05 August 2015

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Our Ref: J27035
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Email received 11 May 2012

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Dear Dr K Prochazka and Dr Verheye

RE: ESKOM EIA CONCERNS FOR THE PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE (DEA Ref. No: 12/12/20/944)

The above-mentioned document dated April 2011 and received by the Department on 03 May 2011 refers. The Department of Environmental Affairs ("DEA") reference number is: 12/12/20/944.

Arcus GIBB's comments on the Additional considerations by the Director: Resources Research: on the comments of the Scientific Squid Working Group as well as the original comments of the Scientific Squid Working Group which follow below are presented as follows: Comments presented by Dr Prochazka will firstly be discussed followed by the body of Dr Verheye's email and finally comments on the Squid Scientific Working Group's EIA Report.

Comment 1:

Although I find the conclusion of the Squid SWG satisfactory in relation to the likely impact on squid, I have some reservations around the accuracy of the statement made that discharging the brine into the breaker zone will "facilitate mixing". My reservation comes from the experience of the Plettenberg bay desalination plant, where discharge of brine into the breaker zone (or surf-zone) in fact has the opposite effect of entraining the brine in the surf-zone, rather than facilitating mixing. I therefore suggest that Dr Stephen Lamberth is consulted in relation to the accuracy of this statement.

You will note that the Report was supported by Dr Kim Prochazka, Director: Resources Research, (as well as Chief Director, Dr Johann Augustyn) subject to an additional consideration regarding the discharge of brine into the breaker zone, which would reportedly facilitate mixing. Dr Lamberth's response to Dr Prochazka's query is as follows:

"[Dr Prochazka] is entirely correct in that the surf-zone is a retention rather than a dispersal zone. The Water Act marine waste disposal policy recognizes this and requires effluent pipes to extend beyond the surfzone. http://www.dwaf.gov.za/Dir_WQM/docs/marine/MarineWaste. I think the responsibility for marine disposal is (slowly) migrating to DEA and the Coastal Management Act. Retention aside, an attempt to pump and disperse effluent from the Sedgefield desalination plant through a beach "sump" resulted in elevated salinity levels in the adjacent surfzone. This fluctuated according to weather but persisted when it occurred."

In the Thyspunt case, the brine will be diluted to undetectable levels with the simultaneous release of the cooling water during the operational phase of the proposed "Nuclear 1". It is therefore believed that its discharge will not result in elevated salinity levels and, hence, have no effect on squid.

Response 1:

Thank you for your comment. The Marine Ecology Specialist will be requested to consult with Dr Lambert with regards to the dilution of brine during the construction phase. The proposal at all the alternative sites is for operational phase brine from the desalination plant to be released via the cooling water outlet pipe.

Comment 2:

Two major issues of concern were identified by the Working Group as requiring further investigation; specifically the impacts of the disposal of spoil in the offshore marine environment during construction and the continuous release of warmed cooling water at either a nearshore or offshore location. The first issue involves two components; namely the loss of spawning habitat through smothering of the seafloor by the spoil and impacts of fine sediment particles suspended in the water column (i.e turbidity) on squid spawning behaviour and paralarval survival. Published information suggests that paralarvae will not survive in waters saturated with suspended particulate matter. However, the area that will be affected by the spoil is relatively small and it is uncertain to what extent it will elevate paralarval mortality. This depends upon paralarval transport routes, which are presently not well documented. An Individual Based Modelling (IBM) approach was employed to assess this latter component.

Response 2:

In order to address these concerns the Scientific Squid Working Group undertook IBM, the results of which are presented and discussed in Comment 35 below.

Comment 3:

The SSWG agrees with the independent marine consultants that the impact of the construction of the inflow and outflow systems if of limited spatial extent and can be considered to be negligible in comparison with the overall area available to squid for spawning.

Response 3:

Your comment is noted.

Comment 4:

The SSWG agrees with the conclusion that closure of the safety zone to exploitation reflects a negligible area lost to the squid fishery.

Response 4:

Your comment is noted and reflects the finding of the Nuclear-1 Marine Assessment.

Comment 5:

The squid fishing industry (SASMIA) is advised to collect the required information on spatial distribution of catches, which would enable it to provide a more accurate assessment of the magnitude of the catches that may be impacted by Nuclear 1.

Response 5:

Your comment is noted.

Comment 6:

The squid fishing industry (SASMIA) should enter into dialogue with Eskom and broker a compensation agreement that clearly specifies the criteria on the basis of which the extent of the impact of Nuclear 1 on squid fishing operations is measured. These criteria should include presence-absence of main fishable concentrations in the vicinity of the Thyspunt site, i.e. Aasvogels, Oysters Bay, Seals Bay and Kromme. These concentrations were a constant feature of the squid jig fishery since its inception.

Response 6:

Your comment is noted. Eskom is not in a position to pay ongoing compensation for the loss of access to a resource.

Comment 7:

The SSWG agrees with the conclusion that the abstraction of cooling water and the release of desalination plant effluent are unlikely to impact on the squid resource or the fishery.

Response 7:

Your comment is noted and reflects the finding of the Nuclear-1 Marine Assessment.

Comment 8:

The issues of radiation contamination, release of sewage effluent and the polluted groundwater, while representing potentially major threats to the marine environment, are adequately discussed in the Marine Ecology Report and were not considered further by the SSWG. It should be noted, however, that perceptions to the international squid market should be taken into consideration. The SSWG cannot provide specific advice on this aspect and suggests that this should be researched by the squid industry itself.

Response 8:

Your comment is noted and reflects the finding of the Nuclear-1 Marine Assessment.

Comment 9:

In assessing the impacts of spoil disposal on the squid spawning habitat, the SSWG assumed that the differences between the disposed spoil and the naturally occurring sediments would reflect a permanent loss of spawning habitat. The worst-case scenario (area covered to a depth of more than 0.5 cm of spoil sediment by the disposal of the full volume of spoil) represents an area of 18.1 km^2. The SSWG considers this to reflect an appreciable (20%) loss of nearshore squid spawning sites in relation to the total number of sites in the core inshore spawning area, recorded between the Tsitsikamma River and Algoa Bay.

Response 9:

Your comment is noted. Please note that the Nuclear-1 assesses a number of alternatives with regards to marine spoil disposal, including near-shore disposal and offshore disposal (beyond the squid spawning grounds). The recommended alternative for the Thyspunt site is disposal at an offshore site, thus avoiding the squid spawning grounds.

Comment 10:

The SSWG considers that the mortality of paralarvae arising from the plume of turbid water resulting from the release of the spoil is negligible. Even in the worst-case scenario of the release of the full volume of spoil, only about 5% of all hatched paralarvae will encounter the plume of turbid water and die. If the disposal of the spoil could be conducted during the winter months when squid spawning is at a minimum, the impacts of this component on squid recruitment will be even further reduced.

Response 10:

Your comment is noted and reflects the finding of the Nuclear-1 Marine Assessment.

Comment 11:

The SSWG considers that the mortality of paralarvae arising from the plume of the warmed cooling water is negligible. Even in the worst-case scenario where water warmed to only 2°C above ambient will result in 100% mortality of paralarvae entering the plume, only about 5% of all hatched paralarvae will be impacted. Even though the warmed cooling water will be a permanent source of paralarval mortality, the low level of this impact can only be considered to be negligible in terms of squid recruitment.

Response 11:

Your comment is noted and reflects the findings of the Nuclear-1 Marine Assessment.

DISRUPTION OF THE MARINE ENVIRONMENT DURING CONSTRUCTION-TEMPORARY

Comment 12:

1.1 **Construction of intake and outflow systems- estimated to be of 1-2 year duration**

According to information from the independent marine consultants, construction of the outflow system is expected to take 2 years. The intake system will take 4 years but little of this time will disrupt the marine environment as most construction consists of the subterranean tunnelling and onshore work. Exact timing has not been planned; however, according to the independent marine consultants, a 1- to 2-year disruption at some stage in the 4-year period should be anticipated.

Construction of temporary coffer dams, excavation of trenches, laying of the intake and outflow pipes followed by the deliberate collapse of the walls and burial of pipes will take place over a 4-year period.

As reported by the independent marine consultants, an area of 500m x 150m will be lost during the construction of the outflow system. Two intake pipes will extend from the shore out to a depth of about 25m, while up to ten outflow pipes will extend to about 400m from the intertidal zone. According to the independent marine consultants, an area of not more than $2500m^2$ will be lost during the construction of each of the intake structures (i.e. assuming a worst case of 50m x 50m for each of the two intake structures). Construction is expected to negatively impact squid through physical disturbance, smothering/loss of potential spawning area and egg beds, and increased turbidity.

Assessment: Severe disruption, but spatially localised and of short duration.

Response 12:

Your comment is noted and reflects the findings of the Nuclear-1 Marine Assessment.

Comment 13:

1.2 **Dumping of spoil (sediment from the excavation of the site) in the offshore zone- estimated to be of 143 days (5 months) duration**

Note: the SSWG was verbally notified by the consultants Arcus GIBB that although a number of options had been proposed and assessed in the report, disposal of the spoil at medium discharge rate at a deep site offshore was the most likely option to be implemented.

As the most severe of these options is the disposal of full volume this is the scenario which the SSWG considered and comments on. This scenario involves approximately 6.37 million m^3 of spoil being mixed with seawater to form slurry (sediment concentration of 15% by volume) that is then pumped at a rate of $3.5m^3/s$ to the offshore disposal site (5km offshore, water depth of about 84m) through three temporary marine pipelines (internal diameter: 0.5m) laid on the seabed, discharging at a rate of $2.06m^3/s$. Two aspects of the spoil disposal were identified by the independent marine consultants as potentially exerting profound negative impacts on the squid resource:

1.2.1 **Smothering of the seafloor resulting in destruction of egg beds and loss of spawning habitat**

Following disposal of the spoil, roughly 3m of sediment will cover an area of $3km^2$ around the discharge site. Subsequently, local water movement will result in a shifting of the spoil in a north-easterly direction towards Seal Point.

Within the first 5 years following disposal, the sediment is likely to spread to cover an area of approximately $8.3km^2$ with sediment to a mean depth of between 0.5 and 1cm (Figure 1). In the next 5 years the spoil is expected to continue to spread towards Seal Point (Figure 2), eventually covering approximately $0.01km^2$ of the small bay east of Seal Point in sediment 0.5-1cm thick. Sediments will not spread into St Francis Bay.

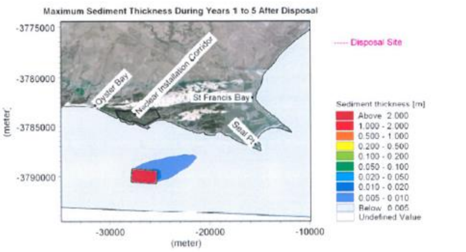

Figure 1: Maximum sediment thickness during years 1 to 5 after spoil disposal (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

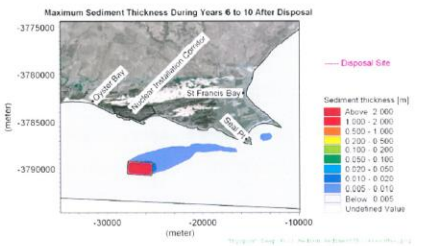

Figure 2: Maximum sediment thickness during years 6 to 10 after spoil disposal (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

The Marine Ecology Report does not specify the total areas that will be affected, but the results of the marine sediment disposal study indicate that for alternative 5 (full volume of spoil discharged at the offshore site at a depth of 8 *(sic)* m) the area impacted in the first 5 years after disposal will range from $2.6km^2$ covered to a depth of more than 1cm, to $11.1km^2$ covered to a depth of more than 0.5cm (see Table 19 in “Marine Sediment Disposal Report 27Nov09.doc”).

In years 6 to 10 after disposal, while the area covered in sediment of more than 1 cm in thickness will not increase, the area covered in more than 0.5cm of sediment will increase to $18.1km^2$.

It is likely that benthic communities that establish on the spoil will be dissimilar to those currently existing owing to the differences in sediment characteristics between the current consolidated sands and the loose sediments derived from the spoil.

1.2.2 **Increased turbidity and the suspension of fine sediment particles in the water column during discharge could influence squid spawning behaviour**

Maximum suspended sediment concentration is not expected to exceed 80mg/l near the sea surface at any time during or after disposal (Figure 3), and will be confined to an area of less than 1.4km^2 near the seafloor (Figure 4). Turbidity levels of this magnitude will also be temporarily limited outside the disposal site, occurring for a maximum of 2 days throughout the entire disposal period.

The possibility that re-suspension of fine particles during storms could result in more frequent and more intense turbidity events than is the norm at present is unlikely considering that the spoil comprises only 7.1% “fines” that will be rapidly dispersed out of the area.

Assessment: While squid will be locally affected, the limited spatial and temporal extent of the spoil dispersal and the elevated turbidity relative to the entire area in which the species spawns suggest that impacts will not be significant to the squid resource as a whole. However, limited information on paralarval dispersal and transport routes makes an adequate assessment of the impact on paralarval dispersal and transport routes makes an adequate assessment of the impact on paralarval survival difficult (sic). The inshore jig fishery is unlikely to be greatly affected as only a small proportion of the catches are taken in the area expected to be impacted.

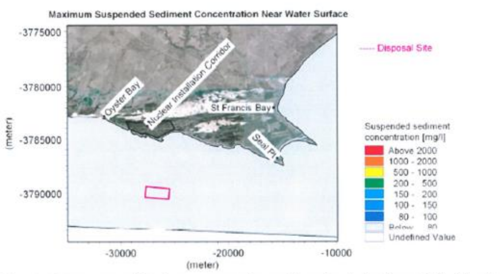

Figure 3: Maximum suspended sediment concentration near the surface during disposal of the full spoil volume (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

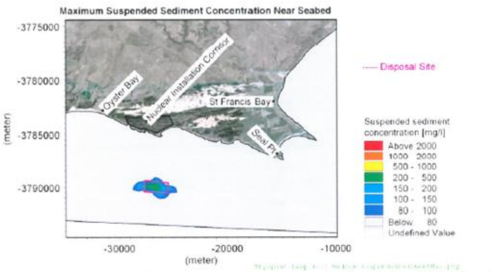

Figure 4: Maximum suspended sediment concentration near the seabed during disposal of the full spoil volume (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

<u>Response 13:</u>

Your comments reflect the findings of the EIA and are noted.

<u>Comment 14:</u>

2 **Abstraction of cooling water and subsequent entrainment of organisms- permanent**

Extraction of cold seawater from the marine environment (for cooling of the proposed plant) will occur at a slow rate (maximum of 1 m^3/s). A number of measures to minimise the fouling of the system by organisms (including continuous low-level chlorination of the intake water) will be implemented, and screens will be used to prevent the intake of larger marine organisms.

Assessment: No species of commercial value are likely to be affected by entrainment and ecological impacts are not anticipated to be important.

<u>Response 14:</u>

Your comments reflect the findings of the EIA and are noted.

<u>Comment 15:</u>

3 **Release of warmed cooling water containing low levels of chlorine at either a nearshore or offshore site- permanent**

The oceanographic models used to estimate the extent of warm-water release assumed a background (ambient) temperature of 19°C. Release of warmed cooling water will occur from multiple points above the seafloor to maximise mixing with cool surrounding water. A nearshore outflow will result in a mean increase of 3°C near the seafloor, limited in spatial extent to an area of roughly 0.2km^2 around the outflow (Figure 5). An area of 0.7km^2 will experience a maximum increase of 3°C or more at any time. Such temperature increases are predicted to be limited to depths shallower than 15m. Offshore release will result in to no temperature increase at the seafloor (Figure 6), while a mean increase of 3°C will affect an area of less than 2.5km^2 near the surface (Figure 7). Note that the offshore estimates were obtained assuming a 10 000-MW plant (i.e a plant more than double the size of the proposed Nuclear 1 plant). It is likely that the temperature effects of the proposed 4000-MW plant will be less than those described above.

Assessment: Squid will be impacted by the release of warmed cooling water. In the case of a nearshore outflow, adult squid are expected to avoid an area of about 0.2km^2, and a certain amount of egg mortality is to be expected. This area is, however, less than 1% of the coastal spawning area. In the case of an offshore flow, the impact will be marginally reduced (although the water column will experience elevated temperatures, the seafloor will not). It is likely that adults avoiding the warm-water plume will move to another spawning ground.

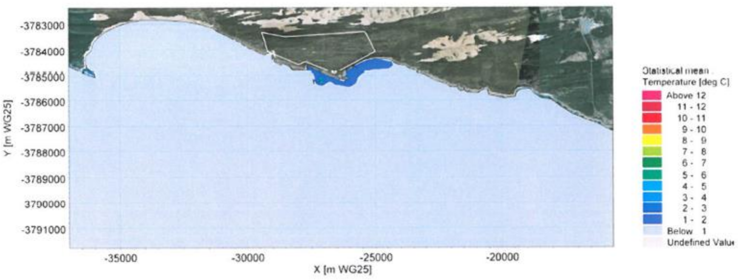

Figure 5: Mean temperature increase arising from the release of warmed cooling water from a nearshore piped outlet (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

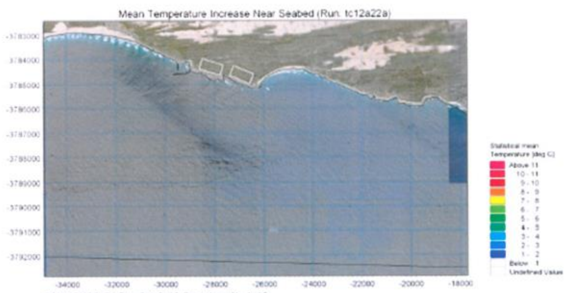

Figure 6: Mean temperature increase near the seabed arising from the release of warmed cooling water from an offshore piped outlet (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

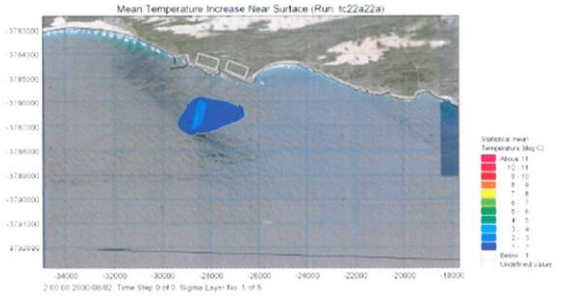

Figure 7: Mean temperature increase near the surface arising from the release of warmed cooling water from an offshore piped outlet (extracted from the presentation to the Squid Scientific Working Group by the independent marine consultants)

Response 15:

Your comments reflect the findings of the EIA and are noted.

Comment 16:

4 **Release of desalination effluent in the inshore zone- permanent**

Construction and normal operation of the proposed development will require access to freshwater. A portable desalination plant will be installed to provide for freshwater needs during the construction phase. This plant will use beach wells for the intake of seawater and will discharge the brine into the breaker zone to facilitate mixing. A permanent desalination plant will be constructed for use during the operational phase, from which the hypersaline effluent will be released together with the warmed cooling water in a ration of less than 99:1 (seawater: brine). The brine will consequently be diluted to undetectable levels prior to discharge into the marine environment.

Assessment: Not an issue during the operational phase owing to dilution of the desalination effluent prior to release. Release into the surf zone during construction will minimise the impact, which is unlikely to influence squid.

Response 16:

Your comments reflect the findings of the EIA and are noted.

Comment 17:

5 **Radiation emissions- permanent**

The most likely source of radiological release into the marine environment is through the release of contaminated cooling water. Such releases are, however, controlled by the National Nuclear Regulator and previous experience at Koeberg Power Station has demonstrated that such radioactive contamination is very unlikely.

Assessment: Such an even may impact the marine environment. Mortalities are expected to be limited to the general area of the plant, but mobile species exposed to low/intermediate radiation levels can move great distances and pose a threat to public health if consumed. It is vital that radionuclide levels in marine species (squid in particular) be monitored.

Response 17:

Your comments reflect the findings of the EIA and are noted. Monitoring of radiation levels in marine biota before the construction phase (to establish the baseline) and into the operation phase is a requirement of the Nuclear-1 Environmental Management Programme. For further information on the Radiological impacts of the power station please refer to Appendix E32 of the RDEIR Version 2.

<u>Comment 18:</u>

6 **Closure of the site to exploitation- permanent**

The safety zone is planned to cover an area of 800m around the power station, extending 1km out to sea. All fishing activities will be excluded from the safety zone.

Assessment: The exclusion zone is not expected to significantly impact the squid fishery owing to its small size relative to the overall fishing grounds.

<u>Response 18:</u>

Your comment reflects the findings of the EIA and is noted.

<u>Comment 19:</u>

7 **Release of sewage effluent- permanent**

During both construction and operational phases, a sewage waste-water treatment plant will treat a maximum of $1000m^3$ per day on site. The effluent, if discharged via the cooling water outflow tunnels, will meet the required national standards for water quality in coastal marine waters.

Assessment: No impact on the marine environment.

<u>Response 19:</u>

Your comment reflects the findings of the EIA and is noted.

<u>Comment 20:</u>

8 **Unintentional discharge of polluted groundwater- permanent**

During the construction and operational phases, potential pollution of groundwater and subsequent contamination of the marine environment may originate from leaks and spillages from both on-site sanitation facilities as well as from fuel, oil and grease storage facilities.

Assessment: Impacts of both organic and inorganic pollution through discharge of contaminated groundwater can be dire, but the exposed nature of coastline with resultant nearshore mixing will facilitate the dilution and dissipation of any contaminants.

<u>Response 20:</u>

Your comment reflects the findings of the EIA and is noted.

<u>Comment 21:</u>

9 **Impacts of the environment on the proposed development plans- permanent**

Not relevant to squid.

<u>Response 21:</u>

Your comment is noted.

Comment 22:

The construction of the intake and outflow systems clearly represents a major disruption to the marine environment, including squid. Adult squid will avoid the area and will probably not engage in spawning activities in the area during construction. Existing squid egg beds will be destroyed, and it is possible that they will not be re-established once construction is completed.

The SSWG agrees that the independent marine consultants that this impact is of limited spatial extent (0.075km^2) and can be considered to be negligible in comparison with the overall area available to squid for spawning (estimated to be about 90km^2-see below).

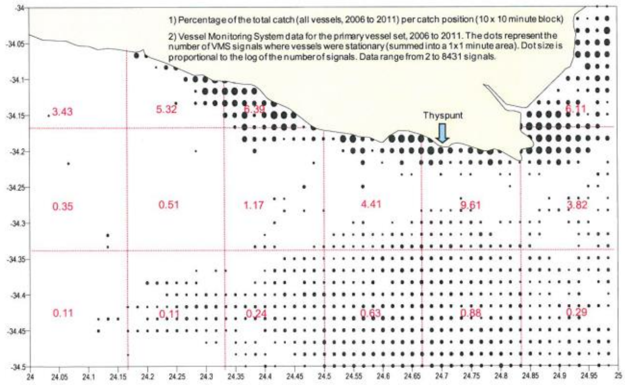

Figure 8: Average squid catches per fishing block (expressed as a proportion of the total catch) and squid fishing vessel presence (computed from VMS data) over the period 2006 - 2011

Response 22:

Your comments reflect the findings of the EIA and are noted.

Comment 23:

The exclusion of fishing from the safety zone represents a loss of fishing area of 0.8km^2. This can only be considered to be negligible in terms of the entire area in which squid fishing occurs.

The SSWG agrees with the conclusion that closure of the safety zone to exploitation reflects a negligible area lost to the squid fishery.

Response 23:

Your comment reflects the findings of the EIA and is noted.

Comment 24:

The fishing block immediately adjacent to the Thyspunt site yields on average 9.61% of the total squid catch (Figure 8). Vessel Monitoring System (VMS) data indicate that squid vessels spend most of their stationary time (presumably the time spent fishing) relatively close to the coast (Figure 8). The average catches calculated for each fishing block may therefore not reflect an accurate perception of the potential impacts of the Nuclear 1 development on the squid fishery in terms of lost catch.

The squid fishing industry (SASMIA) is advised to collect the required high-resolution information on spatial distribution of catches, which would enable it to provide a more accurate assessment on the magnitude of the catches that may be impacted by Nuclear 1.

Response 24:

Your comment is noted and will be forwarded to SASMIA.

Comment 25:

It is possible that long-term effects in terms of changes in squid migration patterns and spawning behaviour may arise from the disruptions/alterations to the substrate (seafloor) and water temperature regime (i.e. impacts that extend beyond the spatial and temporal limits if the disruptions). However, there is little or no information to properly assess this and the SSWG cannot provide comment on the likelihood of such changes in the squid population, or the implications for the resource of the fishery.

The squid fishing industry (SASMIA) should enter into dialogue with Eskom on this possibility and broker a compensation agreement that clearly specifies the criteria on which the extent of the impact of Nuclear 1 on squid fishing operations is measured. These criteria should include presence-absence of main fishable concentrations in the vicinity of the Thyspunt site, i.e Aasvogels, Oysters Bay, Seals Bay and Kromme. These concentrations were a constant feature of the squid jig fishery since its inception.

Response 25:

Your comment is noted.

Comment 26:

The SSWG agrees with the conclusion that the abstraction of cooling water and the release of desalination plant effluent are unlikely to impact on the squid resource or the fishery.

Response 26:

Your comment reflects the findings of the EIA and is noted.

Comment 27:

The issues of radiation contamination, release of sewage effluent and polluted groundwater, while representing potentially major threats to the marine environment, are adequately discussed in the Marine Ecology Report and were not considered further by the SSWG. It should be noted, however, that perceptions of the international squid market should be taken into consideration. The SSWG cannot provide specific advice on this aspect and suggests that this should rather be researched by the squid industry itself.

Response 27:

Your comment is noted.

Comment 28:

Of primary concern are the short-, medium- and long-term impacts on the squid resource and fishery arising from the disposal of the spoil during the construction phase, and the continuous release of warmed cooling water during the operational phase.

Response 28:

Your comment is noted. Both these potential sources of impact have been assessed in the Nuclear-1 EIA and in particular, in the Marine Ecology Assessment (Appendix E15 of the Revised Draft EIR).

Comment 29:

Disposal of the spoil will smother the seabed in loose sediment, destroying existing egg beds and potentially resulting in the long-term loss of spawning habitat. Adult squid may consequently avoid this area during spawning, with no spawning aggregations forming in the impacted area.

Response 29:

Your comment reflects the findings of the EIA and is noted.

Comment 30:

Elevated turbidity levels will result in increased mortality of squid paralarvae passing through the impacted area owing to numerous physiological constraints such as impaired movement and respiration, but also starvation due to inability to catch prey. Published information suggests that paralarvae will not survive in dirty water saturated with suspended particles.

Response 30:

Your comment reflects the findings of the EIA and is noted.

Comment 31:

Elevated water temperatures may increase mortality of paralarvae owing to metabolic effects.

Response 31:

Your comment reflects the findings of the EIA and is noted.

Comment 32:

Adult squid will avoid turbid water as a result of decreased vision.

Response 32:

Your comment reflects the findings of the EIA and is noted.

Comment 33:

The SSWG wishes to emphasise that the impacts of spoil disposal and warmed cooling water release on squid spawning and recruitment cannot be taken lightly, even in view of the relatively short duration of spoil disposal. *Loligo reynaudi* is a relatively short-lived species, most individuals in the population completing their entire life history in about a year. As such, the entire population of the species is based on the successful recruitment of a single year class. Significant increases in the mortality of the paralarvae and juveniles over a short period of time may seriously impact on recruitment and therefore the population as a whole.

Response 33:

Your comment is noted.

Comment 34:

In view of these observations, the SSWG felt that further investigation was required. In considering the impacts of the disposal of the spoil (in terms of both the substrate and turbidity) during the early construction phase and the long-term release of warmed cooling water, the SSWG adopted a spatial comparison approach based on "worst-case" scenarios in an attempt to bound each problem (i.e. establish whether the spatial extent of a specific impact would be negligible or non-negligible relative to the overall habitat available to squid):

Problem

Impacts of the disposal of spoil on spawning habitat (specifically the seafloor)

"Worst-case" scenario

The area covered by the spoil to a depth of 0.5cm or more (including the area impacted by spoil shift over time) represents a long-term loss of squid spawning habitat. Adult squid will not form spawning aggregations over this area and will not deposit egg capsules in the affected area.

Problem
Impacts of elevated turbidity levels.

"Worst-case" scenario
The area of elevated turbidity represents a 100% mortality zone for paralarvae. Adult squid will avoid the affected area for both feeding and spawning.

Problem

Impacts of elevated water temperatures.

"Worst-case" scenario

The area of elevated temperature represents a 100% mortality zone for paralarvae. Adult squid will avoid the affected area for both feeding and spawning.

There were some reservations regarding the estimates of the spatial extent of elevated turbidity levels that were generated by the hydrographic models. These models considered turbidity levels in excess of 80mg/l. This is the value indicated by the marine ecology specialist above which biological impacts can be anticipated. The SSWG is of the opinion that paralarval mortalities may result from turbidity levels substantially lower than this value, and recommended an investigation based on turbidity levels of 20, 40 and 60mg/l. The Marine Sediment Disposal Report indicates that background suspended sediment concentrations (measured in water depths of 5 to 30m) average 5mg/l with a maximum of 29 mg/l.

Response 34:

Your comments are noted and are addressed in response 35 below

Comment 35:

Spatial components against which the extent of the "worst-case" Nuclear 1 impacts were compared:

a) **Area of known spawning sites/egg beds:** Squid spawning habitat is defined as an area over which squid form an aggregation, engage in reproductive behaviour and then deposit egg capsules. This includes the area within which adult squid move at night when spawning activity ceases. Each patch of squid spawning habitat (i.e. spawning site) is assumed to be about 1km^2 in extent, therefore it is important to note that some inshore sites overlap. Thirty nine sites were identified in shallower water between the Tsitsikamma River and Algoa Bay (Sauer et al., 1992) with eight of these possibly impacted, representing 20.5% of the total recorded.

b) **Transport patterns of squid paralarvae from spawning site to nursery areas:** This was modelled using an Individual Based Model (IBM) linked to a hydrographic model employing simple Lagrangian particle transport dynamics. The approach was to simulate the "release" (hatching) of paralarvae from squid egg beds and monitor their transport over time. The proportion of the paralarvae passing through the elevated turbidity and temperature plumes relative to the entire "population" of paralarvae was computed; this proportion assumed to reflect the total mortality arising from the Nuclear 1 impacts.

Two elevated-turbidity and three elevated-temperature scenarios resulting in paralarval mortality were considered:

- Plumes of elevated turbidity (>20mg/l) resulting from disposal of either the full spoil volume (mortality zone D in Figure 9) or half of the spoil volume (mortality zone E Figure 9).
- Plumes of water temperature that were on average 2°C (mortality zone A in Figure 9), 3°C (zone B) or 4°C (zone C) warmer.

Within the model, "paralarvae" were released from 6 release zones (Figure 9) and their transport was driven by the hydrodynamic model, incorporating diel vertical migration effects.

Paralarvae were considered to have died if advected off the shelf ("Agulhas Bank Mortality Zone" in Figure 9) when older than 4 days (to account for yolk-sac depletion), or if they came into contact with the elevated temperature and turbidity plumes. A number of simulations were run for each scenario in order to measure the variance associated with mortality estimates.

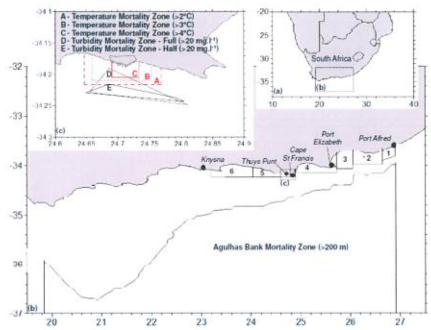

Figure 9: The 6 "paralarvae" release zones and the "mortality" zones used during the IBM model of paralarval transport.

RESULTS AND CONCLUSIONS

1 Impacts of spoil disposal and subsequent movement over time:

The sediment characteristics of the spoil have been described in the Marine Sediment Disposal Report, and were found to fall within the range of the naturally occurring sediments. It should be noted, however, that the samples of naturally occurring sediments, which were used for this comparison, were collected from water depths between 10 and 30m, considerably shallower than the depth of the proposed offshore disposal site (84m). An additional factor to consider is that the naturally occurring sediments are consolidated, whereas the spoil will comprise loose sediments.

The SSWG consequently assumed that the differences between the disposed spoil and the naturally occurring sediments would reflect a permanent loss of spawning habitat.

Assuming the “worst-case” scenario, a total area of 18.1km^2 would be lost as squid spawning habitat over a 10-year period subsequent to spoil disposal. This represents 20.5% of the total nearshore spawning sites recorded between the Tsitsikamma River and Algoa Bay.

***The SSWG is consequently of the opinion that the disposal and subsequent shift of spoil may result in an appreciable impact on squid in terms of spawning habitat*.**

2 Impacts of elevated temperature and turbidity levels:

The results of the simulation are provided in Table 1 below.

Table 1: The average percentage of paralarvae released from each of the release zones (1-6) that were killed in the various mortality zones (A-E)

Release zone	Agulhas Bank advection	A Temp > 2 °C	B Temp > 3 °C	C Temp > 4 °C	D Turbidity full	E Turbidity half
1	54.62 ± 9.19	0.25 ± 0.06	0.20 ± 0.03	0.09 ± 0.04	0.72 ± 0.13	0.39 ± 0.07
2	23.44 ± 5.47	0.92 ± 0.17	0.46 ± 0.15	0.20 ± 0.07	0.94 ± 0.30	0.73 ± 0.25
3	0.24 ± 0.16	0.59 ± 0.15	0.61 ± 0.28	0.34 ± 0.10	1.47 ± 0.37	1.38 ± 1.39
4	0.24 ± 0.10	2.71 ± 0.44	1.95 ± 1.31	1.00 ± 0.22	3.94 ± 1.03	3.14 ± 0.84
5	0	19.64 ± 4.77	14.50 ± 8.95	6.60 ± 2.63	14.26 ± 4.68	10.72 ± 3.75
6	0	0	0	0	0	0
TOTAL	**5.95**	**5.28**	**3.88**	**1.80**	**4.47**	**3.42**

The results indicate that 5.95% of all paralarvae that hatched from nearshore spawning sites will be advected off the shelf area and die. In terms of Nuclear 1 impacts:

- Assuming that paralarvae entering a plume of released cooling water that is 2°C or more warmer than ambient will die, 5.28% of all hatched paralarvae will die as a result of the release of warmed cooling water by Nuclear 1. This percentage decreases to 3.88% if mortality only results from water 3°C warmer than ambient, and to 1.80% if mortality only results from water that is 4°C warmer than ambient.
- If only half of the spoil volume is released offshore, the resulting plume of turbid water will lead to a mortality of 3.42% of all paralarvae that hatched from nearshore spawning sites. This percentage increases to 4.47% if the full volume of spoil is released offshore.

Response 35:

Your comments are noted and reflect the findings of the Nuclear-1 Marine Assessment.

It is recommended to place spoil at a deep site and thereby avoid shallow spawning sites as much as possible. However, the spread of spoil that takes place after disposal will take the sediment into shallower areas and impact on some spawning habitat. This is unavoidable and current-driven. However, the impact of spoil disposal at a deep offshore site would still be much lower than disposal at a shallow site.

Comment 36:

The SSWG considers that the mortality of paralarvae arising from the plume of turbid water resulting from the release of the spoil is negligible. Even in the “worst-case” scenario of the release of the full volume of spoil, only about 5% of all hatched paralarvae will encounter the plume of turbid water and die. If the disposal can be conducted during the winter months when squid spawning is at a minimum, the impacts of this component on squid recruitment will be even further reduced.

Response 36:

Your comment is noted and reflects the findings of the Nuclear-1 Marine Assessment..

Comment 37:

The SSWG considers that the mortality of paralarvae arising from the plume of warmed cooling water is negligible. Even the “”worst-case” scenario where water warmed to only 2°C above ambient will *result in 100% mortality of paralarvae entering the plume, only 5.28% of all hatched paralarvae will be impacted. Even though the warmed cooling water will be a permanent source of paralarval mortality, the low level of this impact can only be considered to be negligible in terms of squid recruitment.*

Response 37:

Your comment is noted.

Yours faithfully
for GIBB (Pty) Ltd

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The Nuclear-1 EIA Team