2D SEISMIC SURVEY

FOR

STATERA ENERGY LTD

Cliffe, Kent

INFORMATION PACK

SEISMIC SURVEYING METHODOLOGY

Prepared by Rees Onshore Seismic Ltd on behalf of Statera Energy Ltd

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Abbreviations

RP	Receiver Point
SP	Source Point
m	metre
mm	millimetre
cm	centimetre
MPA	Mineral Planning Authority
GPS	Global Positioning System
2D	Two Dimensional

1. GENERAL BACKGROUND TO A SURVEY

Seismic surveying is a transient geophysical technique which uses the principles of seismology to allow deep subsurface geology to be imaged and mapped in two-dimensional (2D) detail. The method requires a controlled seismic source, positioned on or near surface to generate a high frequency seismic reflection signal which passes through the various subsurface rock strata. At changes in rock type and density, part of this signal is refracted and reflected back to surface where a series of stand-alone recording nodes receive its return. By recording this 'two-way' time, the depth, extent and characteristics of both rock strata and structure can thus be determined and imaged.

Such a technique is commonly employed by exploration companies as part of their assessment of an area for potential hydrocarbon and mineral reserves, in addition to power, utility and engineering concerns involved in the design and construction of power stations, underground gas storage facilities or other similar type projects.

This acquisition programme will comprise of 21 individual survey line, with positional and spacing parameters of the line programme being dependent on the required subsurface target depth and degree of resolution that is required.

Within England all seismic surveying operations are undertaken strictly in accordance with Schedule 2 Part 17 Class K of the Town and Country Planning (General Permitted Development) (England) Order 2015 (as amended) (GPDO). Part 17 Class K is commonly applied to the survey whereby formal written notification of the works proposal has to be submitted by the exploration company or its acting agent to the Minerals Planning Authority (MPA) at least 28 days prior to the intended commencement date. This allows for the MPA to consult internally and with external stakeholders, and comment on and/or place restrictions on the survey proposal. In addition, the exploration company or its acting agent would consult with all Statutory Undertakers, Conservation and Archaeological Bodies and all other stakeholders affected.

2. PERMISSIONS

All landowner and Stakeholder permission will be contacted, and their approval received before undertaking any field work. Field reconnaissance will take place to identify any locally hazards that may affect the survey, similarly a local Traffic Management company will be hired to undertake the signing for any public highway routes.

The appropriate road space booking will be processed for the mobile works on public highways.

3. HEALTH, SAFETY AND THE ENVIRONMENT

All seismic surveying contractors will have a strong commitment to Health, Safety and the Environment, this being reflected in their Corporate Health and Safety, and Environmental Policies. Field crew operations are carried out to industry accepted standards in accordance with the contractor's Safety Manual and guidelines laid down in the IAGC Land and Marine Geophysical Operations Safety and Environmental Manuals.

In addition, the contractor will comply with all enactments, regulations, codes of practice and working rules relating to safety, health and welfare.

The contractor will take all necessary precautions to prevent damage and/or pollution to the environment. All survey vehicles given approval to operate across agricultural farmland are wherever possible fully fueled prior to field entry. Should refueling be required, this is undertaken within a designated safe area.

Any vehicle taking access to agricultural land is supplied with the appropriate commercial spill kit. Where possible the use of biodegradable hydraulic oil and lubricants are used in the vehicles.

As part of the initial consultation process undertaken with those Conservation and Archaeological Bodies as detailed under section 1. above, any restrictions or conditions placed on a survey are strictly adhered to and incorporated into an operational working plan. Emphasis is placed on ensuring a survey does not compromise management requirements and practices applicable to the Government Environmental Stewardship Scheme, most notably the Entry Level Stewardship element. In line with Class K part K.2 (b) of the GPDO, no trees and/or hedges would be removed, felled, lopped, topped or damaged as part of a survey operation.

4. OPERATIONAL STAGES OF A SURVEY

4.1 Stage 1. Permit – Planning and Access Agreement

Where seismic lines cross private land, all affected owners and occupiers are initially approached by a permit land agent in order that the survey proposal can be explained in full, and their agreement in principle to the works sought. Subject to approval, a walking reconnaissance of the land in question is then undertaken, thus allowing condition of land and cropping patterns to be logged, access points to be determined and assessed, and to ensure each survey line is free of any physical restrictions that might hinder operational activity. A photographic record of condition is commonly undertaken during this stage. Once such a reconnaissance has been completed, a second meeting is normally arranged with each individual to discuss and confirm actual survey line positioning details and reach negotiated access agreement. Where it is practicable, consent will be sought to follow the exploration company's preferred survey line orientations. However, in practice this cannot always be achieved, so a degree of flexibility is incorporated into the positioning process, thus avoiding sensitive areas and helping to limit the potential for any disturbance and damage. To further assist in the positioning process, a request is made with each occupier for information relating to local underground installations, particularly private water supply pipes, electricity cables and land drains etc.

Throughout all aspects of a survey, liaison is maintained with all relevant parties regarding safe working practices, access timings and any other matters relating to the operational undertaking.

4.2 Stage 2. Topographical Surveying – Marking Out of Survey Lines

For 2D survey lines both the individual source and receiver node positions are accurately marked out and Ordnance Survey grid co-ordinates and surface elevations determined. This is undertaken by a topographical survey team normally comprising of 1 or 2 field operatives using GPS technology to position a single bamboo marker cane with individual flagged reference number commonly spaced at a regular 10m interval along the pre-determined survey line orientations. Such activity is undertaken on foot is conducted a few days in advance of the main data acquisition operation as detailed below.

Markers in the field or along road or track ways will have unique numbers. Receivers will be prefixed with a three digit even line number followed by three digits for the station number, sources are prefixed with a three-digit odd line number followed by three digits for the station number. Please note that although there may be a marker in place it does not always mean it will be occupied, safe working distances are applied for both surface and sub surface hazards and a programme prepared for the acquisition team.

All maps prepared for the property will have the proposed points marked, colour coded with blue for receivers and red for sources.

4.3 Stage 3. Data Acquisition

4.3.1 Recording Node Positioning

The positioning and retrieval of the recording nodes is undertaken by a crew of 2 to 3 field operatives taking foot access along each of the marked-out survey lines in turn.

Subject to ground conditions being favorable, and only with landowner consent, limited 4x4 vehicular and/or UTV (or similar) access is taken along elements of the lines, to aid both the setting out and retrieval of recording equipment.

Coupling of nodes to the ground surface is essential to ensure good data quality, and this is achieved by ensuring the node is pushed securely into the ground surface. An example of a typical ‘stand-alone’ node is shown on the photographs below.

Figure 1 A Typical 'Stand Alone' Node

Figure 2 'Stand Alone' Nodes planted in the ground

4.3.2 Seismic source generation

There are a number of options available for a seismic source, for this project we propose to use a 'Weight Drop' and an impulsive 'Seismic Shot'.

4.3.2.1 Gravity propelled energy generator (GPEG) Approach:

This non-impulsive 'Weight Drop' source is commonly used on road-based surveys, within urban areas, and across agricultural farmland when ground conditions allow. It is a relatively fast and efficient method which involves the use of a combination of one specialist tractor unit operating along individual source lines. At regular intervals the unit stops, lower a steel plate onto the ground surface, which is then hit by a hammer enclosed in a sealed casing to produce the required frequency signal.

This procedure is known as a 'hammer blow'. The unit will remain stationary and repeat the exercise 4-6 times before moving several metres further along the line and undertaking the procedure again. This process is repeated at regular 'move up' intervals until the full length of the line is surveyed. Such an operation can therefore cover several kilometres in a working day.

Figure 3 'Weight Drop' mounted on a tractor operating 'cross-country'

Figure 4 ‘Weight Drop’ mounted on a tracked bobact operating ‘cross-country’

4.3.2.2 Seismic Shot Source

This impulsive source involves the loading and detonation of a small seismic charge at the base of a shallow pre-drilled hole. Charge size per hole is usually no greater than 150g in size, and it is the instantaneous detonation of the charge which produces the frequency signal. Such a 'shot point' (SP) will comprise of a single hole. The specific SP depth on this project will be 2m.

Drilling Methods - Rotary Auger:

This process utilises a mechanical auger unit typically fitted to a small agricultural tractor, or lightweight 6WD 'Polaris' UTV. The technique produces an approximate 10cm diameter hole and results in limited spoil being brought to the surface.

For all drilling techniques SP holes will be pre-augered well in advance of data recording. However, should the holes be drilled but not loaded until the day of data acquisition, then to ensure holes remain open and don't collapse and infill, each will be temporarily cased using plastic piping. In livestock fields all holes are plugged at the surface. Once the seismic charge has been loaded to the base of individual SP holes, the casing is then removed and the hole tamped and backfilled where possible with the spoil and 10mm washed pea gravel.

It should be emphasised that no drilling muds or fluids, other than clean water, are used as part of the augering process.

Figure 5 'Polaris' 6WD quad based auger unit

To accommodate farming activities and ensure both pre-drilled and loaded SP holes are not affected by land cultivations, SP's can be 'buried', this being a process by which the hole is covered below plough and/or subsoil depth by means of placing a small wooden ply board across the hole. The initial approximate 0.75m depth of the SP hole is slightly enlarged by manually digging or using a motorised hand auger in order that the board can be accommodated. The excavated spoil is returned and the SP position accurately surveyed using GPS technology. This procedure thus allows subsequent field cultivations to safely pass over SP holes without causing damage.

Once field cultivations are completed, GPS is used to relocate the holes, each is manually 'opened', and data acquisition is undertaken and completed.

Detonation of the SP's is undertaken on an individual SP by SP basis (not as a group of SP's) and is conducted by a team of a least two field operatives taking either foot or UTV (or similar) access. An occasional slight background muffled thud can be heard immediately after such a detonation. All SP holes are made safe immediately after each detonation.

4.3.3 Recording Node Retrieval

Once data acquisition has been completed along a particular recording line, all node equipment is speedily retrieved on foot supported with vehicular access if situated on a track.

4.3.4 Stage 4. Survey Line Restoration

As soon as is operationally convenient, temporary markers are retrieved, and a final physical walk of the occupied route is undertaken.

5. OPERATIONAL TIMELINE

It is proposed to carry out the survey in late September (3Q) 2022 subject to all permissions being in place. We estimate all work would be completed within a 30-day window, it is likely that the source element with tractor will take 1 to 2 hours per field section, our liaison team will be able to advise you in more detail.

6. SAFE WORKING DISTANCES

During the survey pre-preparation, hazard listings for buried infrastructure such as pipes, archaeology etc., and above ground for buildings and other identified restrictions, safe working distances will be applied for the operation, a draft copy of the proposed tables can be found in the attached Appendix.

For additional control during the survey operations, the recording contractor will be operating independent vibration monitoring along the survey routes where sensitive structures may be present.

7. PROPOSED SOURCE AND RECEIVER POSITIONS

Please refer to the accompanying plan which outlines the proposed area of work, with theoretical survey line positions illustrated. Such routing may be subject to minor modification, this being to accommodate landowner requirements, avoidance of utility assets, and major obstructions etc.

At the end of the project final positions will be supplied on request.

APPENDIX

Safe Working Distance Charts For –

Seismic Charge Source
Weight Drop Source

SAFETY DISTANCES - SEISMIC SOURCES

ver. August 2022, prepared by MR.

RECOMMENDED SAFE DISTANCES FOR SEISMIC ENERGY SOURCES (m)

Based on Seismic Grade (High velocity) Source Material

In the absence of any other information or more rigorous local or national stipulations, the following guide will apply:

	Combined / Total Charge Size					
Buildings	**0.09kg**	**0.18kg**	**0.25kg**	**0.5kg**	**1.0kg**	**2.0kg**
Houses and other occupied dwellings	50m	50m	50m	50m	50	50m
Strong industrial buildings	10m	18m	25m	25m	50	100m
Agricultural Building	10m	18m	25m	25m	50	100m
Listed or fragile buildings	50m	50m	50m	50m	50	50m
Church, Mosque	50m	50m	50m	50m	100m	100m
Graveyard	50m	50m	50m	50m	100m	100m
Services	**0.09kg**	**0.18kg**	**0.25kg**	**0.5kg**	**1.0kg**	**2.0kg**
HP gas pipelines	10m	18m	25m	25m	25	50m
MP and LP gas pipelines	5m	5m	5m	10m	15	20m
HP water pipelines	10m	18m	25m	25m	25	50m
MP and LP water pipelines	5m	5m	5m	10m	15	20m
Sewage pipelines	5m	5m	5m	10m	15	20m
Overhead Power pylon (main)	25m	25m	50m	50m	50	50m
Overhead Power pylon (sub)	15m	20m	25m	25m	25	25m
Overhead Electric Cables		No less than 2.5 times the detonator lead length				
Underground Electric Cables	5m	5m	5m	10m	15	20m
UG Telecom or Fibre Optic Cables	5m	5m	5m	10m	15	20m
General Utilities	0.09kg	0.18kg	0.25kg	0.5kg	1.0kg	2.0kg
Roads	5m	5m	5m	5m	5m	5m
Railways	10m	10m	10m	10m	10	10m
Manholes/Cilverts	5m	5m	5m	5m	5m	5m
Bridges, tunnels	10m	18m	25m	25m	50	100m
Water wells	25m	25m	50m	50m	50	50m
Fibr-optic junctions	5m	10m	10m	10m	15	20m
Aquaducts	10m	18m	25m	25m	25	50m

Recommended Minimum Hole Depth*	
0.09kg-0.125	1m
0.15kg-0.20kg	2m
0.25kg	3m
0.5kg	4m
1kg	8m
2kg	12m

Comments:

Local tests should be made on ground typical of the project area to confirm that the appropriate ppv levels are not exceeded.

1. Buildings: Legal requirement with the GDO restrict shot holes to 50m from occupied dwelling.
2. Contractor shall not go closer than quoted distances to a hazard unless specifically requested in writing to do so.
3. Distances should be decreased suitably where local conditions dictate.
4. More restrictive distances specified by any local authorities or utility companies must be adhered to.

PPV Monitoring

*Carry out pre survey PPV monitoring for base line assessment at all expected charge sizes.

1. The above chart is purely an indication, it does not take into account local subsurface anomalies.
2. Monitor and record residential properties at regular intervals.
3. PPV meter should be buried where possible.
4. Stop the operation, or modify the charge size if readings higher than 5mm/s are recorded at residential property.
5. Modify the charge size if the hole depth becomes shallower, as a guide, min 4m cover for 0.5kg charge - well tamped.

SAFETY DISTANCES - Gravity propelled energy generator

RECOMMENDED SAFE DISTANCES FOR GRAVITY PROPELLED ENERGY GENERATOR (m)

Based on GPEG 500kg hammer weight

In the absence of any other information or more rigorous local or national stipulations, the following guide will apply:

	m
Houses and other dwellings	5
Strong Industrial Buildings	5
Listed or fragile buildings	25
Hospitals	25
Petrol storage tanks	5
Culverts, man holes	2
Bridges, tunnels	5
Electricity sub-stations	2
Electric cables	2
HP gas, oil and water pipes, parallel	1.5
HP gas, oil and water pipes, crossing	1.5
Radio masts	5
Telephone Boxes	2
Fire hydrants	2
Telephone, cable TV fibre optic junctions	2
Sewage pipelines	2
Sewer rising main, iron or steel	4
Sewer rising main, plastic	2

Comments:

Local tests should be made on ground typical of the project area to confirm that the appropriate ppv levels are not exceeded.

1. All distances apply to the middle of the base plate.
2. Contractor shall not go closer than quoted to a hazard unless specifically requested in writing to do so.
3. Distances should be increased suitably where local conditions dictate.
4. More restrictive distances specified by any local authority or utility companies must be adhered to.
5. Monitor road surfaces for pad mark damage.
6. Carry out video recording of road surface re and post operations.

PPV Monitoring

Carry out pre survey PPV monitoring for base line assessment.

1. The above chart is purely an indication, it does not take into account multiple hammer blows.
2. Monitor and record residential properties at regular intervals.
3. PPV meter sensor should be buried where possible.
4. Stop the operation, or modify the operation if readings higher than 5mm/s are recorded at residential property.

VER Jan 2021, prepared by CMR