**Final exercise of R&S - Closed questions**

19th June, 2014

Name:_____

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1. Safety Variables and Safety Limits. Definition and examples (2 at least). Explain its usefulness in the "grouping and bounding process"

Safety Variables: Are parameters during the operation of NPP which are related and indactive of the safe operation conditions. Observation, control & regulation of thes variables with in specific ranges will insure optimal & safe preformance of their indicative system.

Safety limits: Are maximal/minimal numeric values of certain parameters which shall not be exceded or under gone for the operation. Certain safety systems, safeguard systems can sometime loose their capability to function properly. The

In the "grouping & bounding process" regarding safety analysis of events affecting the safety variables, are put togeather and treated as a single overall event to reduce the vast number of events that are possible.*1 An overall encapsuling, artifical event can act as the "representing event" of the group. Furthermore events with similar values of the main affected safety limits can be encapsulated into an event group, with the overall lowest / highest safety limit acting as the control variable in simulations, PSAs, etc... for licencing analysis.

*1 during the operation of a NPP

2. Among the 10 detailed identified causes of Three Mile Island Accident, at least one of them was recognized as a design deficiency:

- Select the most significant (if there is more than one)
- Describe it
- Why is it considered a cause?
- How was it corrected by the nuclear industry after the accident?

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~~A significant design deficiency was that the control room had no indicators on that the release valves in the secondary were~~

A significant design deficiency in the CRoom of TMI was the lack of silencing the alarms. The operators were overwhelmed by the number of alarms and were not able to distinguish between the sequence or the severity of each indicated, which could have helped them to analyse the progression & maybe preform corrective measures. Late operator intervention & unfamiliarity with a very complex sequence of alarms indicating a vast number of problems caused the failure and accident causing the core meltdown at TMI.

The Nuclear Industry reacted with:

- Stricter & more intensive operator training
- Redesign of control room (silence alarms, SCHPZI with colour indicators, etc...) ← most important concerning CR Design
- EOP were created and training
- Creation of safety culture with sharing of OE around the world.

3. Conservative methodologies for licensing analysis. Define and characterize. Use properly, among others, the words: pessimistic, initial and boundary conditions, safety-grade equipment, single failure…

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In the licensing analysis for NPP a great deal of work has to be done to demonstrate to the regulatory authority that your NPP is safe. The FSAR must show beyond doubt that the systems implemented in the plant can comply with AOO, DBA, BDBA, etc... Much of this work is done using conservative computational analysis methodologies, which uses pessimistic conditions. This means that the models or methodologies are baised on the worst (or at least very bad) conditions:

- They use failure of multiple systems or unavailability
- Conservative models are the one which predict the worst outcomes from calculations
- Conservative parameters are selected in the conditions, which means they are below or higher than the safety margins & limits dicated#1

The computational analysis starts with a set of inital condition describing the state of the plant and these IC are allowed to evolve with time during the analyses. Boundary conditions (often conservative parameters) are set limits at which certain actions are preformed (e.g. SCRAMS, Injections, activation of systems).

Safety-grade equipment often tested or analysed with conservative methologies as they fulfill important function related to radiological releases, accident or transient conditions.

#1 by codes, standards, regulations, etc... to demonstrate high safety in NPP.

4. Consider the following organizations: Nuclear Energy Agency (NEA), EURATOM and International Atomic Energy Agency (IAEA). Describe briefly how they deal with nuclear safety.

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IAEA: Production of various publications regarding Safety Standards, Non-proliferation, Safety Reviews of Installation, Technological desimnation, Confrences in relation to safe construction, operation & decommision of NP-Installations, Nuclear Waste transport & storage,...

- Produce with help of member states a unified international best practice guides for the safety of nuclear power around the world.
- Confrence for International research projects regarding safety etc...

NEA: Publications & Databases regarding Test-facilit

Euroatom: EU overall organization with intensor to msure the safety of nuclear installation in Europe. Plans for European safety storag of nuclear waste facilities. Sponsuring research programs in relation to nuclear safety.