NERA
NATIONAL ENERGY RESOURCES AUSTRALIA
Creating connections for growth

Environment Plan Reference Case

Anchoring of Vessels and Floating Facilities

Registered office:
Australian Resources Research Centre
Level 3, 26 Dick Perry Avenue
Kensington WA 6151
ABN 24 609 540 285

T: 1300 589 310
E: contact@nera.org.au
W: www.nera.org.au
@NERAnetwork
NERA – National Energy Resources Australia

Australian Government
Department of Industry, Innovation and Science

Industry Growth Centres

- Anchoring activities conducted within 3km of known sensitive benthic habitats (e.g. areas containing critical or sensitive flora and fauna such as coral reefs, seagrass meadows, etc.);

If the activity or the environmental assessment identifies that one or more of these scope exclusions may apply, additional assessment of impacts and risks should be performed, and additional control measures evaluated.

While the scope exclusions describe the circumstances where this reference case cannot be directly used, information and references contained in this reference case may be useful in an activity's EP.

The Activity

A range of offshore petroleum activities are undertaken using vessels and floating facilities. These vessels or facilities may undertake a variety of tasks however most often their primary role is as the platform for an activity, or the transportation of goods and personnel to and from offshore facilities. To conduct operations safely, vessels and facilities used in the oil and gas industry may be required to be anchored to the seabed while activities are undertaken.

Anchoring systems used in the oil and gas industry vary in their footprint depending on the size of the vessel, and the equipment or facility to be secured to the seabed. These may range from a single anchor weight and chain, to multidirectional spreads of multiple anchors. Accordingly, the total disturbance area will vary, as will the geographical extent of the anchoring activity. This reference covers anchoring activities within the following parameters:

- 0.1–0.4 m^2 per anchor/suction pile used for a MODU;
- Disturbance from anchor chains (up to 3800m in length) ranging from a few hundred metres squared to several thousand metres squared;
- 1000 m^2 per clump weight used for equipment (e.g. BOPs etc.);
- Approximately 100 m linear distance for drag embedment anchors.

Accordingly, a vessel anchored within water depths greater than 70m with a single anchor could result in a total disturbance area of up to 1300 m^2, whereas a semi-submersible MODU with an 8 to 12-point anchoring system could disturb up to 13,000 m^2, allowing for anchor footprint and disturbance from anchor chains.

Usage instruction:	Titleholders wishing to utilise this reference case are advised to ensure that the anchoring activities they plan to undertake fall within the activity limitations stipulated above.

Environmental Setting

This reference case applies to the disturbance of soft-sediments because of anchoring activities occurring as part of a petroleum activity within the Commonwealth Marine Area. The scope inclusions and exclusions specified above have been deliberately crafted to include parts of the receiving environment were laying of anchors is preferred for operational and environmental reasons i.e. in soft-substrates. Hence the description of environment provided in the EP should confirm that anchoring on hard-substrates, corals and reef systems, and benthic primary producer habitats is not anticipated. For activities occurring within environments excluded from the scope of this reference case, additional consideration will need to be given to the nature and scale of impacts of seabed disturbance, acceptability of impact, and the control measures adopted to manage impacts to sensitive receptors, and values occurring within these waters.

Anchoring for petroleum activities covered by this reference case typically occurs within the continental shelf, in areas of soft benthic habitats and low sensitivity (i.e. no critical or sensitive flora or fauna). Seabed features and habitats within the continental shelf vary geographically and biological communities in this area vary in response to water depth and substrate (Beaman, 2005; DEWHA, 2008). Benthic assemblages in deeper waters may include sponges and a mixed assemblage of invertebrates (Jordan *et al.*, 2011). Descriptions of habitats and biota for offshore shelf regions (e.g. Northwest Shelf, Bonaparte Basin, Twofold Shelf) include varied sediments (sands, gravels, muds), invertebrates (IMCRA, 1998).

Seabed disturbance because of anchoring will affect sediment compartments of the receiving environment. Values associated with sediment compartments of the receiving environment have been described using the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). Based on ANZECC/ARMCANZ (2000) values which could be affected within the sediment compartments include ecosystem health, e.g. ecosystems, including biological diversity, abundance and biomass of marine life and ecological processes.

Environmental receptors identified in the reference case which may be exposed to the disturbance could include predominantly bare sand habitat; benthic habitats with infauna and/or epibenthic biota (e.g. sessile and mobile invertebrates, sponges etc.); fish (including finfish, sharks and rays), reptiles (e.g. sea snakes, turtles), and marine mammals (e.g. cetaceans and pinnipeds), including those species protected under the EPBC Act.

Usage instruction:	Titleholders wishing to utilise this reference case are advised to ensure that the description of environment in the environment plan for the activity has appropriately described the benthic habitat in the specific area that may be exposed to benthic disturbance from anchoring.

Evaluation of Environmental Impacts and Risks

The following evaluations have been completed based on the limitations set. If a titleholders activity exceeds these limitation or the environment is different to that described further discussion of impacts and risks will be required in the environment plan.

Impact: Seabed Disturbance

A typical anchor spread may utilise between eight to twelve anchors. The anchor radius depends on the operating depth but is typically between 1.5 and 2.5 times the water depth of the operation (Vryhof Anchors BV, 2010). For example, in 1,524 m of water, the anchors can extend 3,811 m beyond the well site (Evans *et al.*, 2011).

The actual area of seabed affected by anchoring operations would depend upon water depth, currents, size of the vessels and anchors, and length of anchor chain. The amount of seabed affected by anchored structures may increase with water depth given the use of larger anchors and longer anchor chains. For example, anchor scars were detected in a radial pattern up to 3 km from a well located on the Gulf of Mexico continental slope (USDOI-BOEM, 2012).

Anchor impact can be exacerbated by movement of the vessel on the anchor line, such as through 'swinging' on the anchor under the influence of wind, tides and currents or dragging of the anchor and cable.

Seabed disturbance from vessel and facility anchoring will impact on receptors through smothering and alteration of benthic habitat and localised and temporary increases in suspended sediments near the seabed. Physical impacts to seabed properties, benthic populations and communities may include (Offshore Energy SEA, 2011; Evans *et al.*, 2011):

- Smothering and scouring;
- Mortality and burial of benthic fauna;
- Increased sedimentation; and
- Scarring, e.g. formation of mounds and trenches.

The impact of seabed disturbance from anchoring depends upon the frequency, magnitude and location of activity, type of sediments, and the sensitivity of benthic communities (UK Marine SAC, 2001). Direct physical smothering of benthic habitats will occur under the anchors; and alteration (e.g. scraping etc.) can occur in areas subjected to anchor drag or chain scour.

Anchoring for petroleum activities covered by this reference case typically occur within areas of low sensitivity (i.e. no critical or sensitive flora or fauna); habitats are predominately soft sediment with possible infauna and sparse epibenthic flora and fauna. In areas of soft sediment with no sensitive benthic communities, any impact from anchoring is likely to be minimal and typically temporary (UK Marine SAC, 2001).

Following recovery of the anchors, impacts from the disturbance are expected to be localised and short-term, with the underlying conditions present to support re colonisation and recovery after the activity has been completed (Ingole et al. 2013 and Bluhm 2001). As such the anchor disturbance to the seabed is determined to be minor and temporary.

Infill of scars can however produce alteration of sediment type within the feature which is longer-term than the topographic expression of the scar, since the infill is usually of finer sediment (DECC, 2011).

During anchoring activities, there is also potential for soft sediments to be suspended into the water column, which has the potential to affect benthic communities through a decrease in water quality or light penetration near the seabed. Given the hydrodynamics in open ocean areas, the area of decreased water quality is expected to be localised and temporary, as sediments would settle out of the water column relatively quickly.

Monitoring of impacts from sediment plumes from large-scale capital dredging programs have shown no significant changes to benthic habitats above natural variation (Chevron Australia, 2013). The nature and scale of anchoring activities is significantly less than that of dredging programs meaning that impacts from a temporary increase in suspended sediments are expected to be insignificant because they are so localised.

Risk: Introduction of marine pests

Marine growth is unlikely to survive on anchoring equipment for petroleum activities as anchoring operations within the scope of this reference case will occur within areas of deep water, soft-substrate, and low sensitivity habitats. Therefore, the risk of an introduced marine pest successfully being introduced and establishing is low.

Vessel and facility anchoring may potentially affect receptors (e.g. benthic habitats) through the introduction of marine pests. Biofouling is the colonisation of immersed surfaces by marine organisms. Introduced marine pests are marine plants or animals that are not native to Australia but have been introduced by human activities such as shipping; these plants or animals can affect Australian marine industries and the environment (e.g. by competing with native flora and fauna) (NSPMMPI, 2017).

Successful introduction of a marine pest requires the following:

1. Colonisation and establishment of the marine pest on a vector (e.g. anchor chain) in a donor region (e.g. home port).
2. Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g. project area).
3. Colonisation (e.g. dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population.

Most introduced marine pests have been found in tidal and subtidal zones, with very few (e.g. New Zealand Screwshell) successfully colonising in the deeper waters over the continental shelf (Bax *et al.*, 2003). It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open-water environments, where the number of dilutions and the degree of dispersal are high (Paulay *et al.*, 2002). Further, marine pests have typically been exchanged between one coastal area to another (e.g. between ports); and are not likely to survive in deep water ecosystems (Geiling, 2014).

Lack of nutrients in open ocean oligotrophic water is a key factor as to why marine pests may not survive as well in offshore waters, as this would significantly slow growth and maturation rates. In addition, newly released gametes or larvae require a period of development before they can settle and metamorphose. In the open ocean larvae are most likely to be swept away prior to being physically able to settle. In addition, anchoring arrays are typically recovered to the deck or topside when not in use meaning that any marine growth will potentially dry out between deployments (NSPMMPI, 2009), therefore reducing the risk of spreading biota.

The inherent features of anchoring activities as part of offshore petroleum activities result in this risk being considered low. As such, no further assessment or specific controls to manage risks from introducing invasive marine species are proposed in this reference case.

Risk: Physical Interaction (Marine Fauna)

Vessel and facility anchoring may affect receptors (e.g. marine megafauna) through the following:

- Entanglement; and
- Displacement.

Results from studies into the risk of entanglement of mooring systems on marine megafauna indicate that taut configurations have the lowest relative risk; but note that the absolute risk of entanglement of marine megafauna is low regardless of mooring configuration (Harnois *et al.*, 2015).

Due to the relatively small footprint of infrastructure within the water column (e.g. anchor lines), anchoring activities from vessels and facilities are unlikely to significantly affect the movement (including migration) of marine megafauna. Any deviation that may occur would be localised and temporary in nature.

Given the low level of risk, no further assessment or specific controls to manage physical interaction between marine fauna and anchoring equipment, are proposed in this reference case.

Control measures

The control measures required to minimise seabed disturbance from anchoring will depend on the type of activity and anchoring configurations. Control measures for vessels and floating facilities are listed in the tables to follow.

ANCHORING CONTROLS	
Single point anchoring	No specified controls for the scope identified in this reference case.
Multiple point anchoring	Anchoring procedure.

Evaluation of impacts from seabed disturbance from anchoring to ALARP

Potential additional controls to manage sea bed disturbance from anchoring include:

- Site specific anchoring analysis for all anchoring;
- Use of dynamic positioning (DP) vessels over anchoring;
- Use of jack-up rigs; and
- Post anchoring monitoring to establish level of disturbance.

Site specific anchoring analysis using geotechnical or geophysical surveys are considered unreasonable for anchoring in areas of low sensitivity because seabed impacts are low and there is negligible environmental benefit to be gained from close examination of the benthos prior to anchor placement.

The use of DP vessels potentially eliminates the need to use anchors. There are additional impacts and risks introduced by using DP vessels such as increased atmospheric emissions and sound-related impacts. DP vessels are also costlier. Given the increased costs and the additional environmental impacts the use of DP vessels is not considered reasonable.

The use of jack-up drilling rigs potentially reduces the area of seabed disturbance because anchoring is not required. However, jack-ups are not always appropriate for some activities and locations from a drilling safety perspective. Jack-up rigs are generally limited to water depths shallower than 100m, and as such are considered impracticable to use in a clear majority of the environment covered by this reference case.

Visual monitoring during and post anchoring is considered unreasonable as such surveys introduce additional vessels and use of ROVs, which would impose additional costs and additional safety risks. There is no additional environmental benefit from this expense given the already high degree of certainty in the prediction of impacts.

Evaluation of impacts and risks from anchoring to acceptable levels

The acceptable level of impact to ecosystem health, primary industry, recreation and aesthetic values from anchoring has been defined as a temporary disturbance (<2 years) to the seabed that does not exceed a total combined area of 13,000 m^2. The impacts and risks considered in this reference case are of an acceptable level because:

- Anchoring is an activity commonly undertaken in the marine environment by multiple industries.
- Seabed disturbance of <13,000 m^2 total area is small in the context of offshore, deep water environments, and can be predicted with confidence.
- Localised disturbance to benthic habitats in deep water is recoverable in the short to medium term.
- The introduction of invasive marine species and physical interaction with marine fauna from anchoring operations are considered inherently low risks.

Environmental Performance Outcomes, Standards and Measurement Criteria

The following table includes the:

- environmental performance outcomes which reflect acceptable levels;
- environmental performance standards for each of the control measures adopted; and
- measurement criteria are appropriate for within the limits of this reference case.

Activity	Aspect	Environmental Performance Outcome	Control	Control Source	Control type	Environmental Performance Standard	Measurement Criteria
Multi-point anchoring	**Seabed disturbance**	**Seabed disturbance from anchoring is less than 13,000 m^2**	Anchoring procedure	Good industry practice	Procedure	Mooring analysis will be undertaken before anchoring, as required API RP 2SK	Mooring analysis report shows mooring analysis was completed before anchoring commenced
						Records indicate mooring/ anchoring undertaken as per the mooring analysis	Evidence confirms anchoring is as per the mooring analysis
						Anchor slipping / tension monitoring will be undertaken during anchoring, as required by ISO 19901-7:2013	Records confirm anchor slipping / tension was monitored during anchoring

References and Additional Guidance Material

This Appendix provides further information to support the EIA content in the reference case, as well as assistance to title holders on how they may achieve compliance with requirements. The information in this Appendix should be used as a guide only.

References

ANZECC/ARMCANZ. 2000. *Australian Water Quality Guidelines for Fresh and Marine Waters, National Water Quality Management Strategy.* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand Available at: http://agriculture.gov.au/water/quality/nwqms

Bax, N, Williamson, A., Agueor, M., Gonzalez, E. and Geeves, W. *Marine invasive alien species: a threat to global diversity.* Marine Policy 247(4): 313-323.

Beaman, R. 2005. *A GIS Study of Australia's Marine Benthic Habitats.* PhD Thesis, University of Tasmania. Available at: https://eprints.utas.edu.au/419/

Chevron Australia. 2013. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Post-Development Coastal and Marine State and Environmental Impact Survey Report, Year 2: 2012-2013.* Available at: https://www.chevronaustralia.com/docs/default-source/default-document-library/gorgon-emp-post-development-coastal-and-marine-state-and-environmental-impact-survey.pdf?sfvrsn=4

Geiling, N. 2014. *Artic Shipping: Good for Invasive Species, Bad for the Rest of Nature.* Smithsonian Magazine. Available at: https://www.smithsonianmag.com/science-nature/global-warmings-unexpected-consequence-invasive-species-180951573/?no-ist

Harris, P., Heap, A., Passlow, V., Sbaffi, L., Fellows, M., Porter-Smith, R., Buchanan, C. and Daniell, J. 2003. *Geomorphic Features of the Continental Margin of Australia.* Geoscience Australia. Available at: https://www.environment.gov.au/system/files/resources/dc614f8f-b053-4388-bfbb-944c9dfded32/files/nmb-geomorphic-report.pdf

Harnois, V., Smith, H., Benhamins, S. and Johanning, L. 2015. *Assessment of entanglement risk to marine megafauna due to offshore renewable energy mooring systems.* University of Exeter. Available at: https://ore.exeter.ac.uk/repository/bitstream/handle/10871/17663/Entanglement%20of%20marine%20animal%20in%20marine%20renewable%20energy%20mooring%20system_v4.pdf?sequence=1&isAllowed=y

IMCRA. 1998. *Interim Marine and Coastal Regionalisation for Australia: An ecosystem-based classification of marine and coastal environments.* Version 3.3. IMCRA Technical Working Group. Available at: http://www.environment.gov.au/system/files/resources/dd0867cf-d8be-40f0-b9e5-7cfa65d6e6b5/files/imcra3-3.pdf

Ingole, B. S. Goltekar, R., Gonsalves, S and Ansari, Z. A. (2005) Recovery of Deep-sea Meiofauna after Artificial Disturbance in the Central Indian Basin. Marine Georesources & Geotechnology Vol. 23(4).

Jordan, A., Davies, P., Ingleton, T., Foulsham, E., Neilson, J. and Pritchard, T. 2011. *Seabed habitat mapping of the continental shelf of NSW. Department of Environment, Climate Change and Water NSW.* Available at: http://www.environment.nsw.gov.au/resources/research/NSWContinentalShelfSeabedMapping.pdf

Paulay, G., Kirkendale, L., Lambert, G. and Meyer, C. 2002. *Anthropogenic biotic interchange in a coral reef ecosystem: A case study from Guam.* Pacific Science 56(4): 403–422.

NSPMMPI. 2009. *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry.* National System for the Prevention and Management of Marine Pest Incursions. Commonwealth of Australia. Available at: http://www.marinepests.gov.au/marine_pests/publications/Documents/Biofouling_guidance_petroleum.pdf

NSPMMPI. 2017. *The marine pest threat.* National System for the Prevention and Management of Marine Pest Incursions. Commonwealth of Australia Available at: http://www.marinepests.gov.au/Pages/default.aspx

UK Marine SAC. 2001. *Anchoring and mooring.* UK Marine Special Areas of Conservation Project. Available at: http://www.ukmarinesac.org.uk/activities/ports/ph3_2_5.htm

API Recommended Practice 2SK: Design and Analysis of Stationkeeping Systems for Floating Structures (API RP, 2005

ISO 19901-7:2013: Stationkeeping systems for floating offshore structures and mobile offshore units (ISO 19901-7, 2013

Registered office:
Australian Resources Research Centre
Level 3, 26 Dick Perry Avenue
Kensington WA 6151
ABN 24 609 540 285

T: 1300 589 310
E: contact@nera.org.au
W: www.nera.org.au
@NERAnetwork
NERA – National Energy Resources Australia

www.nera.org.au