THE NECSA RRA INTERNAL TRAINING PROGRAMME

Johann van Rooyen
Necsa RRT

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

Initialisms defined

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- RRT = Radiation & Reactor Theory section.
- RRA = Radiation and Reactor Analysis – a subsection of RRT.
- SQEP = The Necsa Quality Standard that stipulates that technical work may only be performed by **S**uitably **Q**ualified and **E**xperienced **P**ersonnel.

Why an Internal Training Programme for RRA Analysts?

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- The Necsa SQEP Quality Standard – personnel must be suitably qualified and experienced before they may be independent analysts.
- Nuclear Science & Engineering postgraduates typically start at Necsa RRT with BSc-Honours degrees in Physics, or MSc degrees in either Physics or Nuclear Engineering. However, they typically lack all practical experience with codes used in the "Nuclear Reactor & Radiation World".

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- In a typical University Syllabus, theory is derived and then radically simplified to arrive at closed analytical expressions ("formulas") which are then used by students in assignments, tests and examinations.
- But: No Nuclear Safety / Radiation Safety Regulator will ever accept this methodology.
- RRA incumbents must be "re-educated" to attain an encyclopaedic conceptual grasp of Nuclear Science, but to use very accurate CODE SYSTEMS to perform calculations on digital computers.

Categories of Analyses that RRA Analysts have to perform

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Nuclear Criticality Safety (NCS) calculations for fissioning systems
- Dose-rate calculations
- Radiation shielding design calculations
- Nuclear fuel burnup & isotopic inventory calculations
- Isotopic inventory calculations for activating systems in e.g. a neutron field.

CODES that RRA Analysts must master

- RRA analysts must be able to use the following codes and Code Systems confidently and with almost no margin for error:
  - MCNP (6.1).
  - SCALE (6.2) – an integrated system of more than 60 codes.
  - FISPACT-2007 and FISPACT-II – activation codes.
  - Mathematical software such as Mathematica, MATLAB or MathCAD.

MCNP

- Monte Carlo Code
- Used in RRA to perform criticality calculations, fluence-rate calculations, energy deposition calculations and dose rate calculations.
- Can transport e.g. photons, electrons, neutrons, protons, alpha-particles, many anti-particles and light ions.
- RRA requires at least 3 experienced MCNP users in a team of at least 5 code users.

SCALE

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Integrated Code System containing many functional modules.
- KENO-6 or KENO-5a is used to perform criticality calculations.
- The MAVRIC calculational sequence is used to perform fluence-rate and dose-rate calculations with the code MONACO, and automated variance reduction is available.

SCALE

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- ORIGIN-S is used for nuclear fuel burnup and isotopic inventory calculations, or for isotopic inventory calculations for materials in a neutron field.
- RRA requires at least 2 experienced SCALE users in a SCALE team of at least 3 code users.

FISPACT

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Activation Code for calculating the isotopic inventory and radiated photon-spectrum in materials that are in a known neutron field calculated with e.g. MCNP.
- Not accurate for nuclear fuel burnup and isotopic inventory calculations – ORIGIN-S must be used.

EXAMPLE OF MCNP INPUT

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Refer to external file.

Example of FISPACT-2007 Input

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Refer to external file.

Syllabus for Internal Training

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Refer to EXCEL spreadsheet.

Typical Examinations

- Refer to PDF document.

How RRA internal staff training is done

1. Teaching sessions for module
2. Tutorial sessions for module
3. Examination for module

= = = = =

- Trainees are often enrolled for MSc Nuclear Engineering course at NWU (Potchefstroom) while doing the internal training at Necsa RRT.

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited

- Newly employed, inexperienced staff are initially only allowed to observe how experienced staff perform analyses and write reports.
- As internal training modules are completed with success, the RRA {Person; Skills} matrix is populated with more skills per person.
- As the trainees gain competence and experience, they are allowed to work more and more independently and later become project leaders.

THANK YOU

necsa
We're in your world
South African Nuclear Energy Corporation SOC Limited