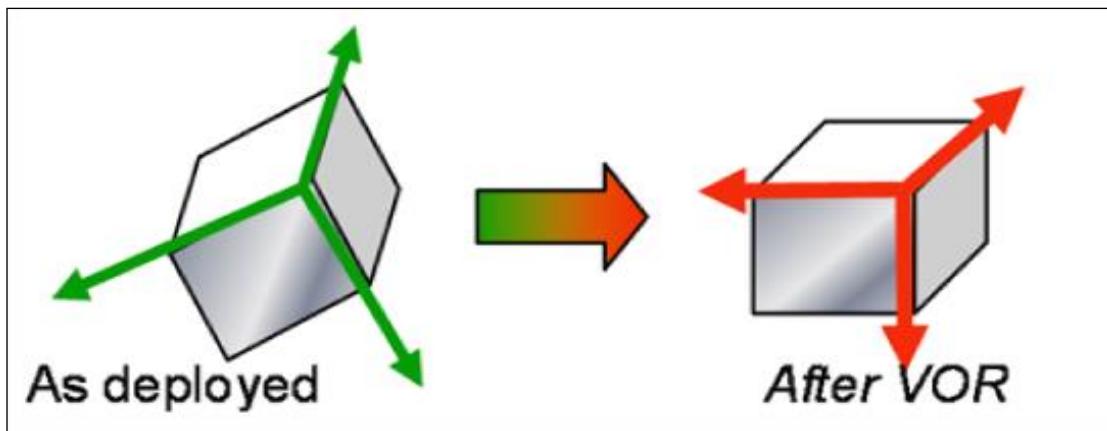


Figure 32. VOR Correction

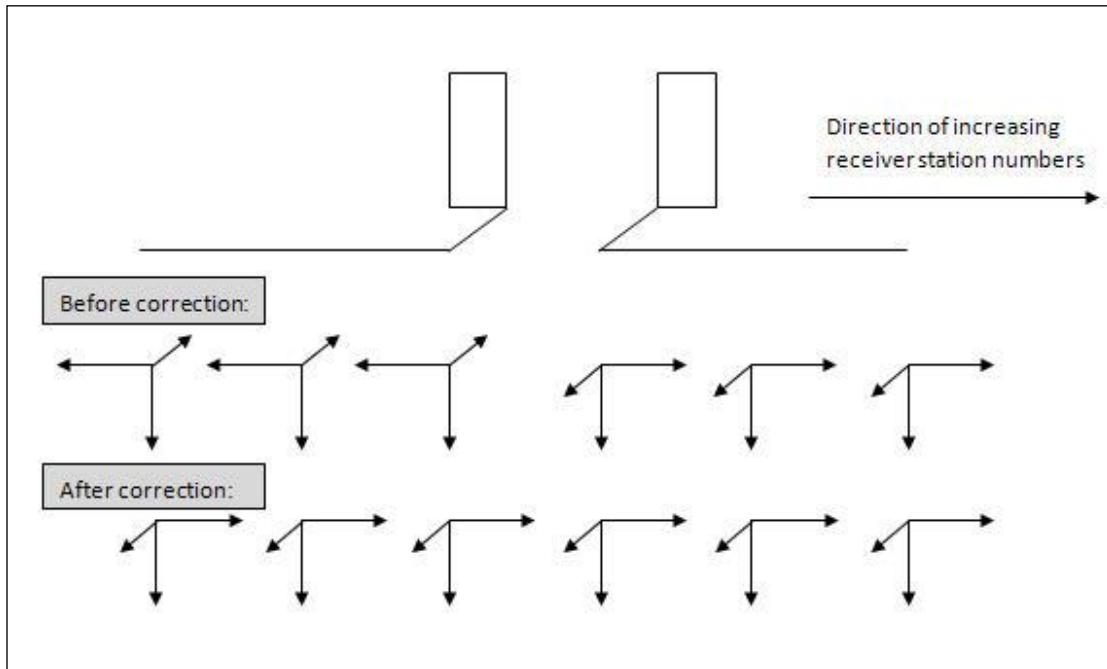


Figure 33. HOR Correction

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

7 OFFLINE QC

The offline QC effort utilizing the VISTA 3D software package was the primary function of the onboard data QC department. The focus of the QC effort can be summarized by the following 4 primary goals:

- that all recorded seismic data was completely downloaded from the data buckets and accounted for (trace accounting)
- that final SPS navigation data (source and receiver positions) was correct and error free
- that the seismic data met contract requirements with regard to acquisition and data quality
- that all final SEGY client tapes contained the correct information and were complete

To facilitate the accuracy and coordination of this effort, all QC processing was performed on a Receiver Line (RL) basis.

7.1 DBU (Data Bucket Unloader) Data Input

The raw data stored on the DBU machine raid drives were read directly into the Vista QC processing machines, merged with preliminary receiver SPS data from navigation and prepped for offline data QC. This preparation process involved the creation of several individual QC datasets that were used in the subsequent QC steps. These output QC datasets included:

1. Near trace data (-1000 to +1000 meters offset or more, depending on the water depth)
2. FB pick ASCII file (passed to navigation for shot and receiver positioning, Hy only)
3. Spike QC dataset
4. DBU post-plot (for aerial display of the initial shot and receiver locations)
5. Missing Shots dataset (for interactive graphical display of all shots for a given RL)
6. VOR edits dataset
7. Raw dataset including every 8th receiver
8. Raw dataset including every 15th FFID
9. Raw dataset including all recorded data for a given RL (for use in final SEGY tape output)

The above datasets had minimal processing applied that included only data sorting for the specific QC process, data resample to 4 msec. and in some cases a 4-94 Ormsby band-pass filter application.

7.2 Data Trace Accounting

7.2.1 Initial Trace Accounting

Using the Raw dataset for a given receiver line that included all recorded data, the data were sorted by sequence and the total number of traces for each sequence were carefully checked against the theoretical number of traces expected based on the acquisition parameters. The theoretical number of traces can be determined by the following simple equation:

$$(\text{Number of shots}) \times (\text{Number of ground stations}) \times (\text{Number of Components})$$

After considering the number of NDR (no data recorded) shots present for the receiver line, any discrepancies were thoroughly investigated to ensure that no data were lost during the

data download. Trace account discrepancies were crosschecked against the Acquisition logs, Navigation Department QC log, and the VSO web interface. All trace accounting information was entered in the QC Log spreadsheet.

7.2.2 Missing Shot Data Check

After the initial trace accounting was performed, an interactive cross-plot of the shots (shot point number) versus sequence number was displayed. Shots that were missing from the cross-plot were missing from the receiver line dataset and were checked against expected NDR shots and edited (bad) shots in the Acquisition logs. As before, all missing shots were accounted for and documented in the QC Log spreadsheet before the QC process continued.

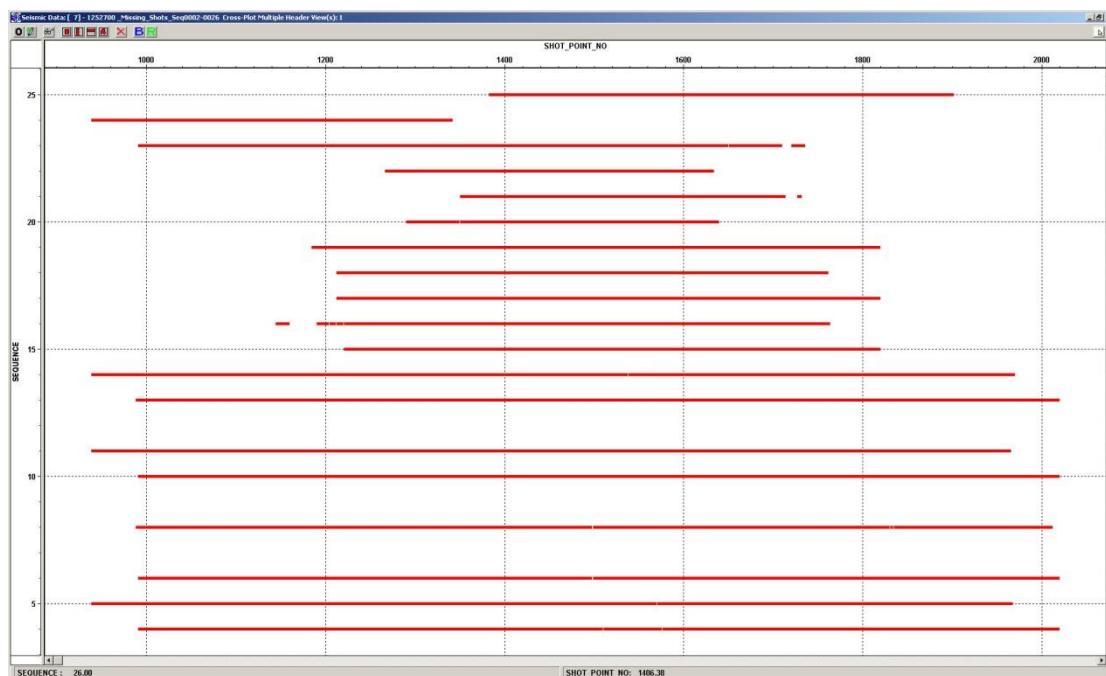


Figure 34. Missing shot point display

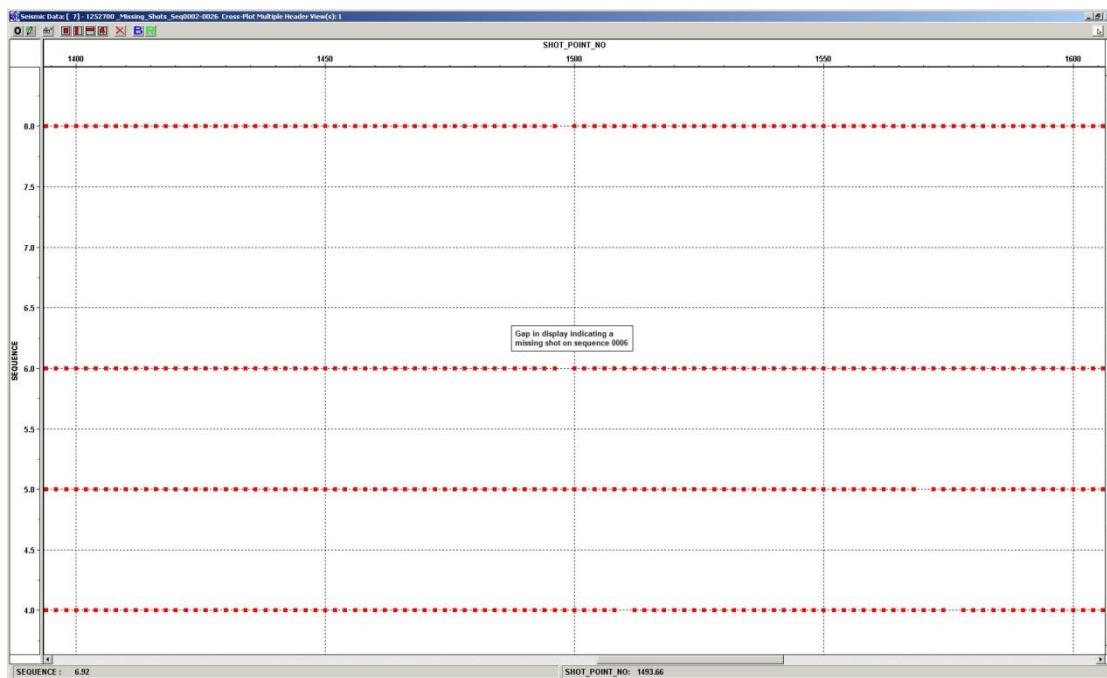


Figure 35. Zoomed display showing missing shots

7.3 QC Data Analysis

7.3.1 Frequency Analysis

F-X analysis displays were produced for each receiver line to check the signal content while monitoring the water layer reverberations within the spectrum. Their main purposes were to ensure that the contract requirements with regard to spectral content were satisfied and that the signal bandwidth was generally consistent between lines. In addition, these analyses are also a good indicator of any electrical interference present in the cables. In most of the F-X displays noise from the propellers of the source vessel could be seen in the near offsets. The noise appeared on all four components and covered the full frequency spectrum with slightly higher lower frequency amplitudes.

Four analysis displays were produced and included:

- Common shot P-wave (Hydrophone and Vertical accelerometer)
- Common receiver P-wave (Hydrophone and Vertical accelerometer)
- Common shot C-wave (IL and XL components)
- Common receiver C-wave (IL and XL components)

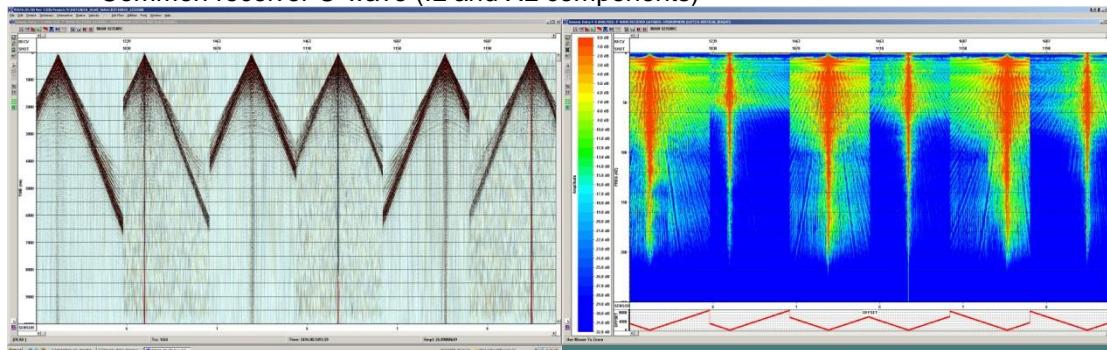


Figure 36. Common Receiver FX display of Hydrophone and Vertical Accelerometer

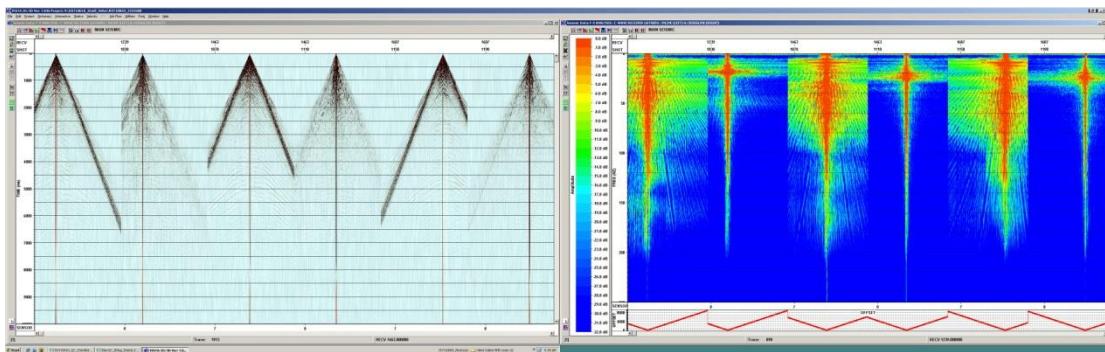


Figure 37. Common Receiver FX display of Inline and Xline Accelerometer

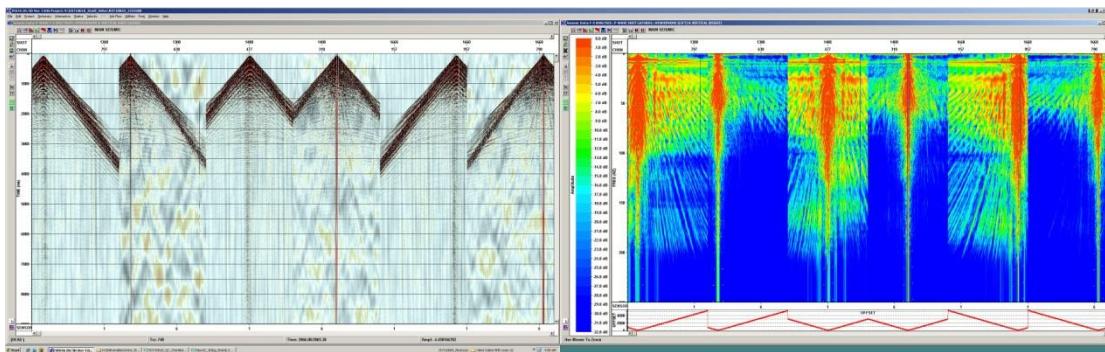


Figure 38. Common Shot FX display of Hydrophone and Vertical Accelerometer

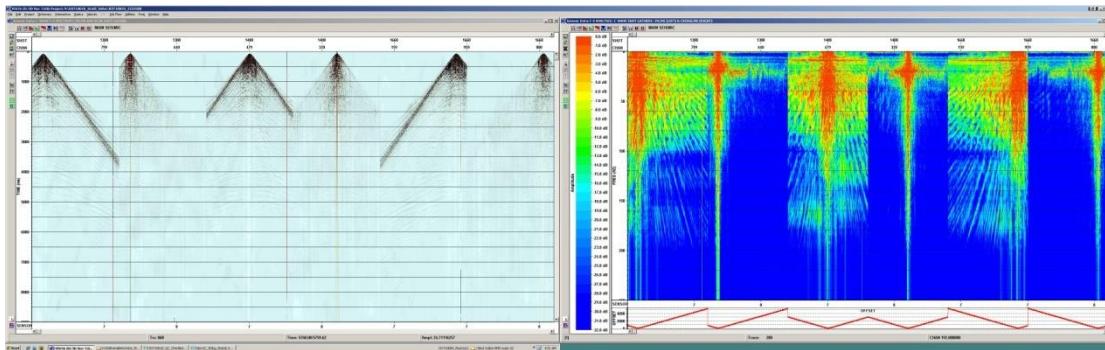


Figure 39. Common Shot FX display of Inline and Xline Accelerometer

7.3.2 Bad Shot Identification

All shots for each sequence contributing to a given receiver line were decimated and displayed for an initial review of overall data quality and to determine bad shots for editing. It was also utilized to identify the presence of noise phenomena such as spiking/electrical leakage, parity errors, seismic interference (SI), and boat/tanker noise. All shots that displayed timing errors, auto-fires and misfires were entered into the acquisition logs and flagged in the SEGY headers for editing. These identified bad shots were cross checked against the Acquisition logs with additional edits added to these logs if necessary.

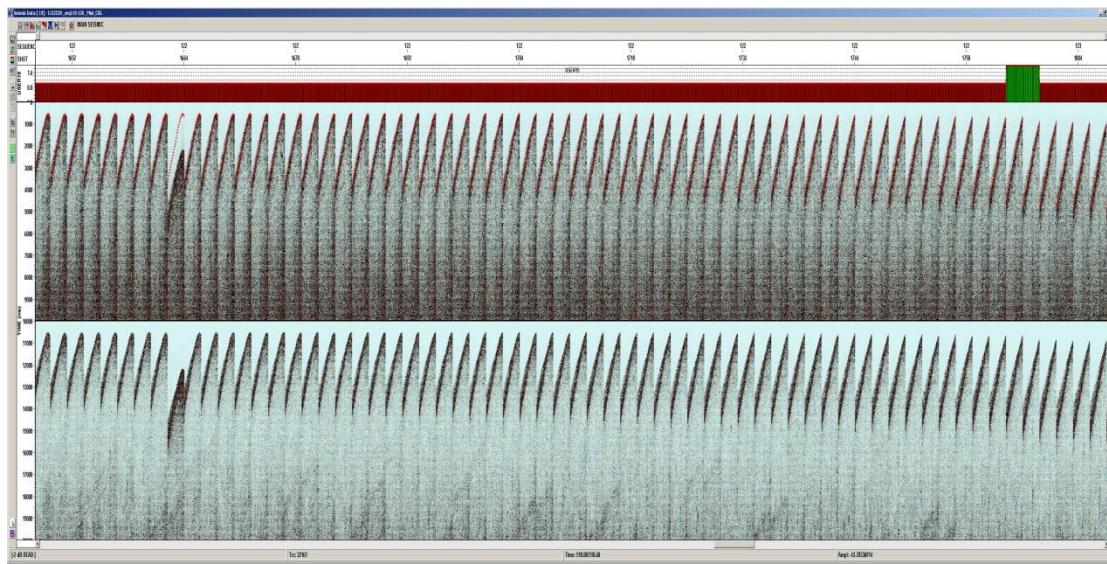


Figure 40. Decimated hydrophone and vertical component shot gathers. The bar graph at the top of the display is used to indicate the production range (red) and first or last shotpoint (green). A buoy timing error can also be seen towards the left on the display. Example from receiver line 1152220.

7.3.3 Bad Channel Identification

This QC was performed on every acquisition sequence by visual inspection of common receiver gathers for each component. The receivers that were consistently noisy, weak, dead or otherwise bad were flagged and added to the list bad receivers on the acquisition log. A list of these edits can also be found in the provided text edit files included as part of the client deliverables. A distinction was made in the channel edit files between those channels which were bad due to instrument problems and those failing due to environmental or external sources.

Note that these edit files and header flags are meant to be a guideline for the processing contractor. The channels have been flagged in the field on the basis of noise and instrument specifications provided by the client. The actual number of traces requiring editing will be a function of the techniques employed by the processing contractor. Edits were flagged for the entire node (i.e. 4 components) if one of the components was bad.

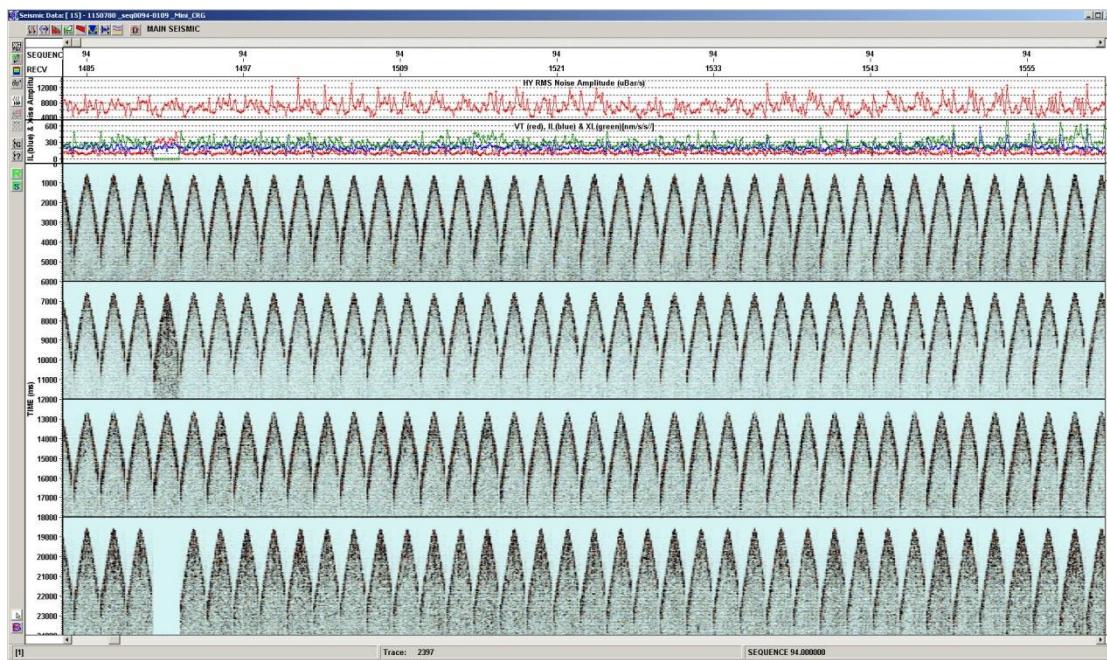


Figure 41. Hydrophone (top), followed by vertical, IL and XL component receiver gathers. A dead accelerometer node is present, RL1150780.

7.3.4 Polarity QC

The purpose behind this QC was the identification and verification of any channels that were recorded with the incorrect polarity. It was also used to confirm that the VSO system adhered to the Society of Exploration Geophysicists (SEG) multi-component polarity standards (GEOPHYSICS Vol. 67, p1028-1037). The forward line direction is in the decreasing receiver station direction. The VSO co-ordinate system is right handed.

- X (inline): The polarity is negative if motion towards high receiver station no. (right-hand index finger pointing away from body while looking in the increasing receiver station direction).
- Y (crossline): The polarity is negative if motion towards right of cable, facing high receiver station no. (Right-hand middle finger pointing to the right).
- Z (vertical): The polarity is negative if motion is upwards. (Right-hand thumb pointing up). Positive polarity if motion is downwards.
- P: compression gives negative output, rarefaction caused a positive output

Near offset linear event data was corrected using LMO (Linear Move-Out) and stacked for each receiver station. The offset range of the pre-stack data is determined by the event being stacked.

This display was also used to determine any receiver station electrical faults. A receiver stack display was investigated for each receiver line deployment. Any trace which was found to have a polarity reversal was corrected and flagged prior to outputting the final SEGY field tapes.

	Prepared by: Client: Project Number: Date:	RXT QC Department Statoil RXT10010 October 2010
---	---	--

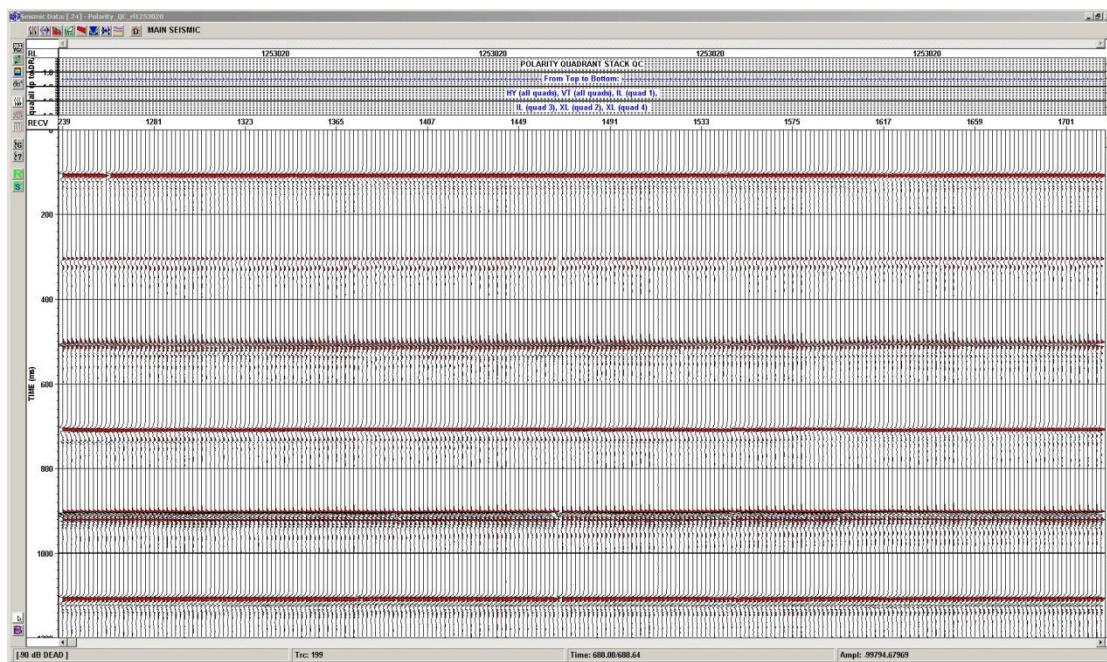


Figure 42. Polarity QC via receiver stack

Image corresponding to receiver line 1253020. On the first 200 ms the hydrophone traces are displayed. From 200-400 ms vertical component traces are displayed. From 400-800 ms inline component traces are displayed (Quadrants 1 and 3). From 800-1200 ms crossline component traces are displayed (Quadrants 2 and 4).

7.3.5 Brute Stacks

Brute stacks of the hydrophone (HY), vertical component (VT), dual sensor (HY and VT) summation, and inline component were created for every RL in the project. The data was gathered from the nearest Sail-Line adjacent to the RL to ensure near offset contribution. The hydrophone and summation stacks were representative of the P-wave data while the inline stack was representative of the C-wave data. All stacks were displayed in full time and the displays were provided as client deliverables.

7.3.5.1 P-Wave Stacks

The following brute stack processing flow was applied to both the hydrophone and vertical accelerometer data:

- Brute stack input (adjacent Sail-Line gather)
- Offset limit to 0-3000 meters
- Datum static correction (source and receiver correction)
- Spherical divergence correction (average regional velocity)
- Ormsby Band Pass filter (3-90 Hz)
- CMP bin grid application
- Trace mute (Top and bottom mutes)
- NMO (Stretch mute: 15 %)
- CMP stack
- Time variant scaling

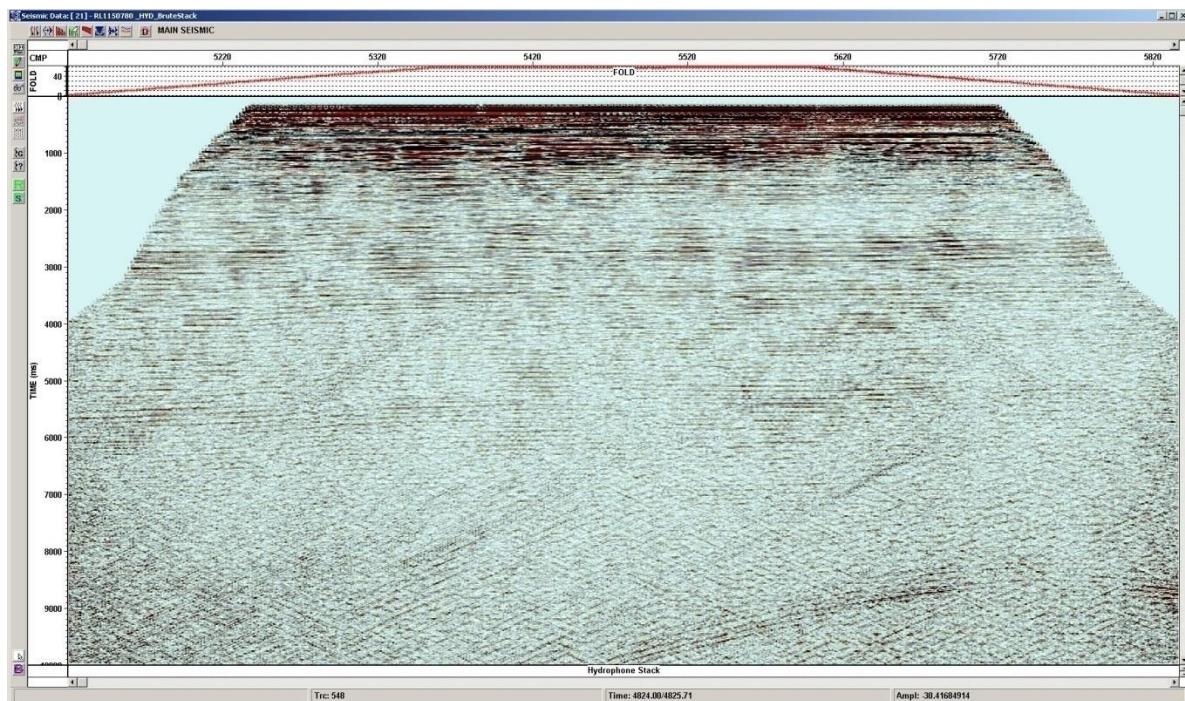


Figure 43. Hydrophone component brute stack. Receiver line 1150780.

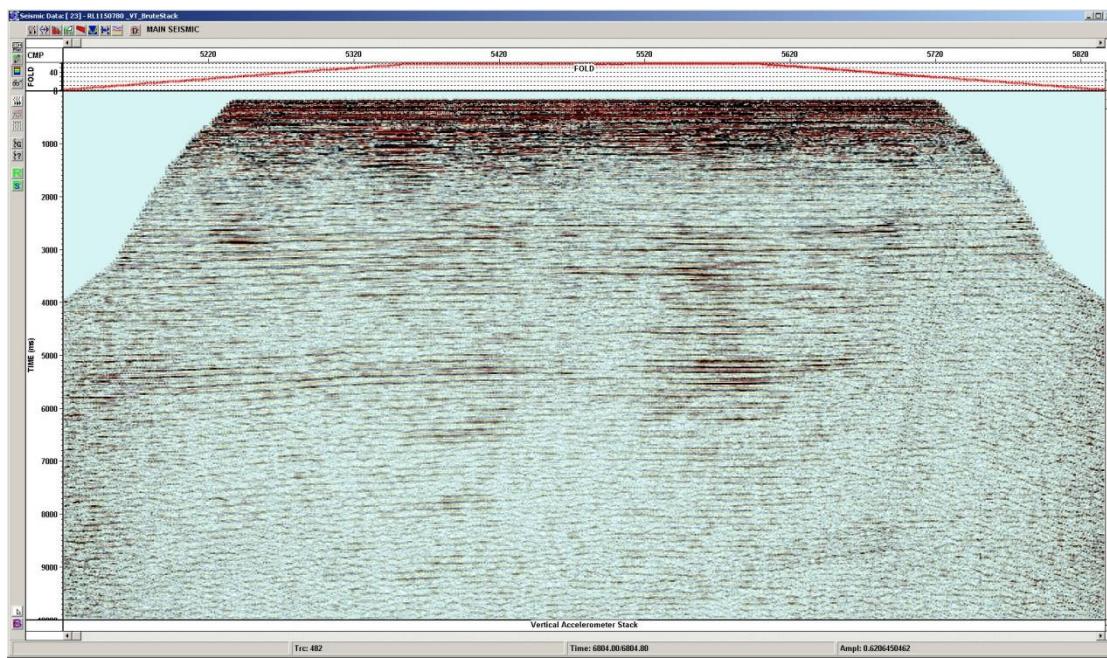


Figure 44. Vertical component brute stack. Receiver line 1150780.

7.3.5.2 HY and VT Summed Stack

The hydrophone (HY) and vertical component (VT) summed stacks were created by multiplying the VT sample values by a simple constant prior to summation with the HY data. The scalar used was 29.4. No post summation scaling was applied.

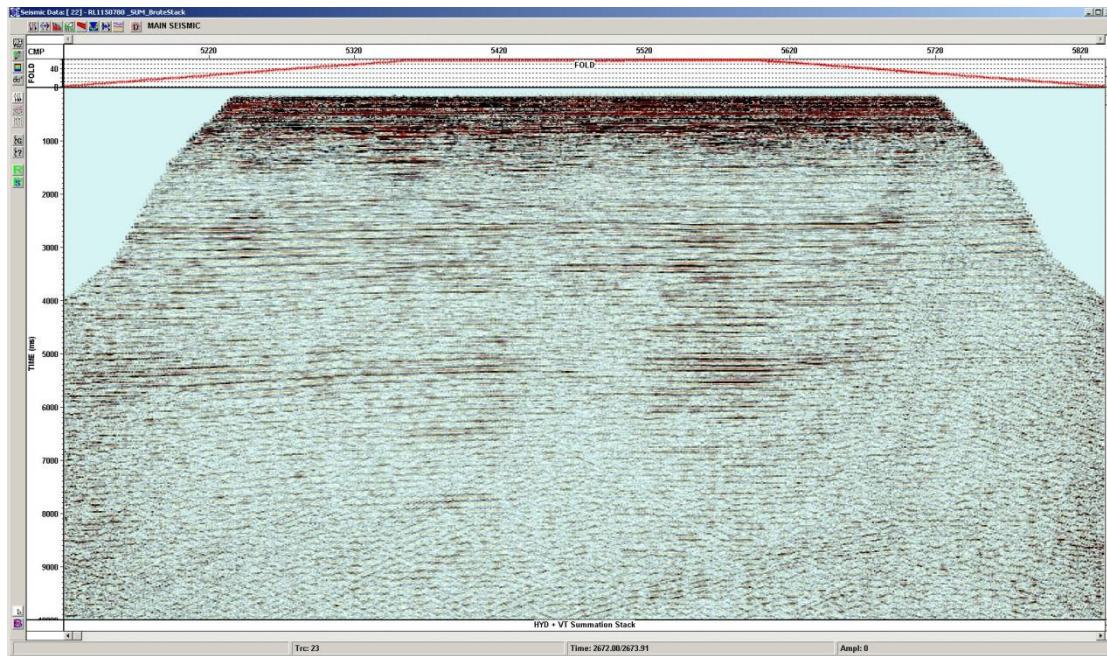


Figure 45. Dual sensor (HY + VT) summed brute stack. Receiver line 1150780.

7.3.5.3 Converted Wave (C-wave) Stack

The following brute stack processing flow was applied to the inline component:

- Brute stack input (adjacent Sail-Line gather)
- Offset limit to 150-3000 meters
- Datum static correction (source and receiver correction)
- Spherical divergence correction (average regional velocity)
- Ormsby Band Pass filter (3-90 Hz)
- Trace mute (Top and bottom mutes)
- CCP bin grid application
- Data sort (In-Line)
- CCP 3D stack
- Time variant Band Pass filter

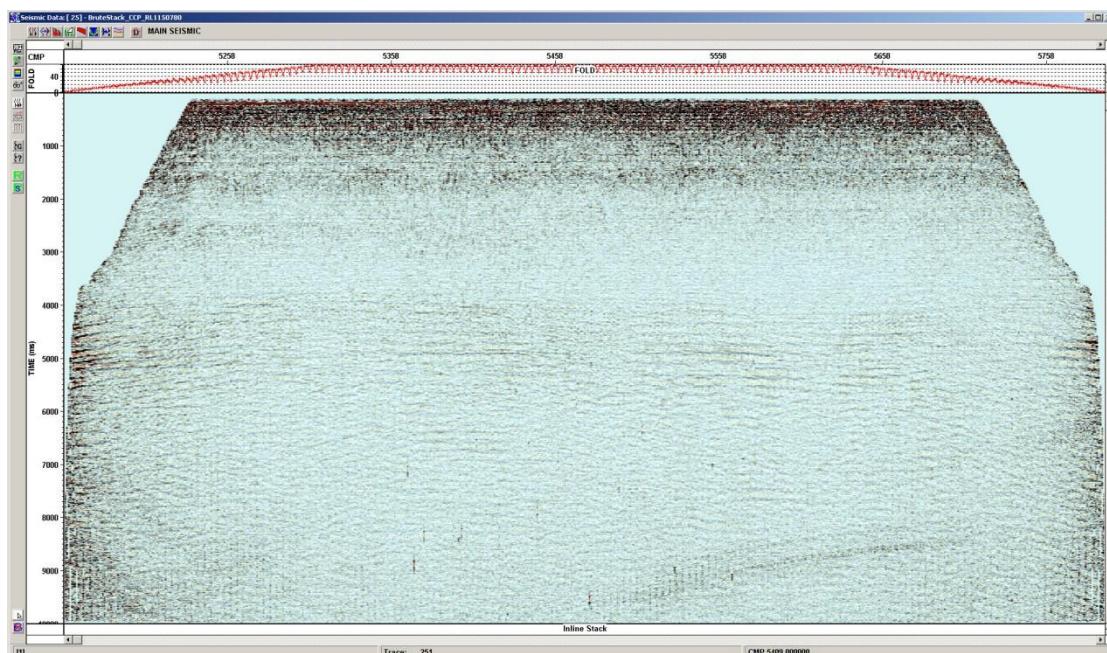


Figure 46. Inline converted wave brute stack. Receiver line 1150780.

7.3.6 RMS Decay

Statoil required an RMS shot decay analysis at the start and end of line. Due to the short interval inherent in OBC line changes, it was agreed with the client that there would be one RMS decay analysis between line changes rather than two unless there was a prolonged line change for some reason, i.e. weather downtime, equipment repair, etc.

Statoil's procedure for the shot decay analysis was to record a shot for 30s and then have a running RMS analysis for each component to evaluate how quickly and to what background the RMS level decayed. In practice, a 10s shot record was taken followed by two 10s noise records were combined in processing to create a pseudo 30s record. A graph and a text file of values were output which contained the overall running RMS average, the RMS average for nodes 1-120, and the RMS average for nodes 121-240. An example graphical output can be seen below in figure 45.

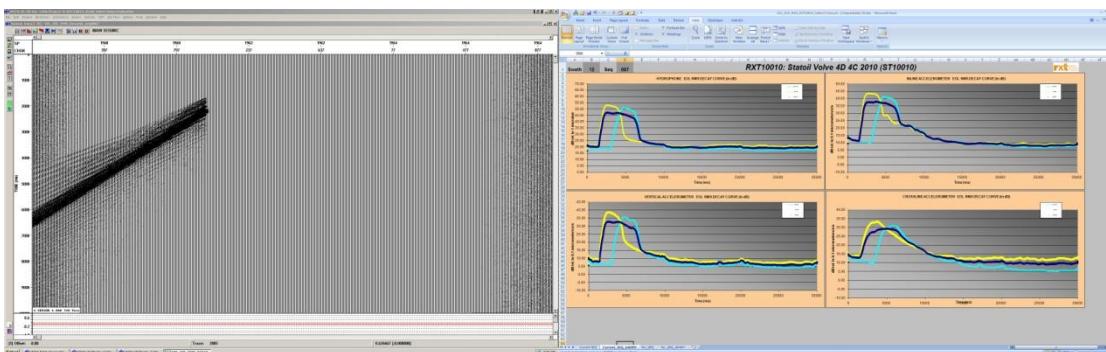


Figure 47. Example RMS decay. The decay data is displayed on the left and the RMS running average for all four components are on the right. The light blue curve is nodes 1-120, yellow is nodes 121-240, dark blue is the entire cable nodes 1-240.

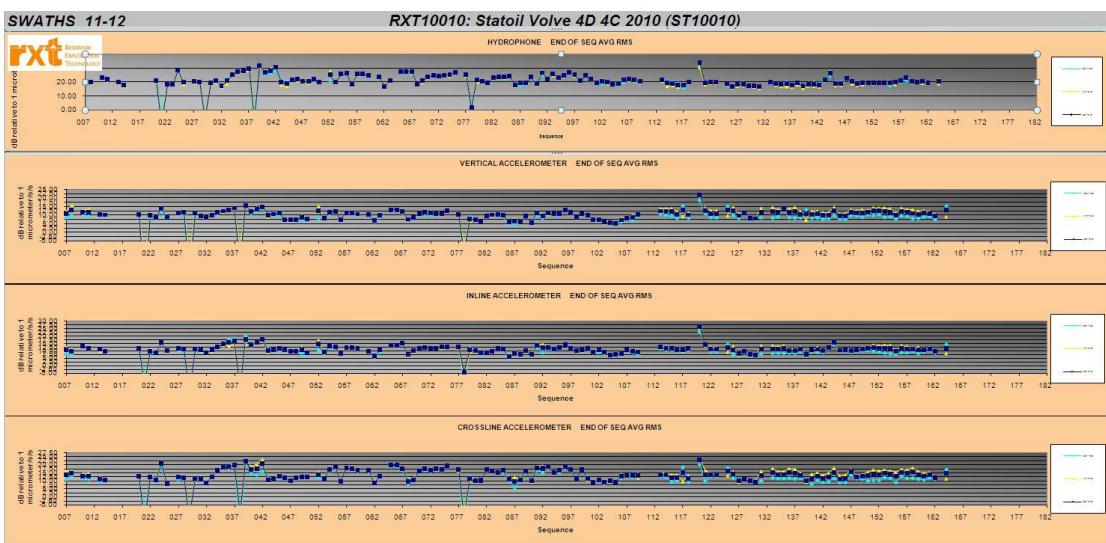


Figure 48. Combined RMS decay plot for all sequences.

7.4 Geometry (Source and Receiver positions) and General QC

One of the most important goals of data QC was to ensure that both shots and receivers are positioned correctly. Therefore, special attention was paid to the process of data positioning and any problems encountered were discussed promptly with the navigation department. Two processes were utilized for receiver line (RL) data positioning QC that included primarily Quadrant stack creation, display and analysis as well as the VISTA software RLP (Receiver location prediction) package performed as a secondary QC step. For the shot position QC, LMO corrected common receivers were gathered by shot point ensemble and summed for display and analysis.

7.4.1 RL Quadrant Stack QC

Utilizing the Near Trace dataset as input, four 90° quadrants were defined surrounding a receiver station with the receiver line direction pointing towards quadrant 1. Since the project RL orientation was 104° from true north, the quadrant boundaries (again from true north) were defined as:

- Q1: 59.0 – 149.0 Degrees
- Q2: 149.0 – 239.0 Degrees
- Q3: 239.0 – 329.0 Degrees
- Q4: 329.0 – 59.0 Degrees

Quadrants 1 and 3 were defined as In-Line and Quadrants 2 and 4 were defined as Cross-Line. The following diagram shows the quadrant specifications for the project:

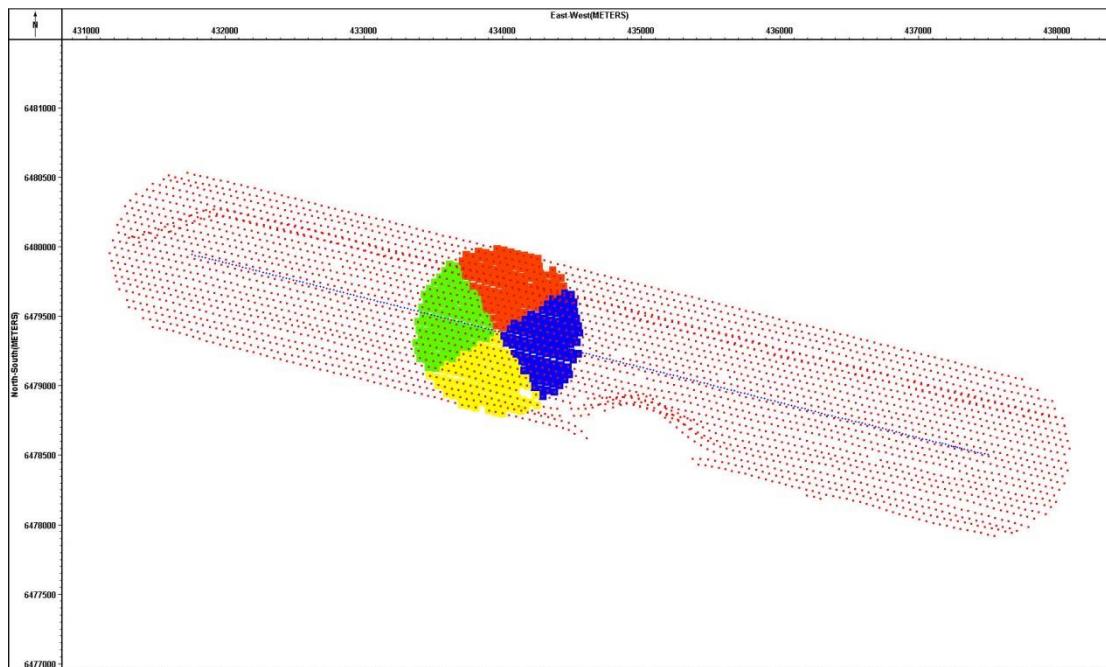


Figure 49. Quadrant definition

Blue=Quadrant 1, Yellow=Quadrant 2, Green=Quadrant 3, and Red=Quadrant 4

Using a single velocity layer approach, the Near Trace data were LMO corrected and stacked for each quadrant. The stacked data was first break picked and the pick times of opposing quadrants compared to establish positioning errors. A composite display was created with all four stacked quadrants (2 In-line and 2 X-Line) displayed with the In-Line and X-Line total error plotted graphically. The stacked quadrant data were checked for overall conformity and "flatness" and were also analyzed for uniform phase shifts that would indicate potential receiver timing problems..

The following representative display shows the stacked quadrant data with all 4 quadrants indicating a smooth flat character that is indicative of proper receiver positioning.

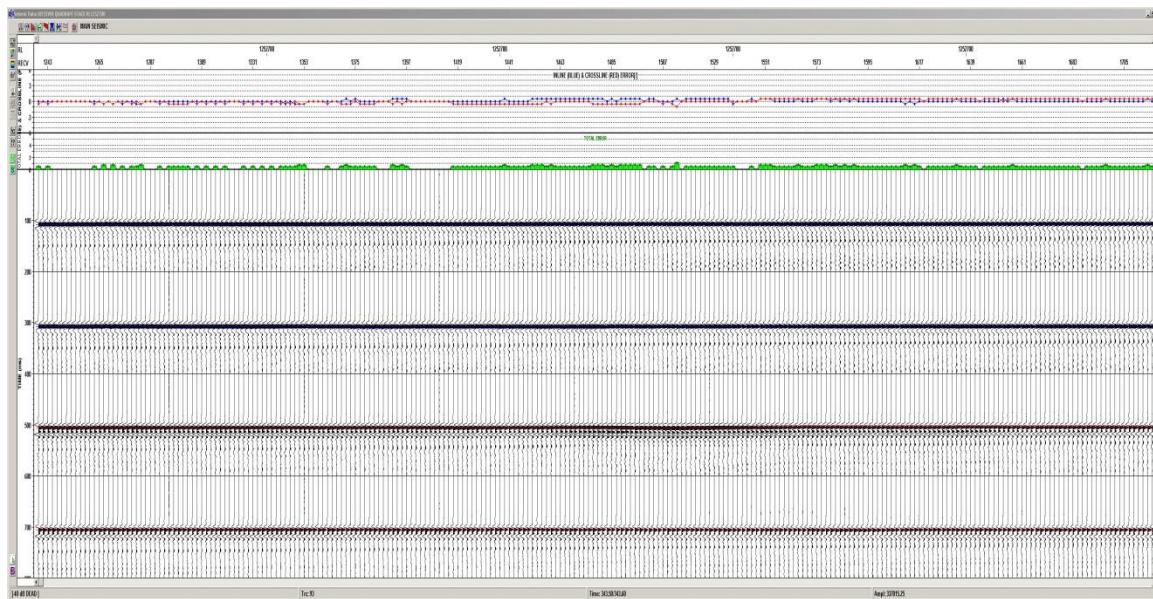


Figure 50. Quadrant Stack QC Display, RL1252700. Indicated errors are less than 1m.

If any anomalies or "busts" are observed in any one of the four displayed quadrants, the navigation department is informed and a new RL solution is solved and passed back to the QC department. This process is iterative until an acceptable RL solution is obtained.

7.4.2 Receiver Location Predictor

A second method of receiver position verification used relied on individual FBP times rather than stacked FBP times. This method utilized Vista's Receiver Location Predictor tool or RLP. This tool required accurately picked FBP to invert receiver position based on fixed shot positions. An example output is given as Figure 49.

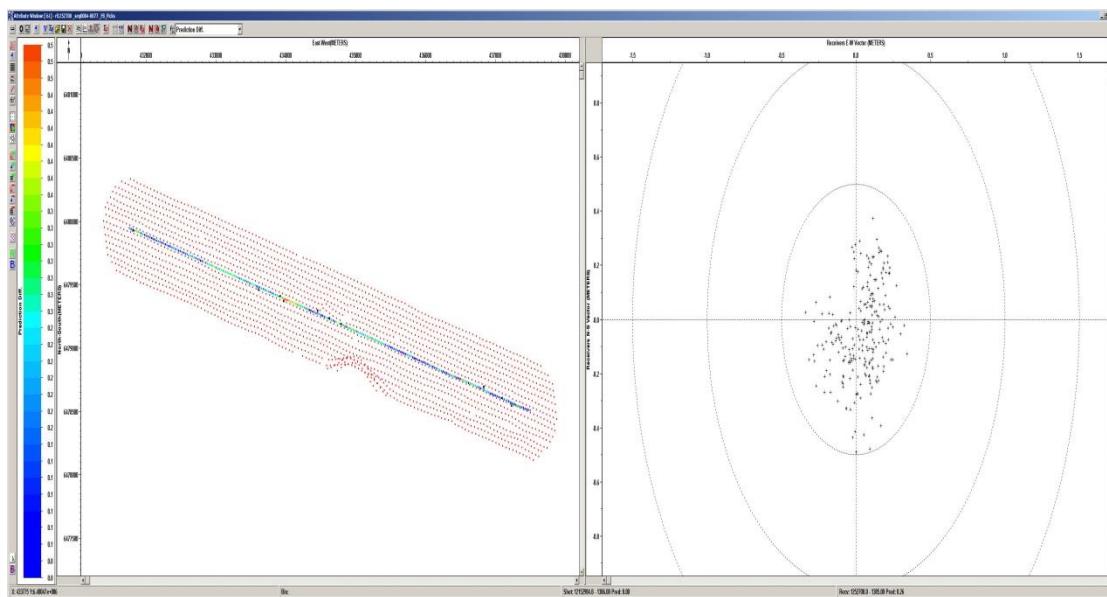


Figure 51. Output from Vista's RLP tool from RL1252700. Predicted error less than 1m. The left side of the figure is a post plot showing direction of error on a ground station basis and the right side is a bull's eye diagram showing overall error.

The well distributed azimuths and offsets led to very accurate receiver positions.

	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Prepared by:</td><td style="padding: 2px;">RXT QC Department</td></tr> <tr> <td style="padding: 2px;">Client:</td><td style="padding: 2px;">Statoil</td></tr> <tr> <td style="padding: 2px;">Project Number:</td><td style="padding: 2px;">RXT10010</td></tr> <tr> <td style="padding: 2px;">Date:</td><td style="padding: 2px;">October 2010</td></tr> </table>	Prepared by:	RXT QC Department	Client:	Statoil	Project Number:	RXT10010	Date:	October 2010
Prepared by:	RXT QC Department								
Client:	Statoil								
Project Number:	RXT10010								
Date:	October 2010								

Final Receiver Line Geometry QC results:

Receiver positions for the project were solved with a maximum error tolerance of 3 meters for the four extracted quadrants (2 inline quadrants and 2 crossline quadrants). All receiver positions that were observed to be outside of this maximum tolerance for any given quadrant were repositioned through the iterative process explained above until an acceptable result was obtained. In conclusion, all final data delivered had receiver positions that met this criterion and for the overwhelming majority of receiver lines, solutions were found to be much less than the 3 meter maximum.

7.4.3 Source Position QC

Source positions were checked by using LMO corrected common receiver gathers (HY component). For each receiver line, 5 evenly spaced receivers were selected. Each of the common receiver gathers (all shots as recorded into a unique receiver station) were LMO corrected using the offset calculated from the processed navigation source and receiver coordinates. A velocity equal to the water column velocity was used in order to flatten the direct arrival event. These five gathers were then spliced on top of one another, providing redundancy in the shot positioning check.

The displays were analyzed for inconsistent traces, inline phase shifts, and other anomalies which could indicate problems with the source coordinates. All problems were investigated and reported to the navigation department for investigation. If problems were encountered, this process was iterated until an acceptable and accurate shot position solution was achieved.

These displays were also checked to confirm that all shots were present. The first and last shot points merged were carefully checked against the acquisition and navigation logs and missing shots and shot ranges were re-verified at this stage.

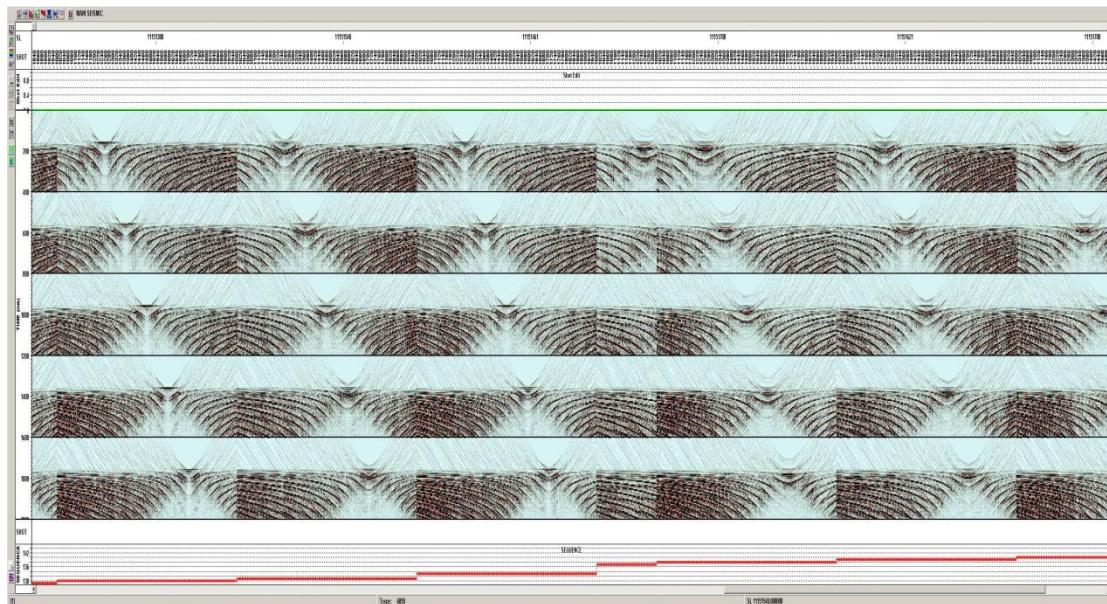


Figure 52. Source Position QC (no source position errors)

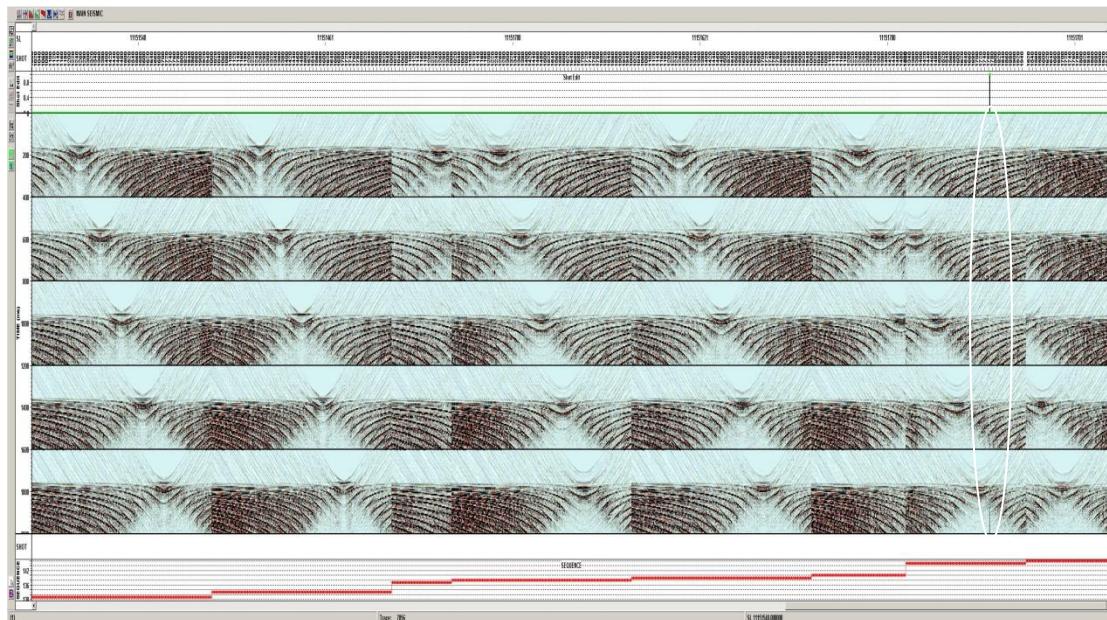


Figure 53. Source Position QC (indicating source position error)

An error in source positioning as indicated by the break along the otherwise smooth stacked direct arrivals (figure 51).

7.4.4 Client final SEGY tapes

Final client SEGY tapes were created containing one single receiver line per tape with final SPS navigation merge. The data were output to 3592 E05 500 GB cartridge tapes in IEEE floating point format. All final SEGY tapes contained both EBCDIC and binary headers. All edits pertaining to shots, receivers, and polarity reversals were flagged in the headers but not applied. In addition, a bit to bit tape copy was made for all final SEGY tapes as a backup and for use in the SEGY tape verification step.

7.4.5 Client OBC SEGY Header Description

All final SEGY data headers (binary, EBCDIC and trace headers) were created via header templates and descriptions provided by Statoil. Thorough QC of all header information was conducted on all final data to ensure that the required header information and fields met client requirements. Header examples and listings can be found in appendices 11.4 through 11.7.

7.4.6 Navigation merge Flow

As mentioned, one of the principal aims of the onboard QC department was to ensure the seismic data on tape were properly merged with the final SPS data from navigation. Final client SEGY tapes were only created after all geometry and seismic QC steps had been completed. Strict file handling procedures were implemented to ensure the correct version of SPS data were used for navigation assignment.

The final navigation files merged with the seismic data were provided by the onboard navigation department. Please refer to the navigation final report for additional details.

Examples of the source, receiver, and relational SPS file headers are provided in appendixes 11.13-11.15 of this report.

7.4.7 Client SEGY Tape Verification

All final SEGY tape copies were read back into the processing system before shipping. Shot gathers, trace counts, post plots, water depths displays, fold displays and limited offset cube datasets were created from output from the SEGY tape verification flow. These QC datasets were thoroughly examined to ensure that all information regarding the RL was correct.

7.4.8 Post Plot

Within the navigation merge final SEGY tape output flow an output header dataset was created in the VISTA database in order to graphically verify the correct co-ordinate assignment. A postplot display of all shots and receivers was generated by reading the final SEGY tape. This was used to check the overall validity of the shot and receiver positions, as well as to check that all data were properly recorded and merged.

In these postplot displays, source locations are shown in red, while receiver stations are shown in blue.

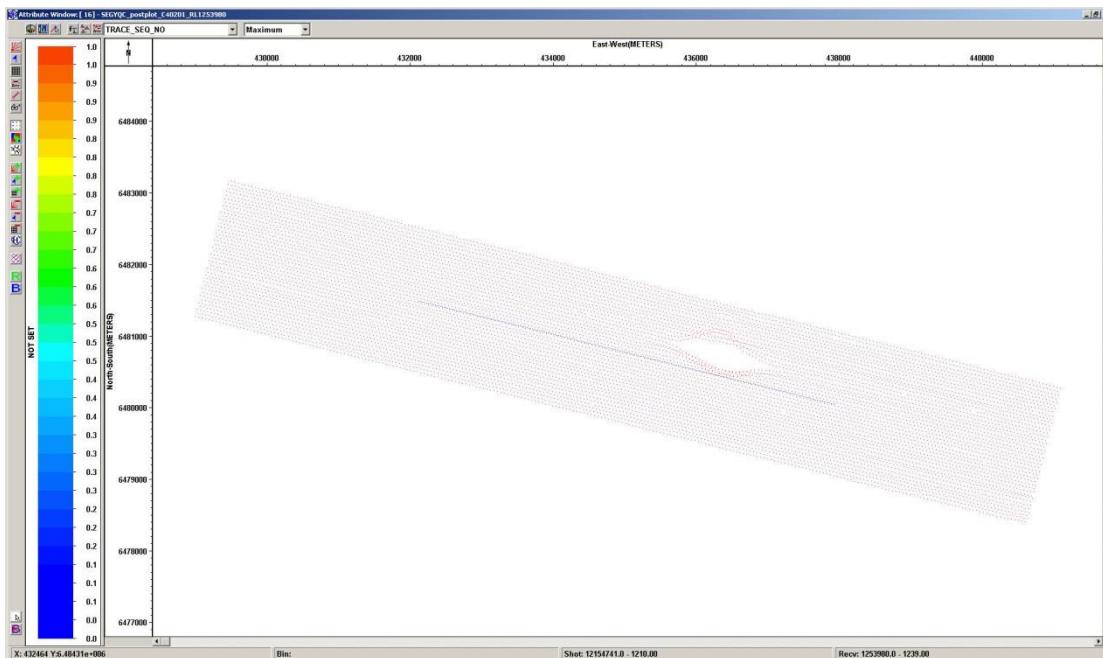


Figure 54. XY post plot extracted from client SEGY tape headers, rl1253980

7.4.9 Trace Accounting

After the final SEGY tape was input to VISTA, the trace count file was checked to verify the number of traces passed for each sequence. These trace counts were then compared to the theoretical number of traces and any discrepancies investigated. The same procedure was employed for the navigation-seismic merge job. At this stage, the number of traces with edit flags in the headers were also investigated and compared to the theoretical number expected. All trace counts were logged in a QC Log spreadsheet, and any acceptable discrepancies explained.

7.4.10 Receiver line depth QC

Special attention was paid to ensure that receiver water depths were solved correctly by navigation. The basic steps of the job were:

- 1) Select an offset range of approximately -600 to 600 meters, hydrophone data only (near trace data input)
- 2) Merge with final navigation SPS data
- 3) Select only that shot nearest to each receiver station
- 4) The total offset from shot to receiver is calculated for each station using the nearest source to receiver offset and the water depth at the receiver as written in the final navigation SPS files
- 5) A calculated arrival time is made using this offset and the average water velocity
- 6) This calculated arrival time is overlain on the seismic near trace dataset
- 7) The difference between the calculated arrival time based on the navigation depth and offset values and the automatically picked actual arrival time as seen on the near trace seismic dataset is then calculated and displayed as an error at the top of the display
- 8) Any errors in excess of 3ms are highlighted in red and investigated

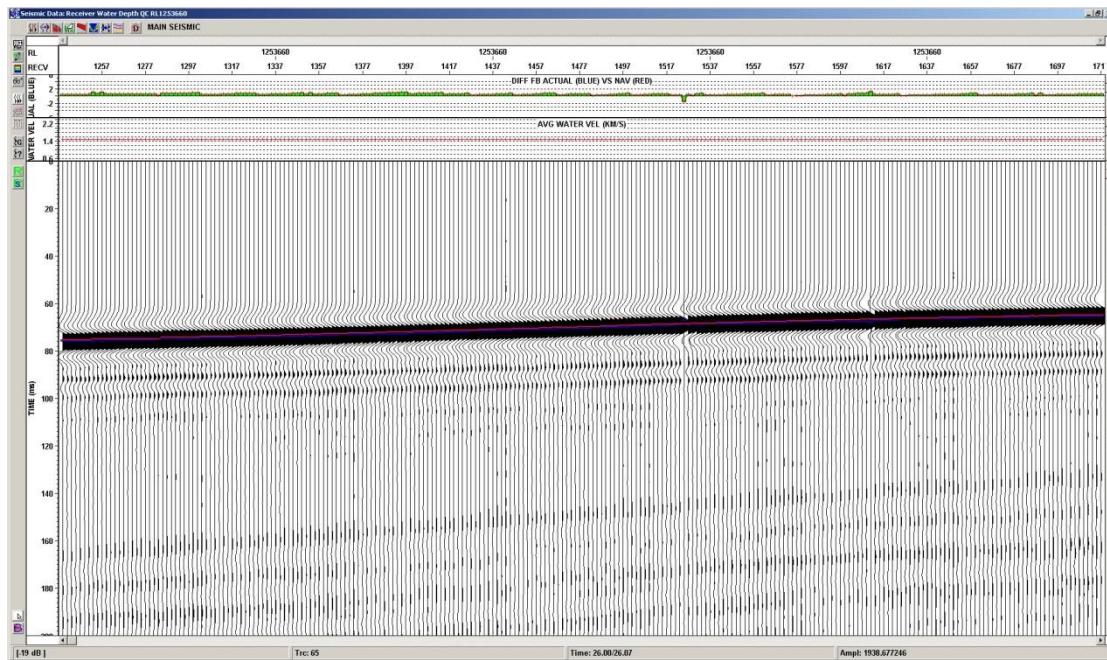


Figure 55. Receiver water depth QC, rl1253660

The above display indicates no errors in the water depths. This can be concluded by the fact that the arrival times based on water depths from the navigation SPS data and the calculated arrival times based on the near trace data using an average water velocity are within the 3 millisecond tolerance specification (green for all receivers).

7.4.11 Aerial Plot Water Depth QC (Source and receiver)

The receiver elevation, water depth at source, source depth and source elevation information was extracted from the SPS files and inserted into the appropriate SEGY data headers. This header information was then displayed spatially to check for any anomalies (Figures 54-58). All elevation, depth and tidal information as contained in the final SPS files were provided by the onboard Navigation department.

This QC was performed only as a secondary verification after the original SPS file had been created and checked by the navigation department. It was not designed to identify global survey errors, such as incorrect ellipsoids or other shifts of this nature. Additionally, it would not detect minor interpolation problems.

A diagram illustrating the water depth and tidal correction naming and sign conventions is provided in appendix 11.12. The byte locations for each related SEGY trace header and the position of this information in the navigation SPS files can also be found on this diagram.

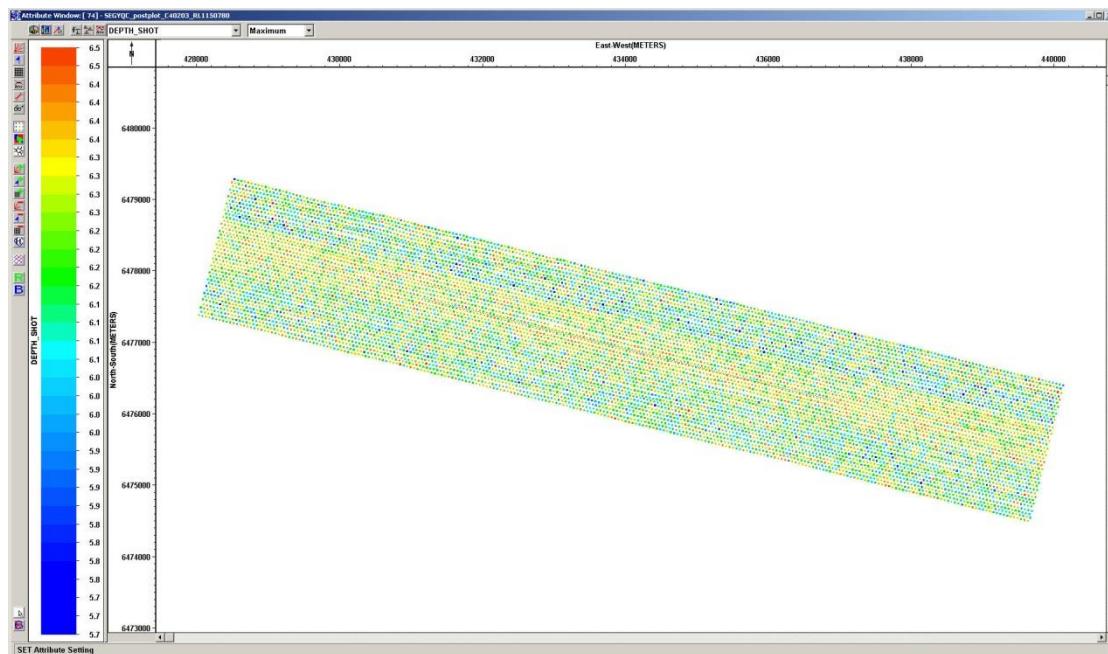


Figure 56. Source Depth QC

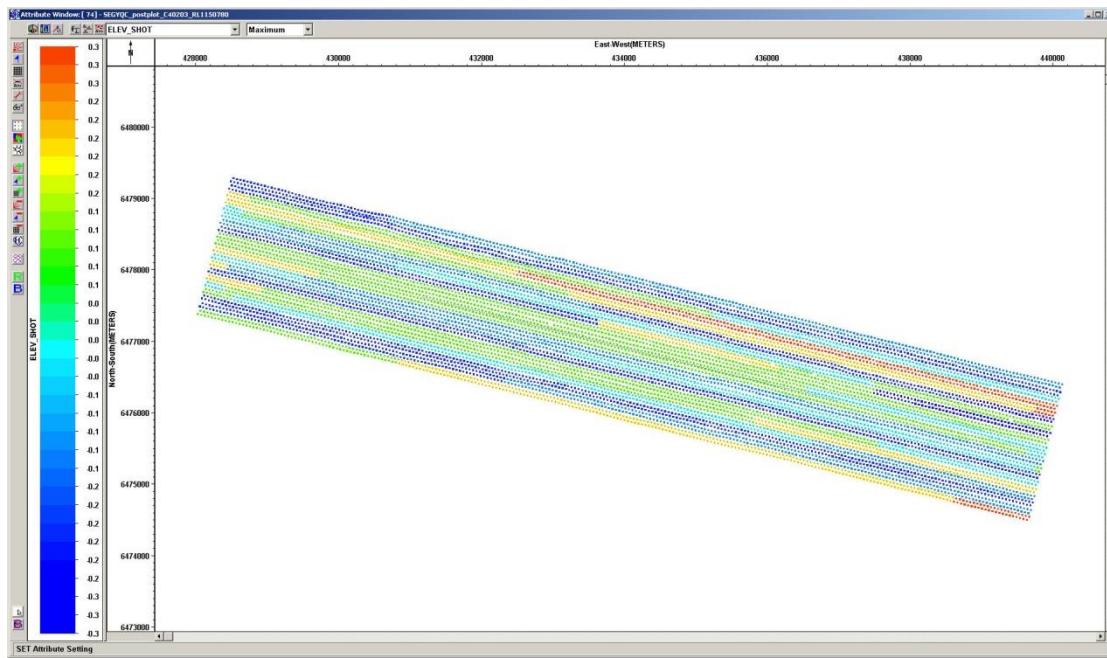


Figure 57. Source Elevation (Tide) QC

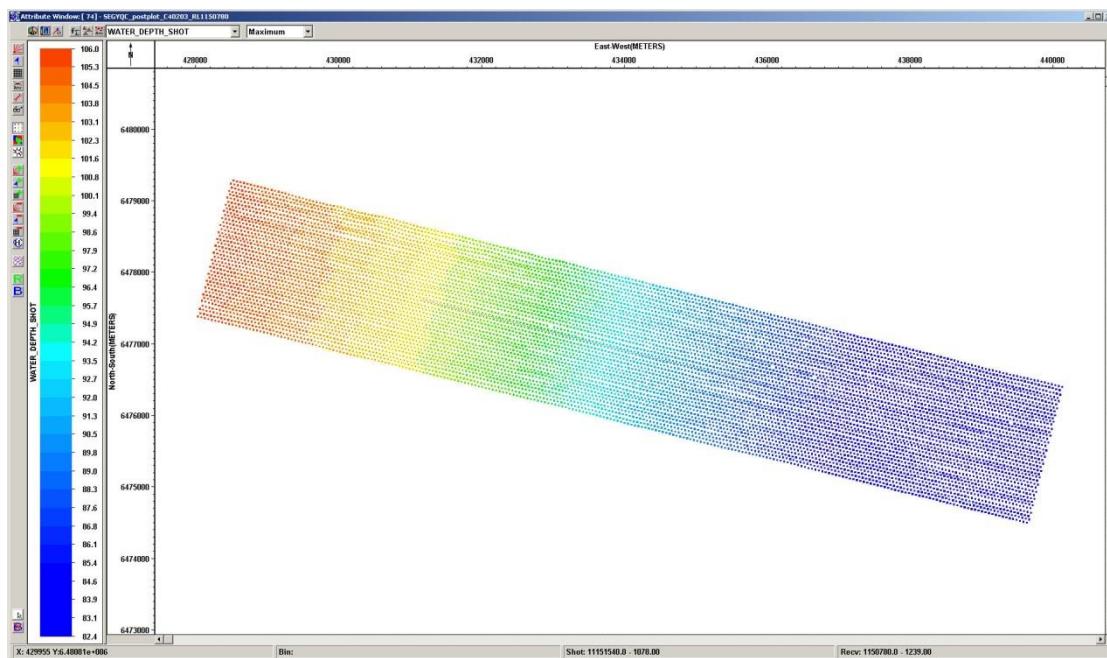


Figure 58. Water Depth at Source position QC

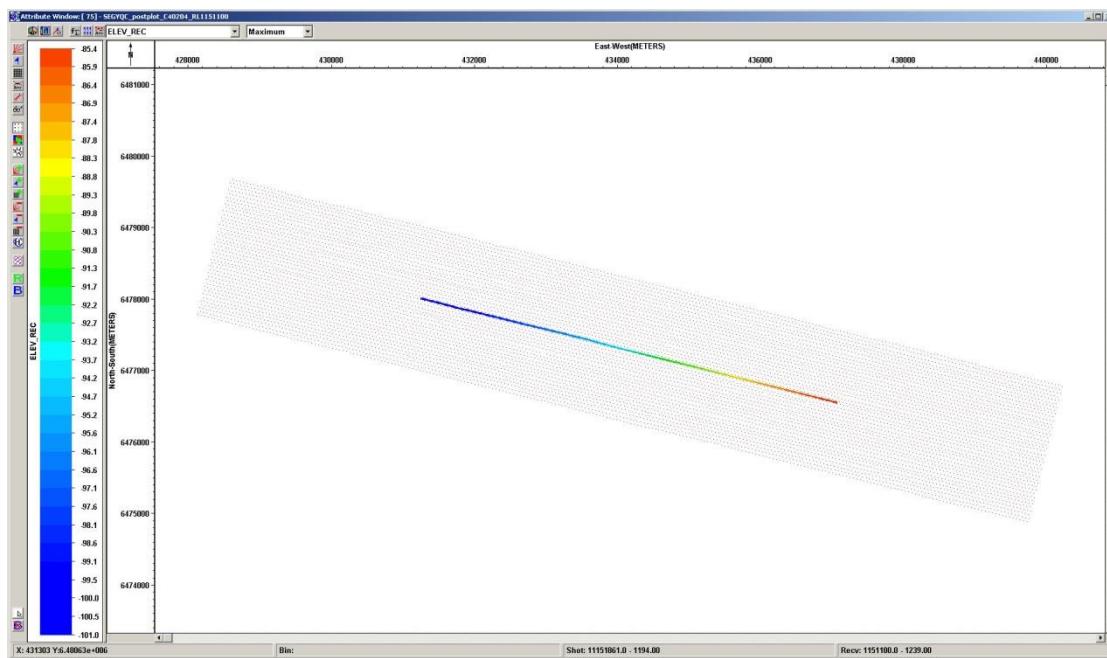


Figure 59. Receiver Elevation QC

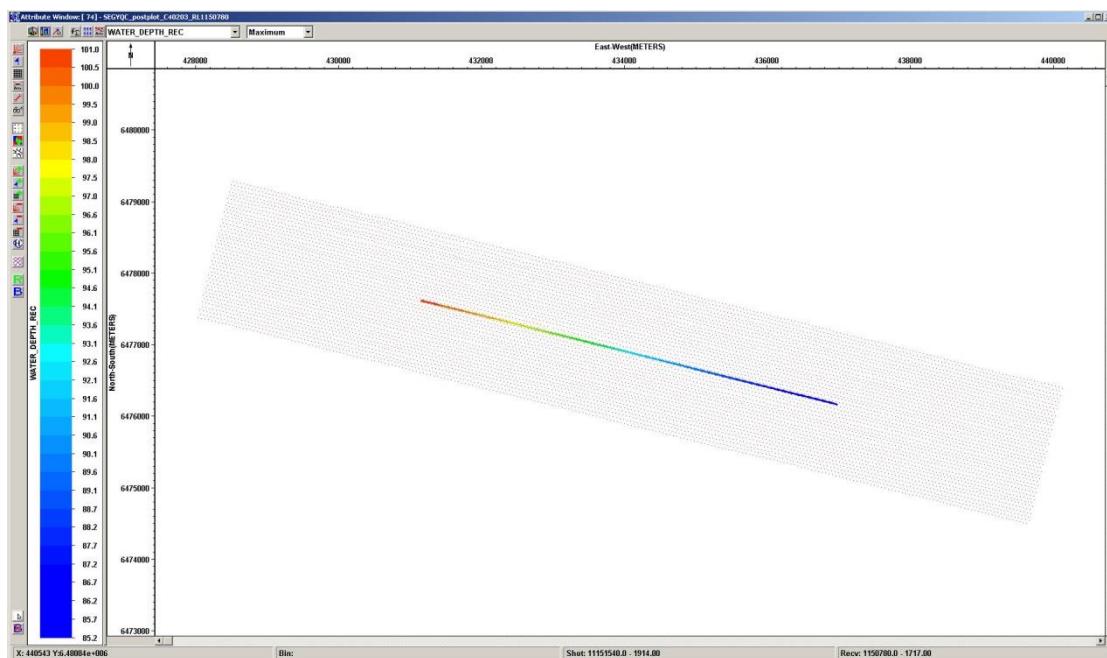


Figure 60. Water Depth At Receiver

7.4.12 Fold QC

Fold displays were created for every receiver line to ensure that all the data was written to the final SEGY tapes and that the final SPS navigation data and seismic data were merged correctly. Any variations or anomalies found in the fold coverage were investigated thoroughly with the aid of the navigation department. If needed, corrections were made and applied and the final SEGY tape written again followed by another iteration of the QC process.

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

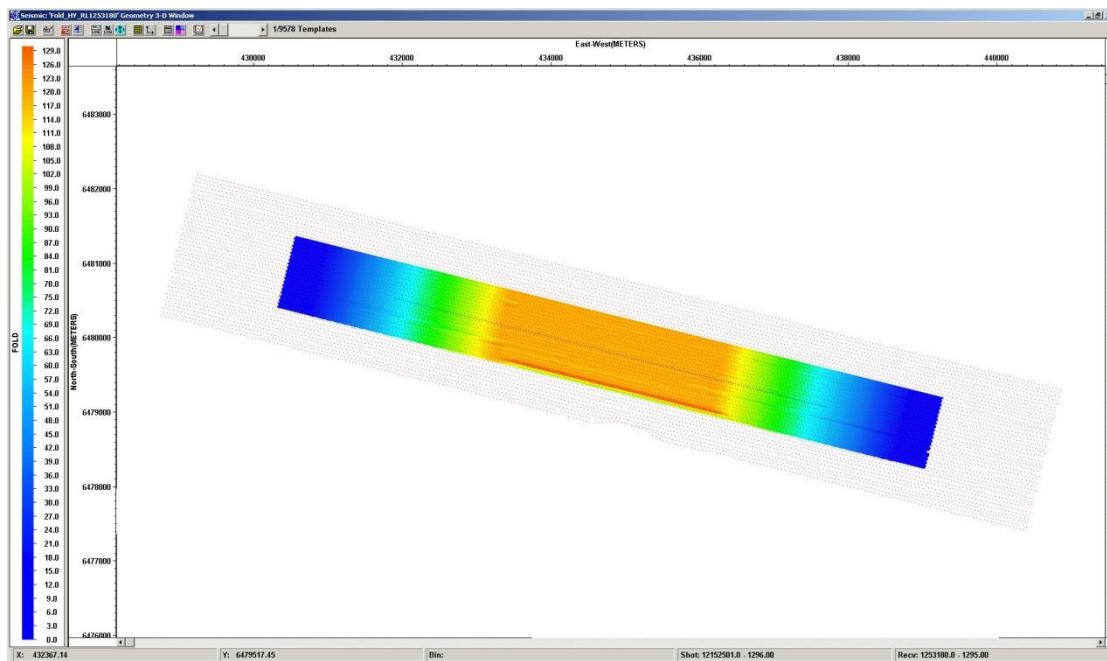


Figure 61. Fold display

7.4.13 Limited Offset 3D Cube

The main function of the limited offset cube was to ensure that the data from all individual receiver lines merged properly without any apparent coverage problems (missing data). In addition, the cube can be used to check for busts in the final navigation as well as overall data quality. It's a good initial "quick" look at the cube data volume.

To create the limited offset cube, raw data input to the final SEGY tape job was offset limited from 0 to 1000 meters. After the application of a basic pre-stack processing flow, the data was stacked and displayed interactively for evaluation. The cube was displayed in the inline and crossline directions as well as time slices. These displays were then checked ensuring there were no shifts or breaks in the data and that noticeable seismic events tied together across the entire project area.

The following processing flow was applied to the limited offset 3D cube:

- Raw data from final SEGY input (HY only)
- Offset limit to 0-1000 meters
- Datum static correction (source and receiver correction)
- Spherical divergence correction (average regional velocity)
- Ormsby Band Pass filter (1-80 Hz)
- CMP bin grid application
- NMO (Stretch mute: 30 %)
- Trace mute (Top and bottom mutes)
- CMP stack
- Time variant Band Pass filter
- Time variant scaling

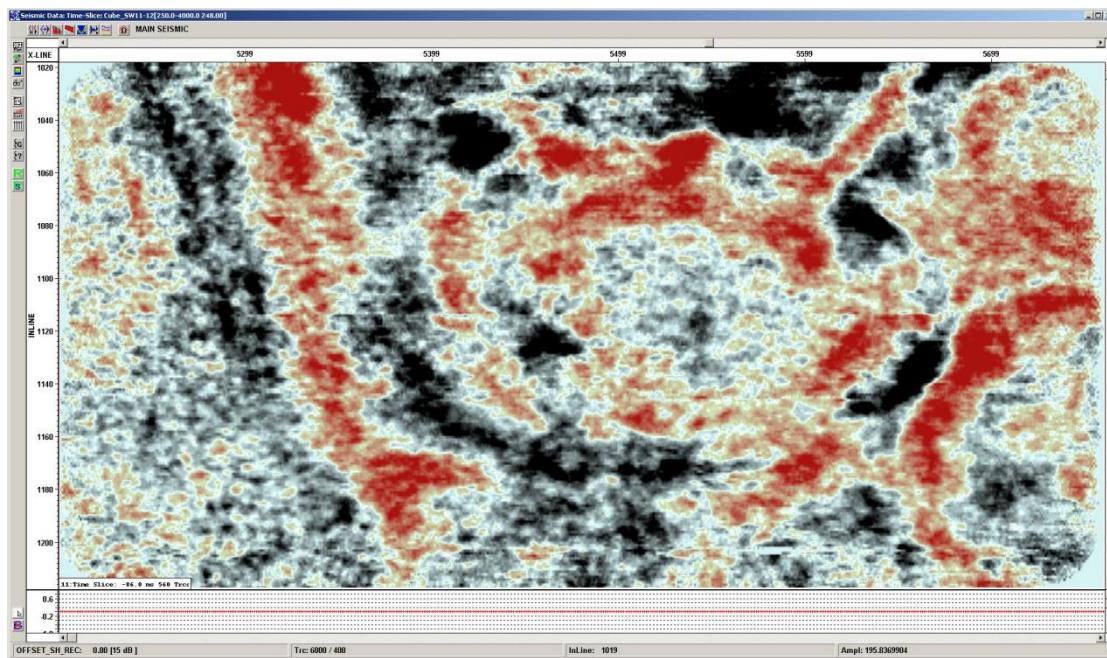


Figure 62. Limited Offset Cube time slice – 2500ms

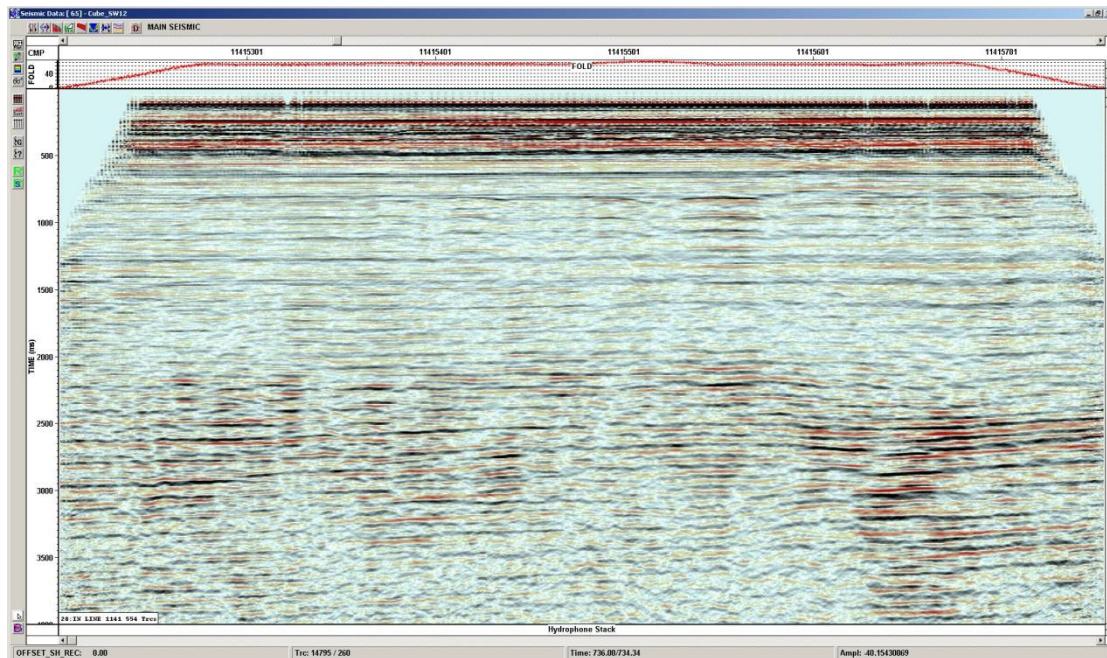


Figure 63. Limited Offset Cube inline display. Inline 1141.

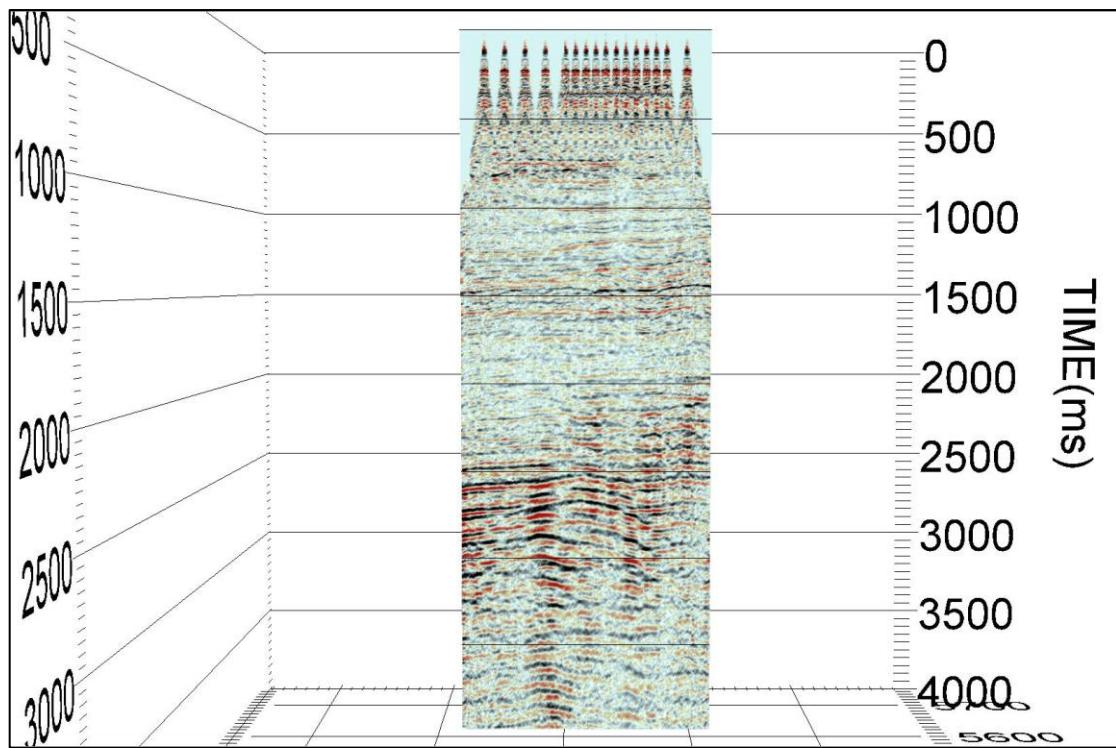


Figure 64. Limited Offset Cube crossline display. Crossline 5623.

	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Prepared by:</td><td style="width: 50%;">RXT QC Department</td></tr> <tr> <td>Client:</td><td>Statoil</td></tr> <tr> <td>Project Number:</td><td>RXT10010</td></tr> <tr> <td>Date:</td><td>October 2010</td></tr> </table>	Prepared by:	RXT QC Department	Client:	Statoil	Project Number:	RXT10010	Date:	October 2010
Prepared by:	RXT QC Department								
Client:	Statoil								
Project Number:	RXT10010								
Date:	October 2010								

8 SUMMARY OF SEISMIC QC DELIVERABLES

There were several client deliverables created for the project. Client deliverables consisted of both seismic data with associated QC information and documentation that included spreadsheets, acquisition logs and shipment information. A complete listing is located in appendix 11.11.

Final seismic data delivered included:

- Final SEGY tapes (IBM 3592 cartridge tapes / 1 per receiver line)
- Copy of Final SEGY tapes (IBM 3592 cartridge tapes / 1 per receiver line)
- Edit files (shot, receiver, and reverse traces)
- Navigation QC displays
- Seismic QC displays
- Data completeness displays
- Brute stack displays and SEGY files
- First break pick files
- Near field hydrophone displays and SEGY files

All data delivered excluding the final tapes were downloaded to external hard drive.

Final documentation delivered included:

- Acquisition logs (1 per sequence)
- Shipment documentation (proforma and tape listing)
- TOC files (table of contents files)

All documentation was also delivered on flash drive media.

Note: All deliveries included final SPS navigation data created by the on board navigation department and forwarded to the QC department.

8.1 Final navigation merged SEGY Tapes

As discussed previously, the output media used for final SEGY data tapes were IBM 3592 E05 cartridge tapes. Final data was output in units of microbar/sec for the hydrophone component and micrometers/sec² for the accelerometer components. The final Navigation-Seismic merged dataset contained a total of 16 original SEGY tapes and 16 SEGY copy tapes. A listing of all Final SEGY Tapes can be found in appendix 11.10.

8.2 Acquisition Logs

Acquisition logs were provided for each sail line sequence. These logs contain information provided by both online and offline QC. These logs contain 3 sheets with the first sheet providing an overview of the acquired spread, recording parameters, and line information. The second sheet ('Line Log') is essentially a shot by shot event log, extracting information from the online recording system, real-time observations, and later edited during offline QC after data analysis. The third sheet ('bad channels') is used to flag channels with problems identified by instrument tests or online/offline QC analysis. In addition, the acquisition logs included general information and comments highlighting events that took place during acquisition including shots or traces (stations) that could be considered bad, external noise (estimated frequency, source, orientation, amplitude) present, and information concerning

	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Prepared by:</td><td style="width: 50%;">RXT QC Department</td></tr> <tr> <td>Client:</td><td>Statoil</td></tr> <tr> <td>Project Number:</td><td>RXT10010</td></tr> <tr> <td>Date:</td><td>October 2010</td></tr> </table>	Prepared by:	RXT QC Department	Client:	Statoil	Project Number:	RXT10010	Date:	October 2010
Prepared by:	RXT QC Department								
Client:	Statoil								
Project Number:	RXT10010								
Date:	October 2010								

observed anomalies or recording problems. An example of an Acquisition log is provided in appendix 11.8.

8.3 SEGY Log

A Seismic QC log spreadsheet was used to check the information contained in the acquisition logs and the navigation production log against the actual recorded seismic data. In addition, it was also used as the primary tool for trace accounting. Although only used internally within the Seismic QC department, this was a very useful tool in identifying any acquisition data problems.

8.4 TOC Files

Table of Contents (TOC) files were also produced that contain tape information as related to the contents of each individual final SEGY tape.

8.5 Edit Files

Edits were provided for each individual receiver line in the form of edit spreadsheets and were identical to those used to flag the bad seismic data in the final SEGY tape headers.

Three separate spreadsheets were created that included edits for:

- Bad Channels
- Reverse polarity channels
- Bad shots

8.6 Near Field Hydrophone Data

Near field SEGY data were included on the external hard drive. The file extension of these SEGY files is *.HYD. The sail line, starting shot point header and whether the shot number increased or decreased was hand entered at the beginning of each line. For this reason there can be discrepancies in the sail line and shot point headers within the SEGY file. The SEGY file is written in standard SEGY format. The following table gives the SEGY header locations to read the near field hydrophone data

Header	Format	Starting Byte
Shot Point	Integer Long	17
Channel	Integer Long	13

Table 4. Near field hydrophone SEGY header definition

8.7 Brute stacks (SEGY format)

All QC brute stacks created (HY, VT, Sum, and IL CCP) were written out in SEGY disk format and delivered along with displays (screen captures) for all receiver lines in the project.

8.8 Seismic QC Displays

Various images were screen captured during the QC process (as detailed previously). The following images were included as part of the final client deliverables downloaded to flash drives:

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

- Brute Stacks: displays were created for the hydrophone, vertical and summed (HY and VT) brute stacks. In addition, an Inline (CCP) stack display was also captured.
- Polarity QC: polarity QC displays were created for all 4 components on each cable.
- F-X Analysis: comparison FX and TX displays were created for both shot and receiver gathers for each receiver line.
- RMS Displays: These displays were provided by the on-line VSO QC
- RMS Spatial Displays: all channels for each shot were stacked and the average RMS values were displayed in a post plot
- Nearfield Source Balance QC: The difference between the maximum amplitudes and the time of the maximum amplitudes for both gun arrays.

8.9 Navigation QC Displays

One of the QC departments primary jobs is to ensure the source and receiver positions received from the navigation are correct. Screen captures from these QC steps were included in the final client deliverables, they were:

- Receiver Positioning Quadrant Stack: quadrant stack displays were generated for each receiver line cable lay.
- SEGY Final Nav-merge Post plot: positioning QC post plots were generated for each receiver line SEGY dataset generated.
- SEGY Final Nav-merge Water Depths: water depth at source, water depth at receiver
- VISTA RLP: VISTA receiver location prediction display
- Cable Movement QC: For each cable and lay a comparison graph was made detailing the difference in VOA value between the first and last shots fired into the respective cable and lay.

8.10 Data Completeness QC Displays

During complicated shooting seen in OBC operations it's vital that all required sequences are identified and written to tape. To ensure this was done fold and data cube displays were used. The following displays were included in the final client deliverables.

- Fold Display: full offset fold display for each receiver line.
- Limited Offset Cube: all swaths contributing to an individual receiver line.

9 SEISMIC QC REVIEW

9.1 Seismic Interference

During the survey some seismic interference was seen. The interference was mainly caused by the PGS vessel, Ramform Valiant working for BP to the south of the Volvo survey. Noise levels from this vessel were in excess of +100µB. Gardline Geosurvey's vessel the Sea Explorer was also operating in the area, just north of the Volvo survey and while we were not affected by their low volume guns they were affected by our larger volume arrays. The Sea Explorer was also working for Statoil.

As a consequence we did time share with both the Valiant and the Sea Explorer.

At the clients request a spreadsheet was created to keep track of the noise created by seismic interference and other external sources. (Appendix 11.16)
Some examples of typical seismic interference can be seen below.

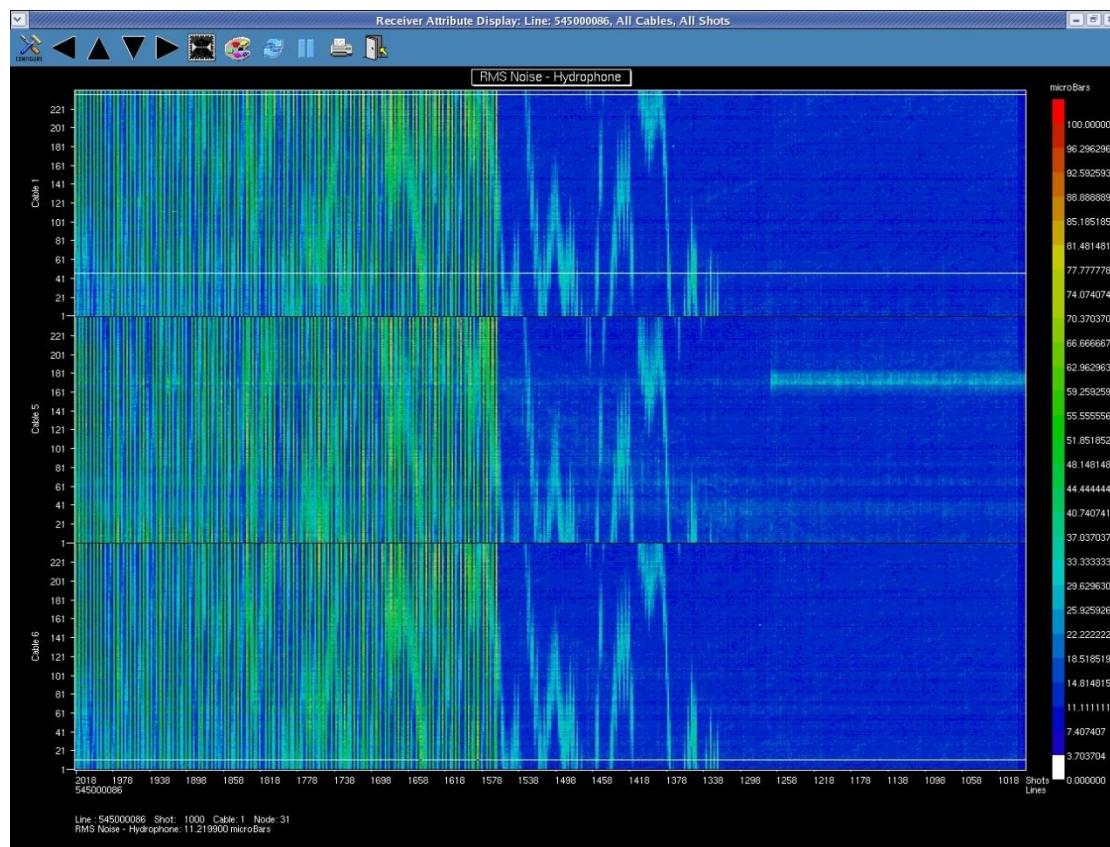


Figure 65. RMS Display showing Seismic Interference, Sequence 86

	Prepared by: Client: Statoil Project Number: RXT10010 Date: October 2010
---	---

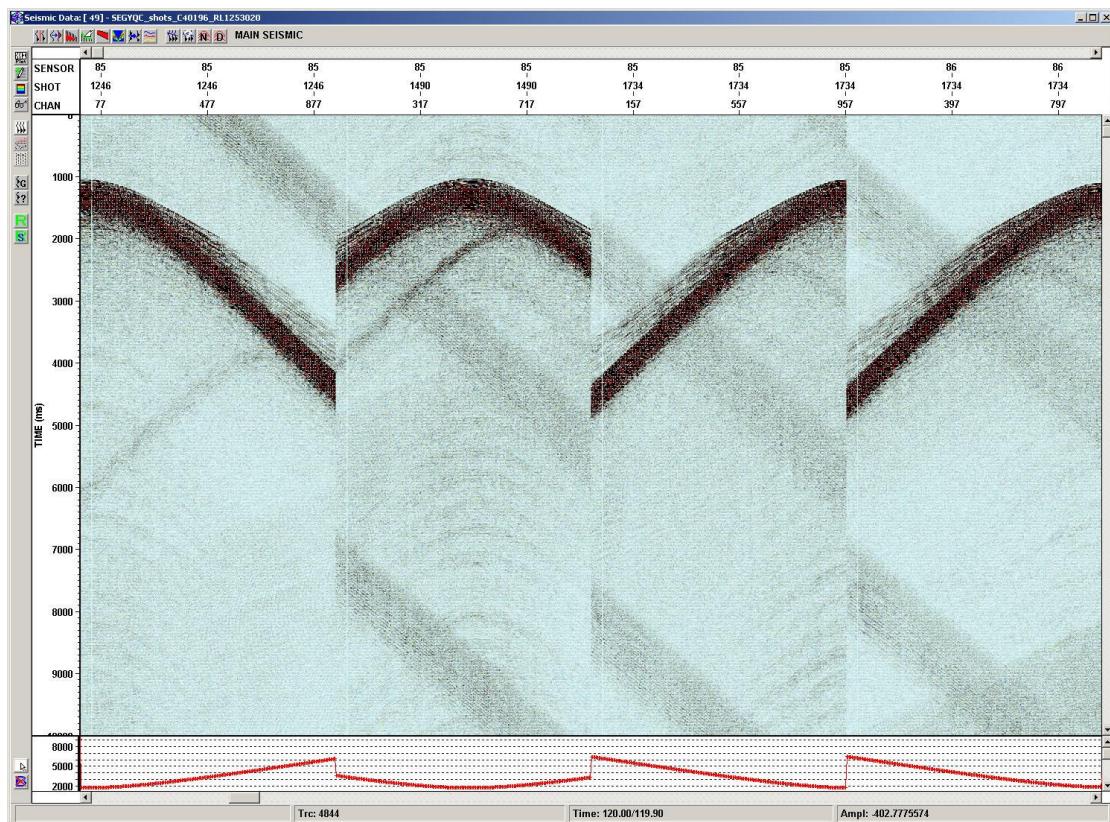


Figure 66. Shot records showing Seismic Interference, Sequences 85 and 86

9.2 Supply Vessel Noise

Several supply and support vessels were in the area working around the Maersk Inspirer and Navion Saga installations within the Volve survey area. Noise from these vessels was occasionally present and at times reached in excess of $100\mu\text{B}$. Whenever noise from the vessels was noticed on the VSOQC Level 2 displays the vessels were asked to move off the line. Generally the vessels were receptive and moved off the spread. Some line portions were reshot due to supply vessel noise.

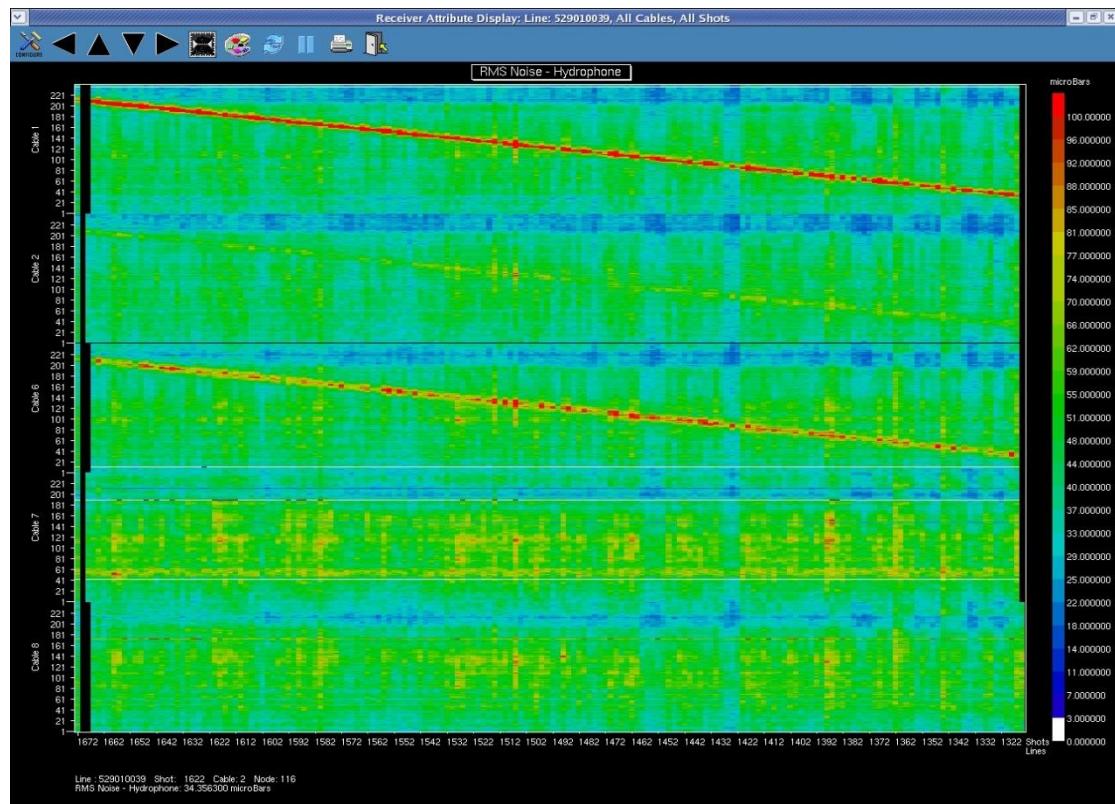


Figure 67. RMS display showing supply vessel noise up to $60\mu\text{B}$ affecting all cables.

9.3 Maersk Inspirer and Navion Saga Noise

As mentioned the Maersk Inspirer and the Navion Saga oil field rigs were both on the survey area and noise related to these installations was occasionally seen. Noise levels in excess of +100µB were seen and some line portions were reshot for excessive noise. Typical examples of noise can be seen below.

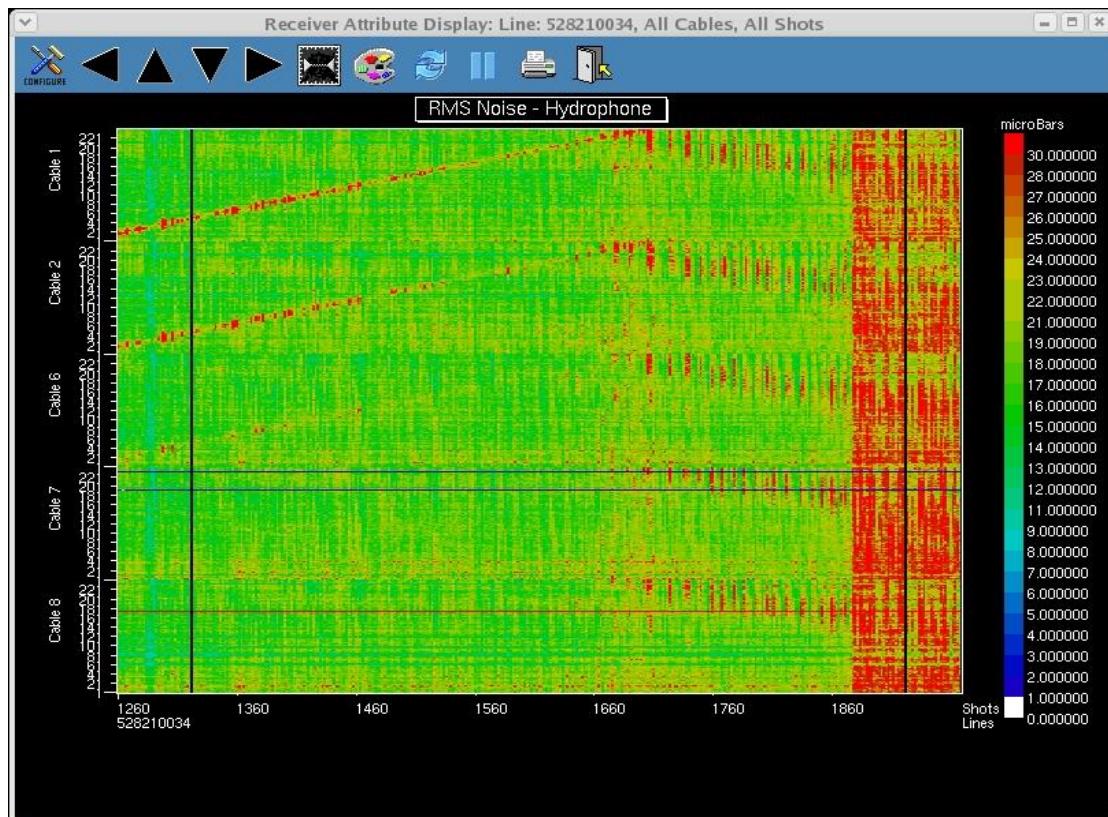


Figure 68. RMS display showing noise from Maersk Inspirer on the right of the display

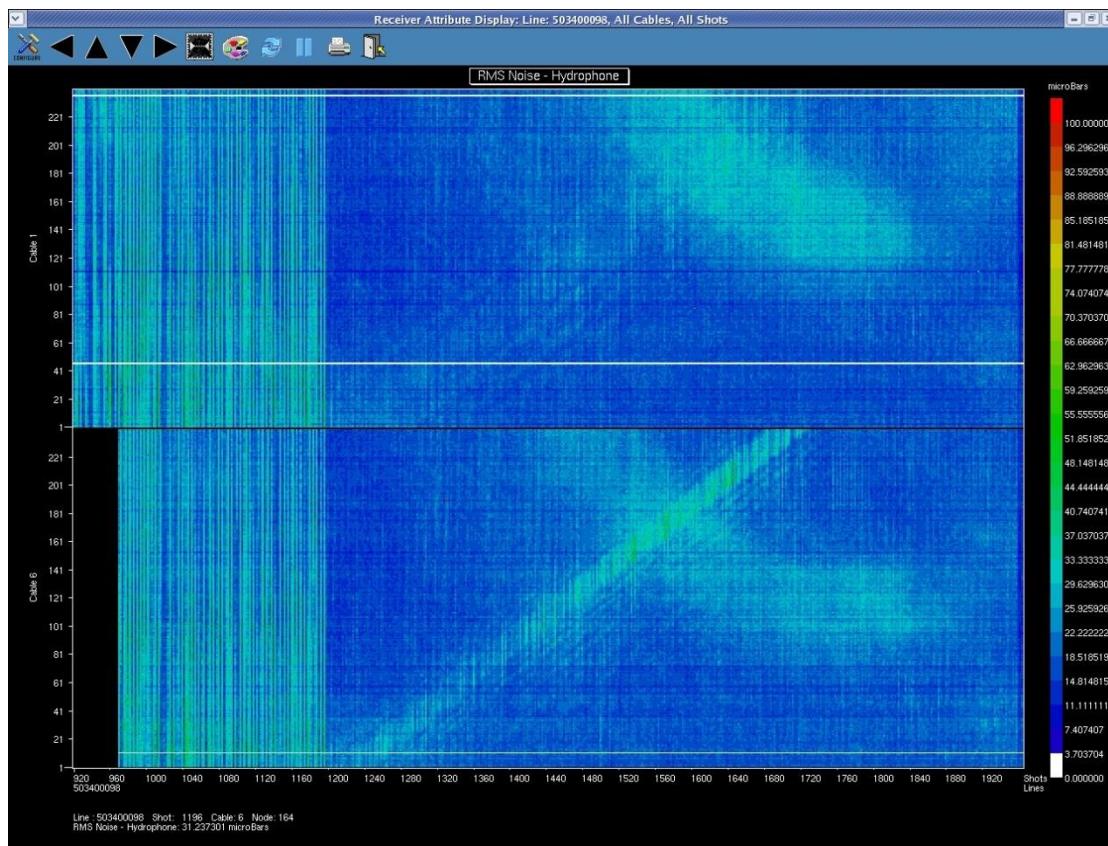


Figure 69. RMS display showing noise from Navion Saga on the left of the display

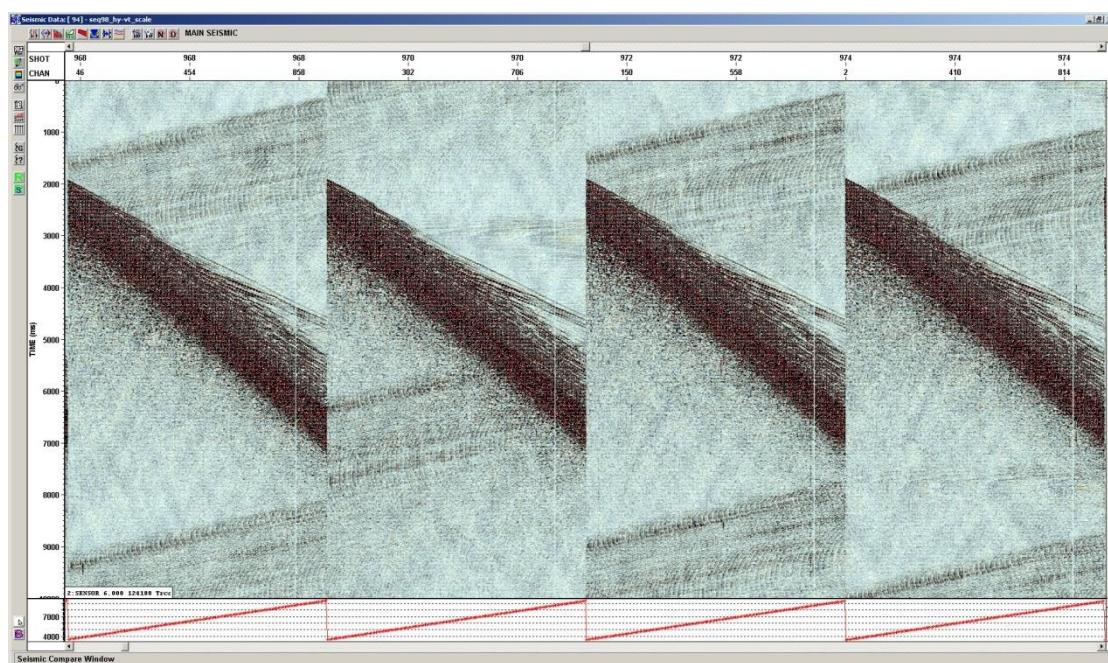


Figure 70. Shot records showing noise from Navion Saga

9.4 Vikland Noise

Some noise was generated by the cable handling vessel the M/V Vikland. This is inherent with this type of OBC operation but was kept to a minimum. Noise levels were generally lower than other vessel noise and levels of up to 30 μ B were occasionally seen. In these instances the Vikland moved away from the cables to reduce noise levels. A typical example of Vikland generated noise can be seen below.

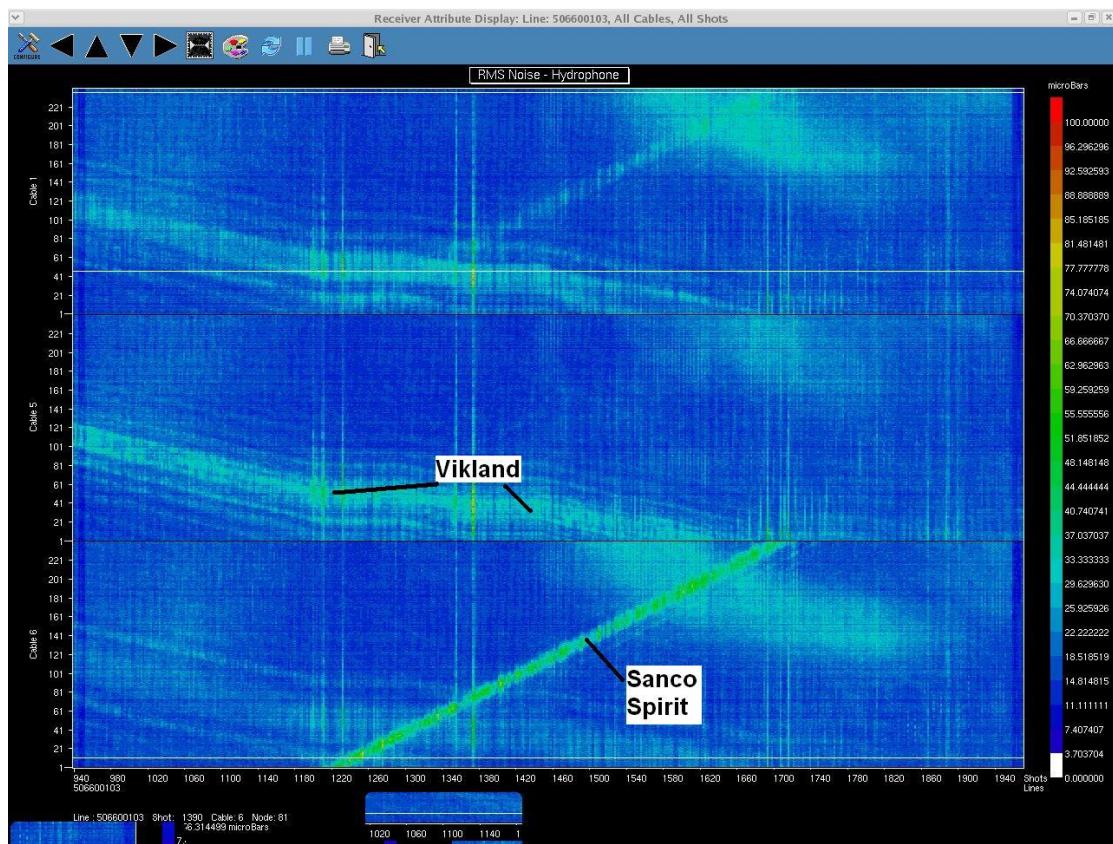


Figure 71. RMS display showing vessel noise from the Vikland

	Prepared by:	RXT QC Department
Client:	Statoil	
Project Number:	RXT10010	
Date:	October 2010	

10 DATA SHIPMENTS

Shipment #	Date	Destination	Description
VIKS10-024	20 th Oct. 2010	WesternGeco	Final SEGY Tape numbers C40194-C40201, Swath 12
VIKS10-027	8 th Nov. 2010	WesternGeco	Final SEGY Tape numbers C40203-C40210, Swath 11 and C45014, RMS Decay files
VIKS10-028	15 th Nov. 2010	Iron Mountain	Final SEGY Copy Tape numbers C40194- C40201, Swath 12; C40203-C40210, Swath 11; C45015, RMS Decay files

Table 5. Data shipments for the RXT10010 project.

11 APPENDICES

11.1 Processing Hardware

Hardware Component	# Units	Specifications
Data buckets	22	5*140GB firewire drives
Tape Drives	8	IBM 3592 E05
DBU Computers	3	Dell 2900, 16GB Ram, 3Ghz Dual-Quad Core, 2x80GB + 8x1TB
VISTA Computers	5	Dell 2900, 16GB Ram, 3Ghz Dual-Quad Core, 2x80GB + 8x1TB
QC Util. computer	2	2GB Ram, 3Ghz Dual Core, 1x450GB
Monitors	7	Dell 27"

Table 6. Processing Hardware



Prepared by:	RXT QC Department
Client:	Statoil
Project Number:	RXT10010
Date:	October 2010

11.2 Far Field Signature Listing

This filter both differentiates and applies recording filter to the unfiltered source signature.
This filter should be used for deconvolution of the accelerometer data and hydrophone data in differentiated mode.

FARFIELD SIGNATURE LISTING

```
Array name      : 3990-D6-S7p5-2000
Total volume   : 3990 cu.in.
Source depth   : 6.00 m
Streamer depth : 0.00 m
Group length   : 12.50 m
Average pressure : 2000 psi
Ghost strength  : -1.00
Primary amplitude : 62.05 bar m
Peak-peak amplitude : 114.88 bar m
P/B-ratio       : 23.05
Bubble period (+) : 80.25 msec
Bubble period (-) : 149.75 msec
Seawater temperature: 10.00 C
Seawater velocity  : 1490.0 m/s
Filter          :
  Low-cut        : OUT
  High-cut frequency: 187.00 Hz
  High-cut slope   : 260.00 dB/oct
Instrument      :
  Time of 1st sample: 0.00 msec i.e. index of time zero = 1.00
Sample interval  : 1.00 msec
Farfield position :
  Distance        : 9000.00 m
  Azimuth         : 0.00 deg
  Angle of vertical : 0.00 deg
```

Amplitudes are in bar m

Time is increasing horizontally

0.000	0.000	-0.001	0.002	0.035	0.227	1.026
3.495	9.372	20.324	36.120	52.634	61.892	55.875
32.647	-0.156	-29.104	-44.594	-47.996	-48.469	-51.611
-51.967	-39.030	-11.619	15.761	24.185	9.078	-14.004
-24.260	-15.786	-1.290	3.761	-2.261	-8.092	-4.851
3.678	7.156	1.932	-5.264	-6.407	-1.534	2.754
2.134	-0.979	-1.824	0.393	2.274	1.236	-1.343
-2.372	-0.952	1.035	1.641	0.930	0.244	0.306
0.664	0.674	0.365	0.208	0.408	0.746	0.955
1.012	1.017	1.001	0.932	0.835	0.804	0.901
1.087	1.259	1.346	1.354	1.335	1.334	1.369
1.433	1.509	1.588	1.671	1.762	1.857	1.944
2.014	2.068	2.122	2.195	2.292	2.404	2.507
2.581	2.617	2.620	2.599	2.558	2.496	2.409
2.294	2.160	2.020	1.886	1.765	1.660	1.574
1.509	1.465	1.439	1.421	1.398	1.360	1.307
1.246	1.186	1.135	1.098	1.076	1.065	1.061
1.058	1.049	1.029	0.997	0.957	0.916	0.884
0.862	0.850	0.838	0.809	0.746	0.629	0.446
0.193	-0.122	-0.480	-0.855	-1.218	-1.540	-1.799
-1.978	-2.070	-2.079	-2.018	-1.906	-1.759	-1.587
-1.401	-1.205	-1.005	-0.800	-0.587	-0.366	-0.138
0.087	0.301	0.496	0.661	0.780	0.834	0.801
0.667	0.428	0.088	-0.336	-0.811	-1.291	-1.722
-2.058	-2.271	-2.357	-2.327	-2.207	-2.030	-1.834
-1.656	-1.514	-1.407	-1.321	-1.236	-1.144	-1.042
-0.935	-0.828	-0.726	-0.633	-0.552	-0.484	-0.427
-0.374	-0.318	-0.257	-0.192	-0.128	-0.071	-0.023
0.015	0.049	0.082	0.116	0.150	0.181	0.209
0.233	0.253	0.267	0.274	0.275	0.272	0.267
0.260	0.250	0.236	0.219	0.200	0.178	0.152
0.124	0.094	0.064	0.034	0.004	-0.026	-0.055
-0.083	-0.108	-0.132	-0.153	-0.172	-0.188	-0.200
-0.208	-0.214	-0.215	-0.213	-0.208	-0.200	-0.188
-0.174	-0.157	-0.138	-0.120	-0.103	-0.088	-0.075

rxt	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10010
	Date:	October 2010

-0.065	-0.054	-0.042	-0.028	-0.012	0.005	0.022
0.039	0.056	0.072	0.085	0.092	0.094	0.095
0.096	0.097	0.098	0.099	0.100	0.104	0.112
0.124	0.138	0.155	0.175	0.198	0.225	0.254
0.284	0.315	0.348	0.382	0.416	0.451	0.486
0.521	0.556	0.590	0.624	0.657	0.689	0.720
0.749	0.777	0.802	0.825	0.845	0.862	0.875
0.884	0.889	0.889	0.885	0.876	0.861	0.841
0.815	0.784	0.749	0.708	0.664	0.617	0.565
0.511	0.453	0.392	0.329	0.262	0.191	0.118
0.042	-0.037	-0.116	-0.196	-0.275	-0.351	-0.424
-0.492	-0.555	-0.610	-0.660	-0.703	-0.740	-0.774
-0.805	-0.833	-0.861	-0.889	-0.917	-0.946	-0.975
-1.002	-1.027	-1.048	-1.064	-1.074	-1.076	-1.071
-1.058	-1.038	-1.013	-0.982	-0.948	-0.912	-0.873
-0.834	-0.794	-0.754	-0.713	-0.672	-0.631	-0.590
-0.549	-0.510	-0.471	-0.432	-0.395	-0.358	-0.323
-0.288	-0.254	-0.221	-0.189	-0.157	-0.126	-0.096
-0.067	-0.038	-0.010	0.018	0.045	0.072	0.098
0.125	0.150	0.176	0.201	0.226	0.251	0.276
0.301	0.326	0.350	0.375	0.399	0.424	0.448
0.473	0.497	0.522	0.546	0.570	0.594	0.618
0.642	0.666					

DERIVATIVE FARFIELD SIGNATURE LISTING

Array name : 3990-D6-S7p5-2000
 Total volume : 3990 cu.in.
 Source depth : 6.00 m
 Streamer depth : 0.00 m
 Group length : 12.50 m
 Average pressure : 2000 psi
 Ghost strength : -1.00
 Primary amplitude : NA
 Peak-peak amplitude : NA
 P/B-ratio : NA
 Bubble period (+) : NA
 Bubble period (-) : NA
 Seawater temperature: 10.00 C
 Seawater velocity : 1490.0 m/s
 Filter :
 Low-cut : OUT
 High-cut frequency: 187.00 Hz
 High-cut slope : 260.00 dB/oct
 Instrument : VSO derivative pressure recording
 Time of 1st sample: 0.00 msec i.e. index of time zero = 1.00
 Sample interval : 1.00 msec
 Farfield position :
 Distance : 9000.00 m
 Azimuth : 0.00 deg
 Angle of vertical : 0.00 deg

Amplitudes are in bar m
 Time is increasing horizontally

0.000	0.000	-0.001	0.005	0.058	0.312	1.178
3.344	7.344	12.578	16.394	14.616	4.357	-12.281
-27.397	-31.992	-23.594	-9.520	-0.836	-1.425	-3.638
3.065	18.524	29.160	21.558	-1.360	-20.659	-19.933
-2.388	12.968	12.051	-0.182	-7.707	-2.800	6.416
7.719	-0.120	-7.162	-5.473	1.756	5.536	2.487
-2.244	-2.712	0.584	2.608	0.858	-1.997	-2.296
0.006	1.942	1.576	-0.053	-0.877	-0.393	0.290
0.274	-0.162	-0.304	-0.014	0.290	0.304	0.137
0.023	0.002	-0.026	-0.083	-0.083	0.018	0.143
0.190	0.141	0.054	-0.006	-0.014	0.016	0.051
0.072	0.079	0.081	0.087	0.095	0.096	0.084
0.066	0.055	0.063	0.085	0.108	0.115	0.098
0.065	0.029	0.000	-0.020	-0.038	-0.061	-0.087
-0.111	-0.126	-0.127	-0.119	-0.104	-0.088	-0.070
-0.050	-0.030	-0.016	-0.013	-0.023	-0.038	-0.051

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10010
	Date:	October 2010

-0.056	-0.051	-0.040	-0.027	-0.014	-0.004	0.001
-0.001	-0.009	-0.021	-0.032	-0.037	-0.034	-0.025
-0.013	-0.007	-0.013	-0.035	-0.076	-0.133	-0.200
-0.267	-0.321	-0.355	-0.361	-0.339	-0.293	-0.226
-0.145	-0.062	0.013	0.073	0.117	0.146	0.166
0.179	0.186	0.190	0.196	0.205	0.214	0.218
0.213	0.200	0.179	0.146	0.095	0.024	-0.065
-0.165	-0.266	-0.359	-0.431	-0.467	-0.453	-0.388
-0.285	-0.163	-0.044	0.059	0.135	0.176	0.180
0.154	0.117	0.087	0.076	0.079	0.089	0.097
0.100	0.099	0.093	0.083	0.071	0.058	0.051
0.050	0.054	0.060	0.062	0.059	0.051	0.041
0.034	0.032	0.032	0.033	0.032	0.029	0.026
0.023	0.018	0.011	0.005	0.000	-0.003	-0.004
-0.007	-0.010	-0.014	-0.016	-0.019	-0.022	-0.025
-0.028	-0.029	-0.029	-0.028	-0.028	-0.028	-0.028
-0.026	-0.024	-0.022	-0.020	-0.017	-0.014	-0.011
-0.008	-0.004	-0.001	0.002	0.006	0.009	0.012
0.014	0.016	0.017	0.017	0.016	0.013	0.011
0.010	0.010	0.012	0.014	0.016	0.016	0.016
0.017	0.017	0.015	0.010	0.005	0.001	0.001
0.001	0.002	0.001	0.001	0.002	0.006	0.010
0.013	0.015	0.017	0.021	0.024	0.027	0.029
0.030	0.031	0.033	0.034	0.035	0.035	0.035
0.035	0.035	0.035	0.034	0.033	0.032	0.031
0.030	0.028	0.026	0.023	0.021	0.017	0.014
0.010	0.006	0.001	-0.003	-0.008	-0.013	-0.019
-0.024	-0.029	-0.034	-0.038	-0.042	-0.045	-0.049
-0.052	-0.055	-0.058	-0.061	-0.064	-0.068	-0.071
-0.074	-0.076	-0.077	-0.077	-0.076	-0.073	-0.069
-0.065	-0.059	-0.053	-0.047	-0.041	-0.037	-0.033
-0.031	-0.030	-0.029	-0.029	-0.030	-0.030	-0.030
-0.029	-0.026	-0.022	-0.016	-0.010	-0.003	0.005
0.012	0.018	0.023	0.028	0.031	0.033	0.034
0.035	0.036	0.037	0.037	0.037	0.037	0.037
0.037	0.036	0.036	0.035	0.034	0.034	0.033
0.032	0.031	0.031	0.030	0.029	0.029	0.028
0.028	0.027	0.027	0.026	0.026	0.026	0.025
0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.025	0.025	0.025	0.025	0.025	0.025	0.025

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.3 VSO System Impulse Response Listing

INPUT/OUTPUT, Inc.

Tabular data for I/O VectorSeis Ocean response

Compilation Date: May, 2007

Number of points evaluated = 2048

Parametric Data:

Sample Rate: 2 ms.
 Anti-Alias Filter: 3/4 Nyquist Minimum Phase
 DC Offset Blocking Filter: Fc= 1.463Hz; 6 dB/octave; (0x80 configuration)
 Low Cut Filter: Out

Response Definitions:

Pressure	The detector, channel, and tape format data deliver <i>pressure domain</i> results. The impulse response shown is the full transfer function of the detector and channel.
dP/dt wrt dP	The detector, channel, and tape format data deliver <i>derivative pressure domain</i> results.
Accel wrt accel	The impulse response shown is the full transfer function fo the detector and channel.
dP/dt wrt Press	The detector, channel, and tape format data deliver <i>acceleration domain</i> results.
Press	This impulse response is used to convert a hydrophone pressure signal of the user into a derivative pressure response including the VSO derivative pressure transfer function. An example of such use is if a pressure domain near- or far-field response is to be converted to a VSO derivative pressure signature. The input response should not include any other instrumentation filter responses.

MINIMUM PHASE 2ms					MINIMUM PHASE 2ms				
time	Pressure	dP/dt wrt dP	Accel	dP/dt wrt Press	time	Pressure	dP/dt wrt dP	Accel	dP/dt wrt Press
0	0.000000	0.000000	0.000000	0.000000	2050	0.000009	0.000000	0.000000	0.000000
2	0.000081	0.000060	0.000084	0.000347	2052	0.000009	0.000000	0.000000	0.000000
4	0.006857	0.005789	0.006981	0.018548	2054	0.000009	0.000000	0.000000	0.000000
6	0.099752	0.089783	0.100719	0.179786	2056	0.000009	0.000000	0.000000	0.000000
8	0.501406	0.474485	0.503491	0.533872	2058	0.000009	0.000000	0.000000	0.000000
10	1.000000	1.000000	1.000000	0.232074	2060	0.000009	0.000000	0.000000	0.000000
12	0.508210	0.585133	0.508134	-1.000000	2062	0.000009	0.000000	0.000000	0.000000
14	-0.560337	-0.516064	-0.547895	-0.598188	2064	0.000009	0.000000	0.000000	0.000000
16	-0.180833	-0.229117	-0.163517	0.915081	2066	0.000009	0.000000	0.000000	0.000000
18	0.378755	0.399179	0.383799	-0.125692	2068	0.000009	0.000000	0.000000	0.000000
20	-0.285992	-0.243227	-0.277177	-0.564164	2070	0.000009	0.000000	0.000000	0.000000
22	-0.095621	-0.125962	-0.081404	0.628391	2072	0.000009	0.000000	0.000000	0.000000
24	0.193776	0.219132	0.199181	-0.237757	2074	0.000009	0.000000	0.000000	0.000000
26	-0.248694	-0.229387	-0.238625	-0.195528	2076	0.000008	0.000000	0.000000	0.000000
28	0.040019	0.024384	0.050685	0.396958	2078	0.000008	0.000000	0.000000	0.000000
30	0.024474	0.053204	0.030379	-0.323260	2080	0.000008	0.000000	0.000000	0.000000
32	-0.157375	-0.156834	-0.146940	0.106427	2082	0.000008	0.000000	0.000000	0.000000
34	0.070910	0.073454	0.078634	0.097018	2084	0.000008	0.000000	0.000000	0.000000
36	-0.073310	-0.054661	-0.066063	-0.182541	2086	0.000008	0.000000	0.000000	0.000000
38	-0.047477	-0.049881	-0.038475	0.156830	2088	0.000008	0.000000	0.000000	0.000000
40	0.016845	0.028660	0.023490	-0.068258	2090	0.000008	0.000000	0.000000	0.000000
42	-0.074407	-0.066458	-0.066646	-0.019386	2092	0.000008	0.000000	0.000000	0.000000
44	-0.012696	-0.009311	-0.005311	0.057873	2094	0.000008	0.000000	0.000000	0.000000
46	-0.028644	-0.018922	-0.021964	-0.049305	2096	0.000008	0.000000	0.000000	0.000000
48	-0.039446	-0.034610	-0.032344	0.025373	2098	0.000008	0.000000	0.000000	0.000000
50	-0.019649	-0.013093	-0.013138	-0.003252	2100	0.000008	0.000000	0.000000	0.000000
52	-0.033648	-0.027164	-0.027176	-0.006527	2102	0.000008	0.000000	0.000000	0.000000

					Prepared by:		RXT QC Department			
					Client:		Statoil			
					Project Number:		RXT10009			
					Date:		September 2010			

54	-0.026389	-0.020980	-0.020075	0.008747	2104	0.000008	0.000000	0.000000	0.000000	0.000000
56	-0.026597	-0.020507	-0.020538	-0.005080	2106	0.000008	0.000000	0.000000	0.000000	0.000000
58	-0.027751	-0.022307	-0.021796	0.002483	2108	0.000008	0.000000	0.000000	0.000000	0.000000
60	-0.025374	-0.019943	-0.019624	0.000259	2110	0.000008	0.000000	0.000000	0.000000	0.000000
62	-0.025858	-0.020566	-0.020264	-0.000177	2112	0.000008	0.000000	0.000000	0.000000	0.000000
64	-0.025009	-0.019932	-0.019575	0.000783	2114	0.000008	0.000000	0.000000	0.000000	0.000000
66	-0.024469	-0.019505	-0.019197	0.000158	2116	0.000007	0.000000	0.000000	0.000000	0.000000
68	-0.024028	-0.019228	-0.018910	0.000368	2118	0.000007	0.000000	0.000000	0.000000	0.000000
70	-0.023496	-0.018840	-0.018530	0.000331	2120	0.000007	0.000000	0.000000	0.000000	0.000000
72	-0.023008	-0.018495	-0.018191	0.000322	2122	0.000007	0.000000	0.000000	0.000000	0.000000
74	-0.022524	-0.018151	-0.017853	0.000317	2124	0.000007	0.000000	0.000000	0.000000	0.000000
76	-0.022050	-0.017815	-0.017522	0.000311	2126	0.000007	0.000000	0.000000	0.000000	0.000000
78	-0.021585	-0.017484	-0.017197	0.000305	2128	0.000007	0.000000	0.000000	0.000000	0.000000
80	-0.021129	-0.017160	-0.016878	0.000300	2130	0.000007	0.000000	0.000000	0.000000	0.000000
82	-0.020682	-0.016841	-0.016565	0.000294	2132	0.000007	0.000000	0.000000	0.000000	0.000000
84	-0.020244	-0.016529	-0.016257	0.000289	2134	0.000007	0.000000	0.000000	0.000000	0.000000
86	-0.019814	-0.016222	-0.015956	0.000283	2136	0.000007	0.000000	0.000000	0.000000	0.000000
88	-0.019392	-0.015921	-0.015660	0.000278	2138	0.000007	0.000000	0.000000	0.000000	0.000000
90	-0.018978	-0.015626	-0.015369	0.000273	2140	0.000007	0.000000	0.000000	0.000000	0.000000
92	-0.018573	-0.015336	-0.015084	0.000268	2142	0.000007	0.000000	0.000000	0.000000	0.000000
94	-0.018175	-0.015051	-0.014804	0.000263	2144	0.000007	0.000000	0.000000	0.000000	0.000000
96	-0.017785	-0.014772	-0.014529	0.000258	2146	0.000007	0.000000	0.000000	0.000000	0.000000
98	-0.017403	-0.014498	-0.014260	0.000253	2148	0.000007	0.000000	0.000000	0.000000	0.000000
100	-0.017028	-0.014229	-0.013995	0.000248	2150	0.000007	0.000000	0.000000	0.000000	0.000000
102	-0.016660	-0.013965	-0.013736	0.000244	2152	0.000007	0.000000	0.000000	0.000000	0.000000
104	-0.016300	-0.013706	-0.013481	0.000239	2154	0.000007	0.000000	0.000000	0.000000	0.000000
106	-0.015946	-0.013451	-0.013231	0.000235	2156	0.000007	0.000000	0.000000	0.000000	0.000000
108	-0.015600	-0.013202	-0.012985	0.000231	2158	0.000007	0.000000	0.000000	0.000000	0.000000
110	-0.015260	-0.012957	-0.012744	0.000226	2160	0.000007	0.000000	0.000000	0.000000	0.000000
112	-0.014926	-0.012717	-0.012508	0.000222	2162	0.000006	0.000000	0.000000	0.000000	0.000000
114	-0.014600	-0.012481	-0.012276	0.000218	2164	0.000006	0.000000	0.000000	0.000000	0.000000
116	-0.014279	-0.012249	-0.012048	0.000214	2166	0.000006	0.000000	0.000000	0.000000	0.000000
118	-0.013965	-0.012022	-0.011824	0.000210	2168	0.000006	0.000000	0.000000	0.000000	0.000000
120	-0.013657	-0.011799	-0.011605	0.000206	2170	0.000006	0.000000	0.000000	0.000000	0.000000
122	-0.013355	-0.011580	-0.011390	0.000202	2172	0.000006	0.000000	0.000000	0.000000	0.000000
124	-0.013059	-0.011365	-0.011178	0.000198	2174	0.000006	0.000000	0.000000	0.000000	0.000000
126	-0.012769	-0.011154	-0.010971	0.000195	2176	0.000006	0.000000	0.000000	0.000000	0.000000
128	-0.012484	-0.010947	-0.010767	0.000191	2178	0.000006	0.000000	0.000000	0.000000	0.000000
130	-0.012205	-0.010744	-0.010567	0.000188	2180	0.000006	0.000000	0.000000	0.000000	0.000000
132	-0.011932	-0.010545	-0.010371	0.000184	2182	0.000006	0.000000	0.000000	0.000000	0.000000
134	-0.011663	-0.010349	-0.010179	0.000181	2184	0.000006	0.000000	0.000000	0.000000	0.000000
136	-0.011401	-0.010157	-0.009990	0.000177	2186	0.000006	0.000000	0.000000	0.000000	0.000000
138	-0.011143	-0.009968	-0.009805	0.000174	2188	0.000006	0.000000	0.000000	0.000000	0.000000
140	-0.010890	-0.009783	-0.009623	0.000171	2190	0.000006	0.000000	0.000000	0.000000	0.000000
142	-0.010643	-0.009602	-0.009444	0.000168	2192	0.000006	0.000000	0.000000	0.000000	0.000000
144	-0.010400	-0.009424	-0.009269	0.000165	2194	0.000006	0.000000	0.000000	0.000000	0.000000
146	-0.010162	-0.009249	-0.009097	0.000162	2196	0.000006	0.000000	0.000000	0.000000	0.000000
148	-0.009928	-0.009077	-0.008928	0.000159	2198	0.000006	0.000000	0.000000	0.000000	0.000000
150	-0.009700	-0.008909	-0.008763	0.000156	2200	0.000006	0.000000	0.000000	0.000000	0.000000
152	-0.009476	-0.008744	-0.008600	0.000153	2202	0.000006	0.000000	0.000000	0.000000	0.000000
154	-0.009256	-0.008581	-0.008440	0.000150	2204	0.000006	0.000000	0.000000	0.000000	0.000000
156	-0.009040	-0.008422	-0.008284	0.000147	2206	0.000006	0.000000	0.000000	0.000000	0.000000
158	-0.008829	-0.008266	-0.008130	0.000144	2208	0.000006	0.000000	0.000000	0.000000	0.000000
160	-0.008622	-0.008113	-0.007979	0.000142	2210	0.000006	0.000000	0.000000	0.000000	0.000000
162	-0.008419	-0.007962	-0.007831	0.000139	2212	0.000006	0.000000	0.000000	0.000000	0.000000
164	-0.008221	-0.007814	-0.007686	0.000136	2214	0.000005	0.000000	0.000000	0.000000	0.000000
166	-0.008026	-0.007669	-0.007543	0.000134	2216	0.000005	0.000000	0.000000	0.000000	0.000000
168	-0.007835	-0.007527	-0.007403	0.000131	2218	0.000005	0.000000	0.000000	0.000000	0.000000
170	-0.007648	-0.007387	-0.007266	0.000129	2220	0.000005	0.000000	0.000000	0.000000	0.000000
172	-0.007464	-0.007250	-0.007131	0.000127	2222	0.000005	0.000000	0.000000	0.000000	0.000000
174	-0.007285	-0.007116	-0.006999	0.000124	2224	0.000005	0.000000	0.000000	0.000000	0.000000
176	-0.007108	-0.006984	-0.006869	0.000122	2226	0.000005	0.000000	0.000000	0.000000	0.000000
178	-0.006936	-0.006854	-0.006742	0.000120	2228	0.000005	0.000000	0.000000	0.000000	0.000000
180	-0.006767	-0.006727	-0.006616	0.000117	2230	0.000005	0.000000	0.000000	0.000000	0.000000
182	-0.006601	-0.006602	-0.006494	0.000115	2232	0.000005	0.000000	0.000000	0.000000	0.000000
184	-0.006438	-0.006480	-0.006373	0.000113	2234	0.000005	0.000000	0.000000	0.000000	0.000000
186	-0.006279	-0.006359	-0.006255	0.000111	2236	0.000005	0.000000	0.000000	0.000000	0.000000

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

188	-0.006123	-0.006241	-0.006139	0.000109	2238	0.000005	0.000000	0.000000	0.000000	0.000000
190	-0.005970	-0.006126	-0.006025	0.000107	2240	0.000005	0.000000	0.000000	0.000000	0.000000
192	-0.005821	-0.006012	-0.005913	0.000105	2242	0.000005	0.000000	0.000000	0.000000	0.000000
194	-0.005674	-0.005900	-0.005803	0.000103	2244	0.000005	0.000000	0.000000	0.000000	0.000000
196	-0.005530	-0.005791	-0.005696	0.000101	2246	0.000005	0.000000	0.000000	0.000000	0.000000
198	-0.005389	-0.005683	-0.005590	0.000099	2248	0.000005	0.000000	0.000000	0.000000	0.000000
200	-0.005251	-0.005578	-0.005486	0.000097	2250	0.000005	0.000000	0.000000	0.000000	0.000000
202	-0.005116	-0.005474	-0.005385	0.000096	2252	0.000005	0.000000	0.000000	0.000000	0.000000
204	-0.004984	-0.005373	-0.005285	0.000094	2254	0.000005	0.000000	0.000000	0.000000	0.000000
206	-0.004854	-0.005273	-0.005187	0.000092	2256	0.000005	0.000000	0.000000	0.000000	0.000000
208	-0.004727	-0.005175	-0.005090	0.000090	2258	0.000005	0.000000	0.000000	0.000000	0.000000
210	-0.004602	-0.005079	-0.004996	0.000089	2260	0.000005	0.000000	0.000000	0.000000	0.000000
212	-0.004480	-0.004985	-0.004903	0.000087	2262	0.000005	0.000000	0.000000	0.000000	0.000000
214	-0.004361	-0.004893	-0.004812	0.000085	2264	0.000005	0.000000	0.000000	0.000000	0.000000
216	-0.004243	-0.004802	-0.004723	0.000084	2266	0.000005	0.000000	0.000000	0.000000	0.000000
218	-0.004129	-0.004713	-0.004635	0.000082	2268	0.000005	0.000000	0.000000	0.000000	0.000000
220	-0.004017	-0.004625	-0.004549	0.000081	2270	0.000005	0.000000	0.000000	0.000000	0.000000
222	-0.003907	-0.004539	-0.004465	0.000079	2272	0.000005	0.000000	0.000000	0.000000	0.000000
224	-0.003799	-0.004455	-0.004382	0.000078	2274	0.000005	0.000000	0.000000	0.000000	0.000000
226	-0.003693	-0.004373	-0.004301	0.000076	2276	0.000005	0.000000	0.000000	0.000000	0.000000
228	-0.003590	-0.004291	-0.004221	0.000075	2278	0.000004	0.000000	0.000000	0.000000	0.000000
230	-0.003489	-0.004212	-0.004143	0.000074	2280	0.000004	0.000000	0.000000	0.000000	0.000000
232	-0.003390	-0.004134	-0.004066	0.000072	2282	0.000004	0.000000	0.000000	0.000000	0.000000
234	-0.003293	-0.004057	-0.003990	0.000071	2284	0.000004	0.000000	0.000000	0.000000	0.000000
236	-0.003197	-0.003982	-0.003916	0.000070	2286	0.000004	0.000000	0.000000	0.000000	0.000000
238	-0.003104	-0.003908	-0.003844	0.000068	2288	0.000004	0.000000	0.000000	0.000000	0.000000
240	-0.003013	-0.003835	-0.003772	0.000067	2290	0.000004	0.000000	0.000000	0.000000	0.000000
242	-0.002924	-0.003764	-0.003702	0.000066	2292	0.000004	0.000000	0.000000	0.000000	0.000000
244	-0.002837	-0.003694	-0.003634	0.000065	2294	0.000004	0.000000	0.000000	0.000000	0.000000
246	-0.002751	-0.003626	-0.003566	0.000063	2296	0.000004	0.000000	0.000000	0.000000	0.000000
248	-0.002667	-0.003558	-0.003500	0.000062	2298	0.000004	0.000000	0.000000	0.000000	0.000000
250	-0.002585	-0.003492	-0.003435	0.000061	2300	0.000004	0.000000	0.000000	0.000000	0.000000
252	-0.002505	-0.003428	-0.003371	0.000060	2302	0.000004	0.000000	0.000000	0.000000	0.000000
254	-0.002427	-0.003364	-0.003309	0.000059	2304	0.000004	0.000000	0.000000	0.000000	0.000000
256	-0.002350	-0.003302	-0.003247	0.000058	2306	0.000004	0.000000	0.000000	0.000000	0.000000
258	-0.002274	-0.003240	-0.003187	0.000057	2308	0.000004	0.000000	0.000000	0.000000	0.000000
260	-0.002201	-0.003180	-0.003128	0.000056	2310	0.000004	0.000000	0.000000	0.000000	0.000000
262	-0.002129	-0.003121	-0.003070	0.000055	2312	0.000004	0.000000	0.000000	0.000000	0.000000
264	-0.002058	-0.003063	-0.003013	0.000053	2314	0.000004	0.000000	0.000000	0.000000	0.000000
266	-0.001989	-0.003006	-0.002957	0.000053	2316	0.000004	0.000000	0.000000	0.000000	0.000000
268	-0.001921	-0.002951	-0.002902	0.000052	2318	0.000004	0.000000	0.000000	0.000000	0.000000
270	-0.001855	-0.002896	-0.002848	0.000051	2320	0.000004	0.000000	0.000000	0.000000	0.000000
272	-0.001790	-0.002842	-0.002796	0.000050	2322	0.000004	0.000000	0.000000	0.000000	0.000000
274	-0.001727	-0.002789	-0.002744	0.000049	2324	0.000004	0.000000	0.000000	0.000000	0.000000
276	-0.001665	-0.002738	-0.002693	0.000048	2326	0.000004	0.000000	0.000000	0.000000	0.000000
278	-0.001604	-0.002687	-0.002643	0.000047	2328	0.000004	0.000000	0.000000	0.000000	0.000000
280	-0.001545	-0.002637	-0.002594	0.000046	2330	0.000004	0.000000	0.000000	0.000000	0.000000
282	-0.001487	-0.002588	-0.002546	0.000045	2332	0.000004	0.000000	0.000000	0.000000	0.000000
284	-0.001430	-0.002540	-0.002498	0.000044	2334	0.000004	0.000000	0.000000	0.000000	0.000000
286	-0.001375	-0.002493	-0.002452	0.000044	2336	0.000004	0.000000	0.000000	0.000000	0.000000
288	-0.001320	-0.002447	-0.002407	0.000043	2338	0.000004	0.000000	0.000000	0.000000	0.000000
290	-0.001267	-0.002401	-0.002362	0.000042	2340	0.000004	0.000000	0.000000	0.000000	0.000000
292	-0.001215	-0.002357	-0.002318	0.000041	2342	0.000004	0.000000	0.000000	0.000000	0.000000
294	-0.001164	-0.002313	-0.002275	0.000040	2344	0.000004	0.000000	0.000000	0.000000	0.000000
296	-0.001115	-0.002270	-0.002233	0.000040	2346	0.000004	0.000000	0.000000	0.000000	0.000000
298	-0.001066	-0.002228	-0.002191	0.000039	2348	0.000004	0.000000	0.000000	0.000000	0.000000
300	-0.001018	-0.002187	-0.002151	0.000038	2350	0.000004	0.000000	0.000000	0.000000	0.000000
302	-0.000972	-0.002146	-0.002111	0.000037	2352	0.000004	0.000000	0.000000	0.000000	0.000000
304	-0.000926	-0.002106	-0.002072	0.000037	2354	0.000004	0.000000	0.000000	0.000000	0.000000
306	-0.000882	-0.002067	-0.002033	0.000036	2356	0.000004	0.000000	0.000000	0.000000	0.000000
308	-0.000839	-0.002029	-0.001996	0.000035	2358	0.000003	0.000000	0.000000	0.000000	0.000000
310	-0.000796	-0.001991	-0.001958	0.000035	2360	0.000003	0.000000	0.000000	0.000000	0.000000
312	-0.000755	-0.001954	-0.001922	0.000034	2362	0.000003	0.000000	0.000000	0.000000	0.000000
314	-0.000714	-0.001918	-0.001886	0.000033	2364	0.000003	0.000000	0.000000	0.000000	0.000000
316	-0.000674	-0.001882	-0.001851	0.000033	2366	0.000003	0.000000	0.000000	0.000000	0.000000
318	-0.000636	-0.001847	-0.001817	0.000032	2368	0.000003	0.000000	0.000000	0.000000	0.000000
320	-0.000598	-0.001813	-0.001783	0.000032	2370	0.000003	0.000000	0.000000	0.000000	0.000000

						Prepared by:		RXT QC Department			
						Client:		Statoil			
						Project Number:		RXT10009			
						Date:		September 2010			

322	-0.000561	-0.001780	-0.001750	0.000031		2372	0.000003	0.000000	0.000000	0.000000	0.000000
324	-0.000525	-0.001747	-0.001718	0.000031		2374	0.000003	0.000000	0.000000	0.000000	0.000000
326	-0.000489	-0.001714	-0.001686	0.000030		2376	0.000003	0.000000	0.000000	0.000000	0.000000
328	-0.000455	-0.001682	-0.001655	0.000029		2378	0.000003	0.000000	0.000000	0.000000	0.000000
330	-0.000421	-0.001651	-0.001624	0.000029		2380	0.000003	0.000000	0.000000	0.000000	0.000000
332	-0.000388	-0.001620	-0.001594	0.000028		2382	0.000003	0.000000	0.000000	0.000000	0.000000
334	-0.000356	-0.001590	-0.001564	0.000028		2384	0.000003	0.000000	0.000000	0.000000	0.000000
336	-0.000325	-0.001561	-0.001535	0.000027		2386	0.000003	0.000000	0.000000	0.000000	0.000000
338	-0.000294	-0.001532	-0.001507	0.000027		2388	0.000003	0.000000	0.000000	0.000000	0.000000
340	-0.000264	-0.001504	-0.001479	0.000026		2390	0.000003	0.000000	0.000000	0.000000	0.000000
342	-0.000235	-0.001476	-0.001451	0.000026		2392	0.000003	0.000000	0.000000	0.000000	0.000000
344	-0.000206	-0.001448	-0.001424	0.000025		2394	0.000003	0.000000	0.000000	0.000000	0.000000
346	-0.000178	-0.001421	-0.001398	0.000025		2396	0.000003	0.000000	0.000000	0.000000	0.000000
348	-0.000151	-0.001395	-0.001372	0.000024		2398	0.000003	0.000000	0.000000	0.000000	0.000000
350	-0.000125	-0.001369	-0.001347	0.000024		2400	0.000003	0.000000	0.000000	0.000000	0.000000
352	-0.000099	-0.001344	-0.001322	0.000023		2402	0.000003	0.000000	0.000000	0.000000	0.000000
354	-0.000073	-0.001319	-0.001297	0.000023		2404	0.000003	0.000000	0.000000	0.000000	0.000000
356	-0.000049	-0.001294	-0.001273	0.000023		2406	0.000003	0.000000	0.000000	0.000000	0.000000
358	-0.000025	-0.001270	-0.001249	0.000022		2408	0.000003	0.000000	0.000000	0.000000	0.000000
360	-0.000001	-0.001247	-0.001226	0.000022		2410	0.000003	0.000000	0.000000	0.000000	0.000000
362	0.000022	-0.001224	-0.001203	0.000021		2412	0.000003	0.000000	0.000000	0.000000	0.000000
364	0.000044	-0.001201	-0.001181	0.000021		2414	0.000003	0.000000	0.000000	0.000000	0.000000
366	0.000066	-0.001179	-0.001159	0.000021		2416	0.000003	0.000000	0.000000	0.000000	0.000000
368	0.000087	-0.001157	-0.001138	0.000020		2418	0.000003	0.000000	0.000000	0.000000	0.000000
370	0.000108	-0.001135	-0.001117	0.000020		2420	0.000003	0.000000	0.000000	0.000000	0.000000
372	0.000128	-0.001114	-0.001096	0.000019		2422	0.000003	0.000000	0.000000	0.000000	0.000000
374	0.000147	-0.001094	-0.001076	0.000019		2424	0.000003	0.000000	0.000000	0.000000	0.000000
376	0.000166	-0.001073	-0.001056	0.000019		2426	0.000003	0.000000	0.000000	0.000000	0.000000
378	0.000185	-0.001053	-0.001036	0.000018		2428	0.000003	0.000000	0.000000	0.000000	0.000000
380	0.000203	-0.001034	-0.001017	0.000018		2430	0.000003	0.000000	0.000000	0.000000	0.000000
382	0.000221	-0.001015	-0.000998	0.000018		2432	0.000003	0.000000	0.000000	0.000000	0.000000
384	0.000238	-0.000996	-0.000979	0.000017		2434	0.000003	0.000000	0.000000	0.000000	0.000000
386	0.000255	-0.000977	-0.000961	0.000017		2436	0.000003	0.000000	0.000000	0.000000	0.000000
388	0.000271	-0.000959	-0.000943	0.000017		2438	0.000003	0.000000	0.000000	0.000000	0.000000
390	0.000287	-0.000941	-0.000926	0.000016		2440	0.000003	0.000000	0.000000	0.000000	0.000000
392	0.000303	-0.000924	-0.000909	0.000016		2442	0.000003	0.000000	0.000000	0.000000	0.000000
394	0.000318	-0.000907	-0.000892	0.000016		2444	0.000003	0.000000	0.000000	0.000000	0.000000
396	0.000332	-0.000890	-0.000875	0.000016		2446	0.000003	0.000000	0.000000	0.000000	0.000000
398	0.000347	-0.000873	-0.000859	0.000015		2448	0.000003	0.000000	0.000000	0.000000	0.000000
400	0.000360	-0.000857	-0.000843	0.000015		2450	0.000003	0.000000	0.000000	0.000000	0.000000
402	0.000374	-0.000841	-0.000827	0.000015		2452	0.000003	0.000000	0.000000	0.000000	0.000000
404	0.000387	-0.000826	-0.000812	0.000014		2454	0.000003	0.000000	0.000000	0.000000	0.000000
406	0.000400	-0.000810	-0.000797	0.000014		2456	0.000003	0.000000	0.000000	0.000000	0.000000
408	0.000412	-0.000795	-0.000782	0.000014		2458	0.000003	0.000000	0.000000	0.000000	0.000000
410	0.000424	-0.000781	-0.000768	0.000014		2460	0.000003	0.000000	0.000000	0.000000	0.000000
412	0.000436	-0.000766	-0.000754	0.000013		2462	0.000003	0.000000	0.000000	0.000000	0.000000
414	0.000447	-0.000752	-0.000740	0.000013		2464	0.000003	0.000000	0.000000	0.000000	0.000000
416	0.000458	-0.000738	-0.000726	0.000013		2466	0.000002	0.000000	0.000000	0.000000	0.000000
418	0.000469	-0.000724	-0.000712	0.000013		2468	0.000002	0.000000	0.000000	0.000000	0.000000
420	0.000479	-0.000711	-0.000699	0.000012		2470	0.000002	0.000000	0.000000	0.000000	0.000000
422	0.000489	-0.000698	-0.000686	0.000012		2472	0.000002	0.000000	0.000000	0.000000	0.000000
424	0.000499	-0.000685	-0.000673	0.000012		2474	0.000002	0.000000	0.000000	0.000000	0.000000
426	0.000508	-0.000672	-0.000661	0.000012		2476	0.000002	0.000000	0.000000	0.000000	0.000000
428	0.000517	-0.000659	-0.000649	0.000012		2478	0.000002	0.000000	0.000000	0.000000	0.000000
430	0.000526	-0.000647	-0.000637	0.000011		2480	0.000002	0.000000	0.000000	0.000000	0.000000
432	0.000535	-0.000635	-0.000625	0.000011		2482	0.000002	0.000000	0.000000	0.000000	0.000000
434	0.000543	-0.000623	-0.000613	0.000011		2484	0.000002	0.000000	0.000000	0.000000	0.000000
436	0.000551	-0.000612	-0.000602	0.000011		2486	0.000002	0.000000	0.000000	0.000000	0.000000
438	0.000559	-0.000601	-0.000591	0.000010		2488	0.000002	0.000000	0.000000	0.000000	0.000000
440	0.000567	-0.000589	-0.000580	0.000010		2490	0.000002	0.000000	0.000000	0.000000	0.000000
442	0.000574	-0.000578	-0.000569	0.000010		2492	0.000002	0.000000	0.000000	0.000000	0.000000
444	0.000581	-0.000568	-0.000558	0.000010		2494	0.000002	0.000000	0.000000	0.000000	0.000000
446	0.000588	-0.000557	-0.000548	0.000010		2496	0.000002	0.000000	0.000000	0.000000	0.000000
448	0.000594	-0.000547	-0.000538	0.000010		2498	0.000002	0.000000	0.000000	0.000000	0.000000
450	0.000600	-0.000537	-0.000528	0.000009		2500	0.000002	0.000000	0.000000	0.000000	0.000000
452	0.000607	-0.000527	-0.000518	0.000009		2502	0.000002	0.000000	0.000000	0.000000	0.000000
454	0.000612	-0.000517	-0.000508	0.000009		2504	0.000002	0.000000	0.000000	0.000000	0.000000

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

456	0.000618	-0.000507	-0.000499	0.000009	2506	0.000002	0.000000	0.000000	0.000000	0.000000
458	0.000623	-0.000498	-0.000490	0.000009	2508	0.000002	0.000000	0.000000	0.000000	0.000000
460	0.000629	-0.000489	-0.000481	0.000009	2510	0.000002	0.000000	0.000000	0.000000	0.000000
462	0.000634	-0.000480	-0.000472	0.000008	2512	0.000002	0.000000	0.000000	0.000000	0.000000
464	0.000639	-0.000471	-0.000463	0.000008	2514	0.000002	0.000000	0.000000	0.000000	0.000000
466	0.000643	-0.000462	-0.000454	0.000008	2516	0.000002	0.000000	0.000000	0.000000	0.000000
468	0.000648	-0.000453	-0.000446	0.000008	2518	0.000002	0.000000	0.000000	0.000000	0.000000
470	0.000652	-0.000445	-0.000438	0.000008	2520	0.000002	0.000000	0.000000	0.000000	0.000000
472	0.000656	-0.000437	-0.000430	0.000008	2522	0.000002	0.000000	0.000000	0.000000	0.000000
474	0.000660	-0.000429	-0.000422	0.000007	2524	0.000002	0.000000	0.000000	0.000000	0.000000
476	0.000664	-0.000421	-0.000414	0.000007	2526	0.000002	0.000000	0.000000	0.000000	0.000000
478	0.000667	-0.000413	-0.000406	0.000007	2528	0.000002	0.000000	0.000000	0.000000	0.000000
480	0.000671	-0.000405	-0.000399	0.000007	2530	0.000002	0.000000	0.000000	0.000000	0.000000
482	0.000674	-0.000398	-0.000391	0.000007	2532	0.000002	0.000000	0.000000	0.000000	0.000000
484	0.000677	-0.000390	-0.000384	0.000007	2534	0.000002	0.000000	0.000000	0.000000	0.000000
486	0.000680	-0.000383	-0.000377	0.000007	2536	0.000002	0.000000	0.000000	0.000000	0.000000
488	0.000683	-0.000376	-0.000370	0.000007	2538	0.000002	0.000000	0.000000	0.000000	0.000000
490	0.000685	-0.000369	-0.000363	0.000006	2540	0.000002	0.000000	0.000000	0.000000	0.000000
492	0.000688	-0.000362	-0.000356	0.000006	2542	0.000002	0.000000	0.000000	0.000000	0.000000
494	0.000690	-0.000355	-0.000350	0.000006	2544	0.000002	0.000000	0.000000	0.000000	0.000000
496	0.000692	-0.000349	-0.000343	0.000006	2546	0.000002	0.000000	0.000000	0.000000	0.000000
498	0.000694	-0.000342	-0.000337	0.000006	2548	0.000002	0.000000	0.000000	0.000000	0.000000
500	0.000696	-0.000336	-0.000331	0.000006	2550	0.000002	0.000000	0.000000	0.000000	0.000000
502	0.000698	-0.000330	-0.000324	0.000006	2552	0.000002	0.000000	0.000000	0.000000	0.000000
504	0.000700	-0.000324	-0.000318	0.000006	2554	0.000002	0.000000	0.000000	0.000000	0.000000
506	0.000701	-0.000318	-0.000312	0.000006	2556	0.000002	0.000000	0.000000	0.000000	0.000000
508	0.000703	-0.000312	-0.000307	0.000005	2558	0.000002	0.000000	0.000000	0.000000	0.000000
510	0.000704	-0.000306	-0.000301	0.000005	2560	0.000002	0.000000	0.000000	0.000000	0.000000
512	0.000705	-0.000300	-0.000295	0.000005	2562	0.000002	0.000000	0.000000	0.000000	0.000000
514	0.000706	-0.000295	-0.000290	0.000005	2564	0.000002	0.000000	0.000000	0.000000	0.000000
516	0.000707	-0.000289	-0.000285	0.000005	2566	0.000002	0.000000	0.000000	0.000000	0.000000
518	0.000708	-0.000284	-0.000279	0.000005	2568	0.000002	0.000000	0.000000	0.000000	0.000000
520	0.000709	-0.000279	-0.000274	0.000005	2570	0.000002	0.000000	0.000000	0.000000	0.000000
522	0.000710	-0.000273	-0.000269	0.000005	2572	0.000002	0.000000	0.000000	0.000000	0.000000
524	0.000710	-0.000268	-0.000264	0.000005	2574	0.000002	0.000000	0.000000	0.000000	0.000000
526	0.000711	-0.000263	-0.000259	0.000005	2576	0.000002	0.000000	0.000000	0.000000	0.000000
528	0.000711	-0.000259	-0.000254	0.000005	2578	0.000002	0.000000	0.000000	0.000000	0.000000
530	0.000711	-0.000254	-0.000250	0.000004	2580	0.000002	0.000000	0.000000	0.000000	0.000000
532	0.000712	-0.000249	-0.000245	0.000004	2582	0.000002	0.000000	0.000000	0.000000	0.000000
534	0.000712	-0.000244	-0.000240	0.000004	2584	0.000002	0.000000	0.000000	0.000000	0.000000
536	0.000712	-0.000240	-0.000236	0.000004	2586	0.000002	0.000000	0.000000	0.000000	0.000000
538	0.000712	-0.000235	-0.000232	0.000004	2588	0.000002	0.000000	0.000000	0.000000	0.000000
540	0.000711	-0.000231	-0.000227	0.000004	2590	0.000002	0.000000	0.000000	0.000000	0.000000
542	0.000711	-0.000227	-0.000223	0.000004	2592	0.000002	0.000000	0.000000	0.000000	0.000000
544	0.000711	-0.000223	-0.000219	0.000004	2594	0.000002	0.000000	0.000000	0.000000	0.000000
546	0.000711	-0.000218	-0.000215	0.000004	2596	0.000002	0.000000	0.000000	0.000000	0.000000
548	0.000710	-0.000214	-0.000211	0.000004	2598	0.000002	0.000000	0.000000	0.000000	0.000000
550	0.000710	-0.000210	-0.000207	0.000004	2600	0.000002	0.000000	0.000000	0.000000	0.000000
552	0.000709	-0.000206	-0.000203	0.000004	2602	0.000002	0.000000	0.000000	0.000000	0.000000
554	0.000708	-0.000203	-0.000199	0.000004	2604	0.000002	0.000000	0.000000	0.000000	0.000000
556	0.000708	-0.000199	-0.000196	0.000003	2606	0.000002	0.000000	0.000000	0.000000	0.000000
558	0.000707	-0.000195	-0.000192	0.000003	2608	0.000002	0.000000	0.000000	0.000000	0.000000
560	0.000706	-0.000192	-0.000188	0.000003	2610	0.000002	0.000000	0.000000	0.000000	0.000000
562	0.000705	-0.000188	-0.000185	0.000003	2612	0.000002	0.000000	0.000000	0.000000	0.000000
564	0.000704	-0.000185	-0.000182	0.000003	2614	0.000002	0.000000	0.000000	0.000000	0.000000
566	0.000703	-0.000181	-0.000178	0.000003	2616	0.000002	0.000000	0.000000	0.000000	0.000000
568	0.000702	-0.000178	-0.000175	0.000003	2618	0.000002	0.000000	0.000000	0.000000	0.000000
570	0.000701	-0.000174	-0.000172	0.000003	2620	0.000002	0.000000	0.000000	0.000000	0.000000
572	0.000700	-0.000171	-0.000168	0.000003	2622	0.000002	0.000000	0.000000	0.000000	0.000000
574	0.000698	-0.000168	-0.000165	0.000003	2624	0.000002	0.000000	0.000000	0.000000	0.000000
576	0.000697	-0.000165	-0.000162	0.000003	2626	0.000002	0.000000	0.000000	0.000000	0.000000
578	0.000696	-0.000162	-0.000159	0.000003	2628	0.000001	0.000000	0.000000	0.000000	0.000000
580	0.000694	-0.000159	-0.000156	0.000003	2630	0.000001	0.000000	0.000000	0.000000	0.000000
582	0.000693	-0.000156	-0.000153	0.000003	2632	0.000001	0.000000	0.000000	0.000000	0.000000
584	0.000692	-0.000153	-0.000151	0.000003	2634	0.000001	0.000000	0.000000	0.000000	0.000000
586	0.000690	-0.000150	-0.000148	0.000003	2636	0.000001	0.000000	0.000000	0.000000	0.000000
588	0.000688	-0.000147	-0.000145	0.000003	2638	0.000001	0.000000	0.000000	0.000000	0.000000

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

590	0.000687	-0.000145	-0.000142	0.000003	2640	0.000001	0.000000	0.000000	0.000000	0.000000
592	0.000685	-0.000142	-0.000140	0.000002	2642	0.000001	0.000000	0.000000	0.000000	0.000000
594	0.000683	-0.000139	-0.000137	0.000002	2644	0.000001	0.000000	0.000000	0.000000	0.000000
596	0.000682	-0.000137	-0.000135	0.000002	2646	0.000001	0.000000	0.000000	0.000000	0.000000
598	0.000680	-0.000134	-0.000132	0.000002	2648	0.000001	0.000000	0.000000	0.000000	0.000000
600	0.000678	-0.000132	-0.000130	0.000002	2650	0.000001	0.000000	0.000000	0.000000	0.000000
602	0.000676	-0.000129	-0.000127	0.000002	2652	0.000001	0.000000	0.000000	0.000000	0.000000
604	0.000675	-0.000127	-0.000125	0.000002	2654	0.000001	0.000000	0.000000	0.000000	0.000000
606	0.000673	-0.000125	-0.000122	0.000002	2656	0.000001	0.000000	0.000000	0.000000	0.000000
608	0.000671	-0.000122	-0.000120	0.000002	2658	0.000001	0.000000	0.000000	0.000000	0.000000
610	0.000669	-0.000120	-0.000118	0.000002	2660	0.000001	0.000000	0.000000	0.000000	0.000000
612	0.000667	-0.000118	-0.000116	0.000002	2662	0.000001	0.000000	0.000000	0.000000	0.000000
614	0.000665	-0.000116	-0.000114	0.000002	2664	0.000001	0.000000	0.000000	0.000000	0.000000
616	0.000663	-0.000113	-0.000112	0.000002	2666	0.000001	0.000000	0.000000	0.000000	0.000000
618	0.000661	-0.000111	-0.000109	0.000002	2668	0.000001	0.000000	0.000000	0.000000	0.000000
620	0.000659	-0.000109	-0.000107	0.000002	2670	0.000001	0.000000	0.000000	0.000000	0.000000
622	0.000656	-0.000107	-0.000105	0.000002	2672	0.000001	0.000000	0.000000	0.000000	0.000000
624	0.000654	-0.000105	-0.000103	0.000002	2674	0.000001	0.000000	0.000000	0.000000	0.000000
626	0.000652	-0.000103	-0.000102	0.000002	2676	0.000001	0.000000	0.000000	0.000000	0.000000
628	0.000650	-0.000101	-0.000100	0.000002	2678	0.000001	0.000000	0.000000	0.000000	0.000000
630	0.000648	-0.000099	-0.000098	0.000002	2680	0.000001	0.000000	0.000000	0.000000	0.000000
632	0.000645	-0.000098	-0.000096	0.000002	2682	0.000001	0.000000	0.000000	0.000000	0.000000
634	0.000643	-0.000096	-0.000094	0.000002	2684	0.000001	0.000000	0.000000	0.000000	0.000000
636	0.000641	-0.000094	-0.000092	0.000002	2686	0.000001	0.000000	0.000000	0.000000	0.000000
638	0.000639	-0.000092	-0.000091	0.000002	2688	0.000001	0.000000	0.000000	0.000000	0.000000
640	0.000636	-0.000091	-0.000089	0.000002	2690	0.000001	0.000000	0.000000	0.000000	0.000000
642	0.000634	-0.000089	-0.000087	0.000002	2692	0.000001	0.000000	0.000000	0.000000	0.000000
644	0.000632	-0.000087	-0.000086	0.000002	2694	0.000001	0.000000	0.000000	0.000000	0.000000
646	0.000629	-0.000086	-0.000084	0.000001	2696	0.000001	0.000000	0.000000	0.000000	0.000000
648	0.000627	-0.000084	-0.000083	0.000001	2698	0.000001	0.000000	0.000000	0.000000	0.000000
650	0.000625	-0.000082	-0.000081	0.000001	2700	0.000001	0.000000	0.000000	0.000000	0.000000
652	0.000622	-0.000081	-0.000080	0.000001	2702	0.000001	0.000000	0.000000	0.000000	0.000000
654	0.000620	-0.000079	-0.000078	0.000001	2704	0.000001	0.000000	0.000000	0.000000	0.000000
656	0.000617	-0.000078	-0.000077	0.000001	2706	0.000001	0.000000	0.000000	0.000000	0.000000
658	0.000615	-0.000077	-0.000075	0.000001	2708	0.000001	0.000000	0.000000	0.000000	0.000000
660	0.000612	-0.000075	-0.000074	0.000001	2710	0.000001	0.000000	0.000000	0.000000	0.000000
662	0.000610	-0.000074	-0.000073	0.000001	2712	0.000001	0.000000	0.000000	0.000000	0.000000
664	0.000608	-0.000072	-0.000071	0.000001	2714	0.000001	0.000000	0.000000	0.000000	0.000000
666	0.000605	-0.000071	-0.000070	0.000001	2716	0.000001	0.000000	0.000000	0.000000	0.000000
668	0.000603	-0.000070	-0.000069	0.000001	2718	0.000001	0.000000	0.000000	0.000000	0.000000
670	0.000600	-0.000068	-0.000067	0.000001	2720	0.000001	0.000000	0.000000	0.000000	0.000000
672	0.000598	-0.000067	-0.000066	0.000001	2722	0.000001	0.000000	0.000000	0.000000	0.000000
674	0.000595	-0.000066	-0.000065	0.000001	2724	0.000001	0.000000	0.000000	0.000000	0.000000
676	0.000593	-0.000065	-0.000064	0.000001	2726	0.000001	0.000000	0.000000	0.000000	0.000000
678	0.000590	-0.000063	-0.000062	0.000001	2728	0.000001	0.000000	0.000000	0.000000	0.000000
680	0.000587	-0.000062	-0.000061	0.000001	2730	0.000001	0.000000	0.000000	0.000000	0.000000
682	0.000585	-0.000061	-0.000060	0.000001	2732	0.000001	0.000000	0.000000	0.000000	0.000000
684	0.000582	-0.000060	-0.000059	0.000001	2734	0.000001	0.000000	0.000000	0.000000	0.000000
686	0.000580	-0.000059	-0.000058	0.000001	2736	0.000001	0.000000	0.000000	0.000000	0.000000
688	0.000577	-0.000058	-0.000057	0.000001	2738	0.000001	0.000000	0.000000	0.000000	0.000000
690	0.000575	-0.000057	-0.000056	0.000001	2740	0.000001	0.000000	0.000000	0.000000	0.000000
692	0.000572	-0.000056	-0.000055	0.000001	2742	0.000001	0.000000	0.000000	0.000000	0.000000
694	0.000570	-0.000055	-0.000054	0.000001	2744	0.000001	0.000000	0.000000	0.000000	0.000000
696	0.000567	-0.000054	-0.000053	0.000001	2746	0.000001	0.000000	0.000000	0.000000	0.000000
698	0.000564	-0.000053	-0.000052	0.000001	2748	0.000001	0.000000	0.000000	0.000000	0.000000
700	0.000562	-0.000052	-0.000051	0.000001	2750	0.000001	0.000000	0.000000	0.000000	0.000000
702	0.000559	-0.000051	-0.000050	0.000001	2752	0.000001	0.000000	0.000000	0.000000	0.000000
704	0.000557	-0.000050	-0.000049	0.000001	2754	0.000001	0.000000	0.000000	0.000000	0.000000
706	0.000554	-0.000049	-0.000048	0.000001	2756	0.000001	0.000000	0.000000	0.000000	0.000000
708	0.000552	-0.000048	-0.000047	0.000001	2758	0.000001	0.000000	0.000000	0.000000	0.000000
710	0.000549	-0.000047	-0.000046	0.000001	2760	0.000001	0.000000	0.000000	0.000000	0.000000
712	0.000546	-0.000046	-0.000045	0.000001	2762	0.000001	0.000000	0.000000	0.000000	0.000000
714	0.000544	-0.000045	-0.000045	0.000001	2764	0.000001	0.000000	0.000000	0.000000	0.000000
716	0.000541	-0.000044	-0.000044	0.000001	2766	0.000001	0.000000	0.000000	0.000000	0.000000
718	0.000539	-0.000044	-0.000043	0.000001	2768	0.000001	0.000000	0.000000	0.000000	0.000000
720	0.000536	-0.000043	-0.000042	0.000001	2770	0.000001	0.000000	0.000000	0.000000	0.000000
722	0.000534	-0.000042	-0.000041	0.000001	2772	0.000001	0.000000	0.000000	0.000000	0.000000



 RXT <small>RESERVOIR EXPLORATION TECHNOLOGY</small>	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway



 RXT <small>RESERVOIR EXPLORATION TECHNOLOGY</small>	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway



 RXT <small>RESERVOIR EXPLORATION TECHNOLOGY</small>	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010



 RXT <small>RESERVOIR EXPLORATION TECHNOLOGY</small>	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway

 RESERVOIR EXPLORATION TECHNOLOGY	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway

 RESERVOIR EXPLORATION TECHNOLOGY	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway

 RESERVOIR EXPLORATION TECHNOLOGY	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway

 RESERVOIR EXPLORATION TECHNOLOGY	Prepared by: Client: Project Number: Date:	RXT QC Department Statoil RXT10009 September 2010
--	---	--

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway

 RESERVOIR EXPLORATION TECHNOLOGY	Prepared by: Client: Project Number: Date:	RXT QC Department Statoil RXT10009 September 2010
--	---	--

Reservoir Exploration Technology - P.O. Box 123, Lysaker Torg 5A, N-1325, Lysaker, Norway

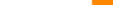
 RESERVOIR EXPLORATION TECHNOLOGY	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Table 9. VSO System Impulse Response Listing

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.4 DBU SEGY Header

HEADER NAME	TYPE	SIZE	LOC.	DESCRIPTION
TRACE_SEQ_NO	Integer Long	4	1	Trace Seq. no. Within Line
TRACE_SEQ_REEL	Integer Long	4	5	Trace Seq. within Reel
FIELD_RECORD_NO	Integer Long	4	9	Original Field record
CHANNEL_NO	Integer Long	4	13	Trace no. Within Original Field Record.
TRACE_ID_CODE	Integer Long	4	29	Trace ID Code 1=seis, 2=dead trace
TEST_CODE	Integer Long	2	35	1=Production, 2=Test
OFFSET_SH_REC	Integer Short	2	37	Distance from shot to recv(May be -ve)
ELEV_REC	Integer Short	2	41	Elevation of receiver group.
ELEV_SHOT	Integer Short	2	45	Surface elevation of shot
DEPTH_SHOT	Integer Short	2	49	Source depth below surface.
ELEV_FLOATDATUM_REC	Integer Short	2	53	Floating Datum elevation of receiver group.
ELEV_FLOATDATUM_SHOT	Integer Short	2	57	Floating Datum elevation of source.
WATER_DEPTH_SHOT	Integer Short	2	61	Water depth at source.
WATER_DEPTH_REC	Integer Short	2	65	Water depth at receiver group.
ELEV_DEPTH_SCALER	Integer Long	4	69	Scalar to be applied to all elevations and depths.
COORD_SCALER	Integer Long	4	71	Scalar to be applied to all coordinates.
XSHOT	Integer Short	2	73	Shot X Coordinate
YSHOT	Integer Short	2	77	Shot Y Coordinate
XREC	Integer Short	2	81	Receiver group X Coordinate
YREC	Integer Short	2	85	Receiver group Y Coordinate
UNITS	Integer Long	4	89	1-Length,2-Lat/long,3-Meters,4-Feet
NSAMPLES	Integer Long	4	115	Number of samples for this trace.
SAMPLERATE	Integer Long	4	117	Sample interval in microseconds for this trace.
GAIN_TYPE	Integer Long	4	119	Gain type of field instruments 1-Fixed/2-
Binary/3-Float/4-Optional				
GAIN_CONSTANT	Integer Long	4	121	Instrument gain constant (preamp K gain)
GAIN_INITIAL	Integer Long	4	123	Instrument early or initial gain(dB).
ALIAS_FILTER_FREQ	Integer Long	4	141	Alias filter frequency, if used.
ALIAS_FILTER_SLOPE	Integer Long	4	143	Alias filter slope.
NOTCH_FILTER_FREQ	Integer Long	4	145	Notch filter frequency, if used.
NOTCH_FILTER_SLOPE	Integer Long	4	147	Notch filter slope.
LOWCUT_FREQ	Integer Long	4	149	Low cut frequency, if used.
HIGHCUT_FREQ	Integer Long	4	151	High cut frequency, if used.
LOWCUT_SLOPE	Integer Long	4	153	Low cut slope.
HIGHCUT_SLOPE	Integer Long	4	155	High cut slope.
DATARECORDED_YEAR	Integer Long	4	157	Year data recorded.
DATARECORDED_DAY	Integer Long	4	159	Day of year data recorded.
DATARECORDED_HOUR	Integer Long	4	161	Hour of day(24 Hour clock).
DATARECORDED_MINUTE	Integer Long	4	163	Minute of hour data recorded.
DATARECORDED_SECOND	Integer Long	4	165	Second of Minute data recorded.
TIME_BASIS_CODE	Integer Long	4	167	Time basis code: 1=local, 2=GMT, 3=other.
NODE_NUMBER	Integer Long	4	175	RXT: Module or Node Number (0-240)
CABLE_NUMBER	Integer Long	4	177	RXT: Cable Number (0=not yet implemented)
BUOY_NUMBER	Integer Long	4	178	RXT: Buoy Number (0=not yet implemented)
BUCKET_NUMBER	Integer Long	4	179	RXT: Bucket Number
TIME_STAMP	Integer Long	4	185	RXT: Transcriber Time Stamp
SHOTLINE_NUMBER	Integer Long	4	189	Shot Line Number (Seq + line no.)
SHOT_POINT_NO	Integer Long	4	193	Energy source point number.
RECEIVERLINE_NUMBER	Integer Long	4	197	Receiver Line Number
FIELD_STATION_NUMBER	Integer Long	4	201	RXT: Ground Station Number
VOA	Integer Long	4	205	RXT: Vertical Orientation Angle (radians/10000)
RECV_POINTINDEX	Integer Long	4	208	RXT: Receiver Point Index. 1=HY, 6=VT, 7=IN, 8=XL
SWATH NUMBER	Integer Long	4	211	RXT: Swath Number.
RAW DATA FILE STATUS	Integer Long	4	219	RXT: Raw Data File Status
HOA	Integer Long	4	221	RXT: Horizontal Orientation Angle (radians/10000)
GUN FLAG	Integer Short	2	229	RXT: Gun Flag (Odd Shots =1, Even Shots = 2)
SENSOR	Integer Long	4	234	RXT: T2M sensor type id 3=HY, 12=IL, 13=XL, 14=VT,
131=HY_Derivative				
ROATATION AND INVERT applied,8=Inverted,10=VORandInvert)	Integer Long	4	240	RXT: Rotate and Invert (0=not,2=VOR

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.5 Volve OBC SEGY EBCDIC Header – Example

```

C 1 CLIENT: STATOIL           COMPANY: RESERVOIR EXPLORATION TECHNOLOGY
C 2 AREA: VOLVE NORWAY BLOCK 15/9          SURVEY: ST10010
C 3 SWATH: 11                      VESSELS:M/V VIKLAND, M/V SANCO SPIRIT
C 4 RCV LINE: 1150780    RCVR RANGE: 1239-1717
C 5 DATA-SET: NAV MERGE   TRACES PER RECORD: 240 X 4  SEQ: 094-133
C 6 RECORDING FORMAT: IEEE SEG-Y          FORMAT THIS REEL: SEG-Y 3592
C 7 SAMPLE CODE: FLOATING PT          PROCESSED: 03/11/2010
C 8 ACQ. GEOM: 8 ROLL 8 INLINE SWATH      LINE PREFIX: ST10010
C 9 INSTRUMENT: VECTOREIS OCEAN BOTTOM    RECORDING SYSTEM DELAY: 0 MS
C10 RECORDING FILTER: 1.5/6-187/260MIN PHS DESCRIPTION: HZ/DB PER OCTAVE
C11 NO OF RECEIVER LINES/SWATH: 8          RECEIVER LINE SEPARATION: 400/200M
C12 ACTIVE CABLE LENGTH: 5975M            RCVRS / RCV LINE 240 X 4
C13 NO OF SOURCES: 2                    SOURCE SEPARATION: 50M
C14 RECEIVER INTERVAL: 25M              SHOT INTERVAL: 25M, FLIP/FLOP
C15 DATUM: ED50, 31N SPHEROID: INT. 1924 PROJECTION: UTM ZONE 31
C16 COORDINATE UNITS: METERS          MAX TIME: 10000 MS
C17 RECORDING SAMPLE RATE: 2MS        OUTPUT SAMPLE RATE: 2 MS
C18 HEADER WORD     BYTE LOCATION    HEADER WORD     BYTE LOCATION
C19 ----- -----
C20 HOR ORIENT ANGLE 181-182          VERT ORIENT ANGLE      183-184
C21 SWATH/PATCH NUMBER 185-186         RLINE RELAY CODE      187-188
C22 GUN FLAG          189-190          SENSOR 1=HY,6=VT,7=IL,8=XL 191-191
C23 NOMINAL RLINE     197-200          NOMINAL SLINE        201-204
C24 CHAN EDIT FLAG    205-205          SHOT EDIT FLAG       206-206
C25 REV POLARITY FLAG 207-207          NAVMERGE FLAG(1=NAV ASSIGNED) 208-208
C26 NODE NUMBER(1-240) 209-210         0=NO,2=VOR,8=INV,10=BOTH,32=HY_DP 216-216
C27 SEQUENCE NUMBER   217-220          SAIL LINE NUMBER      221-224
C28 RECEIVER LINE NO. 225-228          FIELD STATION NUMBER 229-232
C29 INLINE             233-236          CROSSLINE           237-240
C30 PREPLOT CDP GRID: SAIL LINE AZIMUTH = 104.00/284.00 DEGREES
C31 CDP BIN CENTER ORIGIN: X-COORD. = 428020.9 Y-COORD. = 6477397.6
C32 CDP BIN INCREMENT = 25.0 METERS X 12.5 METERS (INLINE X CROSSLINE)
C33 SENSOR: 1=HYDROPHONE(P), 6=VERTICAL(Z), 7=HORIZONTAL(X), 8=HORIZONTAL(Y)
C34 VERTICAL AND HORIZONTAL ORIENTATION SENSOR ANGLE IS IN RADIANS X 10000
C35 REVERSE POLARITY FLAG: NOT APPLIED=0, APPLIED=1
C36 TRACE EDIT FLAG: GOOD=0, BAD=1; VECTOR ROTATION FLAG: NOT ROTATED=0
C37 PROCESSING: SPS TO HEADERS, OMS TIME SHIFT APPLIED, HYDROPHONE DATA HAS
C38 DERIVATIVE APPLIED IN RECORDING, ACCELEROMETER DATA HAS BEEN ROTATED,
C39 WATER DEPTHS AND SOURCE/RECEIVER ELEVS. MULTIPLIED BY 10 (BYTES 41-68)
C40 X-Y COORDINATES HAVE BEEN MULTIPLIED BY 10 (BYTES 73-88)

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.6 SEGY Binary Header – Example

HEADER	BYTE TYPE	DESCRIPTION
400 Byte SEGY Binary Header		
3201 JOB_ID_NO	: Integer Long	0 Job Identification number. = 10010
3205 SHOTLINE_NUMBER	: Integer Long	77 Shot Line Number = 0
3209 REEL_NUMBER	: Integer Long	2 Reel number. = 0
3213 TRACES_PER_RECORD	: Integer Short	3 Number of data traces per record. = 960
3215 AUXS_PER_RECORD	: Integer Short	4 Number of auxiliary traces per record. = 0
3217 SAMPLE_RATE	: Integer Short	5 Sample rate this reel(micro-seconds). = 2000
3219 SAMPLE_RATE_FIELD	: Integer Short	6 Field sample rate(micro-seconds) = 2000
3221 NSAMPLES	: Integer Short	7 No. of samples per data trace. = 5000
3223 NSAMPLES_FIELD	: Integer Short	8 Field no. of samples per data trace. = 5000
3225 FORMAT_CODE = 5	: Integer Short	9 Data Format(1-Float,2-Long,3-Short,4-Fixed point).
3227 CDP_FOLD	: Integer Short	10 CDP fold(expected). = 0
3229 TRACE_SORT Stacked). = 1	: Integer Short	11 Trace sort code(1-NoSort,2-CDP,3-SingleFold,4-1
3231 VERTICAL_SUM 1	: Integer Short	12 Vertical sum code(1-NoSum,2-2Sum,...N = NSum). =
3233 SWEEP_FREQ_START	: Integer Short	13 Sweep start freq. = 0
3235 SWEEP_FREQ_END	: Integer Short	14 Sweep end freq. = 0
3237 SWEEP_FREQ_LENGTH	: Integer Short	15 Sweep length(Seconds). = 0
3239 SWEEP_TYPE Other). = 0	: Integer Short	16 Sweep type(1-Linear,2-Parabolic,3-Exponential,4-
3241 SWEEP_TRACE_NO	: Integer Short	17 trace no. of sweep channel. = 0
3243 SWEEP_TAPER_LENGTH_START	: Integer Short	18 Sweep taper length(Ms) at start. = 0
3245 SWEEP_TAPER_LENGTH_END	: Integer Short	19 Sweep taper length(Ms) at end. = 0
3247 SWEEP_TAPER_TYPE	: Integer Short	20 Sweep taper type(1-Linear,2-CosSqr,3-Other). = 0
3249 CORRELATED_TRACES	: Integer Short	21 Correlated traces 1 = No 2 = Yes = 0
3251 BINARY_GAIN	: Integer Short	22 Binary gain recovered 1 = Yes 2 = No = 0
3253 AMP_RECOVERY_METHOD SphDivergence, 3-AGC, 4-Other)	= 1	: Integer Short 23 Amplitude recovery method(1-None,2-
3255 UNITS	: Integer Short	24 Distance units 1 = Meters 2 = Feet = 1
3257 SIGNAL_POLARITY	: Integer Short	25 Impulse signal polarity. = 1
3259 VIBRATOR_POL_CODE	: Integer Short	26 Vibrator polarity code = 0

11.7 Volve OBC SEGY Output Trace Header

HEADER NAME	TYPE	SIZE LOC. DESCRIPTION
240 Byte SEGY Trace Header		
1 TRACE_SEQ_NO	: Integer Long	0 Trace Seq. no. Within Line = 1 - 11052480
5 TRACE_SEQ_REEL	: Integer Long	1 Trace Seq. within Reel = 5761 - 489600
9 FIELD_RECORD_NO	: Integer Long	2 Original Field record = 1002 - 1968
13 CHANNEL_NO	: Integer Long	3 Trace no. Within Original Field Record. = 1 - 960
17 SHOT_POINT_NO	: Integer Long	4 Energy source point number. = 1002 - 1968
21 CMP_NO	: Integer Long	5 CMP Ensemble Number = 52462242 - 53403678
25 CMP_SEQ_NO	: Integer Long	6 Sequence no. within CMP. = 0
29 TRACE_ID_CODE	: Integer Short	7 Trace ID Code 1=seis, 2=dead trace = 1 - 2
31 FOLD	: Integer Short	8 No. of vertically stacked traces->This trace. = 0
33 TRACE_HSTACK	: Integer Short	9 No. of horiz. stacked traces... = 0
35 TEST_CODE	: Integer Short	10 1-Production, 2-Test = 1
37 OFFSET_SH_REC	: Integer Long	11 Distance from shot to recv(May be -ve) = 14 - 9153
41 ELEV_REC	: Integer Long	12 Elevation of receiver group. = -3390 - -3300
45 ELEV_SHOT	: Integer Long	13 Surface elevation of shot = -11 - 11
49 DEPTH_SHOT	: Integer Long	14 Source depth below surface. = 55 - 64
53 ELEV_FLOATDATUM_REC	: Integer Long	15 Floating Datum elevation of receiver group. = 0
57 ELEV_FLOATDATUM_SHOT	: Integer Long	16 Floating Datum elevation of source. = 0
61 WATER_DEPTH_SHOT	: Integer Long	17 Water depth at source. = 3250 - 3440
65 WATER_DEPTH_REC	: Integer Long	18 Water depth at receiver group. = 3300 - 3390
69 ELEV_DEPTH_SCALER	: Integer Short	19 Scalar to be applied to all elevations and depths. = -
71 COORD_SCALER	: Integer Short	20 Scalar to be applied to all coordinates. = -10
73 XSHOT	: Integer Long	21 Shot X Coordinate = 4033892 - 4134500
77 YSHOT	: Integer Long	22 Shot Y Coordinate = 71232647 - 71334944
81 XREC	: Integer Long	23 Receiver group X Coordinate = 4063171 - 4105064
85 YREC	: Integer Long	24 Receiver group Y Coordinate = 71262864 - 71305472
89 UNITS	: Integer Short	25 1-Length (meters or feet), 2-Lat/long = 1
91 VELOCITY_WEATHER	: Integer Short	26 Weathering Velocity = 0
93 VELOCITY_SUBWEATHER	: Integer Short	27 Sub-Weathering velocity(Replacement Velocity). = 0
95 UPHOLE_SHOT	: Integer Short	28 Uphole time at source. = 0
97 UPHOLE_REC	: Integer Short	29 Uphole time at receiver group. = 0
99 STATIC_SRC	: Integer Short	30 Source static correction. = 0
101 STATIC_REC	: Integer Short	31 Receiver group static correction. = 0
103 STATIC_TOTAL	: Integer Short	32 Total static applied. = 0

```

105 LAG_TIME_A : Integer Short 33 Time in ms. = 0
109 DELAY_TIME : Integer Short 35 Delay recording time(Ms). = 0
111 MUTE_TIME_START : Integer Short 36 Mute time start. = 0
113 MUTE_TIME_END : Integer Short 37 Mute time end. = 0
115 NSAMPLES : Integer Short 38 Number of samples for this trace. = 5000
117 SAMPLERATE : Integer Short 39 Sample interval in microseconds for this trace. = 2000
119 GAIN_TYPE : Integer Short 40 Gain type of field instruments 1=Fixed/2=Binary/3-
Float/4-..Optional = 1
121 GAIN_CONSTANT : Integer Short 41 Instrument gain constant (preamp K gain) = 0 - 18
123 GAIN_INITIAL : Integer Short 42 Instrument early or initial gain(dB). = 0
141 ALIAS_FILTER_FREQ : Integer Short 51 Alias filter frequency, if used. = 187
143 ALIAS_FILTER_SLOPE : Integer Short 52 Alias filter slope. = 260
145 NOTCH_FILTER_FREQ : Integer Short 53 Notch filter frequency = 0
147 NOTCH_FILTER_SLOPE : Integer Short 54 Notch filter slope = 0
149 LOWCUT_FREQ : Integer Short 55 Low cut frequency, if used. = 1
151 HIGHCUT_FREQ : Integer Short 56 High cut frequency, if used. = 0
153 LOWCUT_SLOPE : Integer Short 57 Low cut slope. = 6
155 HIGHCUT_SLOPE : Integer Short 58 High cut slope. = 0
157 DATARECORDED_YEAR : Integer Short 59 Year data recorded. = 2010
159 DATARECORDED_DAY : Integer Short 60 Day of year data recorded. = 247 - 252
161 DATARECORDED_HOUR : Integer Short 61 Hour of day(24 Hour clock). = 0 - 23
163 DATARECORDED_MINUTE : Integer Short 62 Minute of hour data recorded. = 0 - 59
165 DATARECORDED_SECOND : Integer Short 63 Second of Minute data recorded. = 0 - 59
167 TIME_BASIS_CODE : Integer Short 64 Time basis code: 1=local, 2=GMT, 3=other. = 2
181 VWUSER_2 : Integer Short 1001 UDV02: RXT Horizontal Orientation Angle
(Radians*10000) = 0
183 VWUSER_3 : Integer Short 1002 UDV03: RXT vertical orientation angle (Radians*10000)
= 0 - 31390
185 VWUSER_5 : Integer Short 1004 UDV05: RXT patch or swath number = 17 - 22
187 VWUSER_6 : Integer Short 1005 UDV06: RXT cable relay code = 0
189 VWUSER_7 : Integer Short 1006 UDV07: RXT flag to indicate port or starboard gun = 1
- 2
191 VWUSER_26 : One(1) Byte 1025 UDV26: RXT sensor 1=HY(P), 6=VT(Z), 7=IL(X), 8=XL(Y) =
1 - 8
193 VWUSER_9 : Integer Long 1008 UDV09: RXT Old Channel Number in case of renumbering =
0
197 VWUSER_12 : Integer Long 1011 UDV12: RXT Nominal Rline Number = 5294
201 VWUSER_13 : Integer Long 1012 UDV13: RXT Nominal Sline Number = 52020 - 53860
205 VWUSER_14 : One(1) Byte 1013 UDV14: RXT channel edit flag = 0 - 1
206 VWUSER_15 : One(1) Byte 1014 UDV15: RXT shot edit flag = 0 - 1
207 VWUSER_16 : One(1) Byte 1015 UDV16: RXT reverse chan edit flag = -1 - 1
208 VWUSER_23 : One(1) Byte 1022 UDV23: RXT 0 if no nav, 1 if nav has been assigned = 1
209 VWUSER_25 : Integer Short 1024 UDV25: RXT module or node number (0-240) = 1 - 240
213 VWUSER_28 : One(1) Byte 1027 UDV28: RXT physical buoy number = 4
214 BUCKET_NUMBER : One(1) Byte 1028 UDV29: RXT Bucket Number (0= not implemented) = 30 -
111
215 VWUSER_30 : One(1) Byte 1029 UDV30: RXT physical cable number = 4
216 VWUSER_34 : One(1) Byte 1033 UDV34: RXT data mod flag
(0=not,2=VORapplied,8=inverted,10=both,32=hyd dP mode) = 0 - 32
217 VWUSER_27 : Integer Long 1026 UDV27: RXT acquisition sequence number = 221 - 275
221 SHOTLINE_NUMBER : Integer Long 77 Shot Line Number = 17152020 - 22153860
225 RECEIVERLINE_NUMBER : Integer Long 78 Receiver Line Number. = 2052940
229 FIELD_STATION_NUMBER : Integer Long 70 Field Station Number = 1241 - 1719
233 INLINE : Integer Long 71 In-Line or LINE of data trace. = 5246 - 5340
237 CROSSLINE : Integer Long 72 Cross-Line, TRACE of data trace. = 2242 - 3686

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.8 Example Acquisition Log

 ACQUISITION LOG																																																																																																																																				
Vehicle : Suncor Spirit and TikiLand Client : Statoil Area : Valve, Murray, 4D OBS Project : ST10009 Job # : ST10009	Date : 28-Oct-10 Shothole : suethk11 Line : 530640120 Sail Line : 53064 Seq # : 0120 Dir (*) : 105° Type : RESHOOT Status : COMPLETE																																																																																																																																			
Rx LINE : 1152540 1152380 Muder: 240 1 240 1 Channels: 960 1 960 1 Stationar: 1717 1239 1239 1717 <i>Stationar required for coverage given below</i> Muder: 240 1 240 1 Channels: 960 1 960 1 Stationar: 1717 1239 1239 1717 Shot Point: 1834 1592 1592 1834 * Channels: 960 960 Lay Dir (-): 284° 104° Buoy: 6 8 Cable: 4 2 Bucket: 072 105																																																																																																																																				
Rx LINE : Muder: Channels: Stationar: <i>Stationar required for coverage given below</i> Muder: Channels: Stationar: Shot Point: * Channels: Lay Dir (-): Buoy: Cable: Bucket:																																																																																																																																				
Hydrophone data output in units of uBar/sec. Accelerometer data output in units of mm/sec/sec.																																																																																																																																				
Channel Statistics <table border="1"> <tr> <th>Rx Line #</th> <th>Cable</th> <th>* Bed</th> <th>x Bed</th> </tr> <tr> <td>1152540</td> <td>4</td> <td></td> <td></td> </tr> <tr> <td>1152380</td> <td>2</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Total Live Channels</td> <td>1920</td> <td></td> <td></td> </tr> <tr> <td>Dead Channels</td> <td>4</td> <td></td> <td></td> </tr> <tr> <td>Instrument Failures</td> <td>0</td> <td></td> <td></td> </tr> <tr> <td>Environmental</td> <td>0</td> <td></td> <td></td> </tr> <tr> <td>VOR Failure</td> <td>4</td> <td></td> <td></td> </tr> </table>	Rx Line #	Cable	* Bed	x Bed	1152540	4			1152380	2																			Total Live Channels	1920			Dead Channels	4			Instrument Failures	0			Environmental	0			VOR Failure	4			Shot Statistics <table border="1"> <tr> <td>Total SP</td> <td>122</td> </tr> <tr> <td>PDR</td> <td>0</td> </tr> <tr> <td>NDR</td> <td>0</td> </tr> <tr> <td>Mufire</td> <td>0</td> </tr> <tr> <td>Autofire</td> <td>0</td> </tr> <tr> <td>Delta</td> <td>1</td> </tr> <tr> <td>Timing</td> <td>0</td> </tr> <tr> <td>Parity</td> <td>0</td> </tr> <tr> <td>Other</td> <td>0</td> </tr> <tr> <td>Gap</td> <td>0</td> </tr> <tr> <td>Total #</td> <td>1</td> </tr> <tr> <td>Bad SP</td> <td>0</td> </tr> <tr> <td>Total %</td> <td>0.82</td> </tr> </table>	Total SP	122	PDR	0	NDR	0	Mufire	0	Autofire	0	Delta	1	Timing	0	Parity	0	Other	0	Gap	0	Total #	1	Bad SP	0	Total %	0.82	Line Statistics <table border="1"> <tr> <td>Time</td> <td>22:28</td> <td>22:53</td> <td>UTC</td> </tr> <tr> <td>Shotpoint</td> <td>1592</td> <td>1834</td> <td></td> </tr> <tr> <td>Veloc Speed</td> <td>3.8</td> <td>3.9</td> <td>Knots</td> </tr> <tr> <td>Water Depth</td> <td>89.6</td> <td>99.7</td> <td>Meters</td> </tr> <tr> <td>Sea State</td> <td>2.5</td> <td>2.5</td> <td>Meters</td> </tr> <tr> <td>Windr</td> <td>SW22</td> <td>SW22</td> <td>Knots</td> </tr> <tr> <td>HVRMS noise</td> <td>N/A</td> <td>10.0</td> <td>dB</td> </tr> <tr> <td>Array 1 Volume</td> <td>3990</td> <td>3990</td> <td>Cu.In</td> </tr> <tr> <td>Array 2 Volume</td> <td>3990</td> <td>3990</td> <td>Cu.In</td> </tr> <tr> <td>Array Pressure</td> <td>2053</td> <td>2041</td> <td>P.S.I.</td> </tr> <tr> <td>Atmospheric Pressure</td> <td>1010.0</td> <td>1010.0</td> <td>mBar</td> </tr> <tr> <td>Cruising Distance</td> <td>-9.3</td> <td>1.0</td> <td>Meters</td> </tr> <tr> <td>Heading</td> <td>122°</td> <td>122°</td> <td>Degrees</td> </tr> <tr> <td>Course Made Good</td> <td>099°</td> <td>099°</td> <td>Degrees</td> </tr> </table>	Time	22:28	22:53	UTC	Shotpoint	1592	1834		Veloc Speed	3.8	3.9	Knots	Water Depth	89.6	99.7	Meters	Sea State	2.5	2.5	Meters	Windr	SW22	SW22	Knots	HVRMS noise	N/A	10.0	dB	Array 1 Volume	3990	3990	Cu.In	Array 2 Volume	3990	3990	Cu.In	Array Pressure	2053	2041	P.S.I.	Atmospheric Pressure	1010.0	1010.0	mBar	Cruising Distance	-9.3	1.0	Meters	Heading	122°	122°	Degrees	Course Made Good	099°	099°	Degrees
Rx Line #	Cable	* Bed	x Bed																																																																																																																																	
1152540	4																																																																																																																																			
1152380	2																																																																																																																																			
Total Live Channels	1920																																																																																																																																			
Dead Channels	4																																																																																																																																			
Instrument Failures	0																																																																																																																																			
Environmental	0																																																																																																																																			
VOR Failure	4																																																																																																																																			
Total SP	122																																																																																																																																			
PDR	0																																																																																																																																			
NDR	0																																																																																																																																			
Mufire	0																																																																																																																																			
Autofire	0																																																																																																																																			
Delta	1																																																																																																																																			
Timing	0																																																																																																																																			
Parity	0																																																																																																																																			
Other	0																																																																																																																																			
Gap	0																																																																																																																																			
Total #	1																																																																																																																																			
Bad SP	0																																																																																																																																			
Total %	0.82																																																																																																																																			
Time	22:28	22:53	UTC																																																																																																																																	
Shotpoint	1592	1834																																																																																																																																		
Veloc Speed	3.8	3.9	Knots																																																																																																																																	
Water Depth	89.6	99.7	Meters																																																																																																																																	
Sea State	2.5	2.5	Meters																																																																																																																																	
Windr	SW22	SW22	Knots																																																																																																																																	
HVRMS noise	N/A	10.0	dB																																																																																																																																	
Array 1 Volume	3990	3990	Cu.In																																																																																																																																	
Array 2 Volume	3990	3990	Cu.In																																																																																																																																	
Array Pressure	2053	2041	P.S.I.																																																																																																																																	
Atmospheric Pressure	1010.0	1010.0	mBar																																																																																																																																	
Cruising Distance	-9.3	1.0	Meters																																																																																																																																	
Heading	122°	122°	Degrees																																																																																																																																	
Course Made Good	099°	099°	Degrees																																																																																																																																	
Line Naming Conventions PP - SWATH D - LAYNUMBER SAIL LINE - XXXXX RECEIVER LINE - PPXXXXD		PP - SWATH D - LAYNUMBER SAIL LINE - XXXXX RECEIVER LINE - PPXXXXD																																																																																																																																		
<i>For multiple NPEC/SF sequences note the different sequence with an 'N' in 2400-24052-N-05600-05604</i> Line Events and Remarks (Do not use commas in the Acquisition Line remarks) Picking up noise from the Spirit while shooting from SP to SP. No rockburst is required. Average Noise Level for the sequence is 100mV. Pressure sensor in array #6 intermittent Delta error gun 4:4 at SP1714 Cable 2 recorded setup with GS 1243-1721. Changed manually to 1239-1717.																																																																																																																																				
Receiving parameters <table border="1"> <tr> <td>Recordlength (sec)</td> <td>10</td> </tr> <tr> <td>Precursor (s)</td> <td>0</td> </tr> <tr> <td>Sample interval (ms)</td> <td>2</td> </tr> <tr> <td>Hydrophone Source</td> <td>Source</td> </tr> <tr> <td>Hydrophone Impulse</td> <td>Off</td> </tr> <tr> <td>Hydrophone Datamode</td> <td>Diff</td> </tr> <tr> <td>Trace attribute type</td> <td>Peak</td> </tr> <tr> <td>Low cut filter (Hz)</td> <td>0</td> </tr> <tr> <td>Anti-alias filter type</td> <td>Minimum</td> </tr> <tr> <td>Offset/removal filter</td> <td>Dynamic</td> </tr> <tr> <td>Hydrophone Gain</td> <td>6</td> </tr> <tr> <td>Hydrophone Sensitivity</td> <td>High</td> </tr> </table>		Recordlength (sec)	10	Precursor (s)	0	Sample interval (ms)	2	Hydrophone Source	Source	Hydrophone Impulse	Off	Hydrophone Datamode	Diff	Trace attribute type	Peak	Low cut filter (Hz)	0	Anti-alias filter type	Minimum	Offset/removal filter	Dynamic	Hydrophone Gain	6	Hydrophone Sensitivity	High	Party Chief Bob Schram Instrument Tech on Duty 1200-00000 Culum, Janar, Chris Quality Control Phase 0000-1200 Larr, Adam 1200-00000 Dave, Atanar 0000-1200 Chamom, Taylor FINAL	Acquisition Geometry <table border="1"> <tr> <td>Rxline spacing(m)</td> <td>400</td> <td>Station spacing(m)</td> <td>25</td> </tr> <tr> <td>Station increment</td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>Sailline spacing(m)</td> <td>100</td> <td>Shot spacing(m)</td> <td>25</td> </tr> <tr> <td>Station increment</td> <td>2</td> <td></td> <td></td> </tr> </table> Source Parameters <table border="1"> <tr> <td>Number of Sources</td> <td>2</td> </tr> <tr> <td>Sources Separation(m)</td> <td>50</td> </tr> <tr> <td>Depth(m)</td> <td>6</td> </tr> <tr> <td>Volume (cu.in.)</td> <td>3990</td> </tr> <tr> <td>Pressure (psi)</td> <td>2000</td> </tr> <tr> <td>Sub-Array/Stringer</td> <td>6</td> </tr> </table>	Rxline spacing(m)	400	Station spacing(m)	25	Station increment	2			Sailline spacing(m)	100	Shot spacing(m)	25	Station increment	2			Number of Sources	2	Sources Separation(m)	50	Depth(m)	6	Volume (cu.in.)	3990	Pressure (psi)	2000	Sub-Array/Stringer	6																																																																													
Recordlength (sec)	10																																																																																																																																			
Precursor (s)	0																																																																																																																																			
Sample interval (ms)	2																																																																																																																																			
Hydrophone Source	Source																																																																																																																																			
Hydrophone Impulse	Off																																																																																																																																			
Hydrophone Datamode	Diff																																																																																																																																			
Trace attribute type	Peak																																																																																																																																			
Low cut filter (Hz)	0																																																																																																																																			
Anti-alias filter type	Minimum																																																																																																																																			
Offset/removal filter	Dynamic																																																																																																																																			
Hydrophone Gain	6																																																																																																																																			
Hydrophone Sensitivity	High																																																																																																																																			
Rxline spacing(m)	400	Station spacing(m)	25																																																																																																																																	
Station increment	2																																																																																																																																			
Sailline spacing(m)	100	Shot spacing(m)	25																																																																																																																																	
Station increment	2																																																																																																																																			
Number of Sources	2																																																																																																																																			
Sources Separation(m)	50																																																																																																																																			
Depth(m)	6																																																																																																																																			
Volume (cu.in.)	3990																																																																																																																																			
Pressure (psi)	2000																																																																																																																																			
Sub-Array/Stringer	6																																																																																																																																			

Figure 72. Example overview sheet, Acquisition log for sequence 0120.

 <p>RXT RESERVOIR EXPLORATION TECHNOLOGY</p>	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Vessel	Sanco Spirit and Vikland	Line Name	530640120	Seq #:	120
Client	Statoil	Receiver line	1152540	1152380	
System	Input/Output VSO System 2/4	Buoy	6	8	
Area	Valve, Norway, 4D OBS	Cable	4	2	
Project	ST10010	Bucket	72	105	
		Number of Channels	960	960	
Time	File Name	SP	CODE	CODE DESCRIPTION	
	0	1548	SOL	START OF LINE	Start of Line
	0	1548	NDRB8	NDR BUOY 8	Shot not recorded for B8
22:23	201030122230	1550	NR	NOISE RECORD	No Gundata found for Shot 1550
22:28	2010301222802	1592	FPS	FIRST PRODUCTION SHOTPOINT	First Production Shot Point
22:28	2010301222802	1592		FIRST REQUIRED SP	First required SP for RL1152540 RL1152380
22:41	2010301224107	1714	DE	DELTA ERROR	1Delta Errors in shot.
22:53	2010301225357	1834	LPS	LAST PRODUCTION SHOTPOINT	Last Production Shot Point
22:53	2010301225357	1834		LAST REQUIRED SP	Last required SP for RL1152540 RL1152380
22:54	2010301225411	1836	NR	NOISE RECORD	No Gundata Found For Shot 1836
22:54	2010301225411	1836	EOL	END OF LINE	End of Line

Figure 73. Example Line log Sheet, Acquisition log Sequence 0120.

Online & Offline Channel QC			
Nominal Rx Line #	Station	CODE	
5222	1315	N	NOISY
5222	1563	W	WEAK
5254	1673	D	DEAD
5254	1683	V	VOR ERROR

Figure 74. Example Bad Channel Listing, Acquisition log, sequence 0120.

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.10 Navmerged SEGY Tape Listing

TAPE	RLINE	SEQ		Chans	DATE OUTPUT	ORIGINAL SHIPMENT	
		MIN	MAX			DD-MMM-YY	NUMBER
C40194	1252700	0004	0077	960	17-Oct-2010	VIKS10-024	20/10/2010
C40195	1252860	0006	0093	960	17-Oct-2010	VIKS10-024	20/10/2010
C40196	1253020	0008	0093	960	17-Oct-2010	VIKS10-024	20/10/2010
C40197	1253180	0013	0090	960	17-Oct-2010	VIKS10-024	20/10/2010
C40198	1253340	0024	0090	960	17-Oct-2010	VIKS10-024	20/10/2010
C40199	1253500	0041	0090	960	17-Oct-2010	VIKS10-024	20/10/2010
C40200	1253660	0047	0093	960	17-Oct-2010	VIKS10-024	20/10/2010
C40201	1253980	0051	0093	960	17-Oct-2010	VIKS10-024	20/10/2010
C40203	1150780	0094	0133	960	04-Nov-2010	VIKS10-027	08/11/2010
C40204	1151100	0098	0146	960	04-Nov-2010	VIKS10-027	08/11/2010
C40205	1151420	0101	0157	960	07-Nov-2010	VIKS10-027	08/11/2010
C40206	1151740	0107	0164	960	07-Nov-2010	VIKS10-027	08/11/2010
C40207	1152060	0126	0164	960	07-Nov-2010	VIKS10-027	08/11/2010
C40208	1152220	0119	0164	960	07-Nov-2010	VIKS10-027	08/11/2010
C40209	1152380	0115	0164	960	07-Nov-2010	VIKS10-027	08/11/2010
C40210	1152540	0113	0164	960	07-Nov-2010	VIKS10-027	08/11/2010
C45014	1150780-1253980	0004	0164	960	07-Nov-2010	VIKS10-027	08/11/2010

Table 11. Final Navmerged SEGY Tape List

11.11 Deliverables List

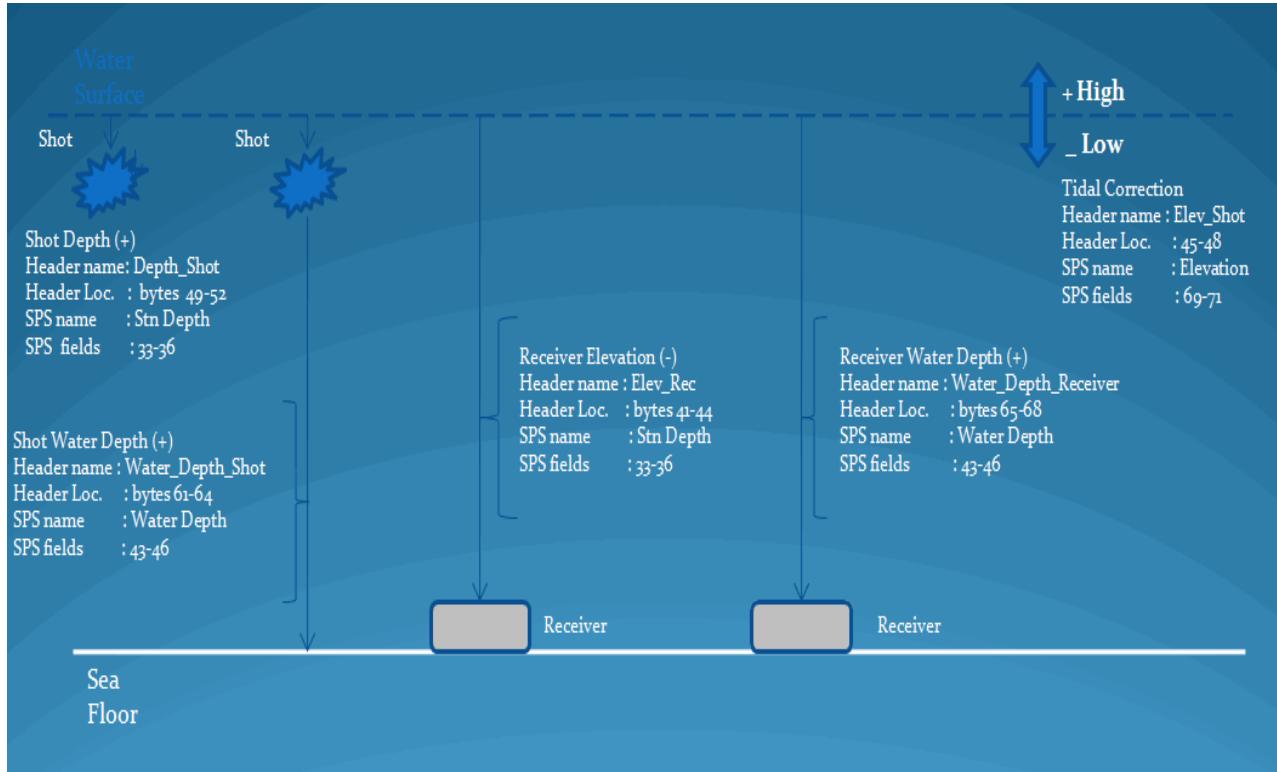
Deliverable	Frequency	Format	Media
Final Acquisition Log	Acquisition Sequence	MS Excel	USB
Online RMS Noise Display HY Component	Acquisition Sequence	jpeg	USB
Online RMS Noise Display X Component	Acquisition Sequence	jpeg	USB
Online RMS Noise Display Y Component	Acquisition Sequence	jpeg	USB
Online RMS Noise Display Z Component	Acquisition Sequence	jpeg	USB
RMS Noise Spatial Display HY (median)	Per Block and Accumulative	jpeg	USB
Near Field Data Package	Acquisition Sequence	SEGY	USB
NF Shot Stack - port/strd amp comparison	Acquisition Sequence	jpeg	USB
Receiver Gather F-X Analysis	3 Gathers per Receiver line (P, Z, X, Y)	jpeg	USB

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

Source Gather F-X Analysis	3 Gathers per Receiver line (P, Z, X, Y)	jpeg	USB
Cable Movement QC	Per Cable Lay	jpeg	USB
Receiver Edits	Per Receiver Line / Block	txt	USB
Shot Edits	Per Receiver Line / Block	txt	USB
Polarity Reversal File	Per Receiver Line/Block	txt	USB
Reciever Prediction Using FBP	Per Cable Lay	jpeg	USB
Reciever Prediction Using FBP	Per Cable Lay	txt	USB
Receiver FBP	Per Cable Lay	txt	USB
Receiver Position QC: Quadrant Stack	Per Cable Lay	jpeg	USB
Receiver Postion QC: Wather Depth LMO	Per Cable Lay	jpeg	USB
Brute Stack HY Pressure Component	Per Receiver Line/Block	SEGY Disk File	USB
Brute Stack VT Velocity Component	Per Receiver Line/Block	SEGY Disk File	USB
Brute Stack HY+VT Summation	Per Receiver Line/Block	SEGY Disk File	USB
Converted wave Brute Stack X Component	Per Receiver Line/Block	SEGY Disk File	USB
Brute Stack P, V, P+V	Per Receiver Line/Block	jpeg	USB
Converted wave Brute Stack X Component	Per Receiver Line/Block	jpeg	USB
Post Plot SEGY Shot Positions	Lay Segment & Accumulative	jpeg	USB
Post Plot SEGY Receiver Positions	Lay Segment & Accumulative	jpeg	USB
Post Plot SEGY Water Depth at Receiver	Lay Segment & Accumulative	jpeg	USB
Post Plot SEGY Water Depth at Shot	Lay Segment & Accumulative	jpeg	USB
Fold	Lay Segment & Accumulative	jpeg	USB
Low Fold Cube HY Component SEGY Cube	Per Block & Accumulative	SEGY	USB
Low Fold Cube Fold Display	Per Block & Accumulative	jpeg	USB
Nav Merged Data Tape Copy 1	Per Receiver Line/Block	SEGY	3592E05
Nav Merged Data Tape Copy 2	Per Receiver Line/Block	SEGY	3592E05
Tap Log	Per Data Shipment	MS Excel	USB

Table 12. Client Deliverables

11.12 Water Depths and Tidal Corrections Diagram (header specifications)



	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.13 Source SPS File, Header Example

```

H00 SPS format version num.      SPS001,01.10.90;
H01 Description of survey area  Norway, Block 15/9,RXT10010,
H02 Date of survey            26/09/2010, 25/10/2010;
H02Tape/disk identifier       ST10010_RL115078;
H03 Client                   STATOIL;
H04 Geophysical contractor   RXT AS,Crew 4;
H05 Positioning contractor   VERICOS Subsea7 C-NAV C&C Technologies Inc;
H06 Pos. proc. contractor    RXT AS-Crew 4;
H07 Field computer system(s) Concept Systems Ltd.,GATOR INS V10.12.3,none;
H08 Coordinate location      Centre of source and of receiver pattern;
H09 Offset to coord. location -/-;
H10 Clock time w.r.t. GMT     0;
H11 Spare                     ;
H12 Geodetic datum and spheroid ED50 International 1924 6378388.000 297.000;
H13 Spare                     H14 is Datum shift from WGS84 to Survey Datum;
H14 Geodetic datum parameters  90.365 101.130 123.384 -0.333 -0.077 -0.894 ;
H15 Geodetic datum param cont. -1.994 ;
H16 Spare                     ;
H17 Vertical datum description MSL, Equipotential,,,;
H18 Projection type          UTM North;
H19 Projection zone          Zone 31N;
H20 Description of grid units Metres;
H201Factor to metre          1.00000000;
H220Long. of central meridian 0030000.000E;
H241Scale factor             0.9996000000;
H30 Project code and description RXT10010, Volvo Norway, 4D OBC;
H26 Source line number prefix ST10010;
H31 Line number format        SW(1:2),LINENUMBER(4:4),SEQ(9:4);
H26 Receiver line number prefix ST10010;
H31 Line number format        SW(1:2),LINENUMBER(3:4),LAY(7:1);
H400Type,Model,Polarity      1,VECTORSEIS OCEAN 24bit,VSO GATOR,SEG;
H401Crew name,Comment         1,RXT Crew 4;
H402Sample int.,Record Length 1,2MSEC,10SEC;
H403Number of channels       1,960;
H404Tape type,format,density 1,Bucket-3592,SEG-Y IBM EBCDIC Reel Hdr;
H405Filter_alias Hz,dB pnt,slope1,187HZ,3DB,186 DB/OCT;
H406Filter_notch Hz,-3db points 1,NONE;
H407Filter_low Hz,dB pnt,slope 1,1.5HZ,-3DB,6 DB/OCT;
H408Time delay,FTB-SOD app Y/N 1,10 MSEC,not applied;
H409Multi component recording 1,P,X,Y,Z;
H410Aux. channel 1 contents 1,N/A;
H411Aux. channel 2 contents 1,N/A;
H412Aux. channel 3 contents 1,N/A;
H413Aux. channel 4 contents 1,N/A;
H26
H26 Hydrophone (numbered 1)
H600Type,model,polarity      H1,IO,IO VectorSeis,SEG;
H601Damping coeff,natural freq. H1,N/A,N/A;
H602Nunits,len(X),width(Y)   H1,1,0.00M,0.00M;
H603Unit spacing X,Y        H1,0.0M,0.00M;
H26
H26 Vertical Accelerometer (numbered 6)
H610Type,model,polarity      R6,SVSM-MARINE,I/O VectorSeis,SEG;
H611Damping coeff,natural freq. R6,N/A,N/A;
H612Nunits,len(X),width(Y)   R6,1,0.00M,0.00M;
H613Unit spacing X,Y        R6,0.0M,0.00M;
H26
H26 Inline Accelerometer (numbered 7)
H620Type,model,polarity      R7,SVSM-MARINE,I/O VectorSeis,SEG;
H621Damping coeff,natural freq. R7,N/A,N/A;
H622Nunits,len(X),width(Y)   R7,1,0.00M,0.00M;
H623Unit spacing X,Y        R7,0.0M,0.00M;
H26
H26 Crossline Accelerometer (numbered 8)
H630Type,model,polarity      R8,SVSM-MARINE,I/O VectorSeis,SEG;
H631Damping coeff,natural freq. R8,N/A,N/A;
H632Nunits,len(X),width(Y)   R8,1,0.00M,0.00M;
H633Unit spacing X,Y        R8,0.0M,0.00M;
H26
H700Type,model,polarity      A1,SERCEL G-GUN,150/250,SEG;
H701Size,vert. stk fold     A1,3990 CUBIC IN,1;
H702Nunits,len(X),width(Y)   A1,36,15.0M,15.0M;
H703Unit spacing X,Y        A1,varies,7.5M;
H716P-P bar m,prim/bubble  A1,110.0,20.6;
H717Air pressure            A1,2000 PSI;
H718No. sub arrays,nom depth A1,3,6M;
H719Spare
H26
H720Type,model,polarity      A2,SERCEL G-GUN,150/250,SEG;
H721Size,vert. stk fold     A2,3990 CUBIC IN,1;
H722Nunits,len(X),width(Y)   A2,36,15.0M,15.0M;
H723Unit spacing X,Y        A2,varies,7.5M;

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

```

H736P-P bar m,prim/bubble      A2,110.0,20.6;
H737Air pressure                A2,2000 PSI;
H738No. sub arrays,nom depth    A2,3,6M;
H739Spare
H26
H990R,S,X file quality control 03/11/2010, 19:03:22,RXT Navigation;
H991Coord. status final/prov   Final, 03/11/2010, 19:03:22,RXT Navigation;
H26
H26 The instrument code is always 1;
H26 Column 13 in the Relation file is used for sensor type;
H26
H26 Water Depth is Draft Corrected;
H26 Water Depth is corrected for sound velocity;
H26 Surface elevation value in Columns 66-71 of R files is entered as zero;
H26 because the tidal correction is included in the Point depth and surface;
H26 elevation;
H26 Surface elevation value in Columns 66-71 of S files is not applied to the;
H26 water depth in cols 43-46;
H26
H26 Due to SPS format limitations the FFID in X file is from columns 7-11
H26
H26
H26 Number of lines included for ST10010_RL115078 is 22
H26                               111501000094
H26                               111502600095
H26                               111500200096
H26                               111501800097
H26                               111503400098
H26                               111504200099
H26                               111505000100
H26                               111505800101
H26                               111509000102
H26                               111506600103
H26                               111508200104
H26                               111505810105
H26                               111507400106
H26                               111509800107
H26                               111510600108
H26                               111509810109
H26                               111511400127
H26                               111512210128
H26                               111513000129
H26                               111513800130
H26                               111515400131
H26                               111514610133
H26
H26 567890123456789012345678901234567890123456789012345678901234567890
H26      1          2          3          4          5          6          7          8
H26
S111501000094      10001A1      6.2      0  0106 428057.2 6477488.5 -0.2287103941
S111501000094      10021A2      6.3      0  0106 428094.6 6477530.8 -0.2287103952

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.14 Receiver SPS File, Header Example

```

H00 SPS format version num.      SPS001,01.10.90;
H01 Description of survey area Norway, Block 15/9,RXT10010;
H02 Date of survey             26/09/2010, 25/10/2010;
H02Tape/disk identifier        ST10010_RL115078;
H03 Client                      STATOIL;
H04 Geophysical contractor     RXT AS,Crew 4;
H05 Positioning contractor     VERIPOS Subsea7 C-NAV C&C Technologies Inc;
H06 Pos. proc. contractor       RXT AS-Crew 4;
H07 Field computer system(s)   Concept Systems Ltd.,GATOR INS V10.12.3,none;
H08 Coordinate location         Centre of source and of receiver pattern;
H09 Offset to coord. location  -/-;
H10 Clock time w.r.t. GMT      0;
H11 Spare                       ;
H12 Geodetic datum and spheroid ED50 International 1924 6378388.000 297.000;
H13 Spare                       H14 is Datum shift from WGS84 to Survey Datum;
H14 Geodetic datum parameters   90.365 101.130 123.384 -0.333 -0.077 -0.894 ;
H15 Geodetic datum param cont. -1.994 ;
H16 Spare                       ;
H17 Vertical datum description MSL, Equipotential,,,;
H18 Projection type            UTM North;
H19 Projection zone            Zone 31N;
H20 Description of grid units  Metres;
H201Factor to metre           1.00000000;
H220Long. of central meridian 0030000.000E;
H241Scale factor              0.9996000000;
H30 Project code and description RXT10010, Volve Norway, 4D OBC;
H26 Source line number prefix  ST10010;
H31 Line number format         SW(1:2),LINENUMBER(4:4),SEQ(9:4);
H26 Receiver line number prefix ST10010;
H31 Line number format         SW(1:2),LINENUMBER(3:4),LAY(7:1);
H400Type,Model,Polarity        1,VECTORSEIS OCEAN 24bit,VSO GATOR,SEG;
H401Crew name,Comment          1,RXT Crew 4;
H402Sample int.,Record Length 1,2MSEC,10SEC;
H403Number of channels         1,960;
H404Tape type,format,density  1,Bucket-3592,SEG-Y IBM EBCDIC Reel Hdr;
H405Filter_alias Hz,dB pnt,slope1,187HZ,3DB,186 DB/OCT;
H406Filter_notch Hz,-3db points 1,NONE;
H407Filter_low Hz,dB pnt,slope  1,1.5HZ,-3DB,6 DB/OCT;
H408Time delay,FTB-SOD app Y/N 1,10 MSEC,not applied;
H409Multi component recording 1,P,X,Y,Z;
H410Aux. channel 1 contents   1,N/A;
H411Aux. channel 2 contents   1,N/A;
H412Aux. channel 3 contents   1,N/A;
H413Aux. channel 4 contents   1,N/A;
H26
H26 Hydrophone (numbered 1)
H600Type,model,polarity        H1,IO,IO VectorSeis,SEG;
H601Damping coeff,natural freq. H1,N/A,N/A;
H602Nunits,len(X),width(Y)    H1,1,0.00M,0.00M;
H603Unit spacing X,Y          H1,0.0M,0.00M;
H26
H26 Vertical Accelerometer (numbered 6)
H610Type,model,polarity        R6,SVSM-MARINE,I/O VectorSeis,SEG;
H611Damping coeff,natural freq. R6,N/A,N/A;
H612Nunits,len(X),width(Y)    R6,1,0.00M,0.00M;
H613Unit spacing X,Y          R6,0.0M,0.00M;
H26
H26 Inline Accelerometer (numbered 7)
H620Type,model,polarity        R7,SVSM-MARINE,I/O VectorSeis,SEG;
H621Damping coeff,natural freq. R7,N/A,N/A;
H622Nunits,len(X),width(Y)    R7,1,0.00M,0.00M;
H623Unit spacing X,Y          R7,0.0M,0.00M;
H26
H26 Crossline Accelerometer (numbered 8)
H630Type,model,polarity        R8,SVSM-MARINE,I/O VectorSeis,SEG;
H631Damping coeff,natural freq. R8,N/A,N/A;
H632Nunits,len(X),width(Y)    R8,1,0.00M,0.00M;
H633Unit spacing X,Y          R8,0.0M,0.00M;
H26
H700Type,model,polarity        A1,SERCEL G-GUN,150/250,SEG;
H701Size,vert. stk fold        A1,3990 CUBIC IN,1;
H702Nunits,len(X),width(Y)    A1,36,15.0M,15.0M;

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

```

H703Unit spacing X,Y          A1, varies, 7.5M;
H716P-P bar m,prim/bubble   A1, 110.0, 20.6;
H717Air pressure             A1, 2000 PSI;
H718No. sub arrays,nom depth A1, 3, 6M;
H719Spare
H26
H720Type,model,polarity      A2, SERCEL G-GUN, 150/250, SEG;
H721Size,vert. stk fold       A2, 3990 CUBIC IN, 1;
H722Nunits,len(X),width(Y)   A2, 36, 15.0M, 15.0M;
H723Unit spacing X,Y          A2, varies, 7.5M;
H736P-P bar m,prim/bubble   A2, 110.0, 20.6;
H737Air pressure             A2, 2000 PSI;
H738No. sub arrays,nom depth A2, 3, 6M;
H739Spare
H26
H990R,S,X file quality control 03/11/2010, 19:03:22,RXT Navigation;
H991Coord. status final/prov   Final, 03/11/2010, 19:03:22,RXT Navigation;
H26
H26 The instrument code is always 1;
H26 Column 13 in the Relation file is used for sensor type;
H26
H26 Water Depth is Draft Corrected;
H26 Water Depth is corrected for sound velocity;
H26 Surface elevation value in Columns 66-71 of R files is entered as zero;
H26 because the tidal correction is included in the Point depth and surface;
H26 elevation;
H26 Surface elevation value in Columns 66-71 of S files is not applied to the;
H26 water depth in cols 43-46;
H26
H26 Due to SPS format limitations the FFID in X file is from columns 7-11
H26
H26
R1150780          12391H1    0101      0101 431164.0 6477612.8  0.0123456789
R1150780          12391R6    0101      0101 431164.0 6477612.8  0.0123456789

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.15 Relational SPS File, Header Example

```

H00 SPS format version num.      SPS001,01.10.90;
H01 Description of survey area Norway, Block 15/9,RXT10010;
H02 Date of survey             26/09/2010, 25/10/2010;
H02Tape/disk identifier        ST10010_RL115078;
H03 Client                      STATOIL;
H04 Geophysical contractor     RXT AS,Crew 4;
H05 Positioning contractor     VERIPOS Subsea7 C-NAV C&C Technologies Inc;
H06 Pos. proc. contractor      RXT AS-Crew 4;
H07 Field computer system(s)   Concept Systems Ltd.,GATOR INS V10.12.3,none;
H08 Coordinate location         Centre of source and of receiver pattern;
H09 Offset to coord. location  -/-;
H10 Clock time w.r.t. GMT      0;
H11 Spare                       ;
H12 Geodetic datum and spheroid ED50 International 1924 6378388.000 297.000;
H13 Spare                       H14 is Datum shift from WGS84 to Survey Datum;
H14 Geodetic datum parameters   90.365 101.130 123.384 -0.333 -0.077 -0.894 ;
H15 Geodetic datum param cont. -1.994 ;
H16 Spare                       ;
H17 Vertical datum description MSL, Equipotential,,,;
H18 Projection type            UTM North;
H19 Projection zone            Zone 31N;
H20 Description of grid units  Metres;
H201Factor to metre           1.00000000;
H220Long. of central meridian 0030000.000E;
H241Scale factor              0.9996000000;
H30 Project code and description RXT10010, Volvo Norway, 4D OBC;
H26 Source line number prefix  ST10010;
H31 Line number format         SW(1:2),LINENUMBER(4:4),SEQ(9:4);
H26 Receiver line number prefix ST10010;
H31 Line number format         SW(1:2),LINENUMBER(3:4),LAY(7:1);
H400Type,Model,Polarity       1,VECTORSEIS OCEAN 24bit,VSO GATOR,SEG;
H401Crew name,Comment         1,RXT Crew 4;
H402Sample int.,Record Length 1,2MSEC,10SEC;
H403Number of channels        1,960;
H404Tape type,format,density 1,Bucket-3592,SEG-Y IBM EBCDIC Reel Hdr;
H405Filter_alias Hz,dB pnt,slope1,187HZ,3DB,186 DB/OCT;
H406Filter_notch Hz,-3db points 1,NONE;
H407Filter_low Hz,dB pnt,slope 1,1.5HZ,-3DB,6 DB/OCT;
H408Time delay,FTB-SOD app Y/N 1,10 MSEC,not applied;
H409Multi component recording 1,P,X,Y,Z;
H410Aux. channel 1 contents   1,N/A;
H411Aux. channel 2 contents   1,N/A;
H412Aux. channel 3 contents   1,N/A;
H413Aux. channel 4 contents   1,N/A;
H26
H26 Hydrophone (numbered 1)
H600Type,model,polarity       H1,IO,IO VectorSeis,SEG;
H601Damping coeff,natural freq. H1,N/A,N/A;
H602Nunits,len(X),width(Y)    H1,1,0.00M,0.00M;
H603Unit spacing X,Y          H1,0.0M,0.00M;
H26
H26 Vertical Accelerometer (numbered 6)
H610Type,model,polarity       R6,SVSM-MARINE,I/O VectorSeis,SEG;
H611Damping coeff,natural freq. R6,N/A,N/A;
H612Nunits,len(X),width(Y)    R6,1,0.00M,0.00M;
H613Unit spacing X,Y          R6,0.0M,0.00M;
H26
H26 Inline Accelerometer (numbered 7)
H620Type,model,polarity       R7,SVSM-MARINE,I/O VectorSeis,SEG;
H621Damping coeff,natural freq. R7,N/A,N/A;
H622Nunits,len(X),width(Y)    R7,1,0.00M,0.00M;
H623Unit spacing X,Y          R7,0.0M,0.00M;
H26
H26 Crossline Accelerometer (numbered 8)
H630Type,model,polarity       R8,SVSM-MARINE,I/O VectorSeis,SEG;
H631Damping coeff,natural freq. R8,N/A,N/A;
H632Nunits,len(X),width(Y)    R8,1,0.00M,0.00M;
H633Unit spacing X,Y          R8,0.0M,0.00M;
H26
H700Type,model,polarity       A1,SERCEL G-GUN,150/250,SEG;
H701Size,vert. stk fold       A1,3990 CUBIC IN,1;
H702Nunits,len(X),width(Y)    A1,36,15.0M,15.0M;

```

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

```

H703Unit spacing X,Y          A1, varies, 7.5M;
H716P-P bar m,prim/bubble   A1, 110.0, 20.6;
H717Air pressure             A1, 2000 PSI;
H718No. sub arrays,nom depth A1, 3, 6M;
H719Spare
H26
H720Type,model,polarity      A2, SERCEL G-GUN, 150/250, SEG;
H721Size,vert. stk fold       A2, 3990 CUBIC IN, 1;
H722Nunits,len(X),width(Y)   A2, 36, 15.0M, 15.0M;
H723Unit spacing X,Y          A2, varies, 7.5M;
H736P-P bar m,prim/bubble   A2, 110.0, 20.6;
H737Air pressure             A2, 2000 PSI;
H738No. sub arrays,nom depth A2, 3, 6M;
H739Spare
H26
H990R,S,X file quality control 03/11/2010, 19:03:22,RXT Navigation;
H991Coord. status final/prov   Final, 03/11/2010, 19:03:22,RXT Navigation;
H26
H26 The instrument code is always 1;
H26 Column 13 in the Relation file is used for sensor type;
H26
H26 Water Depth is Draft Corrected;
H26 Water Depth is corrected for sound velocity;
H26 Surface elevation value in Columns 66-71 of R files is entered as zero;
H26 because the tidal correction is included in the Point depth and surface;
H26 elevation;
H26 Surface elevation value in Columns 66-71 of S files is not applied to the;
H26 water depth in cols 43-46;
H26
H26 Due to SPS format limitations the FFID in X file is from columns 7-11
H26
H26
H26 Number of lines included for ST10010_RL115078 is 22
H26                               111501000094
H26                               111502600095
H26                               111500200096
H26                               111501800097
H26                               111503400098
H26                               111504200099
H26                               111505000100
H26                               111505800101
H26                               111509000102
H26                               111506600103
H26                               111508200104
H26                               111505810105
H26                               111507400106
H26                               111509800107
H26                               111510600108
H26                               111509810109
H26                               111511400127
H26                               111512210128
H26                               111513000129
H26                               111513800130
H26                               111515400131
H26                               111514610133
H26
H26 567890123456789012345678901234567890123456789012345678901234567890
H26      1           2           3           4           5           6           7           8
H26
X      100021111501000094      10001    1  95741150780      1239    17171
X      100026111501000094      10001    2  95841150780      1239    17171

```

 RXT <small>RESERVOIR EXPLORATION TECHNOLOGY</small>	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

11.16 Summary of Noise Affected Lines

<u>Sequence</u>	<u>Affected</u>		<u>Affected Cables</u>	<u>Total Affected G/S</u>	RMS μ B	<u>% Affected</u>	<u>% Affected G/S</u>	<u>Cause</u>
	<u>Shots</u>	<u>Affected G/S</u>						
0004	1958	1854	1717	1597	0060	35 μ B	11.04%	1.04% VIKLAND
0004	1958	1860	1717	1239	0001	0240	10.42%	100.00% Seismic Interference
0008	1724	1738	1717	1829	0001	0060	35 μ B	1.67%
0023	1466	1000	1239	1717	ALL	0960	25 μ B	71.56%
0034	1666	1958	1239	1717	ALL	1200	30 μ B	45.94%
0036	1356	1534	1239	1717	ALL	480	50 μ B	100.00%
0037	1734	1382	1239	1717	ALL	720	50 μ B	100.00%
0038	1392	1628	1239	1717	ALL	960	50 μ B	100.00%
0040	1954	1320	1239	1717	ALL	240	50 μ B	100.00%
0041	1320	1958	1239	1717	ALL	240	50 μ B	100.00%
0046	1000	1318	1239	1717	ALL	1440	30 μ B	100.00%
0047	1000	1958	1239	1717	ALL	1680	30 μ B	100.00%
0048	1498	1958	1239	1717	ALL	1440	30 μ B	100.00%
0049	1468	1690	1239	1717	ALL	1440	30 μ B	100.00%
0050	1810	1958	1239	1717	ALL	1680	30 μ B	100.00%
0051							0.00%	0.00%
0054	1000	1808	1239	1717	ALL	1800	60 μ B	100.00%
0055	1834	1758	1239	1717	ALL	1920	50 μ B	100.00%
0056	1704	1320	1239	1717	ALL	1920	45 μ B	88.13%
0057	1320	1958	1239	1717	ALL	1920	45 μ B	100.00%
0058	1320	1958	1804	1717	ALL	1680	45 μ B	410.26%
0059	1596	1194	1194	1717	ALL	1680	45 μ B	100.00%
0061	1958	1000	1239	1717	ALL	1680	50 μ B	100.00%
0064	1958	1414	1414	1717	ALL	1920	45 μ B	100.00%
0065	1318	1000	1000	1717	ALL	1920	50 μ B	100.00%
0068	1318	1312	1239	1717	ALL	1920	50 μ B	2.50%
0069	1000	1456	1239	1717	ALL	1920	50 μ B	100.00%
0070	1412	1000	1239	1717	ALL	1920	45 μ B	100.00%
0071	1000	1028	1239	1717	ALL	1440	30 μ B	100.00%
0072	1148	1192	1239	1717	ALL	1200	30 μ B	100.00%
0073	1230	1160	1239	1717	ALL	1680	30 μ B	100.00%
0075	1000	1500	1239	1717	ALL	1680	45 μ B	100.00%
0076	1560	1646	1239	1717	ALL	1680	60 μ B	100.00%
0077	1844	1958	1239	1717	ALL	1200	45 μ B	100.00%
0078	1804	1780	1239	1717	ALL	1680	55 μ B	8.55%
0079	1188	1126	1239	1717	ALL	1680	50 μ B	100.00%
0080	1000	1084	1239	1717	ALL	1680	40 μ B	8.96%
								29.17%

	Prepared by:	RXT QC Department
	Client:	Statoil
	Project Number:	RXT10009
	Date:	September 2010

0082	1624	1000	1239	1717	ALL	720	40µB	100.00%	12.50%	
0083	1820	1958	1239	1717	ALL	1200	40µB	14.58%	100.00%	Sea Explorer
0084	1000	1958	1239	1717	ALL	960	40µB	100.00%	16.67%	
0085	1000	1958	1239	1717	ALL	960	50µB	100.00%	16.67%	
0086	1958	1562	1239	1717	ALL	720	60µB	41.46%	12.50%	
0087	1000	1512	1239	1717	ALL	1440	40µB	53.54%	25.00%	
0089	1200	1958	1239	1717	ALL	1440	40µB	79.17%	25.00%	
0097	1000	1958	1239	1717	ALL	960	40µB	100.00%	16.67%	Rig
0098	1000	1180	1239	1717	ALL	1920	40µB	18.96%	33.33%	Rig
0138	1000	1958	1239	1717	7	1680	25µB	100.00%	29.17%	Tanker
0145	1320	1800	1477	1521	7	23	125µB	75.31%	1.37%	Abbas supply vessel
0164	1552	1958	1239	1717	5	1200	35µB	100.00%	100.00%	Ocean Pearl?

Table 13. Noise Log