

INTEGRATED NUCLEAR INFRASTRUCTURE REVIEW (INIR)

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Is South Africa experienced enough in Nuclear Energy?

South Africa is one of the most experienced nuclear energy countries in the world. We have been benefiting from the use of nuclear energy since the dawn of the nuclear era. In 1948, the Atomic Energy Board was established for uranium mining and trade. In 1965 our first nuclear research reactor entered into operation at Pelindaba, west of Pretoria. Known as SAFARI-1, or South African Fundamental Atomic Research Installation, this reactor is currently one of the top three producers (out of over 200 research reactors) of medical radio-isotopes. These isotopes are used in over 30 million medical procedures worldwide. Our research reactor differs from a nuclear power reactor as it cannot be used to generate electricity.

South Africa also proudly holds the record for being the first and only country to voluntarily disarm its nuclear weapons programme. To add to our commitment of peaceful use of nuclear energy, our research reactor facilities at Necsra were the first to successfully implement large scale all Low Enriched Uranium (i.e. a grade of uranium that cannot be used in a nuclear weapon) isotope production in 2009.

Koeberg Nuclear Power station near Cape Town houses the only nuclear power reactors in Africa, each with a capacity of 900 MW (Megawatts). This is enough to provide continuous power for over two (2) million middle-income houses. With no viable coal or gas power stations for base-load electricity in the Western Cape, these reactors have been pivotal in creating stable and affordable electricity to the region for over two (2) decades. The safety record of these nuclear reactors is on par with the best in the world, with not a single nuclear radiation fatality to date. Nuclear Safety Culture and the ALARA (As Low As Reasonably Achievable) principle demands that even the doses and safety be continuously improved.

Since when are we considering a nuclear power programme?

Since the 1998 White Paper on Energy Policy, the South African Government has announced its intention that Nuclear Energy would be investigated as a potential source of electricity generation as part of an integrated energy planning process. In 2007, the draft Nuclear Energy Policy was published for public comment. After consideration of all inputs, the final version was promulgated by Cabinet in June 2008. The full version is available on the Department of Energy website (http://www.energy.gov.za/files/policies/policy_nuclear_energy_2008.pdf). Furthermore, the benefits of nuclear power, as outlined in the Nuclear Energy Policy include:

- Value addition from the beneficiation of uranium ore – we have the 5th largest resource of uranium in the world
- Contribution to social transformation and progression towards a more knowledge based economy through skills development and job creation
- Reduction of Greenhouse Gas emissions
- Increased security of energy supply through a broader mix of options
- Affordable electricity production for residential and industrial use
- Stable base-load power for coastal regions

More recently, in March 2011, the Integrated Resource Plan (IRP) 2010-2030 was endorsed by Cabinet. This came after an extensive public consultation, calculation and policy adjustment process. The IRP arrived at 9.6 GW nuclear power through an in-depth calculation process which considered the optimal mix based on a number of factors and constraints such as price, power availability, construction schedules and carbon emissions.

What is an Integrated Nuclear Infrastructure Review?

An Integrated Nuclear Infrastructure Review (INIR) is a review or assessment of the country's infrastructure as it relates to readiness to start purchasing, constructing and operating nuclear power plants. It is typically meant for countries who are constructing their first nuclear power plant. The assessment is done by answering an evidence based questionnaire on 19 of the key issues related to nuclear power plants. Readiness on each of these 19 issues can be divided into 3 phases indicating various degrees of readiness. This methodology was developed by experts at the International Atomic Energy Agency, of which South Africa is a member state. The full document is entitled "Evaluation of the Status of National Nuclear Infrastructure Development (NE-Series NG-T-3.2)" and is available on the IAEA website (<http://www.iaea.org/NuclearPower/Infrastructure/home.html>).

What is an INIR Mission?

The INIR Mission is the part of the INIR process where IAEA experts would come to South Africa to do an independent review of our nuclear infrastructure. This occurs after we have submitted our own self-assessment report as an input to the IAEA team for their consideration. This self-assessment was conducted by our local INIR team comprising of nuclear professionals from Government Departments and related nuclear organisations. Our self-assessment was completed in mid-2012, and in October 2012 an INIR Pre-mission was conducted in order to prepare for the full mission.

South Africa is set to conduct the INIR mission in early February 2013, where no less than ten (10) nuclear experts will be carrying out the review over the course of almost two (2) weeks. After the mission, the experts will complete a report on the assessment. Most importantly, gaps (areas of improvement) will be outlined, which will need to be addressed as part of the nuclear energy programme.

What happens if there are many gaps that still need addressing?

It is anticipated that most of the gaps that the IAEA will find have already been identified by the local INIR team during the self-evaluation process. These gaps have formed part of the action plan for the nuclear programme implementation and are being managed through the Phased Decision Making Approach, endorsed by Cabinet in November 2011.

With our vast experience, why do we still want to conduct an INIR Mission?

We are learning from the experiences of other countries which have also started expanding their nuclear power programmes. Since the Chernobyl accident in 1986 many countries, including South Africa, stopped their nuclear power programme. After almost 20 years, some of these have started expanding their programmes and are facing delays and cost overruns. We have also seen that many other countries that continued building nuclear power plants post Chernobyl, are able to do so with much reduced schedules and costs. The lesson taken from this is that in the 20 years, much of the basic knowledge of the construction phase needs to be refreshed and carefully considered to successfully construct nuclear power plants. We have therefore taken a conservative approach and conducted this review. We believe that a good nuclear safety culture would allow for even the basics to be questioned and answered. Once again South Africa is the first and only country with a nuclear power plant to conduct such a mission. We have been informed that other countries would soon follow suit.

What does the INIR Mission entail?

The INIR mission would entail the International Atomic Energy Agency expert team conducting an evidence based assessment on the 19 issues related to nuclear infrastructure for a nuclear power plant project. These 19 issues are described below:

1. National Position



Government support for a nuclear programme is fundamental to its success - this is especially relevant during the 10-15 year planning and construction phase. These long timelines are not attractive to private investors, and hence firm Government commitment is necessary during this period.

Nuclear power plants have a much longer life time than other power plants (over 60 years) and produce electricity at a relatively stable long term price compared to other generation technologies due to the much lower fuel cost. In addition, much of the fuel for the life time of the power plant could be purchased and stored relatively easily to further limit price variation.

Government support can be further reassured by public support for nuclear power. This makes sense for a country willing to secure long term price stability and security of supply, and nations with a long term outlook on these issues are the driving force behind nuclear programmes.

PHASED APPROACH AND CONCLUSIONS

Each of the 19 issues would be assessed in accordance with the various phases of the "Milestones Approach" of the IAEA and, these are:

- Phase 1: Considerations before a decision to launch a nuclear power programme is taken
- Phase 2: Preparatory work for the construction of a nuclear power plant after a policy decision has been taken and procurement readiness
- Phase 3: Activities to implement a first nuclear power plant

The Department of Energy would like to take this opportunity to re-assure the people of South Africa that nuclear power is a safe, affordable and reliable source of energy that can bring many benefits to our nation, as will be discussed in the next nuclear energy awareness message from the Department of Energy in conjunction with the South African Nuclear Energy Corporation (NECSA).

Disclaimer: This article is based on some documents of the IAEA but, represents the views of the Department of Energy which may or may not be the same as those of the IAEA.

In South Africa, the following are examples of firm Government commitment:

- ◇ Nuclear Energy Policy of 2008 defining the framework for a nuclear programme
- ◇ Integrated Resource Plan 2010-2030 stating the need for an additional 9,6GW of nuclear by 2030
- ◇ The National Nuclear Energy Executive Coordination Committee comprising of Ministers to make key decisions for the nuclear programme

2. Nuclear Safety

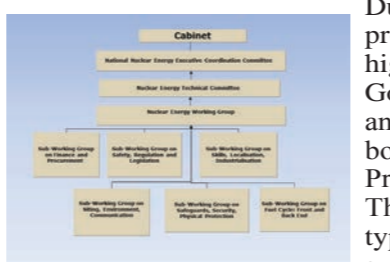


Safety is the highest priority of any nuclear programme, and the commitment starts at National Government, and permeates through the nuclear industry. The reason for this is that nuclear accidents (although very infrequent) can have large scale impact on a country, and a thorough understanding and appreciation of this is required. All of the issues in preparation of the infrastructure for nuclear power have some impact upon safety.

The National Nuclear Regulator (NNR) is the national nuclear safety authority ensuring that operators of nuclear reactor(s) adhere to stringent safety requirements in line with international standards as set out by the International Atomic Energy Agency (IAEA).

Having safely operated Koeberg nuclear power station for over 25 years, and the SAFARI-1 research reactor for over 45 years government believes that this is testimony to the fact that South Africa understands nuclear safety. However, a strong nuclear safety culture requires us not to rest on our laurels and assume that all is well. We continuously strive to improve safety. South Africa is party to almost all the International Conventions on Nuclear Safety, and Eskom has conducted many safety assessments and improvements of Koeberg Nuclear Power Station. We have also actively participated in all the nuclear safety conferences, long before the Fukushima disaster, and continue to do so even more avidly since that incident.

3. Management



Due to the complexity of a nuclear programme, it is essential to establish a high level cross-functional inter-ministerial Government body to improve coordination and monitoring. The IAEA refers to such a body as the NEPIO – "Nuclear Energy Programme Implementing Organisation". The implementation of the programme typically would need other organisations such as a designated plant owner and operator, a regulatory body and technical support organisations.

For our South African nuclear programme, the NEPIO has been established in terms of the NNEECC and Nuclear Energy Technical Committee and supporting structures. Eskom has already been designated as an owner and operator of the nuclear power plants in South Africa. We also have a National Nuclear Regulator which has been established in the early 1990s. The South African Nuclear Energy Corporation as well as other institutions would serve as valuable technical support organisations.

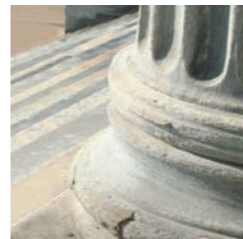
4. Funding and Financing



The funding and financing for a nuclear power programme are very large during the construction of the nuclear power plants. On the other hand the power plants have a very long life time with low operation costs, resulting in one of the lowest average electricity costs. The challenge of securing finance for the initial construction stages is in most cases primarily assured through strong Government backing. During the nuclear plant mid-life (or profit making stages), nuclear power becomes very attractive for private investors, who are willing buyers of nuclear power plants.

The recent recession would make the availability of financing for nuclear power plants difficult. On the other hand, many nuclear export countries seeking to generate income and jobs are willing to provide finance for nuclear power plants. South Africa is at the pinnacle of this point and we are currently evaluating many options to ensure sufficient finance for the nuclear programme.

5. Legislative Framework



The strong legal framework for a nuclear programme is essential to ensure it is well regulated from a safety and security perspective. In addition, Nuclear power programmes cannot be operated in isolation. Legislation should therefore implement, or authorise implementation of, any international instruments to which the government is a party. Some of these instruments are useful during emergencies where assistance can come from other

member states. South Africa has all the necessary legislation for a nuclear programme and is in the process of reviewing these to align with changes in the international environment. This includes lessons learnt from the Fukushima nuclear disaster as well as other institutional aspects relating to Governance and reducing unnecessary red-tape to support commercial activities. We are also party to most international instruments and are planning to accede to more in the near future.

6. Safeguards



Not to be confused with Safety, nuclear safeguards refers to the safe "keeping" of nuclear materials and technology that can be used for making nuclear weapons. This is enforced domestically by most countries and internationally through activities of the multinational organisations such as the International Atomic Energy Agency. Methods of enforcement include accurate accounting system for keeping track of material such as uranium. As mentioned previously, South Africa has many accolades in the field of nuclear safeguards. All our nuclear facilities are open to inspection by the IAEA. We are also continually making strides to improve nuclear safeguards both domestically and internationally.

7. Regulatory Framework



This is closely linked to safety and refers primarily to the establishment of an independent and competent nuclear regulator, whose purpose is to protect people and the environment from the harmful effects of nuclear radiation. A regulator would also develop laws, codes, and standards to ensure the nuclear industry has a clear understanding of the limits and control of risk acceptable to the country. South Africa has the National Nuclear Regulator to ensure a strong regulatory framework. It is governed by a Board that is representative of civil society, industry and Government. The NNR is also a member of several international regulatory collaborative platforms and aligns itself with the best international practice by sending staff for regular training both locally and abroad.

8. Radiation Protection



Radiation protection can be considered as part of nuclear safety, but extends beyond the operation of the nuclear facility. It includes protection of people and the environment during all conditions, including transport and accidents. For example the establishment of an environmental monitoring system to evacuate people during an emergency is a radiation protection measure.

The National Nuclear Regulator of South Africa is tasked with the role of ensuring people are protected from the harmful effects of radiation.

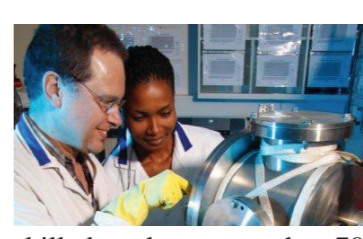
9. Electrical Grid



An electrical grid is the transmission lines made of wires that transport electricity from power plants to the users, such as households and factories. These are often seen in fields surrounding roads. Due to their large electricity production capacity, Nuclear Power Plants need strong transmission lines and the country should ensure that these are available to carry the power from the power plants to the users. Depending on the location of the nuclear power plant, these may have to cover large distances and could take decades to construct, ie. even longer than the nuclear power plant construction.

South Africa's potential nuclear power sites are perfectly suited at the coast where local electricity power plants are needed. Most of the grid infrastructure is in place and well maintained by Eskom, our national grid operator.

10. Human Resources Development



Nuclear Power Plants require some of the most advanced skills of any industry. This is to ensure their efficient, safe, and reliable operation. Even the artisans and tradesman for a nuclear programme have to be highly skilled and continually assessed for competency. A nuclear programme will require thousands of skilled workers, more than 70% of whom will be artisans and technicians.

South Africa has got several higher education institutions and programmes that can adequately train and develop the graduate level skills needed for a nuclear programme. Necsra produces some of the best artisans and technicians. However, there is limited capacity and, one of the key objectives of the nuclear programme is to expand this capability significantly.

11. Stakeholder Involvement



Nuclear energy has a poor track record of being a very isolated by excluding broader society from its development. This probably stems from the culture of its origins in weapons programmes. Consequently, the only messages that got out into the public space were when something really bad happened – accidents and explosions. As a result many people fear and oppose nuclear power. There is an international drive to demystify nuclear power through education and information campaigns. The purpose of this is not to promote nuclear power, but for people to understand it. The development of our nuclear programme will be based on the premise that people understand the risks and benefits of nuclear power through open and honest dialogue. Recent surveys have shown that more than 50% of South Africans do not know what nuclear energy is about and hence do not have an opinion to support or oppose it.

12. Site and Supporting Facilities



Establishing a nuclear power site is crucial to building a nuclear power plant. The optimal location for a nuclear power plant would put nuclear safety first. A site that is unsafe should not be used for nuclear power plants. Other factors such as local population acceptance, location to transmission infrastructure and local worker settlement should also be optimised. It takes at least 5 years to characterise a site for suitability for nuclear power plants.

Eskom has been studying at least five sites for nuclear power plants since the mid 1980's when there were plans to expand the nuclear programme before the Chernobyl Disaster. We are in a fortunate position to have these sites well characterised and, can therefore, be assured of good safety characteristics. One of these sites, namely Thyspunt in the Eastern Cape, has been earmarked as the next nuclear power plant site after Koeberg in the Western Cape. The Environmental Impact Assessment for the Thyspunt site is currently close to its final stage.

13. Environmental Protection



The environment surrounding a nuclear plant is impacted during its life time. Beyond the radiological perspective, there are other factors such as thermal, hydrological, and socio-economic impact. These need to comply with international and domestic standards and regulations which are there to ensure that we do not destroy our environment.

In South Africa, the Department of Environmental Affairs ensures protection of one of our most valuable resources, the natural environment. Legislation such as the National Environmental Management Act (NEMA), Act No. 107 of 1998, requires all nuclear sites to undergo an Environmental Impact Assessment, where public consultation is mandatory and duly considered before a site can be declared acceptable for nuclear power installations.

14. Emergency Planning



Even though nuclear plants are designed to be safe, the probability of an accident occurring is not zero. In order to be prepared for an accident, there needs to be adequate emergency procedures to ensure the population and environment can be protected from the release of nuclear radiation. Typically it must be ensured that all people in the vicinity can be evacuated timeously, interventions are on standby to reduce the extent of the accident and consequent releases, and that people are informed of the risks and procedures to ensure their safety. Following Fukushima, it is imperative that safety of persons and environment around the facility should be maintained even during emergencies and therefore regular emergency exercises are becoming very important. South Africa, through ESKOM, NNR and Department of Energy, is in the process of incorporating the lessons from the recent Fukushima nuclear accident, especially with regard to emergency planning. In addition we are party to the international instruments for emergency management to ensure a transparent process. Nuclear Industry role players are aware that even a minor nuclear accident can bring an end to their business and therefore have a vested interest to ensure nuclear safety and emergency preparedness.

15. Security and Physical Protection



Security and physical protection are intended to prevent malicious acts by inside or outside adversaries that might endanger the public or the environment. Programmes for security and physical protection for the nuclear power plant and other facilities, nuclear material, fuel, and radioactive waste transportation, and storage need to be provided at all times. Nuclear security requires the concerted effort and commitment of all organisations involved in planning, designing, constructing and operating a nuclear power plant.

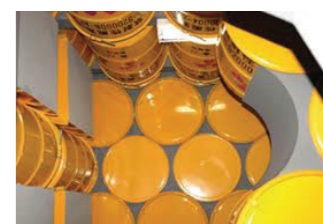
There is close synergy between the nuclear security and physical protection organisations in South Africa. These include the Department of Energy, State Security, Department of Defence, SAPS, and the NNR.

16. Nuclear Fuel Cycle



Nuclear fuel is produced from uranium. There are several stages that natural uranium goes through before it is ready for use in a nuclear reactor. This is known as the front end of the fuel cycle. Some countries have the capability to carry out all these stages, and hence ensure full beneficiation and security of supply. One fuel load in a reactor typically lasts for 18 months. A country must ensure it has adequate access to nuclear fuel to supply its nuclear reactors. Once fuel is used, there are several stages that are necessary to recycle or discard it as nuclear waste. South Africa once had the full capability for the front end of the fuel cycle to supply Koeberg Nuclear Power Plant with fuel. However, this was later dismantled. The nuclear energy policy states that we will investigate the feasibility of establishing this capability once again, given the much more expanded programme it would make socio-economic sense to have local fuel production that could also be exported.

17. Radioactive Waste



The handling and disposal of radioactive waste is an essential issue associated with the application of nuclear power. Radioactive waste needs to be managed in such a way as to avoid imposing an undue burden on future generations. That is, the generations that produce the waste have to seek and apply safe, practical and environmentally acceptable solutions for its long term management. The issue of radioactive waste has to do with spent nuclear fuel, as most of the other types of waste disintegrate to background levels within a few hundred years.

South Africa has established the National Radioactive Waste Disposal Institute which will be responsible for the management of nuclear waste. We also endorse the "polluter pays principle", implying that the waste generators need to pay for the complete management of radioactive waste produced. Currently, a fund is being set up for ensuring the funds are accumulated during production. We are also signatory to the international legislation around management of radioactive waste and, therefore, will ensure that treatment of waste is done in accordance with internationally acceptable prescripts that protect future generations from this potential burden.

18. Industrial Involvement

Nuclear Power Plants require a large number of advanced and high quality components (parts and spares). The manufacture of these components is usually a lucrative industry and can be a source of significant jobs and income for the local manufacturing industry. The South African Government has repeatedly emphasised the need to maximise local content of nuclear power plants, for the purpose of creating jobs and driving the knowledge economy. This is aligned with the New Growth Path, National Development Plan, and Industrial Participation Programme. Studies are currently underway to ensure optimal localisation can be achieved. Most industries are already preparing for potential involvement in the nuclear programme.

19. Procurement

Procurement is the process followed to acquire the nuclear power plants from a supplier or vendor. It involves vendor evaluation and negotiation of contracts to suit what the country wishes to achieve.

Preparations to launch the procurement of nuclear power plants are currently underway in South Africa. This is being led by the National Nuclear Energy Executive Coordination Committee.



energy

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