9 UNDERWATER NOISE & VIBRATION

9.1 INTRODUCTION

Measurement of underwater noise has been undertaken by Subacoustech Ltd, the contractor carrying out the current COWRIE study on subsea noise and vibration. Baseline and during construction work has been undertaken on the North Hoyle Offshore Wind Farm, post-construction monitoring is ongoing.

Detailed methodologies have been provided and approved by Subacoustech as part of the COWRIE bidding process. Subsea noise monitoring has thus been approved by the agents to the Licensing Authority; which will therefore satisfy the monitoring requirements of the Licensing Authority.

Additionally, NWP Offshore Ltd. are in contact with Subacoustech to ensure that biological (particularly fish) and acoustic monitoring can be combined as far as possible and the results of each survey related and the results integrated into annual monitoring reports.

Subacoustech have undertaken baseline assessments for the COWRIE study in respect of North Hoyle; based on the methods approved by the Licensing Authority's agents. The summary results of this work is presented below.

The conditions of the Food and Environmental Protection Act (FEPA) 1985: Part II, licence 31579/05/0 (as amended) to NWP Offshore Ltd. for the proposed North Hoyle Offshore Wind Farm specifies:

"The Licence Holder must make provision during the construction phase of the wind farm to install facilities to enable subsea noise and vibration from the turbines to be assessed and monitored during the operational phase of the wind farm. Before completion of the construction phase the Licence Holder must supply specification to the Licensing Authority of how it proposes to measure subsea noise and vibration. Collaborative studies, e.g. research funded by COWRIE in this respect, would be an acceptable means of fulfilling this condition."

"Detailed post construction data must be collected on the frequencies and magnitudes of underwater noise produced by the North Hoyle offshore wind farm."

NWP Offshore Ltd appointed Subacoustech Ltd to write a detailed specification for a post construction monitoring programme which has been submitted to the Licensing Authority for approval. It is proposed that fixed facilities are not appropriate under the specification. DEFRA have indicated by formal correspondence that the existing COWRIE monitoring may discharge condition 9.6 above. Further discussion with the Crown Estates indicates that the results of the COWRIE study may be used to discharge this monitoring condition.

9.2 SUPPORTING STUDIES

The Subacoustech report titled “Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore wind farms, and comparison with background noise. Report No. 544 R 0424” has been reviewed and the following key points are summarised:

The purposes of the investigation was to provide measurements which would:

1. Evaluate the pre-existing background noise environment;
2. Measure and interpret the underwater noise from construction and operation of wind farms, and thus to;
3. Interpret these measurements in terms of any potential for environmental effect, and thus to;
4. Provide information allowing the wind energy industry to minimise any impact of noise during the lifecycle (construction, operation and decommissioning) of wind farms.

9.3 BASELINE

Background noise at North Hoyle was measured pre-construction. The measurements at the North Hoyle site have been taken along two transects, one running parallel to the shore and of reasonably constant depth, the other perpendicular to the shore line and representing a line of approximately constant slope. The reason for choosing this orientation of the transects is that the two cases of “constant depth” and “maximum rate of change of depth” were thought to be the two extreme cases in respect of propagation of noise. It may be noted that nearby there was an oil and gas production platform "*BHP Douglas*".

The levels of background noise at North Hoyle is towards the upper bound of typical deep water background noise levels. The overall sound pressure level varies significantly more during the daytime than at other times of day, due to the higher number of short local ship movements. The noise levels are higher at low wind speeds, contrary to the normal assumption that they will rise with increasing wind speed. At North Hoyle pre-existing man-made noise is probably a significant contributor to the background noise level. Significant variation in background noise was measured and can be categorised as follows:

- At frequencies of 2kHz to 100kHz there was little variation of noise level. It is thought that this noise is generated by wind and wave sources.

- At frequencies below 1 kHz or so, the results spread significantly. Interpretation of these results indicates that they are due to shipping movements. When there is local movement of shipping the levels increase significantly; however, even when there is no apparent local movement, distant ships can still contribute significantly to the noise.

- At low frequencies, below 200 Hz, the noise is dominated by shipping noise.

While measurements were being taken at North Hoyle it was noted that noise from the nearby *Douglas* oil and gas facility, situated to the north-east of the North Hoyle wind farm site, was present in some of the measurements. The levels from the *Douglas* facility, could be heard during some of the measurements made at the wind farm site.

A transect, recorded at 5 m depth on the 30th May 2003, in close proximity to the platform, indicated a Source Level of 195 dB re 1 mPa @ 1 m, and 225.7 dB re 1 mPa @ 1 metre at 10 metres depth respectively (Nedwell et al, 2004).

For the results at North Hoyle, the distribution of levels is centred around a mean at about 112 dB re 1 µPa. However, there is also a strong indication that there is a second process in operation, leading to a second peak in the noise distribution where the SPL is about 130 to

140 dB re 1 µPa. It is possible that this second peak is caused by man-made noise from other activity near the site (Nedwell et al, 2004).

The species weighted background noise levels have been calculated for three fish (salmon (*Salmo salar*), dab (*Limanda limanda*) and cod (*Gadus morhua*)) and for three marine mammals (bottlenose dolphin (*Tursiops truncatus*), harbour seal (*Phoca vitulina*), and harbour porpoise (*Phocoena phocoena*)). These common species were chosen from the relatively limited number of species for which audiograms of useable quality are known (Nedwell et al, 2004).

Marine mammals (dolphin, seal and porpoise) perceive a higher level of noise than the fish (salmon, cod and dab). Of the mammals, the porpoise perceives the highest level, at a mean of about 53 dBht (*Phocoena phocoena*). By comparison, the three species of fish perceive rather lower levels, the lowest being about 15 dBht (*Salmo salar*) for the salmon. This species is insensitive to sound, probably as a result of adaptation for noisy riverine environments (Nedwell et al, 2004)..

Fish detect primarily low frequencies, and hence the variability in the low frequency noise spectrum is reflected in the variability of the perceived levels for them. By comparison, marine mammals hear at high frequency.

In all cases, the species considered would perceive the background noise environment as being relatively quiet, and generally equivalent to the perception for humans of a typical rural night time background of 20 - 40 dB(A) (Nedwell et al, 2004).

9.4 CONSTRUCTION NOISE

An estimation of the likely behavioural and physical effects on a number of species of fish and marine mammals was undertaken using both conventional analysis and the dBht (*species*) scale. The measurements showed:

1. that piling at North Hoyle gave a Source Level of 260 dB re 1 µPa @ 1 metre for 5 m (metres) depth, and 262 dB re 1 µPa @ 1 m at 10 m depth. Calculations using the dBht scale levels indicate that strong avoidance reaction by a range of species would be likely at ranges of up to several kilometres. The levels of sound recorded during piling are such that within perhaps a hundred metres they could cause injury.

2. that cable trenching at North Hoyle gave a Source Level of 178 dB re 1 µPa @ 1 m if a Transmission Loss of 22 log(R) is assumed;

3. that rock socket drilling produced a strong fundamental component at 125 Hz, and harmonics up to 1 kHz, but it was not possible to establish the Source Level and Transmission Loss. Tonal components of the drilling could, however, be identified at ranges of up to 7 km.

About 75% of the measurements are in excess of 90dBht, which has been suggested as a threshold at which a “significant avoidance reaction” will occur, indicating that significant avoidance reaction by a range of species would be likely at the ranges at which measurements were made of up to 10 km (Nedwell et al, 2004). The ranges at which significant avoidance reaction would be expected, based on a criterion of 90 dBht, have been reproduced below.

Species	Distance
Salmon	1400 m
Cod	5500 m
Dab	1600 m
Bottlenose Dolphin	4600 m
Harbour Porpoise	7400 m
Harbour Seal	2000 m

Table 9.1 Calculated ranges for significant avoidance reaction as a function of species. Species Calculated range for significant avoidance reaction

The levels of sound recorded during piling were such that in the immediate vicinity of piling, say within 77 metres or so, the underwater noise could cause a high incidence of moderately severe blast-type injuries to marine mammals, including eardrum rupture (Nedwell et al, 2004).