TIDAL LAGOON CARDIFF

Chapter 20.0
Marine Noise and Vibration

20.0 Marine Noise and Vibration

20.1 Overview of existing situation

20.1.0.1 Estuaries by their nature (relatively shallow with large volumes of water movements) are naturally noisy environments. Along the extent of the Bristol Channel and Severn Estuary the neighbouring land uses are diverse ranging from remote tranquil areas such as the Gwent Levels and the upper Severn Estuary; popular seafront destinations such as Penarth; coastal cities with industrial ports such as Barry, Cardiff and Newport; and industrial areas. The waters are also subject to a number of varied uses including water based recreational activities, dredging and disposal of materials, fishing and commercial port and shipping activities.

20.1.0.2 The Severn Tidal Power SEA Topic Paper – Noise and Vibration (Department of Energy and Climate Change (DECC), 2010) identifies that the main generic noise sources include "*impact noise (breaking waves and water hitting solid surfaces such as rocks); bubble noise (noise* generated *through* processes *such as rain hitting the surface or breaking waves. The oscillation of these bubbles occurs in the range of 15Hz-300kHz); turbulent noise (generated by surface disturbance and in particular for the Severn estuary, tidal flow); seismic (generating low frequency noise by movement of the seabed); as well as biological and anthropogenic noise.*"

20.1.0.3 Baseline noise levels within the Bristol Channel and Severn Estuary will therefore vary with each contributing noise source. These could be continuous, intermittent or transient, and they may vary with the tide, diurnally, weekly, monthly, seasonally or annually. Thus baseline noise levels will vary depending on geographic location, time of day and season. These variables result in an infinite number of scenarios, and a significant dynamic range in the underwater soundscape. However, although the estuary will be a relatively noisy environment, particularly in certain areas due to anthropogenic activities and the relatively shallow water, long distance propagation will not be supported, resulting in noise propagation being relatively localised (DECC, 2010).

20.1.0.4 Underwater vibration is generated and propagates in the same way as ground vibration on the shore. In some situations the resultant vibration re-radiates as noise and this is assessed as part of the underwater noise predictions. The impact of the vibration itself in the underwater environment is a very localised effect, with potential to directly disturb seabed habitats in the immediate vicinity of high energy interactions with the seabed and underlying rock, such as piling or blasting.

20.2 Scope of potential impact to be assessed

20.2.0.1 Noise and vibration will arise from the construction, operation and decommissioning of the Project and could potentially affect a variety of receptors in the marine environment. The magnitude of noise arising from the Project will be quantified in order to inform other specialist topics comprising Intertidal and Subtidal Benthic Ecology (Chapter 12), Fish, including Recreational and Commercial Fisheries (Chapter 13), Marine Mammals (Chapter 14) and Coastal Birds (Chapter 15).

20.2.0.2 The assessment will consider the following aspects during the various Project phases:

i. Construction: Construction noise arising from capital dredging, vessels associated with construction works, construction of the breakwater, temporary cofferdam, turbine and sluice gate housings and foundations, which may include piling (vibro or impact).

ii. Operation: Operational noise levels from the operational turbines and maintenance dredging activities within the lagoon. Operational noise is most likely to be relatively localised in nature.

iii. Decommissioning: the noise and vibration arising from decommissioning will depend on the scenario progressed (see Chapter 6 Project Description for further details). A worst case scenario will be examined as part of the EIA process.

20.2.0.3 The potential cumulative effects of projects and plans will also be considered, as discussed in Chapter 3 Structure of the Environmental Statement.

20.3 Existing baseline data, consultation and need for survey

20.3.0.1 The Severn Tidal Power SEA (DECC, 2010) identified a lack of knowledge of the ambient marine noise within the Severn Estuary and identified that an underwater baseline noise study would be required for any project to take account of the particular and unique environment of the Severn Estuary. The underwater noise methodology would need to be designed taking into consideration the contributing factors within the environment such that measurements can be taken when the noise climate is least likely to result in unusually high ambient noise levels. Ambient noise within the marine environment can be taken to include (National Physical Laboratory (NPL, 2014):

i. "*sea surface noise: the noise of wind and wave action at the surface, usually referred to as wind dependent noise, and rain noise;*

ii. biological noise, the noise of fish, mammals and invertebrates;

iii. natural seismic/geoacoustic noise;

iv. *traffic noise, the noise of distant shipping*".

20.3.0.2 The survey will allow measurements of the existing anthropogenic sources of underwater noise in the area. Measurements will be undertaken around high tide as this allows the broadest range of frequencies to be monitored (Urick, 1983).

20.3.0.3 It is proposed that an underwater noise survey would be taken in the vicinity of the Project using relevant guidance documents including the NPL (2014) Good Practice Guide No 133: Underwater Noise Measurement and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (2012) Guidelines for data acquisition to support marine environmental assessments for offshore renewable energy projects.

20.3.0.4 Where possible, the underwater noise survey will be co-ordinated with airborne survey activities around the study area. Both will be subject to contingency planning to allow for the influence of adverse meteorological conditions, relatively benign weather conditions being required for both activities.

20.3.0.5 Underwater noise measurements will be undertaken from a dedicated survey vessel, a suitable craft having already been identified to provide a stable platform from which to access a range of locations in the study area over a period of one to two days. Measurements will be centred around, but not restricted to, high tide periods to provide maximal access and a range of conditions.

20.3.0.6 During the measurement sequences, the survey vessel's engine will be turned off to minimise interference with measurements of the ambient underwater noise climate in the area, and the craft allowed to drift to minimise water flow induced noise across the hydrophone. Continuous, synchronised GPS tracks will be recorded throughout the survey such that the precise measurement location can be matched to measured and recorded data in post processing analysis.

20.3.0.7 Measurements will be undertaken in multiple measurement locations within and outside of the area of the Project, at varying distances from the shipping routes and also a range of distances from the shoreline out to the main channel.

20.3.0.8 Hydrophone depths will be selected at each location to provide a range of measurements throughout the study area close to the surface, at mid depth and close to the bottom. These will be selected on the basis of bathymetric survey data, and direct sonar observations in situ. Typically the surface and bottom measurements would be made 0.5m to 1m away from each interface to minimise disturbance from and contact with the surface itself and seabed obstructions respectively.

20.3.0.9 Detailed contemporaneous notes will be made during the surveys, including range and location estimates of all other craft in the study area, and any other activities which could influence the survey data, including changes in sea state and wind speed and direction. Assistance will be sought from the crew of the survey vessel in plotting the locations of other craft, their distance from the measurement

location being a critical factor in interpreting the measured data during post-processing.

20.3.0.10 A Type approved calibrated hydrophone evaluated by statistical means (sometimes called random uncertainties) will be used for the survey measurements and recordings, the full measurement chain, including pre-amplification and digital recording equipment being subject to field calibration checks directly prior to and on completion of each set of survey measurements.

20.3.0.11 The hydrophone will be deployed to minimise measurement artefacts in-situ, which may necessitate mounting on an anti-heave buoy or suspension from the sea bed and implementation of a minimum stand-off distance between the measurement location and the survey vessel to account for the influence of wave slap on the hull.

20.3.0.12 Prior to each underwater noise measurement and recording cycle, the live signal will be converted to a format which can be heard directly via headphones and tested to ensure that the quality of the signal is suitable for further analysis, also enabling the influence of any measurement artefacts or anthropogenic influences to be gauged.

20.3.0.13 Following each measurement sequence, the integrity of the measured data and contemporaneous notes will be verified and a backup made of both prior to moving on to the next sequence.

20.3.0.14 On completion of the field work and post processing analysis a comprehensive archive of all data and notes will be compiled for any future reference purposes.

20.3.0.15 The key aspects that will be considered in the design of the survey is to sample the sound field at appropriate point(s) in the water column for the duration and range of conditions required, whilst minimising spurious sources of non-acoustic signals caused by the presence of the hydrophone and its platform, which contaminate the measurements and lead to spurious data. The following aspects have also been considered in relation to the proposed survey design:

i. Recording underwater noise levels around high tides allows the broadest possible range of frequencies to be monitored (as water depth influences sound propagation (Urick 1983)).

ii. Use of a drifting vessel (without engine noise) for transect recording.

iii. All equipment to be used for the noise recordings will be calibrated, traceable to the UK national measurement standard. Certificates will be available on request; and

iv. Use of anti-heave buoy and stand-off distance between the boat and the hydrophone to minimise noise artefacts in-situ.

20.4 Proposed assessment methodology

20.4.1 Introduction

20.4.1.1 Whilst information on noise generation from maritime plant is available, the noise and vibration SEA topic paper (DECC, 2010) identified that the most limiting factor relative to the assessment of noise and vibration was the lack of specific information available from previous similar projects. The SEA topic paper identified that tidal technology was relatively new, and previous tidal projects prior to this date had not covered noise within their environmental appraisals which resulted in a lack of data.

20.4.1.2 The following methodologies are proposed to assess noise arising from the construction, operation and decommissioning of the Project based on relevant research and guidance, including the NPL (2014) Good Practice Guide No 133: Underwater Noise Measurement. The Tidal Lagoon Swansea Bay (TLSB) Environmental Statement (TLSB, 2014) examined the potential noise effects from the construction and operation of a tidal lagoon in Swansea Bay. This project will employ similar construction methods and involve the use of similar tidal turbines and the process used for the assessment has also been reviewed as part of the preparation of this Chapter.

20.4.1.3 It will be important to ensure that the most relevant underwater noise measurement parameters are measured for the assessment which can depend on the nature of the source under study.

20.4.1.4 For pulsed sounds, such as piling, the most suitable metrics for assessment are:

i. Single pulse Sound Exposure Level (SEL);
ii. Cumulative Sound Exposure Level (SEL) (for a series of pulses);
iii. Peak sound pressure level;
iv. Peak-to-peak sound pressure level.

20.4.1.5 For continuous sound, such as dredging, general noise from construction and operation of the turbines, and ambient noise assessments, the most suitable metric is Sound Pressure Level (SPL) including reference to the averaging time of the measurement, although raw calibrated recordings and other metrics will be collected to enable a range of post-processing analyses, including SEL and other weightings as appropriate.

20.4.1.6 To establish relative source strengths of mobile noise features in the underwater soundscape, reference will be made to the standardised effective sound pressure level at 1m as is the convention in underwater acoustics.

20.4.1.7 Underwater noise level data from on-site measurements and library data for different activities will be used to provide predictions of noise levels at a range of distances from the noise sources.

20.4.1.8 Throughout the EIA process, there will be close liaison between specialists in order that the noise and vibration study is able to provide appropriate data for robust assessments of the potential effects on marine sensitive receptors e.g. marine mammals, fish, marine ecology and birds. In order to ensure scientific integrity of the work, internationally established methods, i.e. those approved through a peer-review process or through a consensus of an expert committee, would be used in reporting the impact zones and potential impact on marine life (Urick, 1983).

20.4.2 Construction

20.4.2.1 The potential noise impacts of construction works offshore (piling, dredging, installation of turbines) will be considered in terms of noise levels within the receiving underwater environment using the following methodology.

20.4.2.2 The propagation of noise as a result of the construction phase of the Project will be modelled using the 20logR relationship, which is commonly applied to propagation in water (Parvin et al, 2008).

20.4.2.3 The transmission loss ("**TL**"), is referred to in underwater acoustics when describing predicted or measured noise levels at varying distance ("**R**") from the source.

20.4.2.4 The general relationship **TL = NlogR + aR** is used to describe the two components of sound level reduction with distance, geometric spreading and absorption. N describes the divergence pattern and a, the rate of absorption per metre.

20.4.2.5 Modelling the absorption term, **a**, can be very involved, especially in shallow waters where the bottom and sediment interactions provide significant attenuation. CEFAS and NRW will be consulted to agree a suitable value for **N** for the shallow water in the bay, as well as any corrections for **a**.

20.4.3 Operation

20.4.3.1 During the operational phase, the assessment will consider noise arising from the turbines, adopting the same methodology used for assessing underwater noise during the construction phase. Any other works required for operation of the lagoon, such as dredging within the lagoon, and the operation of lock gates and sluice gates will also be considered as part of the operational noise assessment.

20.4.4 Decommissioning

20.4.4.1 The worst case decommissioning scenario will be considered, adopting the same methodology used for assessing underwater noise during the construction phase where appropriate. Current decommissioning scenarios are outlined in Chapter 6 Project Description and involve either an upgrade or removal of turbines and sluice gates.

20.5 References

CEFAS (2012) Guidelines for data acquisition to support marine environmental assessments for offshore renewable energy projects

DECC (2010) Severn Tidal Power SEA Topic Paper – Noise & Vibration

NPL (2014) Good Practice Guide No. 133 - Underwater Noise Measurement

Nedwell & Edwards (2004) A review of measurements of underwater man-made noise carried out by Subacoustech Ltd, 1993-2003

Parvin SJ, Nedwell JR, Kynoch J, Lovell J, Brooker AG (2008) Assessment of underwater noise from dredging operations on the Hastings shingle bank.

TLSB (2014) Tidal Lagoon Swansea Bay Environmental Statement

Urick (1983) Principles of Underwater Sound for Engineers.