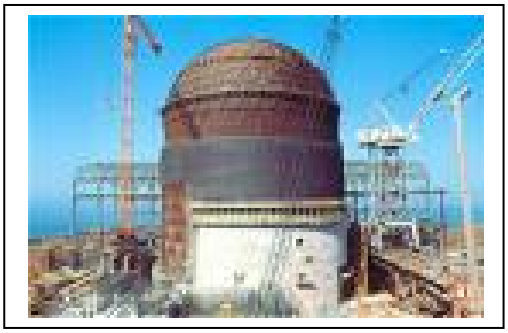
Eskom Holdings Limited

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR 1') AND ASSOCIATED INFRASTRUCTURE



Emergency Response Assessment Study

December 2009

EXECUTIVE SUMMARY

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Emergency Response and was carried out by Mogwera Khoathane/SRK Consulting.

This assessment aims to demonstrate the emergency planning feasibility within the study area. Emergency Planning Assessments provide decision makers with information that will guide their decision on final site choice.

Emergency preparedness in the context of an NPS can be defined as the measures that enable individuals and organisations to stage a rapid and effective emergency response in the context of nuclear emergencies. Protective actions include measures to limit the exposure of the public to radioactive contamination through external exposure, inhalation and ingestion. The objectives of these actions are to prevent deterministic effects (early mortality) and to reduce stochastic effects (principally cancer) as much as is reasonably practicable.

For nuclear emergencies, two sets of requirements have to be fulfilled.

- Functional (response) requirements; and
- Infrastructure (preparedness) requirements

Functional response requirements refer to the “capability” to perform an activity. The “capability” includes having in place the necessary authority and responsibility, organisation, personnel, procedures, facilities, equipment and training to effectively perform the task or function when needed during an emergency.

The “capability” includes having in place the necessary authority and responsibility, organization, personnel, procedures, facilities, equipment and training to perform the task or function when needed during an emergency. In this context, infrastructure means transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site.

In demonstrating the feasibility of the emergency plan, many site related factors should be taken into account. The most important factors are:

- Population density and distribution, distances from population centres, groups of population difficult to shelter or to evacuate in the event of an emergency;
- Special geographical features, such as islands, mountains terrains, rivers, capabilities of local transport and communication network;
- Agricultural activities that are sensitive to possible discharges of radionuclides, and
- Disastrous external events or foreseeable natural phenomena.

The key findings and recommendations of this Emergency Response study can be summarised as follows:

a. Infrastructure Considerations

- The current Duynefontein Site is in proximity to the Koeberg Nuclear Power Station, therefore the emergency response infrastructure and systems are in place. However, the outcomes of the Safety Analyses, done prior to commissioning as part of Safety

Analysis Report will determine if the current infrastructure would be adequate to cope with the demands of the additional and proposed Nuclear-1 Power Station.

- The Bantamsklip and Thyspunt sites will require substantial upgrading of infrastructure since they are in remote areas as indicated by the land use studies done by Eskom.

b. Population Distribution

The siting process for a NPS generally consists of a study and investigation of a large area to select one or more candidate sites (see IAEA Safety Guide 50-SG-S9 on Site Survey) followed by a detailed evaluation of those sites.

Major factors considered are:

- Effect of the region of the site on the plant;
- Effect of the plant on the region;
- Population considerations.

In the course of the "selection" phase, during which a regional analysis is performed, sites in zones having the highest population densities are eliminated from the search; it is in effect reasonable, all other things being equal, to prefer sparsely populated zones to highly urbanised zones. The Thyspunt and Bantamsklip sites are satisfactory in this respect.

The Thyspunt and Bantamsklip sites are acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggests that an NPS can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis (i.e. no countermeasures). The EUR requirements prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g. evacuation) beyond 800 m from the reactor, and provide a set of criteria which a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements.

The assessment of the impacts has been conducted according to a synthesis of criteria. The impacts are assessed with and without mitigation and the results presented in impact tables, which summarise the assessment. The significance of all potential impacts that would result from the proposed project are summarised overpage.

Impact: Natural disasters								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
Impact: Extreme weather effects								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
Impact: Design Basis Accidents								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	Negative	High
	1	3	1	5				
With mitigation	Regional	High	Short term	**Very low**	Improbable	Very Low	Negative	High
	1	1	1	3				
Impact: Beyond Design Basis Accidents								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	Negative	High
	1	1	1	3				
Impact: Severe Accident Releases								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	Negative	High
	1	1	1	3				

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR 1') AND ASSOCIATED INFRASTRUCTURE

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ABBREVIATIONS

EUR	European Utility Requirements
LWR	Light Water Reactor
IAEA	International Atomic Energy Agency
DBA	Design Basis Accident
BDBA	Beyond Design Basis Accidents
DBR	Design Basis Release
BDBR	Beyond Design Basis Release
SAR	Severe Accident Release
PRA	Probabilistic Risk Assessment
NREP	National Radiation Emergency Plan

GLOSSARY

Accident	Any unintended event, including operating error, equipment failure or other mishap, the consequences of potential consequences of which are not negligible from the point of view of protection and safety.
Cloud shine	Gamma radiation from radioactive materials in an airborne plume
Deterministic effect	A radiation induced health effect that is certain to occur – with the severity that increases with increasing dose – in an individual exposed to a radiation dose greater than some threshold dose. The level of the threshold dose is characteristic of the particular health effect but may also depend, to a limited extent, on the exposed individual. Examples of deterministic effects include erythema and radiation sickness.
Emergency	Any natural or man caused situation that results in or may result in substantial injured or harm to people, property or the environment, and which prompt action is needed to protect people, property or the environment.
Emergency plan	A document describing the organizational structure, roles and responsibilities, concept of operation, means and principles of intervention during an emergency.
Emergency planning zone	Zone within which plans are developed to take protective actions in case of a nuclear accident
Evacuation	The rapid, temporary removal of people from the area to avoid or reduce short term radiation exposure in the event of an emergency.
Exposure pathway	A route by which radiation or radioactive material can reach or irradiate humans
Iodine prophylaxis	The ingestion of a compound of stable iodine (usually potassium iodine) to prevent or reduce uptake or radioactive isotopes of iodine by the thyroid in the event of an accident involving radioactive iodine. The term thyroid blocking is used in the literature as a synonym.
Longer term protective action zone (LPZ)	Zone within which plans are developed to control agricultural products.
Plume (atmospheric)	The airborne “cloud” of material released to the environment, which may contain radioactive materials and may or may not be invisible.
Precautionary action zone (PAZ)	Zone that should be automatically evacuated or sheltered in the event of an imminent release to prevent deterministic effects in the population
Relocation	The removal of members of the public from their homes for an extended period of time, as a protective action in a chronic exposure situation.
Ground shine	Gamma radiation from radioactive materials deposited on the ground
Sheltering	A protective action whereby members of the public are advised to stay indoors with windows and doors closed, intended to reduce their exposure in an emergency exposure situation.
Stochastic effect	A health effect, the probability of occurrence of which is greater for a higher radiation dose and the severity of which (if

	it occurs) is independent of dose. Stochastic effects may be somatic effects or hereditary effects, and generally occur without a threshold level of dose. Examples include cancer and leukaemia.
Urgent protective action	Protective action that is taken within the first few days after the accident and includes sheltering, stable iodine, evacuation and immediate ban on locally grown food.
Urgent protective action zone	Zone within which plans are developed to take protective actions if the environmental surveys and plant parameters indicate the need to do so.

1 INTRODUCTION

1.1 Description of Proposed Project

This EIA concerns the construction and operation of a Conventional Nuclear Power Station (NPS) and associated infrastructure in the Eastern and Western Cape areas. The sites have been identified based on previous site investigations undertaken since the 1980s and this EIA study.

Eskom proposes to construct a nuclear power station in line with the philosophy of the European Utility Requirements (EUR) for LWR Nuclear Power Plants. In many ways the structure of the nuclear plant resembles that of a conventional thermal power plant. The difference between such plants is in the manner in which heat is produced. In a fossil plant, oil, gas or coal is fired in the boiler, which means that the chemical energy of the fuel is converted into heat. In a nuclear power station, however, energy from the fission chain reaction is utilised. Cooling water for the NPS will be utilised directly from the sea. The proposed NPS will include nuclear reactor, turbine complex, spent fuel, nuclear fuel storage facilities, waste handling facilities, intake and outfall basin and various auxiliary service infrastructures.

1.2 Project Terms of Reference

The terms of reference are to provide:

- Discussion of relevant policies and frameworks, where applicable;
- The affected environments (baseline information) as well as inferred changes to the baseline environment considering the effects of climate change;
- Identification of information gaps, limitations and additional information required;
- Description of the anticipated impacts using the impact assessment criteria as defined in Section 6 for the various phases of the project, i.e. design, construction and operation;
- Development of relevant mitigation measures;
- Determine the effects of climate change on the proposed development and vice versa in terms of their fields of expertise;
- Utilisation of information from the existing Koeberg NPS in order to determine the cumulative impacts at the Duynefontein site;
- Assessment of the impacts associated with the desalination plant;
- Derivation of monitoring and auditing programmes, where necessary.

The Terms of Reference specific to Emergency Response are:

- To address all emergency procedures that will need to be put in place to address an emergency response both during construction and operational phases. The study must consider evacuation and resources required for such emergency responses.
- To discuss any other emergency response services that are identified during the public participation and scoping processes.

1.3 Legislative Framework

At the outset of the EIA for NPS, the Department of Environmental Affairs (DEA) (previously the Department of Environmental Affairs and Tourism (DEAT) as the lead authority on environmental matters, and the National Nuclear Regulator (NNR) agreed to work in close collaboration regarding the cross-cutting issues related to the EIA process and the NNR licensing process. In order to give practical impetus to the process described above a cooperative governance agreement was entered into between the DEAT and the NNR. The agreement provides for a working relationship with regard to environmental impact issues between DEA and NNR as follows:

I. The NNR has responsibilities in respect of the monitoring and control of radioactive material or exposure to ionising radiation in terms of the National Nuclear Regulator Act, 1999 (Act No. 47 of 1999);

II. The Department of Environmental Affairs has responsibilities with regard to the regulation environmental management associated with radiation hazards in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the Environment Conservation Act (Act No. 73 of 1989);

III. The NNR is the lead authority in the regulation of radiation hazards with a view to protecting persons, property and the environment against nuclear damage.

Beside the normal decision-making structures for an EIA, several other acts, regulations and treaties apply to this particular proposed study. These include, *inter alia*:

- **The Constitution of South Africa, Act 108 of 1996 – Chapter 2 Section 24**

Everyone has the right:

1. *to an environment that is not harmful to their health or well-being; and*
2. *to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that*
   - *i. prevent pollution and ecological degradation;*
   - *ii. promote conservation; and*
   - *iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.*

- **National Environmental Management Act, 1998 (Act No. 107 of 1998) – Section 30(1)(a)**

Section 30(1)(a) of the Act provides for control of emergency incidents including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of detriment to the environment, whether immediate or delayed.

- **National Nuclear Regulator Act, 1999 (Act No. 47 of 1999) – Sections 38(2) and 38(4)**

In terms of section 38(2) of the Act, the Regulator must ensure that an emergency plan is established, in terms of section 38(1), by agreement between the holder of a

nuclear authorisation and the relevant municipalities and provincial authorities. Such an emergency plan must be effective for the protection of persons and the environment.

Section 38(4) of the Act deals with the development surrounding a nuclear installation and provides that the Minister may, on recommendation of the Board of the Regulator and in consultation with the relevant municipalities, make regulations on the development surrounding any nuclear installation to ensure the effective implementation of any applicable emergency plan.

- **National Water Act, 1998 (Act No. 36 of 1998) – Section 20**

Section 20 of the Act deals with pollution of water resources following an emergency incident, such as an accident involving the spilling of a harmful substance that finds or may find its way into a water resource.

- **National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) – Section 24(b)**

The Act generally gives effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

- **Disaster Management Act, 2002 (Act No. 57 of 2002) – Section 7(1).**

In terms of section 7(1) the Minister (i.e. the Cabinet member designated in terms of section 3 to administer this Act) must prescribe a national disaster management framework. The framework must reflect a proportionate emphasis on disasters of different kind, severity and magnitude that occur or may occur in South Africa.

Regulations:

- The Regulations in terms of Chapter 5 of the National Environmental Management Act, contained in Government Notice, 28753, as published in the Government Gazette of 21 April 2006.
- National Road Traffic Regulations as published in the Government Gazette of 17 March 2000.
- Regulations for the safe transport of radioactive material (IAEA No. TS-R-1 (ST-1 revised).
- Government Notice No. 1047 of July 2003 published under Government Gazette No.25217 provides for Draft Regulations in terms of the National Nuclear Regulator Act, made by the Minister (i.e. Minister of Minerals and Energy), on the development surrounding any NI (Nuclear Installation) to ensure the effective implementation of any nuclear emergency plan. Section 3 of the Regulation provides that the Regulator shall lay down, where appropriate, specific requirements relating to the control and/or monitoring of development within the formal emergency planning zone surrounding a specific NI, after consultation with the relevant provincial and /or municipal authorities.

- **European Utility Requirements on Emergency Planning**

Eskom has developed a document [NSIP-01344] on a framework for demonstrating that a proposed nuclear installation can be built in South Africa without the need for

off-site short-term emergency interventions like sheltering, evacuation or iodine prophylaxis, in line with the *European Utility Requirements* [EUR] *for Light Water Reactor (LWR) Nuclear Power Plants*. These documents prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g., evacuation) beyond 800 m from the reactor, and provide a set of criteria that a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements. The EUR requirements can be summarised as follows:

1. no *emergency protection action* beyond an 800 m site boundary;
2. no *delayed action* beyond 3 km;
3. no *long term action* beyond 800 m; and
4. limited economic impact.

The underlined terms above are defined as follows:

Emergency protection action: actions involving public evacuation, based on projected doses up to seven days, which may be implemented during the emergency phase of an accident, e.g. during the period in which significant releases may occur.

Delayed action: actions involving temporary public relocation, based on projected doses up to 30 days caused by groundshine and aerosol resuspension, which may be implemented after the practical end of the release phase of an accident.

Long term action: actions involving public resettlement, based on projected doses up to 50 years caused by groundshine and aerosol resuspension. Doses due to ingestion are not considered in this definition.

Further to the national statutes (acts and regulations) a number of provincial and local authority regulations/ordinances must be satisfied, particularly those related to land-use planning, economics and service provision.

1.4 Limitations

The following are the limitations encountered in the current study which will be addressed in the Safety Analysis Report investigation to be done prior to commissioning of the plant:

(i) **Safety analysis:** A comprehensive safety analysis of sources of potential exposure to evaluate radiation doses that could be received by the public as well as potential effects on the environment must be conducted. The safety analysis shall take into account potential accidents over a wide range of probabilities. The safety analysis must identify potential threats and determine the likelihood, nature and magnitude of the nuclear and radiological consequences.

2 DESCRIPTION OF AFFECTED ENVIRONMENT

2.1 Location

The sites being investigated as part of the EIA were identified based on previous site investigations undertaken since the 1980s (**Figure 2.1**) and work carried out during this EIA. They include Thyspunt, in the Eastern Cape, located W of Port Elizabeth near Cape St Francis; Bantamsklip, in the Western Cape, located 8 km SE of Pearly Beach; and Duynefontein, within the existing Koeberg NPS (KNPS) site in the Western Cape.

2.1.1 Thyspunt

Thyspunt is located on the Kouga Coast of the Eastern Cape Province, approximately 80 km W of Port Elizabeth. The Kouga Coast is located within the jurisdiction of the Humansdorp Transitional Representative Council. The planning area, for which a Structure Plan has been undertaken, extends 155 km along the coast between the Tsitsikamma Forest and Coastal National Park in the W and the Kabeljous River mouth in the E, and inland to the Suuranysberge, some 1 700 km^2 in extent.

The Kouga Coast is a transition zone between various geological formations, and experiences winter and summer rainfall climates. The resulting range of landscapes and ecological niches, with their diverse flora and fauna, results in a rich and interesting landscape. It is this natural environment that forms the basis for a number of the region's economic activities, including agriculture, forestry and tourism. The Kouga Coast has a distinct cultural and ecological character, with great potential for the development of tourism.

2.1.2 Bantamsklip

The Overberg Region is the southern-most region in the Western Cape and incorporates Cape Agulhas, the southern tip of Africa. The Southern Overberg Sub-Regional Structure Plan area includes portions of the Hermanus and Bredasdorp magisterial districts and is 2 300 km^2 in extent.

The region has a Mediterranean type climate with most of its rainfall occurring in winter. As part of the Cape Floristic Kingdom, the area has many unique and vulnerable fynbos species. There are also several archaeological sites, mostly along the coastline, as well as well-known shipwrecks.

Agriculture is the primary activity of the Overberg. With the exception of a few farming and holiday resort towns, the region is relatively undeveloped. However, the Southern Overberg is currently experiencing growth in development as a result of its increased popularity as a holiday and tourist destination. Infrastructure and services are close to capacity during peak tourist seasons but under-utilised for the remainder of the year.

2.1.3 Duynefontein

The KNPS is located N of Ouskip, Van Riebeeckstrand and Melkbosstrand and to the W of the R27 on the farm Duynefontein 34. The site is located about 2.0 km from the Duynefontein residential area, 30 km N of Cape Town and 10 km S of Atlantis. The KNPS site is surrounded on three sides by a proclaimed nature reserve of 3 000 ha.

The site and surrounding nature reserve are managed according to a formal Integrated Environmental Management System (IEMS).

Eskom owns Duynefontein (farm number 34), which stretches 4.4 km along the coast and 3.5 km inland, comprising 1 257 ha. The West Coast Road (R27) passes over the farm giving excellent access to the site. The adjoining farm, Kleine Springfontein (farm number 33) also belongs to Eskom. This property includes 3.6 km of coast to the N of Duynefontein and stretches 3.75 km inland measuring 1 590 ha. S of Duynefontein, Eskom also owns land that has been developed as a housing estate, originally for Koeberg employees. The housing development utilises about 87.5 ha of the local area of 309 ha owned by Eskom. This housing development area is now private property and part of Melkbosstrand.

The land and land-use within a 20 km radius of the KNPS can be classified in the following categories: nature reserve, cultivated land; uncultivated land; residential development; industrial development; dune areas; wetland areas. The Melkbosstrand urban strip, which lies along the coast, is the dominant land-use within a 5 km radius of KNPS. The area to the immediate E of KNPS is largely uncultivated as it consists of sandy soil of low agricultural value.

The area N of the KNPS consists of Standveld Coastal Shrublands. Poorly vegetated sands occur in the dune areas along the coast and further inland to the NNW of the KNPS. The soil quality generally improves outwards towards the 20km radius and this is reflected in the intensity and quality of the agricultural output. The farming is typically Swartland with wheat and fodder crop cultivation dominating agricultural activities. Dairy farming is also popular. Poultry farming occurs mainly in the NE sector, particularly in the area of smallholdings E of Atlantis.

The industrial and residential town of Atlantis forms the most significant urban development to the N of the KNPS. There is metropolitan growth in the area N of Milnerton (SSE and SE of KNPS). The area immediately N of Table View is exhibiting rapid growth. Residential development in this area is still beyond the 10km radius from the KNPS. S of the KNPS, adjacent to the conservation area, lies the town Duynefontein.

Scattered industries in the form of brickfields and waste disposal sites also occur in the SE and SSE sectors. Extensions of industrial areas S of the Diep River characterise the SE sector around the 20 km radius.

SRK Consulting
Engineers and Scientists

PROJECT NO.	COORDINATE SYTEM			DATE	SCALE
378677	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE SPECIALIST STUDY: EMERGENCY RESPONSE LOCATION OF THE PROPOSED NUCLEAR POWER STATION SITES	12/08/2009	1:9,000,000
	SPHEROID: WGS84	CENTRAL MERIDIAN: 25		COMPILED BY: SCHN	FIG NO.: 2.1

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2.2 Land Use

2.2.1 Bantamsklip

Numerous agricultural land units were identified within the 16 km radius. It was further found that cattle, milk and sheep production are the dominant agricultural practices in the area. This production is concentrated within the NW to NE sectors.

Agricultural production within the 7.5 km radius from the proposed Bantamsklip site is limited and of little significance. The rural settlement of Buffeljags is situated within this sector, NW of the proposed Bantamsklip site.

The 7.5 to 10 km annulus reflects more intensive agricultural use between the NW and the NE sectors. Land uses include cattle farming, dairy production, fynbos harvesting and sheep farming. The bulk of agricultural production is concentrated in the 10 to 16 km radius. As a whole the NNW to NE sectors are the most productive, producing 84% of the area's milk.

Meat production (cattle) takes place from the NW to the SE sectors with the NNW and the N sectors being the most productive. These two sectors account for 74 % of total production within a 16 km radius within this specific category.

Trout are farmed within the NE sector, in the 10 to 16 km radius. A total of 40 tonnes of trout are produced annually. A farming unit that produces lavender was also detected. However, production is not intense and small amounts are delivered to local shops. Fynbos is also harvested within the area. Harvesting is erratic and total production numbers could not be provided. About 2 000 kg of honey is produced within the area. This production is concentrated in the ENE sector within a 16 km radius from the proposed Bantamsklip site.

Permanent residential activities are focussed in the two coastal resort towns of Franskraal and Pearly Beach, and the two rural villages of Baardskeerdersbos and Wolwegat. Pearly Beach is located 6 km away to the NW. A small coastal resort (Die Dam), which is run by Cape Nature, is located 14 km from Bantamsklip to the SE. No significant commercial or industrial activities were noted.

2.2.2 Thyspunt

Thyspunt is situated on the coastal plain W of Cape St. Francis and some 4 km ESE of Oyster Bay. The land-use pattern within a 20 km radius of the site can be classified in the following categories in order of importance: significant extensive agricultural activity, with the closest being dairy pastures within 3 km and centre-pivot irrigated crops (grazing) at a distance of 4 km; tall shrubland (dune strandveld and dune fynbos) within a 5 km radius from Thyspunt; commercial dryland agriculture between the NW and NE sectors and EW trending sand dunes across the strandveld. Some fynbos spreads into dryland crops between the N and NNE sectors from the N. A single centre-pivot irrigated crop is found inside commercial dryland agriculture between the NNW and N sectors. Oyster Bay also occurs in this zone and is the closest residential area to Thyspunt (i.e. about 5 km).

2.2.3 Duynefontein

Located on the coast approximately 30 km N of Cape Town, this site already contains the KNPS. The land-use pattern within a 20 km radius of the site can be classified in the following categories in order of importance: cultivated (commercial dryland); fallow land (areas disturbed by agriculture); tall shrubland (strandveld); mixture of cultivated (commercial irrigated) and agricultural industry; low shrubland (fynbos and renosterveld); urban/built-up (residential); bare soil (sand dunes); urban/built-up (light industrial); wetlands; water bodies; urban/built-up (heavy industrial); mines and quarries (surface-based mining); and urban/built-up (informal squatter settlements).

The land within the 5 km radius is predominantly covered by tall shrubland (strandveld), low shrubland (fynbos), sand dunes and the existing KNPS directly S of the site. Urban development is limited to the northern extension of Melkbosstrand (Duynefontein and Van Riebeeckstrand) further south. Duynefontein is the closest residential area, located 3 km SSE of the site. Fallow land borders the sector on the NE. Parts of the area, especially E of the West Coast Road (R27), are heavily infested with alien vegetation. Poorly vegetated sands occur in the dune areas N of the site and further inland to the N, corresponding with the southern part of the Witzand mobile dune system.

The 5-10 km radius reflects the first intensive agricultural use between the ENE and ESE sectors. Cultivated land, a large portion of which now lies fallow, is dominant in this area with wheat, fodder crops and dairy farming being the main agricultural products. Chicken farming is present in the ENE sector, 9 km from the site, and beyond into the Klein Dassenberg smallholdings SE of Atlantis. Also present in this zone is the Atlantis industrial area in the NE and Melkbosstrand residential area on the coast to the south. Strandveld vegetation covers the northern portion of the zone and the extreme southern part (S of Melkbosstrand). The most fertile land is found in the 10-20 km band NE of the site. Known as the Klein Dassenberg smallholdings, this area shows more specialised farming activities that include bee-keeping, vegetables, poultry and egg production, stud-farming and dairy farming. Atlantis is the largest urban node in the northern half of the study area. In addition, well-established wheat farms and accompanying high production of fodder crops characterise the E and ESE sectors. Some of the farmers here also have a well-established dairy component. The nature of the farming is typical of the Swartland. Extensive areas, degraded by agriculture but no longer cultivated, are found between the NNW and NE sectors and between the SE and SSE sectors. As a result of urban development and proximity to the sea, there is a decrease in agriculture towards the south. Most of the land N of Table View is developed or destined for future urban development.

2.3 Population distribution

2.3.1 Bantamsklip

There is a maximum cumulative population of approximately 227 284 people within 80 km of the NPS site (estimated 2008). If the population distribution results per sector are viewed, it is clear that the main towns of Gansbaai, Hermanus, Hawston, Kleinmond, Betty's Bay, Grabouw, Caledon, Greyton and Bredasdorp contain higher population concentrations.

A relatively small population resides within 16 km of the NPS site (approximately 2 560 people in 2008) with Pearly Beach to the NW containing the highest population density in this distance radius.

2.3.2 Thyspunt

There is a maximum cumulative population of approximately 339 400 people within 80 km of the NPS site (estimated 2008). If the population distribution results per sector are viewed, it is clear that the main settlements are Nompumelelo Village, Zitzikama, Kareedouw, Humansdorp/Kruisfontein, Hankey, Jeffreys Bay, Uitenhage and the Greater Nelson Mandela Bay/Port Elizabeth.

A relatively small population resides within a 16 km of the NPS site (approximately 4 724 people in 2008) with Sea Vista to the ENE containing the highest population density in this distance radius.

2.3.3 Duynefontein

There is a maximum cumulative population of approximately 3,9 million people within 80 km of the NPS site (estimated 2008). If the population distribution results per sector are viewed, it is clear that the Cape Town region, South Peninsula region, Blaauwberg region, Tygerberg region, Oostenberg region, and Helderberg region are densely populated, as is the area NNE of Koeberg corresponding with Atlantis.

A population of approximately 83 358 people resided within a 16 km of the NPS site (estimated 2008), with Avondale and Saxonsea in Atlantis containing the highest population densities.

2.4 Infrastructure (transport & communication)

2.4.1 Bantamsklip

- **Transport**

The major road in the network with the highest traffic volumes currently, is the MR00028 between Ratelrivier and Gans Bay with a traffic volume of approximately 7 861 vehicles per day (vpd). TR02802 (R43) serves as a link to Hermanus and to the N2 via the MR00267 (R326) and carries a volume of approximately 4 966 vpd. MR00267 which serves as the main link on the eastern side of the Bantamsklip site to the N2 carries a vehicle volume of 1 668 vpd. MR00262 runs between Vogellvlei and Bredasdorp and carries a low vehicle volume of approximately 450 vpd. MR00261 connects Agulhas to Bredasdorp and further extends to Goudini and Caledon and carries an approximate vehicle volume of 2 945 vpd.

- **Telephone exchanges**

The telephone exchanges falling within a 25 km radius of the Bantamsklip site, together with the total number of subscribers and the number of subscribers within the specified radius, are listed in **Table 2.1**.

Table 2.1: Telephone Exchanges: Bantamsklip

Exchange	Distance (km)	Sector	No. of subscribers	
			Total	No. within 25 km radius
T1 - Pearly Beach	7.37	NW	260	260
T2 - Franskraalstrand	18.95	NW	520	520
T3 - Gansbaai	23.09	NW	1 590	1 590
T4 - Haasvlakte	22.83	ENE	330	330

- **Radio and television transmitters**

Sentech (Pty) Ltd controls the radio and television transmitters in the region. There are no radio or television transmitters within a 25 km radius of the site. The nearest transmitter to Bantamsklip is located at Napier (34° 31' 45" S, 19° 53' 33" E) and transmits KFM, RSG, SAFM as well as SABC1 and SABC2. This transmitter is approximately 37 km from the Bantamsklip site.

2.4.2 Thyspunt

- **Transport**

Current traffic volumes on the N2 in the vicinity of Humansdorp is in the order of 3 768 vehicles per day (vpd) in both directions, with the percentage of trucks being 18.38%. Information on accident hotspots and accident statistics are not available. However, road signs warn motorists that the 5 km section to the east of the N2/R330 interchange is an accident hotspot.

- **Telephone exchanges**

The telephone exchanges falling within a 25 km radius of the Thyspunt site, together with the total number of subscribers and the number of subscribers within the specified radius, are listed in **Table 2.2**.

Table 2.2: Telephone Exchanges: Thyspunt

Exchange	Distance (km)	Direction	No. of subscribers	
			Total	No. within 25 km radius
T1 - Oyster Bay	5.04	WNW	79	79
T3 - St Francis Bay	11.58	ENE	1 431	1 431
T4 - Aston Bay	22.12	ENE	644	644
T5 - Jeffreys Bay	24.75	NE	2 508	2 508
T6 - Wavecrest	26.87	NE	2 398	2 398
T7 - Humansdorp	18.80	NNE	2 800	2 484

- **Radio and Television Transmitters**

Sentech (Pty) Ltd controls the radio and television transmitters in the region. The nearest transmitter to Thyspunt is located at Port Elizabeth (33° 56' 10" S, 25° 26' 29" E) and transmits RSG, SAFM, R2000, LOBO, 5FM, METRO FM, LOTUS FM and ALGOA Radio as well as SABC1, 2, 3, eTV and MNET. This transmitter is approximately 90 km from the Thyspunt site.

2.4.3 Duynefontein

- **Transport**

The R27 and the N7 serve primarily as north-south national and regional distributors, with the additional function of providing local rural access. The R27 links the Cape Town metropolitan area with the north western coastal areas, traversing the farm Duynefontein at approximately 2.3 km from the Koeberg 900 PWR units 1 and 2. This road provides the major access to the Koeberg site and is a dual carriageway from Table Bay Boulevard to approximately 400 m north of Porterfield Road, Table View.

- **Telephone Exchanges**

The telephone exchanges falling within a 25 km radius of the Koeberg site, together with the total number of subscribers within the specified radius, are listed in **Table 2.3**.

Table 2.3: Telephone Exchanges: Duynefontein

Exchange	Distance (km)	Direction	No. of Subscribers	
			Total	Within 25km Radius
Altria	9.19	NNE	1700	1700
Atlantis	13.25	NNE	8250	8250
Bloubergstrand	14.84	SSE	5124	5124
Bothasig	24.75	SSE	15216	11412
Darling	32.43	N	1878	376
Durbanville	27.70	SE	21946	6584
Kalbaskraal	23.08	ENE	544	272
Klipheuwel	25.89	E	512	51
Maitland	28.60	S	16768	1677
Mamre	17.73	NNE	1048	1048
Melkbosstrand	6.70	SSE	3828	3828
Milnerton	24.27	SSE	2648	2383
Philadelphia	14.05	E	400	400
Robben Island	16.25	SSW	208	208
Table View	19.65	SSE	18928	18928

- **Radio and Television Transmitters**

Sentech (Pty) Ltd controls all radio and television transmitters in the region. There are no radio or television installations within the 25 km radius of the Koeberg site. However, the Sentech Tygerberg Transmitter station is the closest. It is located on Tierkop approximately 27.6 km SE of the site. The regional operations centre of Sentech, situated approximately 23 km south of the Koeberg site, handles all transmissions of radio and television programmes.

2.5 Sensitivity of the Affected Environment

The indication of the sensitivity of the affected environment is summarised as per the table below.

Affected environment	Tolerance	Sensitivity
Land use	Low	High
Population	High	Low
Infrastructure	High	Low

Land use: Sensitivity, in this context, refers to the "ability" of an affected environment to tolerate disturbance, for example, in the event of an accident, radionuclides would disperse to an agricultural area and affect the crops and their yield, the affected environment would in this case be categorised as having a "low tolerance" to disturbance and is, therefore, termed a "highly sensitive".

Population: In the event of an accident, the population could be sheltered or evacuated. Sheltering involves keeping members of the population indoors, with closed doors and windows, to reduce direct radiation exposure from radioactive plume, from ground shine, and from inhalation of radioactive material. Sheltering is not recommended for a period exceeding 48 hours.

Evacuation is the prompt removal of the population from the affected area. Evacuation is not recommended for a period exceeding seven days

Sensitivity, in this context of sheltering and evacuation disturbance would be tolerable, that is, the population could withstand significant disturbance without a marked impact, thus the population measure could be categorised as having a high tolerance to disturbance (i.e. "low sensitivity").

Infrastructure: In the event of an accident, the infrastructure would withstand significant disturbance, since the disturbance will not result in permanent loss of use of the infrastructure. The affected environment would in this case be categorised as having a "high tolerance" to disturbance and is, therefore, termed a "low sensitive".

3 IMPACT IDENTIFICATION AND ASSESSMENT

The assessment of the impacts has been conducted according to a synthesis of criteria. Each possible impact is analysed and discussed in detail in tables below. The impacts are assessed with and without mitigation and the results presented in impact tables which summarise the assessment.

In order to assess these impacts, the proposed development has been divided into two project phases, namely the construction and operation phase. The criteria against which these activities were assessed are discussed below.

a. Nature of the Impact
This is an evaluation of the type of effect the construction, operation and management of the proposed development would have on the affected environment. This description should include what will be affected and the manner in which the affect will transpire.

b. Extent of the Impact
The specialist must describe whether the impact will be: local (limited to the site and its immediate surroundings); or whether the impact will be at a regional or national scale.

c. Duration of the Impact
The specialist must indicate whether the lifespan of the impact would be short-term (0-5 years), medium-term (6-10 years), long-term (>10 years) or permanent.

d. Intensity
This will be a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Does it destroy the impacted environment, alter its functioning, or render it slightly altered? The specialist study must attempt to quantify the magnitude of the impacts and outline the rationale used.

e. Consequence
The consequence of the potential impacts will be determined according to the main criteria for determining the consequence of impacts, namely the extent, duration and intensity of the impacts.

f. Probability of Occurrence
The specialist should describe the probability of the impact actually occurring and should be described as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).

g. Degree of Confidence in Predictions
The specialist must state the degree of confidence (low, medium or high) there is in the predictions made for each impact, based on the available information and level of knowledge and expertise as well as the associated implications.

h. Significance
The overall significance of the impacts will be defined based on the result of a combination of the consequence rating and the probability rating, as defined above. The significance defines the level to which the impact will influence the proposed development and/or environment in any way. It determines whether mitigation

measures need to be identified and implemented or whether the resource is irreplaceable and/or the activity has an irreversible impact.

i. Cumulative
Incremental impacts of the activity and other past, present and future activities on a common resource.

j. Reversibility
The ability of the impacted environment to return to its pre-impacted state once the cause of the impact has been removed.

k. Irreplaceability
The ability of an environment aspect to be replaced should it be impacted on.

l. Mitigation measures
The development of mitigation measures in order to reduce and prevent the significance of the impact.

3.1 Construction Phase

Before final approval of a NPS site, the feasibility of an emergency plan should be considered. There should be no adverse site conditions which could hinder the sheltering and evacuation of the population in the region or the ingress or egress of external services needed to deal with the emergency.

3.1.1 Natural Disasters

The seismology and geology of the region and the engineering geology of the proposed site has been evaluated as part of the Site Safety Report process. If the site is within a zone of surface faulting that has a significant potential for relative displacement at or near the ground surface, the site should be deemed unsuitable. The design basis earthquakes shall be determined from the seismotectonic evaluation of the region.

a) Bantamsklip

Low levels of tectonic activity have been recorded and several faults extend to within the site area. However, there is no evidence of recent activation of any faults (old structures).

Impact: Natural disasters								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				

b) Thyspunt

Situated in a region of low seismicity and relatively low fault density. No faults extending into site area.

Impact: Natural disasters								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				

c) Duynefontein

The seismic hazard is relatively high, much similar to Bantamsklip.

Impact: Natural disasters								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				

	CI	**REV**	**IRR**
Without mitigation	Medium	Medium	No
With mitigation	Low	Medium	No

CI - Cumulative impacts
REV: Reversibility
IRR: Irreplaceability

3.1.2 Extreme Weather Events

Extreme weather events affect the design of the planned plant. They depend on the local climatic conditions:

High winds

For wind, the maximum velocities, instantaneous peak velocities, and monthly maximum velocities are used to determine the normal and extreme basic dynamic pressures that are used in turn to determine the possible wind load on the buildings.

a) Bantamsklip

Impact: Extreme weather effects								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				

b) Thyspunt

Impact: Extreme weather effects								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				

c) Duynefontein

Impact: Extreme weather effects								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	negative	Medium
	2	3	1	6				

	CI	**REV**	**IRR**
Without mitigation	Medium	Medium	No
With mitigation	Low	Medium	No

CI - Cumulative impacts
REV: Reversibility
IRR: Irreplaceability

3.2 Operational Phase

3.2.1 Design Basis Accidents

Design-basis accidents are events that are taken into account in the design of the safety systems. They include, for example:

- 100% reactor outlet header break with failure of ventilation outlet dampers to close automatically;
- 100% reactor outlet header break with partial failure of dousing; and

- 60% reactor outlet header break with coincident loss of emergency core cooling.

DBRs are *unlikely*; safety systems are designed to mitigate the consequences of such events and to prevent further degradation of the situation. The fission product mix, release fractions to the environment and release timing vary depending of the accident.

a) Bantamsklip

Impact: DBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Regional	High	Short term	**Very low**	Improbable	Very Low	negative	High
	1	1	1	3				

b) Thyspunt

Impact: DBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Regional	High	Short term	**Very low**	Improbable	Very Low	negative	High
	1	1	1	3				

c) Duynefontein

Impact: DBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Regional	High	Short term	**Very low**	Improbable	Very Low	negative	High
	1	1	1	3				

	CI	**REV**	**IRR**
Without mitigation	Medium	Low	No
With mitigation	Low	Medium	No

CI - Cumulative impacts
REV: Reversibility
IRR: Irreplaceability

3.2.2 Beyond Design Basis Accidents (BDBA)

This family of accidental releases corresponds to events where additional failures occur, leading to greater release fractions to the environment. BDBRs are *very unlikely* due to the number of failures that must occur in order to get significant releases of radioactive products into the environment.

The American safety organisations raised in 1973 the problem of the failure of the emergency shutdown system (scram), which involves the drop of all the reactor shutdown rod cluster control (RCC) assemblies, during the frequent transients which trigger a scram. The RCC assemblies drop by gravity when their holding mechanisms are de-energised. These devices are de-energised by two series mounted trip breakers, supplied by two independent channels. It would nonetheless appear that there is a probability of between 10^{-5} and 10^{-4} of failure of emergency shutdown for each request.

a) Bantamsklip

Impact: BDBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	negative	High
	1	1	1	3				

b) Thyspunt

Impact: BDBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	negative	High
	1	1	1	3				

c) Duynefontein

Impact: BDBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	Negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	Negative	High
	1	1	1	3				

	CI	**REV**	**IRR**
Without mitigation	Medium	Low	No
With mitigation	Low	Medium	No

3.2.3 Severe Accident Releases (SAR)

Severe accidents occur when the safety systems are impaired and are unable to prevent significant core damage, with the greatest release fractions. Such events are *extremely unlikely* because a large number of coincident failures of process and safety systems would need to occur. Furthermore, in some scenarios, the accident may threaten the integrity of the containment envelope. These are the worst case scenarios.

One such extremely rare postulated event is a power excursion with impairment and/or failure of the cooling systems leading to early core failure and disassembly. In this postulated event, the shutdown system fails to prevent a significant and prompt power increase.

a) Bantamsklip

Impact: SAR								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	negative	High
	1	1	1	3				

b) Thyspunt

Impact: SAR								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	negative	High
	1	1	1	3				

c) Duynefontein

Impact: SAR								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	negative	High
	1	1	1	3				

	CI	**REV**	**IRR**
Without mitigation	Medium	Low	No
With mitigation	Low	Medium	No

3.3 Decommissioning Phase

Site construction is scheduled to take five years and the NPS will be in operation for about 60 years. Decommissioning will therefore only occur in more than 65 year's time. This is too far ahead for any meaningful predictions of likely impacts and mitigating measures. Decommissioning will therefore be conducted in accordance with formal environmental and human health risk management plans, based on a comprehensive environmental impact assessment in accordance with relevant laws and regulations that would apply at the time of decommissioning.

4 ENVIRONMENTAL ASSESSMENT

In terms of the NEMA EIA Regulations one of the criteria to be taken into account by the competent authority when considering an application is "*any feasible and reasonable alternatives to the activity which is the subject of the application and any feasible and reasonable modifications or changes to the activity that may minimise harm to the environment*". Alternatives are defined in the Regulations as "*different means of meeting the general purpose and requirements of the activity*". It is therefore necessary to provide a description of the need and desirability of the proposed activity and any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives will have on the environment and on the community that may be affected by the activity.

The identification, description, evaluation and comparison of alternatives are important for ensuring the objectivity of the assessment process. In cases where there is no objective and thorough assessment of alternatives, the EIA process usually only confirms a chosen activity and the value of the assessments as an input to decision-making may be compromised.

The NEMA EIA Regulations indicate that alternatives that are considered in an assessment process be reasonable and feasible. The number of alternatives that are selected for assessment should not be set arbitrarily, but should be determined by the range of potential alternatives that could be reasonable and feasible and should include alternatives that are real alternatives to the proposed activity.

4.1 Bantamsklip

For emergency planning, major considerations in site selection include infrastructure, population distribution and land use considerations. The impact of these measures is summarized below:

Population: A relatively small population resides within 16 km of the site (approximately 2,560 people in 2008)

Infrastructure: On the infrastructure (i.e. transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site) measure, Bantamsklip is currently not suitable, especially for emergency response purposes due to the fact that the region is relatively undeveloped. However, this could be mitigated by the infrastructure development that will take place during the commissioning of the NPS.

Summary

The Bantamsklip site is acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggest that a proposed nuclear installation can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis (i.e. no countermeasures). The EUR requirements prescribe that modern nuclear power plants should have no or only minimal need for emergency

interventions (e.g., evacuation) beyond 800 m from the reactor, and provide a set of criteria which a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements.

4.2 Thyspunt

Population: A relatively small population resides within 16 km of the site (approximately 4724 people in 2008)

Infrastructure: On the infrastructure measure (i.e. transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site), Thyspunt is currently not suitable due to the fact that the region is relatively undeveloped. However, this could be mitigated by the infrastructure development that will take place during the commissioning of the NPS.

Summary
The Thyspunt site is acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggest that a proposed nuclear installation can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis (i.e. no countermeasures). The EUR requirements prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g., evacuation) beyond 800 m from the reactor, and provide a set of criteria which a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements.

4.3 Duynefontein

Population: A population of approximately 83 358 people resided within 16 km of the NPS site in 2008.

Infrastructure: The current site is in proximity to the KNPS, therefore the emergency response infrastructure (i.e. transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site) and systems are in place.

Summary:
The Duynefontein site is considered the least preferred site due to the population factor. The presence of large populations in the region or proximity of a city to the nuclear power plant site may diminish the effectiveness and viability of an emergency plan. In the course of the "selection" phase, during which a regional analysis is performed, sites in zones having the highest population densities are eliminated from the search; it is in effect reasonable, all other things being equal, to prefer sparsely populated zones to highly urbanized zones.

5 MITIGATION MEASURES

For future sites (Thyspunt and Bantamsklip), Eskom has developed a document [NSIP - 01344] on a framework for demonstrating that a proposed nuclear installation can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis, in line with the philosophy of the *European Utility Requirements* [EUR] *for Light Water Reactor (LWR) Nuclear Power Plants*. These documents prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g., evacuation) beyond 800 m from the reactor, and provide a set of criteria that a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements. Nuclear emergency protective actions would therefore be applicable for the Duynefontein Site:

- urgent protective actions, which must be taken within hours of an accident to be effective. These include evacuation, administration of stable iodine and sheltering; and
- longer-term protective actions, which may need to be adopted in a matter of days following an accident. These include control of foodstuff, relocation and resettlement.

5.1 Sheltering

Sheltering involves keeping members of the public indoors, closing all ventilation and blocking all air paths into the dwellings to reduce radiation exposure from cloud shine, ground shine and inhalation. In addition to protecting the population, sheltering allows better and more effective communication with the affected population. Sheltering is not recommended for a period exceeding 48 hours. In practice, it is difficult to maintain for more than 24 hours. Beyond that period, evacuation or relocation needs to be considered.

5.2 Evacuation

Evacuation is the prompt removal of the population from the affected area. It is generally the most effective protective action against major airborne releases of radioactivity. Mass care facilities must be available for a substantial fraction of the evacuated population. The dose that can be averted by evacuation is the projected dose that would be received by an individual staying outside, under the plume, for the duration of the evacuation, i.e. for a maximum of seven days.

5.3 Administration of Stable Iodine

Radioactive iodine tends to concentrate in the thyroid gland and can cause early or latent effects such as thyroid cancer. Ingesting stable, non-radioactive iodine, before or immediately after exposure to radioactive iodine saturates the thyroid gland and prevents the absorption of radioactive iodine. The dose that can be averted by taking

stable iodine just before exposure to the release is equal to the projected dose to the thyroid from inhalation without the administration of stable iodine.

5.4 Temporary Relocation and Resettlement

Temporary relocation is used when there is a need to keep the population out of the affected area for a period exceeding approximately seven days but not more than a few months. This measure requires that mass care facilities be provided to the affected population. It is expected that the temporarily relocated population will be able to return to their homes.

By definition, resettlement is permanent. It is adopted when the dose to the affected population over a lifetime would exceed a certain criterion. However, decisions in that later stage rely on a detailed analysis of the consequences, land use and exposure pathways.

5.5 Food Ban and Food Control

Protective actions related to food include:

- An immediate ban on the consumption of locally grown food in the affected area;
- The protection of local food and water supplies by, for example, covering open wells and sheltering animals and animal feed;
- Long term sampling and control of locally grown food and feed.

Control of milk production and distributors is generally considered particularly important because it is a significant part of children's diets.

6 CONCLUSIONS

The key findings and recommendations of this Emergency Response study can be summarised as follows:

a. Infrastructure Considerations

- The current Duynefontein Site is in proximity to the KNPS, therefore the emergency response infrastructure and systems are in place. However, the outcomes of the Safety Analysis will determine if the current infrastructure would be adequate to cope with the demands of the additional and proposed Nuclear-1 Power Station.
- The Bantamsklip and Thyspunt sites will require upgrading of the emergency planning infrastructure since they are remote areas as indicated by the Land Use Studies done by Eskom.

b. Population Distribution

The siting process for a NPS generally consists of a study and investigation of a large area to select one or more candidate sites (see IAEA Safety Guide 50-SG-S9) on Site Survey, followed by a detailed evaluation of those sites.

Major factors considered are:

- Effect of the region of the site on the plant;
- Effect of the plant on the region; and
- Population considerations.

The acceptability of a site is closely related to the design of the proposed nuclear power plant. From the safety point of view, a site is acceptable if there are technical solutions to site problems which give assurance that the proposed plant can be built and operated with an acceptably low risk to the population of the region.

In the course of the "selection" phase, during which a regional analysis is performed, sites in zones having the highest population densities are eliminated from the search; it is in effect reasonable, all other things being equal, to prefer sparsely populated zones to highly urbanised zones. In terms of the Site Safety Reports done for demography, the Thyspunt and Bantamsklip sites are satisfactory in this respect.

In general the Thyspunt and Bantamsklip sites are acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggest that a proposed nuclear installation can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis (i.e. no countermeasures). The EUR requirements prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g., evacuation) beyond 800 m from the reactor, and provide a set of criteria which a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements.

The assessment of the impacts has been conducted according to a synthesis of criteria. The impacts are assessed with and without mitigation and the results presented in impact tables, which summarise the assessment. The significance of all potential impacts that would result from the proposed project are summarised below.

Impact: Natural disasters								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
Impact: Extreme weather effects								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
With mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	Medium
	2	3	1	6				
Impact: DBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Low**	Improbable	Very Low	Negative	High
	1	3	1	5				
With mitigation	Regional	High	Short term	**Very low**	Improbable	Very Low	Negative	High
	1	1	1	3				
Impact: BDBA								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	Negative	High
	1	1	1	3				
Impact: SAR								
	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional	High	Short term	**Medium**	Improbable	Low	Negative	High
	1	3	1	5				
With mitigation	Local	Low	Short term	**Very low**	Improbable	Insignificant	Negative	High
	1	1	1	3				

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Date	3 December 2009