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The Licensing of the Pebble Bed Modular  
Reactor (PBMR) in South Africa

Some Regulatory Challenges

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# Introduction

- The South African Electricity utility, Eskom, is committed to investigating alternative energy sources. One of the many technologies currently being investigated is the Pebble Bed Modular Reactor (PBMR) .
- In terms of the National Nuclear Regulator Act (NNRA) (Act No 47 of 1999), no person may site , construct, operate etc.. a nuclear installation, except under the authority of a nuclear installation licence (NIL), granted by the NNR.

# Introduction

- In response to the early investigation from Eskom the NNR had been proactively reviewing aspects of High Temperature Gas Cooled Reactor (HTGR) technology from 1998-99, in anticipation of the PBMR licence application.
- In July 2000 the NNR received a Nuclear Installation Licence (NIL) application from Eskom for a PBMR Demonstration module electricity generating power station

# Challenges faced by the National Nuclear Regulator -NNR

- With the introduction of the licensing of this "new" reactor technology in South Africa the major challenges faced by the NNR were/are mainly related to
  1. The adjustment of its internal human resources capacity (numbers and competencies/expertise) to undertake the licensing review of the PBMR and
  2. The adjustment of the regulatory philosophy and processes to the licensing of a "first of a kind" reactor project

# Challenges faced by the NNR

## Human resources capacity

- At the onset of the PBMR Project (1998-99) the NNR staff, were more experienced in licensing of Light Water Pressurized Water Reactors.
- In terms of the human resources capacity of the NNR, it became evident that in order to undertake the necessary licensing work associated with the PBMR reactor technology it will clearly be necessary to bolster the NNR staff and to develop in-house expertise in gas/graphite reactor technology

# Challenges faced by the NNR

## Human resources capacity

- A campaign of identifying potential local and international Technical Support Organizations in this reactor technology was started.
- It was concluded that at that time there were no local institutions that could provide such specialized services.
- Thus contact was established with various international organisations that could possibly provide the NNR with the necessary consultancy services and the necessary expertise and experience with this type of reactor technology.

# Challenges faced by the NNR

## Human resources capacity

- Two international companies have been providing technical services to the NNR for the formulation of regulatory requirements/guidance, review of the PBMR safety submissions and internal capacity building of the organisation.
- To date the support of these two international companies to the NNR has proved very successful and beneficial to the progress of the licensing review and also to the capacity building of the regulator.
- It is envisaged that their services will be retained for future technical support, and capacity building of the regulator, during the various stages of the PBMR licensing.
- Future interaction with other relevant Nuclear Regulatory Authorities internationally is being investigated and could be beneficial in the overall licensing review

# Challenges faced by the NNR

Adjustment of the regulatory philosophy and processes to the licensing of a “first of a kind” reactor project.

- Before presenting the adjustment that the NNR made to its regulatory processes and philosophy it is important to first understand the licensing philosophy and processes which the regulator applied to the licensing of the first nuclear power plant in South Africa .

# Philosophy/process applied to the licensing of the Koeberg Nuclear Power Station (KNPS)

- Eskom operates the Koeberg Nuclear Power Station, comprising two 900 MWe pressurised water reactors (PWRs), on the Atlantic coast 40 kilometres north of Cape Town
- The station was built by a French consortium, as a “turnkey” project.
- First Nuclear Licence NL-1 was issued to Eskom for the construction of the power station, which commenced in 1976. The two units were brought into commercial operation in July 1984 and November 1985 respectively.

## Philosophy/process applied to the licensing of the Koeberg Nuclear Power Station (KNPS)

- The legislation , applicable at that time, was broad enabling legislation that empowered the regulatory body to apply whatever conditions are necessary to provide for the protection of persons, property and the environment against nuclear damage and enabled the regulator to call for whatever information was necessary in order to evaluate the licensee's application.
- These broad principles are still applicable in the revised legislation of 1999
- On the basis of these statutory requirements, the licensing process adopted, for the licensing of the Koeberg Nuclear Power Station (being a "turkey project" ) was that the design of the plant to be constructed should be based on one that was licensed in the country of origin and that utilised design codes and criteria that were broadly recognised internationally

## Philosophy/process applied to the licensing of the Koeberg Nuclear Power Station (KNPS)

- In terms of meeting international norms and standards, the design and general operating rules of the nuclear installation conformed to the applicable laws, regulations, codes and standards that were used in the design and construction of the nuclear installation as used in the reference station in France being Tricastin
  - Which at that time were largely based on the US 10 Code of Federal Regulation 50 and associated design codes and standards
- In addition, the design was required to be subject to a quantitative safety assessment making use of probabilistic risk assessment techniques which demonstrate compliance with the quantitative risk criteria laid down by the regulatory body

# Regulatory philosophy/process adopted for the licensing of the PBMR

- As indicated previously the licensing philosophy of the NNR is not prescriptive as far as the adoption of codes and standards to the design and operation of the Nuclear Installation as long as the applicant or the holder of an authorization adopt and apply internationally acceptable, proven standards and practices.
- The regulatory philosophy applied to the licensing of the KNPS, summarised in previous slides, presented some challenges to the NNR, in terms of its applicability to the PBMR, some of which are indicated in the next few slides.

## Regulatory philosophy/process adopted for the licensing of the PBMR

- One of the major aspects of the PBMR licensing process, which must be thoroughly considered as an integral part of the development (by the applicant) and review (by the regulator) of the safety case, is the credibility of the PBMR design basis and of the safety case.
- Unlike Light Water Reactors (LWRs) such as the Koeberg Nuclear Power Station, for which well-researched and documented design criteria, rules, codes and standards , operational data etc..are readily available, broad international consensus has not been developed on general design criteria, design rules codes and standards for the PBMR..

## Regulatory philosophy/process adopted for the licensing of the PBMR

- Although High Temperature Gas Cooled Reactors have been licensed and operated elsewhere in the world, no international “off the shelf” package is available for defining the design basis and the safety case of the PBMR.
- As part of the safety case the establishment, documentation and assessment of the PBMR design basis, applicable codes and standards etc..is thus an important step in the licensing process and is receiving major attention by the designers, applicant and the NNR

## Regulatory philosophy/process adopted for the licensing of the PBMR

- The KNPS reactors were subjected to licensing requirements developed in the 1970's, one of the first challenge faced by the NNR was to develop licensing requirements for this "new " type of reactor
  - taking cognizance of reactor operating experience, developments in international safety standards and application of these in the design of new generation of reactors such as for example the European Pressurised Reactor (EPR)
- The NNR, with the support of its international Technical Support Organisations, developed and published the first revision of the "Basic licensing requirements for the PBMR" in 2000.
  - This was followed by the progressive development of many specific Regulatory Requirements and Guides documents (some still in development) in support of these Basic Licensing Requirements which form the basis for the NNR review of the safety case as presented by the applicant.

## Regulatory philosophy/process adopted for the licensing of the PBMR

- The next challenge faced by the NNR was to provide guidance to the applicant and the designer on the processes that will need to be undertaken to demonstrate compliance with these requirements.
  - Development and implementation of a structured framework/process to develop the PBMR safety case for which, as opposed to LWR's, well-researched and documented safety case framework ( e.g Safety Analysis Report) , design criteria rules, codes and standards are not readily available.
  - This process also provides a logical link between the various steps of the design process, the safety assessment and the development of operational support programmes

# Regulatory philosophy/process adopted for the licensing of the PBMR

- Within this framework the main components for the development and review of the PBMR safety case are:
  1. **The Safety Case Philosophy (SCP)** providing the intellectual and philosophical arguments of how PBMR safety will be demonstrated to meet the safety requirements set by the NNR in respect of the PBMR.
    - These refer to the broad safety objectives of the PBMR.
    - The process for developing the SCP also involved the systematic identification of Key Licensing Issues (KLIs), applicable to this type of reactor technology, which will need to be addressed as part of the demonstration of the PBMR safety objectives in the Safety Analysis Report.

## Regulatory philosophy/process adopted for the licensing of the PBMR

- Within this framework the main components for the development and review of the PBMR safety case are (cont.):
- 2. The Safety Analysis Report (SAR) for the PBMR, and other supporting documents are to provide a detailed justification of how the safety arguments/objectives presented in the SCP are or will be demonstrated.
- 3. The General Operating Rules (GOR) and additional Development/Support Documents e.g. on Project and Licensing Management and Test and Commissioning.
  - The General Operating Rules (GOR) refer collectively to safety related practices or programmes that are applicable during the operational phase of the plant and may also be applicable during interim licensing stages.

## Regulatory philosophy/process adopted for the licensing of the PBMR

- The NNR acknowledges that the production of a Safety Case, particularly for the Demonstration Plant of a novel type of reactor, is a difficult undertaking especially taking into account that international well-researched and documented design criteria and rules are not readily available
- The NNR is confident that, following the systematic approach summarised above, a considerable amount of thought has been put into the strategy to be employed in the development of a credible safety case and its review against international norms and standards, which ultimately must demonstrate the safety of the PBMR.

# Stakeholders involvement and interaction in the PBMR project

- In terms of South African legislation there are two major processes for stakeholders involvement and interaction in the PBMR Project:
  - ❖ Public Participation in the NNR Licensing process under the NNR Act of 1999.
  - ❖ Public Participation in the Environmental Impact Assessment (EIA) under the Environment Conservation Act of 1989
- Although these two processes are guided by two different legislation there is some interface between them in terms of addressing public concerns related to radiological issues.

# Public participation in the NNR licensing process

- One of the most significant change made to the South African legislation the National Nuclear Regulator (NNR) Act in 1999 was the introduction of the provision of public representation and public hearings in the licensing process of nuclear installations.
  - ❖ This also introduced some challenges to the NNR in terms of the PBMR licensing process.
- Planning process has been initiated but public hearings still have to be conducted

# Conclusions

- With the development of the Pebble Bed Modular Reactor being pursued by South Africa as one of its alternative energy sources, the National Nuclear Regulator was faced with many challenges in terms of its adequate internal human resource capacity to undertake a credible licensing review and the adaptation of its regulatory philosophy and processes to the licensing of a "first of a kind" reactor project.
- The NNR is confident that adequate strategies and measures have been/are being implemented towards addressing these challenges.
  - Future interaction with other relevant Regulatory Authorities internationally could be very beneficial to the overall licensing review
- However the NNR still has to face the challenge to engage in its public participation process
  - ❖ Experiences from and interaction with other Nuclear Regulatory Authorities internationally, who are /have been involved in such process, would be very valuable

THANK YOU