APPENDIX

Technical Description of Main Sources

There are a large number of different seismic sources presently available and being used. However at the time of going to press 99% of the world production of marine seismic data is using either airguns or waterguns as the seismic source. Technical information on these two sources is therefore given in this appendix.

SOURCE TYPE : AIRGUN

DESCRIPTION : The airgun has become the most widely used of all marine sources because of its simplicity, robustness and reliability. The principle of operation, as the name suggests, is the explosive release of a 'charge' of high pressure air into the water. The traditional design has two air chambers, a control chamber and a firing chamber. The two are connected by a moving shuttle which is kept closed by the pressure of air in the control chamber. At firing time a charge of air is forced under the shuttle pressure plate in the control chamber. The shuttle triggers, opening the firing chamber and venting the air. Some designs have four venting holes, others have a sleeve which allows full 360° venting. On release the bubble of air oscillates producing an essentially periodic decaying signal (see Chapter 1 for more details). The amplitude of the primary pulse and period of oscillation increase with chamber volume. Special modifications to the airguns called waveshape kits are available to attenuate the bubble oscillations if desired.

VARIETIES : Standard pressure, high pressure, sleeve guns, and many variations.

TECHNICAL DATA : Reservoir volume range 0.5 - 10000 cubic inches (more restricted for high pressure and sleeve guns).
Operating pressure:
400 - 5000 psi for standard pressure guns (typically 2000 psi).
4000 - 6000 psi for high pressure guns.
Cycle time typically 3 - 6 seconds.
Energy released per shot 200 - 11000000 Joules.
Weight 18 - 4000 lb.
Primary to bubble ratios of single guns typically 2:1 (0-250 Hz).
Power output examples (peak to zero, 0-250 Hz):
10 cubic inch - 0.5 b-m.
200 cubic inch - 3.0 b-m.

ARRAYS : Airguns are usually fired in arrays in which a mixture of chamber sizes are used to increase the power, increase the primary to bubble ratio, and produce a broad, relatively smooth spectrum. The

total airgun volume in typical arrays lies in the range 100 - 8000 cubic inches. The peak to peak output of a 1000 cubic inch array (0-125Hz) would lie in the range 15 - 30 bar-metres, with primary to bubble ratios of about 8:1.

OTHER INFORMATION : Figure A1 shows a representative unfiltered near field airgun signature from a 200 cubic inch gun fired at 2000 psi and 5m depth. Figure A2 shows a representative array signature (vertical far field) from a 910 cubic inch, 7-gun array fired at 2000 psi and 5m depth. Both of the amplitude spectra on the right are normalised and are on a linear amplitude scale.

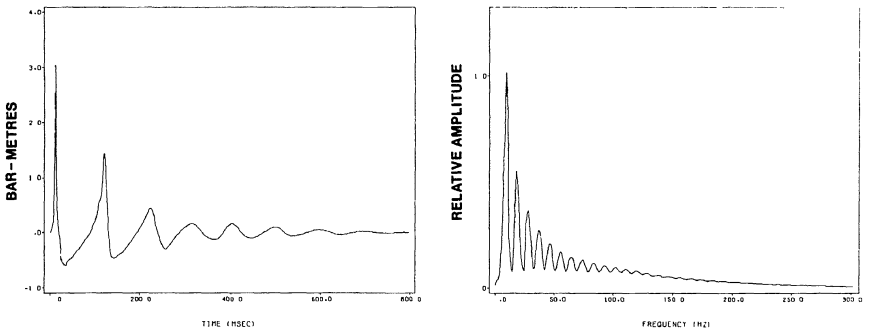


Figure A1 : Near field signature and amplitude spectrum of a 200 cubic inch airgun fired at 5m depth.

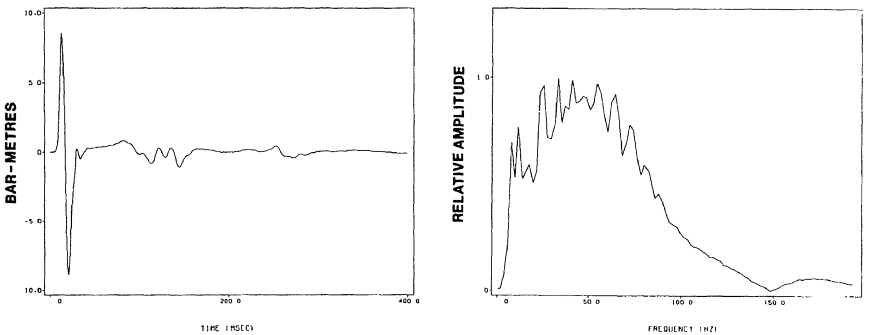


Figure A2 : Vertically travelling far field signature and amplitude spectrum of a 910 cubic inch array of airguns.

REFERENCES : The following list is a selection of papers on airguns. These references and references therein should provide a useful starting point for a more definitive sample of the available literature.

Dragoset (1984)
Giles and Johnson (1973)
Johnson (1978)
Johnson (1980)
Johnson (1982)
Nooteboom (1978)
Parkes et al. (1984a)
Parkes et al. (1984b)
Safar (1980)
Vaage et al. (1983)
Vaage et al. (1984)
Ziolkowski (1970)
Ziolkowski (1971)
Ziolkowski and Metselaar (1984)

SOURCE TYPE : WATERGUN

DESCRIPTION : The watergun is basically an implosive source. In the traditional design there are two chambers, an upper air chamber and a lower water chamber which is open to the sea. A moving shuttle divides the chambers. High pressure air is fed into the top chamber. At firing time the shuttle is released, and the high pressure of the air forces the shuttle downwards. A slug of water is thereby violently ejected from the lower chamber. As the shuttle slows down and the water continues to expand a vacuum cavity is formed between them. The expansion slows, stops, and is followed by an implosion of water into the cavity. The primary peak in the emitted signature is caused by this implosion. This is preceded by a lower frequency pre-cursor produced at the water expansion stage. Since there is no gas bubble, the radiation pulse is short and without oscillations. In general, the emitted radiation is broad band and extends to high frequencies, although some waterguns suffer from deep notches in their spectra at low frequencies.

VARIETIES : Pneumatic, hydraulic and hybrid models available, also combination models which can be operated as airguns or waterguns.

TECHNICAL DATA : Volume range 15 - 500 cubic inches (water emitted).
Water pressure 500 - 3000 psi.
Air pressure 140 - 3000 psi.
Weight 29 - 375 lb.
Some air driven models require air exhaust line to surface.
Firing cycle 0.5 - 8 seconds.
Minimum and maximum firing depths are 1ft to 1800ft.
Power example: a 400 cubic inch gun delivers a peak to zero power of about 3 bar-metres in the 0-125 Hz band, with a primary to secondary ratio of about 4:1.

ARRAYS : Waterguns are frequently deployed in arrays, although unlike airguns it is common for the array elements to be the same size.

OTHER INFORMATION : Figure A3 shows a representative near field signature from a large watergun. Figure A4 shows the vertically travelling far field signature of the same gun. Both of the amplitude spectra on the right are normalised and are on a linear amplitude scale.

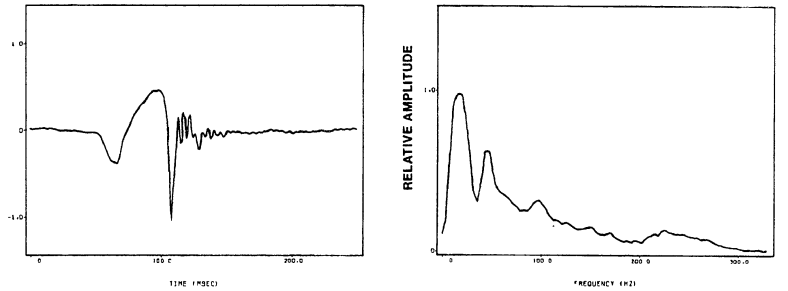


Figure A3 : Near field signature and amplitude spectrum of a large watergun.

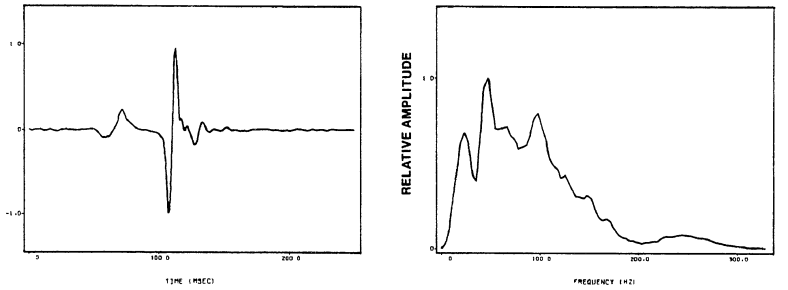


Figure A4 : Vertically travelling far field signature and amplitude spectrum for the watergun of Figure A3.

REFERENCES :

Newman et al. (1977)
Safar (1984)
Safar (1985a)
Safar (1985b)
Tree et al. (1982)

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INDEX

Absorption 87
Acoustic wave generation 3
Acoustic wave propagation 4
Airgun array 85
Airgun(s) 3, 47, 50, 58, 60, 100
Arrays 25
- long 33
- tuned 25
- wide 34
Average reflection coefficient 74

Bandwidth 45
- effective 85
Bar 19
Bar-metres 20
Beam forming 36
Beam-steering 25, 31
Bubble motion 8
Bubble period 69, 87

Chirp 59
Coalescence 45
Convolutional model 21, 58, 81

Determinism 45, 62
Deterministic deconvolution 83
Deconvolution
- directionally dependent 41
Directivity
- effects of 39
Directivity functions 29
Dominant horizon 94
Dominant reflection deconvolution 94

Effective bandwidth,
see Bandwidth
Effects of directivity
see Directivity
Elasticity
- bulk modulus of 6
Elastic waves 4

Energy 7, 29
- conservation of 8
- - law of 28
Energy conservation paradox 60
Equation of motion 5
Exponential taper 93

'Far field' 15
'Far field' hydrophone 77
'Far field' measurements 16
'Far field' signature 10, 55
Flotation 68
Forced minimum phase 93
Fringe patterns 27

Ghost 10
Ghost notches 12, 13, 74

Interaction 45, 58, 61
- linear 45, 50
- non-linear 49
Interaction distance 51
Interference 12, 28
Isentropic 5

Law of conservation of energy,
see Energy
Law of superposition of wavefields,
see Superposition
Linear interaction,
see Interaction
Linear relative velocity model 18
Linear superposition,
see Superposition
Long arrays,
see Arrays

Mainlobe 38
Marine ghost variability 74
Marine vibroseis 59
Mass equation
- conservation of 4

Measurement of signatures 16
Minimum entropy deconvolution 94
Mis-fires 71
Multiple images 36

Navier-Stokes equation of motion 5
Near field 15
- measurements 18, 53
Noise suppression 36
Non-linear interaction, see Interaction
Norwegian buoys 68
Notional source(s) 17, 53, 54
Numerical modelling 58

Paravane 68
Paravane technology 55
Particle velocity 15
'Peak to peak amplitude' 19
Period of oscillation 9
Phase delay 27
Point sources 16
Predictive deconvolution 93
Pressure 7
Primary to bubble ratio(s) 19, 20, 50, 87, 93
Pulse duration 20
Pulse repeatability 20, 21
Pulse shaping 25

Reflection coefficient 73
Relative motion 17
Rough surface 73

Scaling law 56
Sea wave distribution 72
Seismic source deconvolution 81
Shot effect 75
Shot to shot variations 71, 77
Sidelobes 28, 31, 72
Signature deconvolution 81, 93
Significant height 73
Sideswipe 37, 38
Sound velocities 7
Source generated noise 38
Sparker 4
Spatial extension 62
Speed of sound 6
Spherical-cap bubble 51
Spherical spreading 40
Spherical wave equation 6
Stability 68
Statistical deconvolution 93
Superposition
- law of 60
- - of wavefields 17
- linear 53, 62
System stability 70

Temporal extension 62
Time synchronisation 67
Timing errors 67
Total energy emission 8
Tuned arrays, see Arrays

Velocity 7
Virtual image 10

Watergun(s) 3, 57, 67, 88, 103
Wave height 73
Waveshape kit 50
Weather 55, 67, 72, 74
- effect 74
Wide arrays, see Arrays
Wide deployment 69