05 August 2015

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Our Ref: J27035/ J31314

Your Ref: Email received 08 August 2011

Thyspunt Alliance
St Francis Bay Resident's Association
St Francis Kromme Trust

Dear Mr Thorpe, Thyspunt Alliance and its members, the St Francis Bay Resident's Association and the St Francis Kromme Trust

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

Comment 1:

THYSPUNT ALLIANCE NUCLEAR 1

REPSONSE TO SECOND DRAFT ENVIRONMENTAL IMPACT REPORT

THE COOLING SYSTEM CIRCULATING WATER CIRCUIT

CHAPTER 3, SECTION 3.6.1 & APPENDIX E 16, SECTION 1.3.1

Response compiled by H. Thorpe and submitted on behalf of the St Francis Bay Residents' Association, the St Francis Kromme Trust and the Thyspunt Alliance

1. **The Fukushima Factor**

   The Fukushima accident has highlighted the critical importance of the cooling system for all current forms of nuclear reactor, including Pressurized Water Reactors. Failure of the cooling system at Fukushima has led to tragic devastation of surrounding land, resulting in the possibly permanent evacuation of large numbers of people, with massive disruption in normal life, huge economic losses and trauma to those involved. This is an environmental & social disaster of major proportions

   In the case of Fukushima, the primary cause was the tsunami, which exceeded all expectations. This may not appear to be a major consideration at Thyspunt, although it does raise the question as to whether risk assessment has been too lenient in general. Be that as it may, the accident has emphasized the importance of this component of the project. Unless it can be demonstrated that the cooling system is guaranteed to function flawlessly for the entire life of the plant, any NPS must be regarded as a flawed undertaking.

   Questions
   1. Is it accepted that the Fukushima accident was caused by failure of the cooling system?
   2. Are modern PWRs susceptible to the same risk?
   3. What would happen to a modern PWR in the event of failure of the cooling system?
   4. Can it be shown beyond all reasonable doubt that the containment building would contain any conceivable radiation arising from failure of the cooling system?

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5. Can it be accepted that flawless functioning of the cooling system has to be guaranteed for the lifetime of the plant?

Response 1:

1. All nuclear power stations have backup systems to drive the cooling system. The primary reason for the Fukushima Daiichi accident was that the pumps that operated the cooling system, as well all power supply to these pumps (offsite power and backup generators that provided power to the pumps) were incapacitated by the Tsunami. Resultantly, cooling water could no longer be pumped into the reactor (for a more detailed discussion please see Appendix 32 and 33 of the Revised Draft EIR Version 2).
2. The Fukushima Daiichi reactors were all Generation II reactors and were not designed for passive cooling of the core as a means of preventing overheating if all electrical power is lost. Generation III reactors are significantly safer than the units involved in the Fukushima Daiichi disaster. Rather than relying on engineered safeguards requiring electrical power, Generation III designs make use of mechanical systems to ensure continued cooling and require no electrical power. For instance, some of these systems make use of gravity to drains water from a tank into the reactor. Thus, the possibility of a similar outcome to the Fukushima accident due to loss of power to the cooling system is eliminated in a Generation III nuclear power station (for a more detailed discussion please see Appendix 32 and 33 of the Revised Draft EIR Version 2).
3. As indicated in 2 above, the passive cooling system would ensure safe cooling of the reactor after shutdown.
4. Nuclear power plants are licensed in accordance with strict licensing criteria stipulated by the South African National Nuclear Regulator (NNR). These criteria align with international standards such as those issued by the US NRC and the IAEA. The design and licensing of the containment structure will be in accordance with these criteria through the NNR.
5. Continued functioning of the cooling system is necessary for any thermal power plant, whether the power generated by nuclear reaction or by the burning of coal. Should the cooling system fail, a Generation III power station is designed to shut down safely whilst the passive cooling system continues to operate.

ADDITIONAL COMMENTS FROM INDEPENDENT NUCLEAR SPECIALIST

Agreed - in addition both the initiating event scenarios, frequency and reactor design will all be different making direct comparisons potentially misleading - however lessons learned from the Fukushima event have been applied by the industry in order to identify reasonably practicable design modification in the beyond design basis region assessment of which will form part of the safety case assessment and licensing process by the NNR.

Comment 2:

2. **Defence in depth**

Much is made in Eskom's publicity of the concept of defence in depth. This, of course, failed at Fukushima. Eskom's proposal for the intake of cooling water is described in section 3.11.1 of the Project description (Ch 3)

3.11.1 Intake tunnels

An undersea intake tunnel will draw cooling water from the sea into the cooling water intake basin adjacent to the cooling water pump houses. No detailed design for the intake tunnel(s) has been done, but the design will comply with the requirements of the relevant specialist recommendations, so as to minimise the impact on marine ecosystems and sediment movement. The following basic principles will, however, apply. The construction of the intake tunnel(s) will involve sinking of a shaft on land to a depth of approximately 65 m below mean sea level. At this point the tunnel will be driven seawards underneath the seabed. The tunnels will be lined with precast or in-situ poured concrete. At the other end of the tunnel, a tower extending approximately 5 m to 10 m above the sea bed floor will be constructed to connect the intake structure and the tunnel.

Fixed dredging may need to be installed at the base of this tower. The length of the tunnel from the onshore access shaft will be approximately 1 km to 2 km **and the depth of water in which the intake structure will be constructed is limited to 30 m.**

“A more detailed description is given in section 1.3.1.3 on pages 4 – 5 of App E 16 Oceanographic Study”

Questions

1. It is not clear how many tunnels are proposed. If it is to be only one, with one tower above the sea bed, can this legitimately be described as “defence in depth”?
2. What would happen if a blockage were to occur at the tunnel entrance?
3. Would Eskom be able to guarantee that this would not occur during the lifetime of the plant?
4. If not, would Eskom accept that this is a fatal flaw in the whole design concept?
5. In view of the evidence of major seismic activity across the globe, including a recent tremor at Plettenberg Bay, will any allowance be made for possible earth movement, and what impact could this have on concrete pipelines?

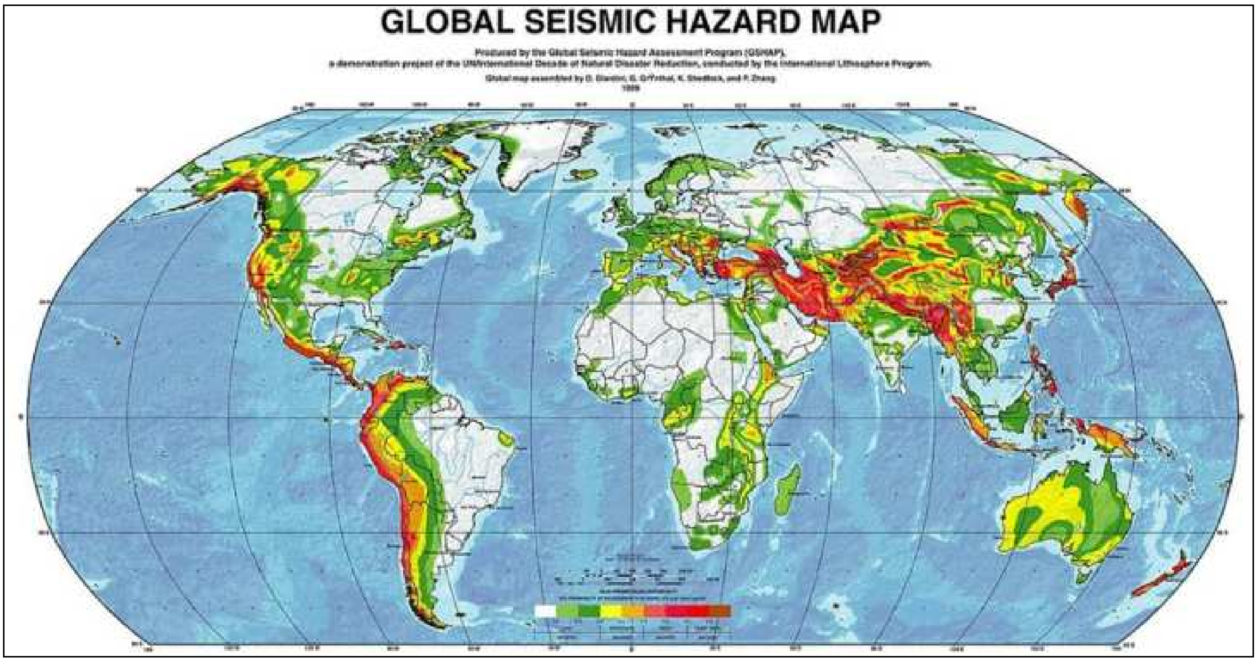
Response 2:

1. As indicated in the Consistent Dataset (Appendix of the Revised Draft EIR), there will be either one or two tunnels with a diameter of 5 to 10 m each.
2. It is highly unlikely that any object in the sea would be large enough to cause a complete blockage of the intake. The intake will be designed to prevent the update of sediment from the seafloor and will have screens to prevent the intake of large marine organisms such as kelp, fish and jellyfish. Smaller organisms will have no impact on the operation of the system. This type of system has been in use at Koeberg Nuclear Power Station and at countless other nuclear power stations around the world without incident.
3. The possibility of a complete blockage of the cooling water intake tunnel, given the precautions indicated above, is negligible. It should also be noted that the sea will not represent the ultimate heat sink and alternate cooling systems will be provided to remove heat from safety systems in the event of a blockage to the CW intake. The alternate cooling systems will be sized to safely remove the residual heat generated and will be designed to survive beyond design basis hazards. Nuclear safety demands the use of diverse, redundant and independent safety systems.
4. The operation of similar cooling systems across the world has never resulted in any incident. Thus it is not regarded as a fatal flaw.
5. Of the three alternative sites, Thyspunt was found to present the lowest seismic risk. The earth tremor that was felt in the in Southern Cape on 14 May 2011 measured 4.3 on the Richter Scale. This is far below the design threshold at which a nuclear power station would be damaged. A nuclear power station designed for peak ground acceleration of 0.3g can withstand an earthquake of approximately 7 on the Richter Scalein the near field. In this respect, it must be remembered that the Richter Scale is a logarithmic scale, This implies that an earthquake with a magnitude of 7 is 1000 times more intense than one measuring 4 on the Richter Scale.

South Africa is seismically relatively stable, compared especially to Japan, which is situated on a major seismic subduction zone, where continental plates collide. The figure below illustrates the relatively low seismic risk is South Africa, compared to high risk zones such as the western coastlines of South America and North America, the Asia-Pacific Rim, most of South-Central Asia and the Middle East.

The worldwide, large seismic events referred to correspond to tectonic movements at plate boundaries. No such plate boundaries exist in South Africa.
As the design basis seismic event for the Nuclear power plant represents one of the major load cases to be considered, seismic movement will be considered in all safety related structures. It should be noted that seismic movement corresponds to vibratory ground motion.

Lined tunnels and buried pipelines will accommodate seismic displacements along their length. As they are below ground structures they are not subject to the amplification effects experienced by buildings and as such are relatively robust against earthquakes.



Comment 3:

3. **Detailed design**

It is disturbing to note the acknowledgement in the section quoted that the detailed design for the intake tunnels has still not been done.

Questions

1. Will this detailed design be done prior to an application to the DEA for an ROD, or to the NNR for a license? If not, why not?
2. Does such an installation not require a separate EIA?
3. Will the tender specifications include flawless functioning and seismic protection?

4. What will happen if the consultants engaged to do the detailed design are unable to guarantee flawless functioning throughout the life of the plant?
5. How will “defence in depth” be possible on this design?
6. What are the cost estimates for this structure? Have these costs been included in the economic assessment on the relative costs of the three sites? (See attached Appendix on costing by Dr Mike Roberts)

Response 3:

1. The detailed design for the intake tunnels will not be done for EIA process. However, detailed designs are required for the NNR process. The current conceptual designs for the intake tunnels were regarded as sufficient to assess the environmental impacts, based on the marine specialist team’s experience with monitoring of marine impacts at Koeberg Nuclear Power Station.
2. There is a large number of listed activities that have been applied for in the Nuclear-1 EIA, of which the intake tunnels is one. No separate EIA is required. Many EIAs for large scale infrastructure include a number of different listed activities.
3. Eskom will develop performance specifications for the CW intake tunnels and design requirements which take into account the hazards relevant to the site. The design requirements also account for the safety classification of the structures under consideration as well as South African and international Nuclear regulatory requirements. Both the local and international requirements and regulations will ensure the nuclear safety of the power plant operation.
4. The consultants / contractors engaged will be required to design a system which complies with the performance specifications, design requirements and nuclear regulations contained in the design brief. The CW system however, is backed up by alternate cooling systems which are designed to cool all safety related components independently.
5. Defence in Depth may be provided by 2 tunnels instead of one (redundancy), the use of an alternate cooling system for safety systems (diversity) which uses an independent source of water (independence).
6. Costs for the intake tunnels, including the tunneling and moving of spoil, have been included in the cost estimate.

Comment 4:

4. **Appendix**

   “An Estimate of the cost of the intake tunnels for the Thyspunt nuclear site” by Dr Michael Kinroe Charles Roberts is attached. His CV is given on p. 2. He is a recognized authority on tunneling.

1 AN ESTIMATE OF THE COST OF THE INTAKE TUNNELS FOR THE THYSPUNT NUCLEAR REACTOR.

Dr Michael Kilroe Charles Roberts 27/07/2011
Attached as Appendix 1 are excerpts from the document “Revised DEIR Chapter 3 Project description.pdf”, page 19. Namely section 3.11.1 and section 3.11.2 dealing with both the intake tunnels and the outfall tunnels.

1.1 Introduction

An estimate of the cost of the intake tunnels will be approximate in that costs will be estimated at a concept level.

1.2 The intake tunnels

An indication of the volume of water that would be required to report to the reactors via the intake tunnels is given by the statement in Appendix 1 namely section 3.11.2 “It is estimated that **six pipelines of** approximately 3 m diameter will be required for the outfall.” This means that the sum of the cross area sections of the intake tunnels would be required to be 42m^2.

As a rough check, Koeberg draws in 80 tons of water per second for cooling purpose. A tunnel or tunnels whose cross sectional sum is 42m^2 will require water to move at a velocity of 2 m/s thus providing 80 tons of water per second to the reactors. These numbers look reasonable.

In order to get 42 m^2 of cross sectional tunnels there are a number of permutations some of which are shown below:

- One rectangular tunnel of dimensions of 6.5 m by 6.5 m, drill and blast, end might be too big for conventional drill and blast.
- Two rectangular tunnels of dimensions of 4.6 m by 4.6 m, drill and blast.
- One circular tunnel with a 7.5 m diameter excavated by tunnel borer.

Each one of these options would have their own costs for excavation complicated by the requirement that the tunnel/s will be required to be lined.

Response 4:

Dr Roberts’ quote above “*It is estimated that **six pipelines of** approximately 3 m diameter will be required for the outfall*” refers to the outfall tunnels, not to the intake tunnel. Please refer to the Intake / Outfall Structure section of the Consistent Dataset (Appendix C of the Revised Draft EIR) and to Chapter 3 of the Revised Draft EIR for a description of the marine intake and outfall tunnels.

Furthermore dependent on the rock conditions, the tunnel lining may comprise elements of the following. It should be noted that there are intake tunnels around the world which are left unlined as they are formed in very favourable rock:

- Grouting ahead of the tunnel face where water ingress is considered to be a hazard
- Barring and Removal of loose rock after blasting
- Local rock support by means of rock bolting
- Shotcreting where needed by the rock conditions to ensure temporary support
- Grouting into the rock to block off local water ingress
- Erection of rebar for the tunnel lining around the tunnel circumference
- Erection of formwork
- Casting of the concrete
- Removal of the formwork once the concrete has gained sufficient strength
- Additional consolidation and contact grouting where required.

Comment 5:

1.3 Costs

1.3.1 Establishing the infrastructure

In order to access the intact rock at some depth below surface an 8 m diameter shaft will be required to be sunk. This shaft will give access to the development faces as the intact tunnel/s are developed. Once the intake tunnel/s are developed the shaft will itself be part of the intake as it is here that the water (enclosed in a pipeline) will emerge on surface on its way to the reactors. There will be two cost components namely the pre-sink civils to about 30 m and the sink to an estimated depth of 80 m to intact rock.

- Pre- sink civils - **R 50** million
- Sink to 80 m - **R 40** million (R0.8 million/m)

1.3.2 Developing the tunnel/s

It is assumed that the tunnel/s will be developed for 1500 m to a point where the depth of the ocean is 30 m. A cost per ton of R 2000 will be used and included in this cost is the cost of the lining.

- The number of cubic metres to be developed is 1500 m * 42 m^2 = 63000 m^3
- This represents 63000 m^3 * 2.7 = 173200 tons
- At R 2000 a ton the tunnel/s excavation and lining costs are
- R 2000 * 173200 = R 346500000 rounded off to **R 347** million

1.3.3 Intake tower on sea bed

This tower will stand about 10 m above the sea bed. Estimated cost **R 30** million

1.3.4 Geotechnical drilling

This will be required in order to geotechnically classify the rock that will be traversed and will have to be done from vessels at sea. Estimated cost **R 10** million

1.4 Total cost of the intake tunnels and related infrastructure.

Summing the rand values in bold comes to a value of **R 477** Million

Response 5:

The project amount can only be confirmed upon design evaluations. Any figures at this stage are estimated amounts. However, Eskom will ensure that the envisaged project costs are not exceeded by ensuring that the specifications and designs are robust.

2 CV DR. MICHAEL KILROE CHARLES ROBERTS

Dr Roberts has a PhD in mining engineering from the University of the Witwatersrand, an MSc in structural geology and rock mechanics from Imperial College London. He is a certificated rock engineering practitioner and consultant on hard rock underground mines with 34 years of experience. He was a C2 NRF rated researcher with a record of 54 publications as author or co-author in technical journals. He is a Professional Natural Scientist PrSci Nat Registration number 400117/96.

3 APPENDIX 1

3.1 Excerpt from file: Revised DEIR (Version 1) Chapter 3 Project description.pdf, page 19

3.11.1 Intake tunnels

An undersea intake tunnel will **draw** cooling water from the sea into **the cooling water** intake basin adjacent to the cooling water pump houses. No detailed design for the intake tunnel(s) has been done, but the design will comply with the requirements of the relevant specialist recommendations, so as to minimise the impact on marine ecosystems and sediment movement. The following basic principles will, however, apply. The construction of the intake tunnel(s) will involve sinking of a shaft on land to a depth of **approximately 65** m below mean sea level. At this point the tunnel will be driven seawards underneath the seabed. The tunnels will be lined with precast or in-situ poured concrete. At the other end of the tunnel, a tower extending approximately **5 m to 10 m** above the sea bed floor will be constructed to connect the intake **structure** and the tunnel. Fixed dredging may need to be installed at the base of this tower. The length of the tunnel from the onshore access shaft will be approximately 1 km to 2 km **and the depth of water in which the intake structure will be constructed is limited to 30 m.**

3.11.2 Outfall tunnels

The outfall **pipelines/tunnels** dispose the seawater used to cool the **turbo-generators and other smaller heat exchangers as well as** diluted chemical effluent into the ocean. It is estimated that **six pipelines of** approximately 3 m diameter will be required for the outfall works. The marine biologist recommends the use of multiple **discharge** points in order to facilitate dispersion of the warmed water and mixing with the relatively cooler sea water. The objective of the outfall works will be to transfer the heated water at least beyond the surf zone (estimated to be in the order of 500 m to a depth of **5 m** below mean sea level). The final depth and distance of release of the heated water will be determined by the **results** of the marine specialist study. The water released into the ocean will be 12 °C warmer than the seawater, as a result of the heat absorbed from the process. The primary objective is to ensure that the heated water **has minimal** impact on sea life. The velocity of the water in the pipes will fast enough to ensure adequate dispersion into the sea. A high velocity of the expelled water ensures an adequate rate of mixing with the sea water, which reduces thermal pollution of the benthic environment.

Yours faithfully
for GIBB (Pty) Ltd

The Nuclear-1 EIA Team