NATIONAL NUCLEAR REGULATOR

For the protection of persons, property and the environment against nuclear damage.

HRD FOR EXPANDING NUCLEAR POWER PROGRAM IN SOUTH AFRICA

9-11 JUNE 2014

ATOMEXPO, MOSCOW

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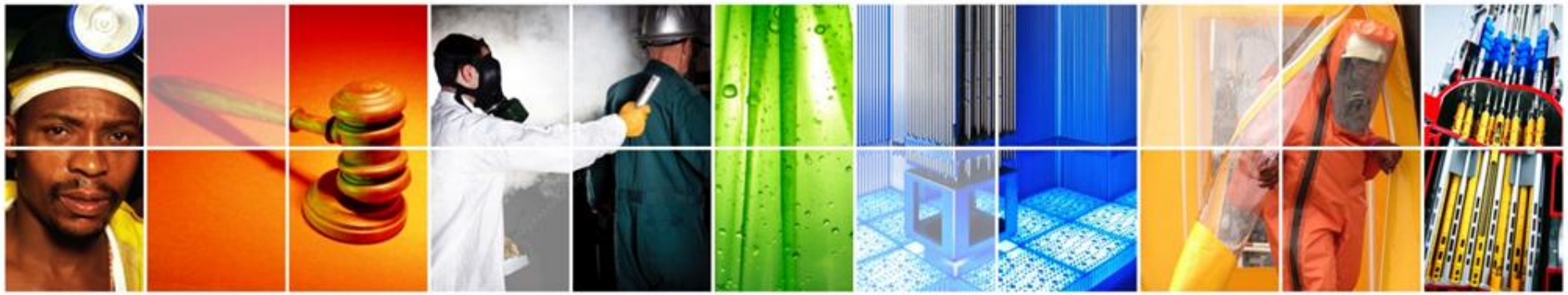

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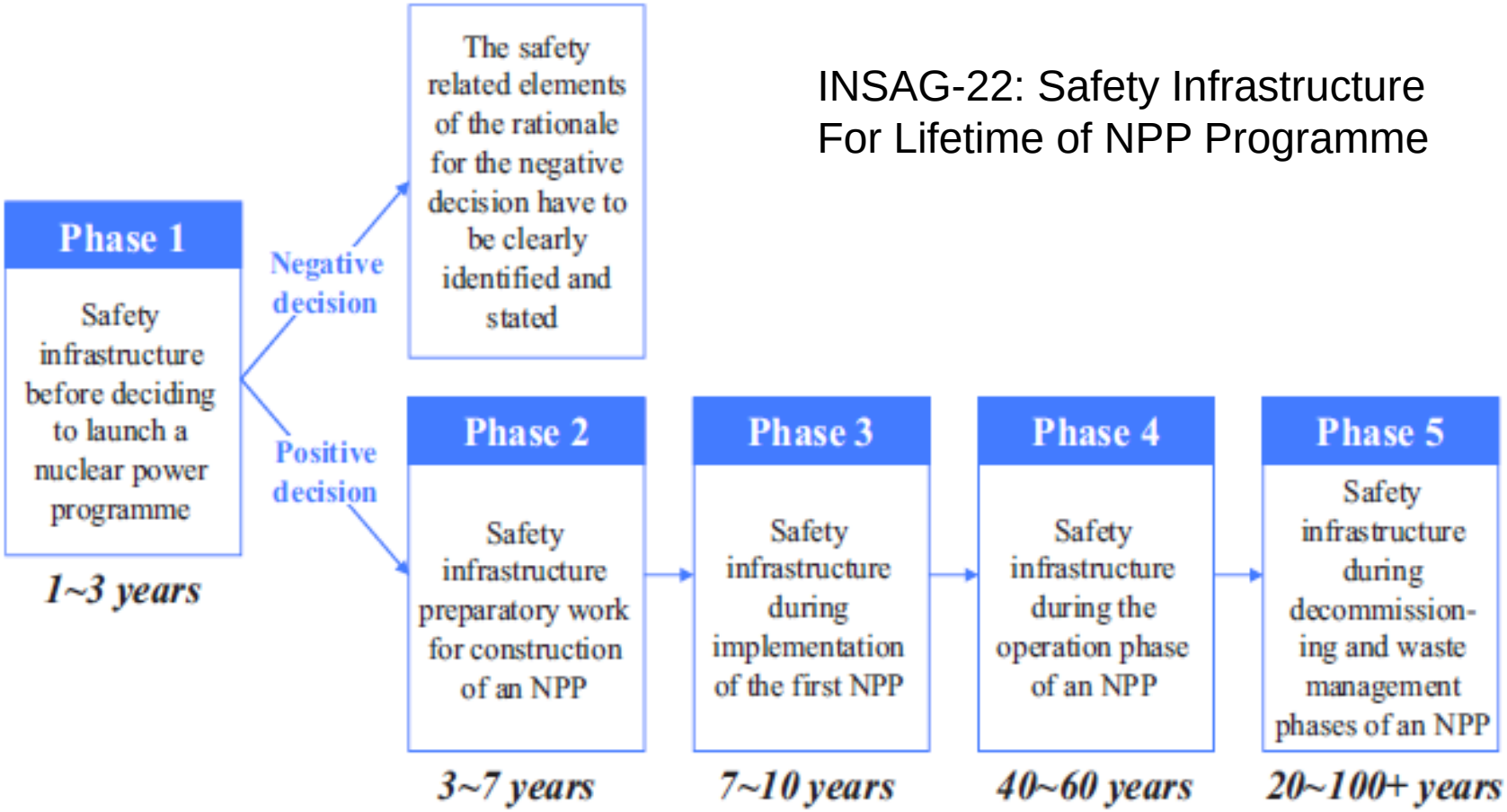
Introduction

INSAG-22: Safety Infrastructure
For Lifetime of NPP Programme



Introduction

- The Human Resource Development strategy for RSA is based on the guidelines aligned with IAEA's SSG-16 (Establishing the Safety Infrastructure for a Nuclear Power Programme).
- The SSG-16 uses the same approach in considering Phases 1, 2 and 3 of INSAG-22
- Actions 85-98

Integrated Resource Plan (IRP)

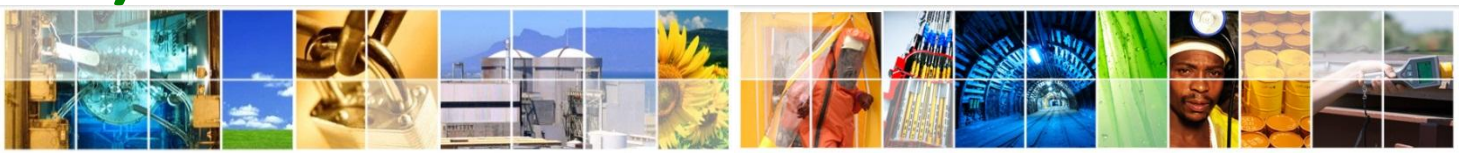
- ***The decision to embark on a nuclear power programme has to come from the government.***
- ***The prime importance of safety has to be recognized and reflected in policy decisions as well as in the strategy adopted by the government.***

Integrated Resource Plan (IRP)

- The Department of Energy (DoE) of South Africa has initiated the Integrated Resource Plan (IRP) after a first round of public participation in June 2010.
- This led to the Revised Balanced Scenario (RBS) that was published in October 2010.
- The IRP laid out the proposed generation new build fleet for South Africa for the period 2010 to 2030.
- This scenario was derived based on the cost-optimal solution for new build options (considering the direct costs of new build power plants), which was then “balanced” in accordance with qualitative measures such as local job creation.

Integrated Resource Plan (IRP)

- A second round of public participation was conducted in November/December 2010, which led to several changes to the IRP model assumptions.
- This led to the adjustment of investment costs for nuclear units, from the costs of a traditional technology reactor to newer technology reactor (a possible increase of 40%).



Integrated Resource Plan (IRP)

In addition to all existing and committed power plants, the RBS included:

- **9.6 GW new nuclear power plants;**
- **6.3 GW of coal;**
- **11.4 GW of renewables; and**
- **11.0 GW of other generation sources.**

Integrated Resource Plan (IRP)

	New build options							
	Coal (PF, FBC, imports, own build)	Nuclear	Import hydro	Gas – CCGT	Peak – OCGT	Wind	CSP	Solar PV
	MW	MW	MW	MW	MW	MW	MW	MW
2010	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	300
2013	0	0	0	0	0	0	0	300
2014	500[1]	0	0	0	0	400	0	300
2015	500[1]	0	0	0	0	400	0	300
2016	0	0	0	0	0	400	100	300
2017	0	0	0	0	0	400	100	300
2018	0	0	0	0	0	400[4]	100[4]	300[4]
2019	250	0	0	237[3]	0	400[4]	100[4]	300[4]
2020	250	0	0	237[3]	0	400	100	300
2021	250	0	0	237[3]	0	400	100	300
2022	250	0	1 143[2]	0	805	400	100	300
2023	250	1 600	1 183[2]	0	805	400	100	300
2024	250	1 600	283[2]	0	0	800	100	300
2025	250	1 600	0	0	805	1 600	100	1 000
2026	1 000	1 600	0	0	0	400	0	500
2027	250	0	0	0	0	1 600	0	500
2028	1 000	1 600	0	474	690	0	0	500
2029	250	1 600	0	237	805	0	0	1 000
2030	1 000	0	0	948	0	0	0	1 000
Total	6 250	9 600	2 609	2 370	3 910	8 400	1 000	8 400

Firm commitment necessary now

Final commitment in IRP 2012

Integrated Resource Plan (IRP)

- ***A State that is considering launching a nuclear power programme is likely to look for proven existing technologies rather than developing a specific new design.***
- **South Africa has attempted to develop a new specific design of the Pebble Bed Modular Reactor (also known as the PBMR).**
- **This development was put on hold and decided go with proven technologies i.e. PWR.**

Safety Infrastructure

- Regulatory Body
- Two nuclear power reactors generating 5% of its electricity,
- One research reactor - the 20 MWt Safari-1 reactor.
- Uranium mining in South Africa has generally been a by-product of gold or copper mining.
- Historically South Africa has sought self-sufficiency in its fuel cycle by manufacturing nuclear fuel in the country.

Relevant organizations

Relevant organisations in Implementing Nuclear Power program:

- Governmental officials;
- Legislative bodies;
- Organizations that are given an explicit governmental mandate to assess the feasibility of or to coordinate the development of a nuclear power programme;

Relevant organizations

- Regulatory bodies;
- Operating organizations;
- External expert support entities, technical and scientific support organizations;
- Industrial organizations, designers and constructors;
- Organizations for radioactive waste management and spent fuel management;
- Organizations involved in preparedness for and response to a nuclear or radiological emergency;

Relevant organizations

- Organizations involved in the transport of nuclear material;
- Competent authorities for matters relating to nuclear security;
- Education and training organizations;
- Research centres.

NNEECC

Organizations that are given an explicit governmental mandate to assess the feasibility of or to coordinate the development of a nuclear power programme;

- **The government has established the National Nuclear Energy Executive Coordination Committee (NNEECC).**
- **All relevant organisations are represented in this committee and one of the working groups within this committee is to look at the capacity building issues.**

Regulatory Body

- Competence of regulatory staff is one of the prerequisites for the safety of nuclear facilities in the IAEA Member States.
- Well-established staff qualification and training programmes.

Regulatory Body

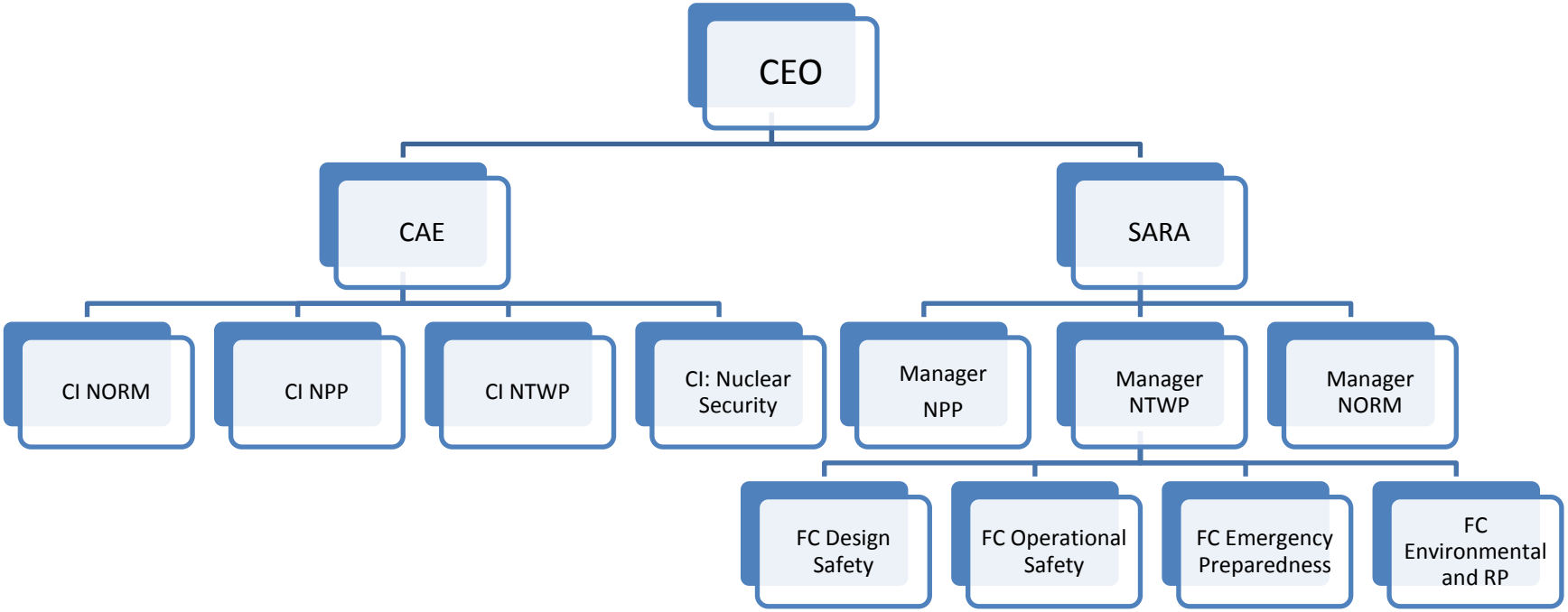
<1993	Atomic Energy Act	Atomic Energy Board (Licensing Branch)
1993	Nuclear Energy Act	Atomic Energy Corporation Council for Nuclear Safety
1999	National Nuclear Regulator Act	National Nuclear Regulator (NNR)
1999	Nuclear Energy Act	Nuclear Energy Corporation (NECSA)

Regulatory Body

- Authorization
- Review and assessment
- Inspection and enforcement
- Development of regulations and guides
- Supplementary functions

NNR Structure

Function-based Structure



Gap Analysis

- Skills audits have been conducted stating the essential knowledge, skills and abilities required to perform all the necessary regulatory functions.
- Audit conducted to assess the compliance NNR with the regulatory body competency framework guidelines TECDOC-1254
- Self-Assessment Tool (SAT) was used
- The NNR does not have a dedicated training unit or a specific training programme.

Gap Analysis

- NNR depends on external Human Resources for its continuous supply of competent personnel;
- Effort to embark on mentoring and succession planning is being developed
- TSOs approached on different aspects for support

Operating organizations

- Eskom has been given the responsibility of operating the Nuclear Power Plants.
- Eskom has a major role to play in the HRD.
- However, the government has announced a National Development Plan (NDP).
- One of the objectives of NDP is Infrastructure expansion
- Move Eskom's system operator, planning, power procurement, power purchasing and power contracting functions to the independent system and market operators.

Research Centres

- The Nuclear Energy Corporation of South Africa (Necsa) was established as a public company under the 1999 Nuclear Energy Act, and is wholly owned by the State.
- Its main functions are to undertake and promote research and development in the field of nuclear energy and radiation sciences and technology, and to process source material.

Research Centres

- Participates in various R&D projects and teaching at academic institutions
- Hosts various students conducting research
- Training programs

Industrial organizations, including designers and constructors

- **NPPs in South Africa were designed by Areva (previously Framatome),**
- **Various training programs were developed between the designer/vendor and the operating organisation**
- **Later a dedicated training organisation was established (ARECSA)**

TSOs

External expert support entities, including technical and scientific support organizations;

- ***TuV***
- ***IRSN***
- ***Excel Services***
- ***IRDP (USNRC)***
  - ***SAR Reviews***
  - ***Construction Permit***
  - ***HRD***
  - ***Power Uprates***

University of Johannesburg

Masters in Science and Organisation of Nuclear Energy

- Introductory mathematics for nuclear energy (UJ)
- Advanced mathematics for nuclear energy (UJ)
- Thermodynamics and electromagnetism in energy systems (UJ)
- Special relativity and quantum mechanics for nuclear applications (UJ)
- Nuclear physics for Power Reactors I (iThemba)
- Nuclear physics for Power Reactors II (iThemba)
- Radiation and radiological protection (NECSA)

University of Johannesburg

- Numerical methods for Nuclear Science (UJ)
- Nuclear materials and the Nuclear Fuel Cycle (NECSA)
- Environmental and Nuclear waste science (NECSA)
- Risk analysis and safe reactor operations (BIRA)
- Nuclear project management (UJ)
- Introduction to Nuclear Engineering (UJ)
- Experimental projects (iThemba, NECSA, UJ)

North-West University

- North-West University's involvement in the nuclear field can be summarized as follows:
- The Centre for Applied Radiation Science and Technology (CARST) at the Mafikeng campus started with the MARST (Masters in Applied Radiation Science and Technology) programme in 1996.
- CARST awarded more than 60 masters degrees since 2000 and most graduates were successful in finding positions in the nuclear industry.

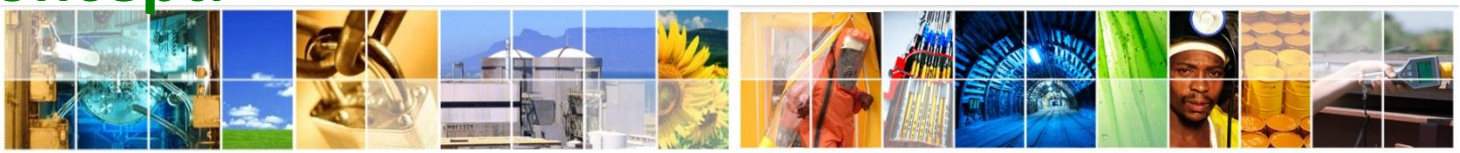
North-West University

- **MARST-Masters in Applied Radiation Science and Technology**
  - **Reactor Science**
  - **Accelerator Science**
  - **Radio-Biology**
  - **Nuclear Chemistry**
  - **Nuclear Physics**

North-West University

MSc in Nuclear Engineering

- The engineering faculty has been involved with the PBMR project since 1997.
- Substantial research programme in support of the PBMR project.
- During 2002 the Faculty developed, with input from PBMR staff, a physical model of the power conversion unit (PCU) of the PBMR that demonstrated the feasibility of the PBMR PCU concept.



North-West University

- The Postgraduate School of Nuclear Science and Engineering houses three different PBMR sponsored test facilities at its Potchefstroom Campus.
- These are the:
  - Pebble Bed Micro Model (PBMM),
  - High Pressure Test Unit (HPTU), and
  - the High Temperature Test Unit (HTTU).

Wits University

Postgraduate Course in Radiation Protection

- **Collaboration between:**
  - Necsa,
  - NNR,
  - Schonland Research Institute for Nuclear Sciences (SRINS),
  - Wits University and
  - the IAEA.

Wits University

- Fundamental Physics, Mathematics, Statistics and Biology (Pre-Course Module)
- Interaction of Radiation with Matter
- Biological Effects of Ionising Radiation
- Radiation Dose Assessment
- Occupational Radiation Protection
- Public Exposure from Radiation Practices - Principles of Environmental Protection & Waste Management
- Medical Physics (Exposures in Medical Practices)

Conclusions

- **HRD for expanding nuclear program depends all relevant organizations**
- **HRD and training programmes have to be relevant to the chosen technology;**
- **HRD programmes have to cover all phases of NPP development.**

THANK YOU

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