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 variables used in order to evaluate if the state of the plant / reactor is safe or not. Two examples would be the DNBR (Departure for Nucleate Boiling Ratio which gives us the state of the coolant inside the core itself) and the Power.

The Safety limits are values of the safety variables that you should take into account in order to have your plant safe. (For example DNBR = 1,3) They can be upper limits (should not be greater than them) or lower limits (should not be lower than them).

The grouping and bounding process consists in gathering transients in group with similarities and chosing one of them as the representative transient. This representative transient must be the worst case of the group it represents and to know that we use the Motors of Safety variables and Safety limits. Furthemore, when it is difficult to chose in between the transient, an hypothetical transient is defined as is slightly worst than the transients of the group; this hypothetical transient is determined by imposing a calculating safety variables in comparison with the ones of the transients of the group..

So this Safety variable are use to compare and classify in an easier way the different transients as well as to chose in an easier way the representative one in the "grouping and bounding process".

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

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- 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?

A design deficiency cause of the three Mile Island Accident was the display of the state of the valves. Indeed, in the control room, there was no such displays and thus, the operators could not know how actually was the valves concerned. They just concluded that since there was a closing signal for the relieve valve after the pressurizer, then the valve must have closed. But that was not the case: the closing signal happened but the valve was stuck open: this is the reason why they got a LOCA, water from the primary was escaping. Thought this valve. The same happened with the AFW valve which was stuck closed (since it had been manually closed before the whole accident started) and they thought it was open since the signal to open it had been given.

As said before, it is considered a cause because, in the case of AFW valve, it led to the loss of feedwater (with the loss of the AFW pump, too) and in the case of the relief valve, it led to the loss of coolant accident and the operators were not aware of what was happening and they could not make appropriate diagnosis because they though the valve were in the right State.

After the accident, a correct display for all components such as valves, pumps, breakers has been installed in the control room. It consists in a light system, red or green depending on the state of the component. For instance, red means a valve is open or a pump is running.

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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Conservative methodologies are methodologies used for the analysis made for the licensing of a plant which deal with many different areas (reactor core / neutronics / normal operation / transients accidents / environmental impact analysis / human factor / ...)

They use conservative codes and the analysis made by this codes are always pessimistic (for example compared to nuclear data that we already have). In such codes, the general conditions are already set up and you are only able to change few conditions and variables to simulate the scenario (such as single failures) you are interested in: you can decide of your initial and boundary conditions (example: thermal hydraulic codes, neutronic codes modelling only the core ...) Furthermore, you can combinate those conservative codes for studies.

Those conservative methodologies are used for safety analysis in normal operation, transients and accident scenario but they are also used to classify systems and organisation of the plant.

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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The IAEA is an international organisation which is an independant organisation. It provides the public any information about nuclear (transparency), explaining how it works, providing datas about the plants of the world... However they have a politic of non-advertisment when it comes to nuclear.

EURATOM is a european organisation which is also independant, non governmental.

Same for NEA.

When it comes to nuclear safety, such organisations need to approve any paper, analysis, procedure related to safety.