CSE 031

Issues Relating to Licensing and Liability for Small Modular Reactors in Africa

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Summary

The internationally accepted nuclear regulation policy is for each country to undertake first principle analysis and approvals for the technical design and operating rules, benchmarking against nationally determined regulations and standards that are aligned to the IAEA standards. This is largely due to the acceptance that the liability of any risk emanating from the operation of a nuclear power plant is the strict liability of the licensed operating company locally. This approach results in a very large national technical regulator with expensive foreign support along with a very large in-house engineering team in the licensee. While this is economically credible in a technically advanced country with an existing nuclear fleet (such as Canada) it is an extreme overhead on a African country considering the deployment of a limited number of SMRs. The paper discusses how it may be possible to create a pan-African regulation option for SMRs, possibly based on the African Union.

KEYWORDS

Nuclear, SMR, Regulation, Utility, Safety, Economics

1. Introduction

One of the key issues for the operation of nuclear power plants is that of liability for damage caused by nuclear accidents. In other industries (e.g. aviation industry, chemical industry etc.) the normal practice is that, within the national regulations, the liability for any damage to the public is a function of which organisation was at

fault. For example if an airliner crashes, the liability could be with whichever aspect caused the crash, be it the aircraft designer, the airline itself, the engine manufacturer and so on. Due to the creation of the commercial nuclear industry under the shadow of the nuclear weapons programs and with the fear of the impact of nuclear radiation, the civil nuclear industry has a virtually unique system where the operator of the nuclear plant (the holder of the operating license) has strict liability for any nuclear damage caused by the plant. There is no defence by the operator against the claims from those affected and there is no option for affected party to sue anyone other than the operator. While this may seem to be an elegant and straight forward method of resolving a highly controversial issue it puts a very significant responsibility on the nuclear operator and the related national regulatory body.

2. Discussion

This approach is specified in international conventions such as Vienna Convention "*no person other than the operator shall be liable for nuclear damage*"[1]. This is aligned to most national regulations such as the South African "*a holder of a nuclear installation licence is, whether or not there is intent or negligence on the part of the holder, liable for all nuclear damage caused by or resulting from the relevant nuclear installation*"[2]. Another example is the Swiss Federal Office of Energy "*Under the Federal Nuclear Energy Liability Act, operators of nuclear installations bear unlimited liability for nuclear damage arising from the operation of their installations*"[3].

This is not just a financial insurance requirement but requires an engineering competence that license holders "*should maintain an 'Intelligent Customer' capability for all work carried out on their behalf by suppliers that may impact upon nuclear security.*"[4] This implies a full design understanding of the installation and the knowledge of specifications for all components and systems. This requirement explicit states that the related resources must be in-house expertise and cannot be contracted out.

In a similar industry that is perceived as a high risk, the airline industry, it is widely accepted that the designer and constructor of the aircraft is liable for the fundamental safety of the aircraft, given that the operator obeys the operating, inspection and maintenance rules and programs laid down by the designer and any modifications considered essential by the designer are implemented. In terms of the certification of the design, it is accepted that the aviation authorities in the country of origin are seen to be competent to assess the design. This was tested in the issues relating to the Boeing 737 Max problems in the previous years. Under these circumstances it is accepted that the "Design Authority" for the aircraft is the original designer throughout the service life of the aircraft. With this relationship it is reasonably possible for a small African airline to purchase an airliner without the full set of liability obligations. The airline will have to train the aircrew in line with the designer regulations and will have to have the aircraft maintained by an organisation certified as competent by the designer. Similarly the airline regulator will be limited to confirming that the local airline is following the design requirements.

This is not the case with a nuclear power station. As all the liability rests on the operator both they and the national nuclear regulator are required to have a full understanding of the design of the power plant, along with the operation, inspection and maintenance requirements. This results in the operator of the plant being the "Design Authority" of the plant, with all the overheads that this requires. It is notable

that due to national requirements, unlike the aviation industry, virtually every country has variations of the original design with different safety justifications. This also largely applies to the regulator. If one considers the situation of South Africa, with one nuclear power station, Koeberg, of some 2000MW then the operator, Eskom, has an engineering and licensing team of over 200 skilled people and the regulator, the National Nuclear Regulator, has a staff (2022 annual report) of 173, largely committed to the regulation of the Koeberg power station.

Such a nuclear regulator has taken about fifty years to produce. South Africa was the first African country with a Nuclear Regulator. It was routed in the legislated establishment of the Atomic Energy Board (1948), which became the Atomic Energy Corporation (AEC) just before South Africa became a member state of the IAEA in 1957. In 1982, again be legislation, the AEC became responsible for all nuclear matters in 1982, with the Council for Nuclear Safety (CNS) being established as an independent consultative body. The CNS became the fully independent regulatory body in 1988. In yet another new Act in 1999, the National Nuclear Regulator (NNR) superseded the original CNS, fully by 2000. This process was accompanied by a deep process of human capacity building, essentially over more than two generations.

Egypt is now in the construction phase of four nuclear power reactors at El-Dabaa. It will be the second country in Africa with Nuclear Energy (not counting small research reactors) . Egypt had a similar deep and long process to develop its regulator. First was the formation of its Atomic Energy Commission in 1955, evolving to the Egyptian Atomic Energy Authority (EAEA) in 1956. The Nuclear Regulatory and Safety Committee (NRSC) was established in 1982. The NRSC formed the National Center of Nuclear Safety and Radiation Control (NCNSRC) within the EAEA. Finally the Egyptian Nuclear and Radiological Regulatory Authority (ENRRA) was established as an independent nuclear regulatory body in 2010.
The long lead time to the development of the National Regulator reflects the complexity of nuclear reactors, which involve many sub-disciplines in science and engineering, each at an extreme level of competence.

This level of engineering support required for a nuclear power plant is not specifically related to the size of the nuclear fleet, but primarily the diversity within such a fleet. In relation to a single nuclear plant it can be seen that under the current international approach to nuclear liability and related licensing a base overhead of some 300 skilled personnel can be expected in a country. With a power plant size of some 2000 MW this, while expensive, can be justified as part of the overall advantages of such a plant.

A large reactor or set of reactors, (Koeberg about 2GW and El-Dabaa about 5 GW) is not appropriate at this stage for most countries in Africa, due to matching the size of a single source with the grid capacity. Smaller reactors, such as the Small Modular Reactors (SMRs) of around 50MW – 300MW would be better matched. However, in the case of a small SMR project the current regulatory model would be a significant barrier to entry.

Estimates of staffing for a 924MWe 12 unit NuScale plant is 270 [5] and the staffing for the 210MWe HTR-PM operating in Shandong, China is quoted at 175. In the African context there are many national grids where unit sizes of about 100MW would be appropriate and therefore the “strict liability” requirement would imply a more than doubling of the resources to operate the early units. It can be seen that this would be a significant barrier to entry for SMRs in the African market.

3. Proposed solution

The African continent has adequate resources to support the deployment of SMRs into the small grids that would benefit from them to allow industrialisation while moving towards a Net Zero Carbon status by 2050. The issue of achieving this is constrained by the infrastructure overheads that are induced by the current international licensing regime.
It is proposed that there has to be a number of changes to the way that nuclear power is managed to resolve this:

1. The African Union, in conjunction with the SMR vendor, undertakes the equivalent of the US Design Certification (DC) of SMR designs.
2. This Certification is supported by the existing nuclear regulators in the AU, such as the South African National Nuclear Regulator.
3. It is accepted that the SMR design(s) that obtain a DC are completely standardised.
4. The SMR vendor accepts liability for nuclear damage caused by errors in the design of the SMR.
5. The national regulator in the country of construction accepts the DC as being appropriate and undertakes the QA/QC that the design is constructed and installed as per the reference design.
6. The operator(s) of the specific SMRs installed across the continent under this scheme have a joint liability for nuclear damage on all the related SMRs. There may, in fact, be a trans-national operating company.

4. Conclusions and recommendations

SMRs offer a potential solution to Africa's chronic electricity shortage in a low carbon world however there are direct technical and economic issues. The current infrastructural and legal construct makes the "roll out" of SMRs in diverse African countries very challenging. For these to be resolved there needs to be a different approach to SMRs in the region to that historically used in the developed countries.
For SMRs to effectively assist Africa to meet its needs for industrialisation within a Net Zero Carbon world there needs to be a continent-wide agreement to allow supra-national nuclear licensing and liability in place of the current international practice.

References

1. IAEA/INFCIRC500 20 March 1996 Vienna Convention on Civil liability for nuclear damage
2. National Nuclear Regulator Act" Act No 47 of 1999
3. Swiss Federal Nuclear Energy Liability Act www.bfe.admin.ch/bfe/en/home/versorgung/kernenergie/kernenergiehaftpflicht.exturl.html/
4. ONR - PROCUREMENT AND INTELLIGENT CUSTOMER CAPABILITY www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-4.1.pdf
5. NuScale SMR Technology – An Ideal Solution for Repurposing US Coal Plant Infrastructure and Revitalizing Communities - www.nuscalepower.com/-/media/nuscale/pdf/publications/nuscale-smr-technology-an-ideal-solution-for-coal-plant-replacement.pdf