ASSAf STATEMENT ON NUCLEAR ENERGY SAFETY

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INTRODUCTION

Both public and political attitudes on the introduction and use of nuclear energy change with time and events. A movement towards extending its use and building new advanced power stations is driven largely by the contribution that nuclear energy can make to a reduction in greenhouse gas emissions and hence nuclear energy's positive role in the climate change debate, as well as its contribution to satisfying the world's increasing demand for base load electricity.

Nuclear fuel resources are plentiful, but their economic viability remains uncertain in some cases. South and southern Africa are particularly well endowed with these resources. In addition to the well-established use of uranium (as ^{235}U), research into developing viable thorium (^{232}Th) breeding to the lighter fissile isotope of uranium (^{233}U) holds future promise, especially as constraints develop in uranium supply. Proponents point to the potential for some thorium fuel cycles to be cleaner, safer and more efficient than the present $^{235}U/^{238}U$ fuel cycle.

In 2011, the South African government approved the Integrated Resource Plan for Electricity 2010-2030 (IRP 2010) (Department of Energy, 2011), which provides for the installation of 9.6 GW of additional nuclear energy capacity by 2030. If there are no revisions to the IRP 2010, it is envisaged that the first new nuclear plant will be commissioned in 2023.

Should the South African government continue with its plans to expand the contribution of nuclear energy to the energy mix, there is no room for complacency, particularly after the March 2011 events at the Fukushima Daiichi nuclear power plant in Japan. These events have focused attention on safety and risk as key issues in the use of nuclear power and have created an understandable anxiety about the use of nuclear technology.

South Africa needs to heed the lessons learned from the Fukushima Daiichi accident, as well as other accidents and ensure that these lessons are incorporated into current and future nuclear energy planning.

NUCLEAR SAFETY, SECURITY, SAFEGUARDS AND RISK

The issue of safety is a top concern in the case of nuclear energy. There are a number of key factors to consider.

- The first is *the safety of current and future nuclear power stations in South Africa*

  It is essential that the current two reactors at Koeberg, north of Cape Town, continue to be maintained and operated to the highest international standards. Clearly any new reactors have to incorporate the current expertise in safety systems and procedures, efficiency of operation and construction, and be located optimally with respect to environmental and human considerations.

- The second is *that mining and processing operations are conducted safely*

  Mining uranium exposes miners to radiological hazards, which are mainly due to airborne radio-nuclides and those that are concentrated in minerals processing operations, or form part of the "tailings" from production. These include radon and its short-lived daughter products, and radium and polonium, in addition to uranium itself. Mining operations in southern Africa, including South Africa, must take all the necessary precautions to ensure that mining injuries and deaths are minimised and the exposure to radiation complies with international standards. Furthermore, "tailings" from uranium processing must be disposed of in an environmentally acceptable manner and according to international standards.

- The third is that *new nuclear power stations should be designed to minimise the cost and risks when they eventually have to be decommissioned*

  While the risks of large scale releases of radioactivity during decommissioning of nuclear facilities are lower than during the operational phase, due to the non-routine nature of decommissioning tasks, the risk of worker exposure is potentially higher. There is a need for careful, advanced planning, appropriate national and international regulation, innovative technologies, suitably qualified and experienced people and resources, leading to a decommissioning process that is safer, faster and cheaper (UNEP, 2012).

- The fourth relates to *the management of spent fuel (used fuel)*

  There is a need for strategic long-term planning at the outset, as the multi-decade to century timescales of new nuclear programmes require this (Royal Society, 2011). It needs to be transparent to the public that different technologies are required to deal with short-lived (years) and highly active decay products, as opposed to very long-lived (millennia) decay products with very low activity.

  Geological systems may be found to be significantly more complex than was anticipated at the onset of nuclear site investigations, as in the case of the politically contested Yucca Mountain project in the United States. As a consequence, it is important to establish competent long-term, funded Research, Development and Demonstration teams that conduct scientific and engineering, evidence-based and peer-reviewed research to devise and support spent fuel management strategies and to keep abreast of developments. In addition, appropriate engineering project and operating experience skills need to be used for practical application of good practice and established engineering know-how to reduce the cost of facilities in the long-term.

- The fifth is *proliferation of nuclear weapons and related risks*

  It is important to acknowledge that nations must remain vigilant to ensure that proliferation risks are reduced. The International Atomic Energy Agency (IAEA) is central to managing dual-use nuclear risks. The IAEA should receive all support possible to exercise its safeguards inspection responsibilities (Royal Society, 2011).

  Proliferation concerns are a major inhibitor to peaceful nuclear programmes being established. All universities and industries that are involved in civil nuclear power programmes should ensure that relevant education and awareness-raising courses are developed for relevant personnel.

In order to avoid the use of plutonium in the spent fuel in nuclear weapons, it should be made as unattractive as possible (Royal Society, 2011). This means that the barriers for its use (such as the isotopic radiation barriers) should be increased. For example, nuclear fuel should be developed and nuclear reactors should be configured to enable the maximum burn up, consistent with efficient and economic operation of the reactor, to reduce potential access to Pu-239 (Royal Society, 2011). Furthermore, some thorium fuel cycles substantially minimise the risks associated to the proliferation of nuclear weapons.

LESSONS LEARNT FROM THE FUKUSHIMA DAIICHI ACCIDENT

The severe earthquake (9.0 on the Moment Magnitude Scale) and consequent tsunami that struck the north-east coast of Japan on 11 March 2011 led to a series of events, which resulted in fuel meltdown in three reactors at the Fukushima Daiichi nuclear power station. While the reactors had been automatically shut down after the earthquake, the complete station blackout precipitated the failure of the several emergency cooling systems following the tsunami, which then led to the accident conditions in the plant. Key lessons learnt can be summarised as follows (Government of Japan, 2011):

- *The need to re-examine the validity of probability estimates for a severe nuclear accident*

  Events of a very low probability can occur quasi-simultaneously, thereby triggering a severe accident and presenting challenges for current safety methodologies.

- *The need to strengthen preventive measures against a severe nuclear accident*

  Although the reactors and major equipment at Fukushima Daiichi survived the earthquake, the external power supplies were damaged, thus compromising the injection of water to cool the nuclear fuel in the reactor core and used fuel pools. Design guidelines should take account of a potential power loss and devise an alternative water injection system. There is also a need to limit the quantities of fuel assemblies in fuel storage pools, and to consider systems of enhanced containment, filtration and controlled release for potential radioactive emissions, including the sharing globally of safety upgrades that have been applied in some jurisdictions but not in others. All aspects of the nuclear fuel cycle must be hardened against catastrophe. Fukushima showed, for example, the vulnerability of the internal used fuel pools, which represent large inventories of nuclear material in immediate proximity to operational reactors. These were much less protected, especially in the case of the same facilities being applied for fuel unloading for maintenance and particularly some design aspects for old reactors.

  The possibility of hydrogen deflagration and detonation outside the reactor pressure vessel was underestimated by the Japanese regulators and operators. Current operating plants and future designs should take into account the existing best practice and additional measures to eliminate this risk.

- *The need to enhance emergency response to nuclear accidents*

  The possibility of a hydrogen explosion outside the reactor pressure vessel, not only inside the vessel, should be taken into account during emergency planning.

- *The need to strengthen safety infrastructure, particularly the legal framework and safety regulatory bodies*

  Criteria and guidelines and adequate human resources should be ensured. Authorities must organise and support training of personnel needed to run nuclear power infrastructure Decisions taken by authorities need to be guided by best available information. Research into severe accidents should be strengthened.

- *The need to manage radioactive waste production, including contaminated water, without delay*

  The challenge is to manage the waste timeously to avoid the spread of radioactivity and to decontaminate water for recycling.

- *The need to find decontamination methods that will not spread radioactivity to other areas*

  It may be required to decontaminate large areas in order to allow residents to return quickly to the area. A challenge is to find decontamination methods that will contain the radioactivity during and after such activities.

INVOLVEMENT OF THE PUBLIC IN NUCLEAR ENERGY

The key message here is that the public cannot be ignored. Whereas in the past it may have been possible to take decisions about a nuclear future based on standards and technical factors, this is no longer acceptable practice. There has been a paradigm shift in the structure of power in many countries, implying far greater public awareness, interest and activism. The importance of providing relevant and evidence-based information to the public from a variety of trusted sources and managing communication of safety and risks in a transparent and credible manner is indispensable.

RECOMMENDATIONS

If nuclear power in South Africa is pursued, as planned, it would be important to:

- Enhance research and develop human capacity in nuclear energy, particularly in nuclear safety, security, safeguards and nuclear waste. The entire science base related to nuclear energy must be developed and decision-makers must be provided with balanced, evidence-based science to make informed decisions. Additional priorities include further research into the use of thorium as a fuel; investigation into the occurrence of natural and anthropogenic events in the region; effects of low doses of radioactivity on the local environment including fauna, flora and water; management of accident remediation; effects of severe accidents, in particular the dispersion of radionuclides in the environment; and the safe disposal of nuclear waste.

- Strive towards the inclusion of fourth generation nuclear reactors in the later phases of the new nuclear build due to the following potential benefits:
    - Reduced decay times of nuclear waste
    - Greater energy yield from an equivalent amount of nuclear fuel
    - The ability to 'burn' fissionable radio-nuclides that are contained in used fuel from

currently operated reactors in the production of electricity with fourth generation reactors
    - Improved operating safety
    - The higher abundance of thorium on earth when compared to uranium

- Develop the capacity of South African Industry to participate with leadership and localisation in all aspects of the nuclear energy life cycle. This will provide the commercial base that will sustain the development of human capacity, which can address all concerns around nuclear energy, and create employment and economic growth from this opportunity.

- Support the work of the IAEA, which provides the framework for global nuclear energy safety, and enhance international cooperation to ensure a continuous learning environment.

- Acknowledge nuclear energy safety as an overriding priority. This is the only way to engender confidence amongst the public.

- Promote an integrated approach to safety and security, risk assessment and management. This approach would ensure that safety, security and proliferation risks would no longer be considered in isolation. The integrated approach should be taken into account from the outset, and in the design of the nuclear facilities (Royal Society, 2011).

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