6 ANALYSIS OF ALTERNATIVES

6.1 INTRODUCTION

Seismic surveying is a specialised field and the alternative options are therefore restricted by technological development and the specifications required. SEIC has carried out an analysis of the value of information that would be obtained from a 3D seismic survey in relation to the information required for safe and efficient development of the Lunskoye Field. The need for the survey (discussed in *Chapter 3)* is primarily to optimise the drilling performance by reducing geological risk, and maximising reservoir performance by efficiently draining the hydrocarbon reserves.

The different methods and technologies available for carrying out seismic surveys are discussed below, together with the reasons for the chosen options.

6.2 ALTERNATIVE TECHNOLOGIES

6.2.1 *Survey Type*

There are two main types of seismic survey, two-dimensional (2D) and three-dimensional (3D). 2D surveys are a relatively simple form of survey and produce data along lines. They are generally used for initial, low-level investigations. 3D surveys record a third axis, producing data over surfaces. This provides additional data points that enable a 3-dimensional map of the sub-surface geology to be produced and a higher level of accuracy to be attained. 3D surveys have a higher shot density [(1)] but have the same energy level per shot as compared to 2D surveys.

Given the complex geology and impending development drilling of the Lunskoye Field (see *Chapters 3* and *4*), SEIC propose to use the 3D technique, as it represents the best method to obtain the quality of data required.

6.2.2 *Sound Sources*

A variety of sound sources have historically been used for seismic surveys, including explosives (*eg* dynamite), water guns, vapour guns and airguns. Airguns are now the most commonly used technique for offshore seismic surveys, as they are the most reliable and, when compared to other sources, are considered to cause the least impact to aquatic life (National Environmental Protection Committee of the Russian Federation, 2000). Other technologies such as marine vibrating sources are under development but are not currently available commercially and can only be used in stationary mode. SEIC propose to use airguns for the Lunskoye seismic survey.

(1) Shots per square kilometre.

Airgun Barrel Volumes

The volume of airgun barrels has a positive correlation with the depth the produced acoustic signal can travel, the sound level that is produced and the quality of data collected. Therefore, the larger the barrel volume, the higher the sound energy and the further the signal can penetrate the subsurface geology, the better the quality of the data received.

The maximum barrel volumes of the airguns proposed for the Lunskoye survey are 3.5 litres, which produce acoustic signals that can penetrate to a depth of up to 5 km. The main target depth for the Lunskoye survey is 2 km, however, reducing the signal strength would reduce the quality of data acquired. As the objective of the 2003 survey is the illumination of data beneath a highly absorbing gas cloud, a powerful source is required to avoid a result as poor as that acquired from the 1997 3D survey (see *Chapter 3*).

6.2.3 *Detectors*

There are currently two methods of recording seismic survey data:

- streamers;
- ocean bottom cables (OBCs).

OBCs are cables laid on the seabed with hydrophones and geophones [(1)] that detect the reflected waves from the sound source. After the completion of each series of survey lines, cables are lifted and relocated on the seabed ready for the survey vessel and equipment to progress to the next section of the survey grid. This relocation process is time consuming, extending the duration of the survey.

Towed streamers are most commonly used, as they are a simple, cost effective, safe and rapid method of conducting surveys in open water. They are not suitable for water less than 20 m deep (due to the risk of streamer entanglement with features on the seafloor) or for any areas where there are obstructions reaching to within 20 m of the sea surface.

Streamers are either kerosene filled or solid (foam-filled). Solid streamers are less sensitive to swell-noise than kerosene filled streamers and offer a reduced risk of kerosene spills when a section is ruptured. Solid streamers are currently more expensive than kerosene-filled streamers and replacement of the current stock of kerosene-filled streamers by seismic contractors will take a few years in view of these costs. It will not be known if solid or kerosene streamers will be used for the Lunskoye survey until contractors are assigned to the project in late 2002/early 2003.

For the Lunskoye seismic survey, streamers will be used as the water depths over the survey area are typically 25 to 55 m and streamer surveys are easier

(1) Geophones are used both onshore and offshore to detect the vertical velocity of ground particles produced by seismic waves. Geophones transform this motion into electrical impulses. OBC surveys can either be two component (2C) which use hydrophones and geophones or four component (4C) which use hydrophones and three orthogonal geophones.

to conduct, safer, and more cost effective. The use of streamers will also reduce the duration of the survey from an estimated three months for OBC to one month. This has an important advantage in reducing the period where there could be disturbance impacts on other users of the area and on marine mammals, in particular the western gray whale.

6.3 SPATIAL AND TIMING CONSIDERATIONS

6.3.1 *Area of the Survey*

Reducing the area of the survey would reduce the duration and potential impact of the operations. However, the perimeter of the survey area is defined by the gas-water contact of the field and SEIC have reported that the proposed survey area is optimal for the acquisition of sufficient information to allow the safe and efficient development of the field.

6.3.2 *Number and Orientation of Survey Lines*

The number and spacing of survey lines is determined by the quality of data required, the depth and thickness of the target geological horizons and the sound source frequencies used. The 60 Hz source frequency proposed for the Lunskoye seismic survey is routinely used in seismic surveys and allows the delineation of beds with a thickness of 30 m or more.

The approximate east-west orientation of the survey lines is required to allow partial undershooting of the underlying shallow gas sands in the central portion of the field that is obscuring the target geological horizons (see *Chapter 3*). Alternative orientations would not allow partial undershooting and would invalidate the purpose of the survey.

6.3.3 *Timing*

The survey schedule is limited to the ice-free season, which is typically between May and October. Meteorological conditions such as strong winds and high waves in spring and autumn further restrict the optimal timing for survey to the summer months (June to September). Conducting the survey in good weather conditions reduces the duration of the survey, provides better quality data [(1)] and reduces safety risk. Seismic surveys using cables can be conducted through ice where it extends to the seabed. This method cannot be used in areas where there is surface or pack ice as the reflections between the undersurface of the ice and the seabed surface mask the returning sound waves from the subsurface geology. The winter sea ice in the Lunskoye area is typically 1 to 4 m thick and is often broken-up, which would make a survey on ice unviable and would introduce unacceptable safety risks (*pers comm* SEIC, 2002).

For marine seismic surveys in the northeastern Sakhalin Island region, a key timing consideration is the potential presence of migrating or feeding western

gray whales. As discussed in *Chapter 4*, western gray whales migrate north in spring and early summer to their preferred feeding ground to the north of the Lunskoye Field, and migrate south to overwintering grounds during the autumn. The period when western gray whales are least likely to be encountered within the survey area is between July and September. These are also the months when meteorological conditions are at their most stable.

Seismic surveys are usually carried out on a 24 hours a day basis. For the Lunskoye seismic survey this would limit the duration of the survey to an estimated 30 days (20 days surveying and 10 days contingency for poor weather and technology failure). This reduces the likelihood of working in adverse weather conditions associated with a longer survey and the period over which there will be potential disturbance impacts to marine mammals.

An alternative to 24 hour working would be to restrict surveying to periods of daylight and good visibility only. This would have the advantage of allowing the marine mammal observers to have a clear view of the survey area and be able to advise of the presence of marine mammals (see *Chapter 7*). Working continuously over 24 hours, however, has the advantage of providing a continuous acoustic source, which would discourage marine mammals from entering the area. Stopping surveying over night may allow marine mammals to move close to the vessel and therefore increase the risk to these animals when the seismic survey recommences. Shooting only during the day would also double the length of time that the survey vessels would be active in the area.

For the Lunskoye survey, the July to September period is within the ice-free season, presents the most suitable climatic conditions and reduces the potential disturbance impacts to the western gray whale by avoiding their main migration through the Lunskoye Field.

6.3.4 'Zero Option'

If the proposed seismic survey was not conducted (the 'zero option'), then SEIC would have to reconsider their strategy for developing the Lunskoye Field. Options would include:

- abandoning plans to develop the field;
- continuing with planned drilling accepting health, safety and environmental risks associated with drilling through active geological fault;
- revising field development plans *eg* the drilling of satellite wells and the installation of additional platforms and connecting pipelines. This would have associated additional costs, health and safety risks and environmental impacts.

(1) By reducing background 'noise'.

6.4 CONCLUSIONS

Seismic surveys are a specialised technical area, and alternative methods and technologies are limited. SEIC has reported that the safe and efficient development of the Lunskoye Field requires the acquisition of data from a 3D survey to provide the necessary detailed geological information.

The survey technique and equipment specifications for the proposed seismic programme are considered to be necessary for the acquisition of quality data to allow geological evaluation and the safe and optimal development of the Lunskoye Field.

The survey schedule and duration reduces safety risks and the potential for adversely impacting western gray whales to ALARP levels.