Task 1 (ILO1, ILO2)

GOAL: collect information on general design specification of the nuclear power plant with selected reactor type

GRADE: 2

Explanation of grading and evidences of achieving respective ILO

The first task is very well presented in the report, which results readable, clear, well structured and organized. The images really help the reader going through this first description and introduction about NuScale reactor while the reported table list all the required parameter of Task1. Overall, the intended learning outcomes are acquired by the authors of the report, who menage to provide the main characteristics of the presented NPP. However, the description is quite brief and concise, and some more info might be given describing more in detail the structure of the NuScale element. Components like pressurizer, steam generators, balance of plant, supports of the structure etc... are just rapidly mentioned. In addition, some figures representing each single module could give an hint on how those fundamental parts are structured.

Suggestions for improvements and other comments

To improve the task1 section, a more deep study should be provided, reporting some general features of the different components characterizing one single module of a NuScale power plant, as well as introducing a more detailed analysis of the entire structure of the plant. One could start from the various elements represented in fig.1, discussing their functions and utilities together with some design-based comments. A brief paragraph about the turbine/generator group would be appreciated, since it's a topic we discussed in detail during lectures. Eventually, adding some peculiarity in the design and project of this innovative reactor would give the report even more brilliance and authority.
In addition, I found very interesting the core composition schemes shown in fig.4 and fig.5, however it was not so clear to me why the enrichment should change in the following loads with respect to initial reactor load. Some more discussion can be done.

Task 2 (ILO1, ILO2)

GOAL: describe operational principles of the power plant

GRADE: 3

Explanation of grading and evidences of achieving respective ILO

Again, the descriptive part presenting the Task2 is very well structured, following a chronological order of events and discussing in very precise details all the operations a single module NuScale reactor must go through before reaching criticality and being connected to the grid.
Moreover, the possible shut-down conditions are clearly analyzed, bringing into the attention of the reader the main differences in the procedures and how the various elements of the plants enter into play during these delicate situations.
Working condition in normal operations are also well presented, discussing the working principles of natural circulation.
Another goal required in the task was the reactivity control system analysis: it is well achieved in section 2.3, where soluble poison and control rods are discussed, providing also the core cross section with the control assemblies disposition.
In conclusion, a detailed description of the refueling process is included, presenting also some doubts and possible concerns, always sided by proper references in the available literature.
Overall, this section is very accurate and precise, and the authors show deep knowledge and interest in discussing these topic, acquiring and presenting all the required information.

Suggestions for improvements and other comments

The only few suggestion I feel like to add for this section are related to some situation encountered during normal operations. In particular I'm referring to possible load follow behaviour, both scheduled and unplanned: thus I suggest adding to the section, for example, the possible available drive velocities allowed by the reactor's safety parameter.
Also, another topic which has not been mentioned is about the eventual presence of burnable and non-burnable poison. Some more words might be helpful.
In conclusion, if available in the literature, it would be interesting to add some brief design description of the control rods driving system (maybe some figure or scheme) to have complete comparison with other nuclear reactor of similar technology.

Task 3 (ILO1, ILO2)

GOAL: explain safety features of the power plant

GRADE: 3

Explanation of grading and evidences of achieving respective ILO

The aim of this section is to provide a general description of reactor safety including protection systems and main safety features implemented in the plant, adding, if available, parameters such as CDF or LRF.
All these elements are well presented in the reviewed document, which includes a detailed discussion of the main passive safety systems, i.e. ECCS and DHRS, explaining how they menage to work in a passive condition with the support of very clear and intuitive images who help the reader visualizing the concepts.
In addition, some peculiarities implemented in the reactor unit are presented in section 3.3, with some hints related to a comparison with other technologies of large PWR.
Finally, some problems in the fuel-reloading are mentioned, outlining possible failure, which denote very high critical thinking of the authors, together with a graph (fig.12), presenting the required safety parameters.

Suggestions for improvements and other comments

The overall presentation is pretty good and detailed, thus the proposed corrections/improvement are just to make the document more complete and precise.
First, if available in the literature, it would be interesting to know more about possible power source (if present, i.e. diesel generator, electric battery/accumulators, etc...) that aliment pumps or generic electric motor, since mainly passive safety system are mentioned and maybe the plants is provided also with active systems.
Secondly, no systems related to the containment safety are mentioned (except a very brief introduction in section 3.4). If present, it would be interest to know more about possible over-pressure protection, possible containment spry system etc..

Task 4 (ILO3)

GOAL: calculate selected core parameters

GRADE: 2

Explanation of grading and evidences of achieving respective ILO

In this section the authors present a simplified model to estimate some thermodynamic properties of the reactor, during normal operating conditions. The section is divided into two main part, the first one where the modeling is presented, the second one instead discussing the results.
The collected data are well presented and introduced, but some inaccuracies are evident. In particular, it's not clear how the peak factors are calculated, how they are implemented in this section (it should not be an hot channel, as previously specified in the report) and how the P_{max} coefficient is calculated. The normalization is probably missing or it would be better to specify the approach you followed, if, for example, you considered an average linear power density. Also, probably a typo is present: in the graph (fig.14) it's plotted the surface power density (W/m^2). Is that what you mean?
The rest of the model results pretty accurate and shows that the authors possess the capability to deal with logical and suitable assumptions in the contest of a nuclear reactor, being able to justify them.
Concerning the results, they all seem very reasonable and suitable with the assumptions included in the previous part. In particular, the pressure drops evaluation results very clear and easy-to-read thanks to the graph in fig.16, which includes both reversible and irreversible contributions. Enthalpy and temperature profile are well in agreement with expected results, but a better explanation of the "S" profile would be appreciated. Also, a comparison with the predicted outlet temperature and enthalpy could be performed to return an idea of the accuracy of the implemented model.
In conclusion, the flow characteristic of the core shows a result which is very closed to the expected ones, whereas proper right considerations are done to explain the behaviour at low and high flow rate combined with low and high power. However, some critical points also discussed several time during presentations in class are missing (see the section below).

Suggestions for improvements and other comments

Despite a very good job done in this section, some suggestions are now listed to improve the layout and content.
First, it would be interesting to divide in two paragraphs the single-phase normal-operating-conditions model, with respect to the flow characteristic model, where boiling is mentioned, to avoid confusion since in a PWR no two-phase flow is expected.
Second, the visualization of orifice pressure drops in the graph in fig.15 and fig.16 would help understanding the real contribution of that phenomena. (You can simply add a vertical line to represent the initial drop).
Third, related to the last graph (fig.19) you can include another figure with a zoom in the high flow condition, to discuss at which power we see the higher pressure drop and why. Moreover, a clear explanation is missing to describe why in the zero-flow rate condition, the 0-power curve is so dominant in terms of pressure drops, when compared to the others. (Hydrostatic contributions should be mention in the "results" section.)
Lastly, the Colebrook/Haaland correlation is implemented for single pipe, not for tube bundle. According to several studies available in literature the difference should not be that huge, but for the sake of completeness you can search and try to implement a tube-bundle correlation.

Task 5 (ILO4a)

GOAL: calculate CHF margins in a hot channel

GRADE: 2

Explanation of grading and evidences of achieving respective ILO

This section is related to the core design constraints, especially in terms of critical heat flux. This reviewed paper include very satisfying results combined with a comparison of different available correlations in the literature, from which one can deduce a deep acknowledgement of the topic has been achieved by the authors. In fact, two possible model for the critical heat flux are provided, including a discussion where it is explained why one should work better than the other when it comes to the final prediction of the MDNBR, with reasonable conclusions in terms of validity limits. However, in the report it's missing all the analysis related to hot channel pressure drops, quality, temperature and enthalpy distribution, which is fundamental in the understanding of the two phase flow regime, especially when compared with nominal conditions. Therefore, I suggest to implement a new code where you first modify of all the power profile and then, performing the same analysis as previous section, you analyze the hot channel under a thermodynamic point of view, adding, if necessary, the two phase model correlations for pressure drops.
Appreciable is the consideration about the peak factor and how it should be modified to remain within the non-boiling regime reported during the description of task4.To be more clear, you could add a new graph with this modified peak factor.

Suggestions for improvements and other comments

Some suggestions to implement the project work are now discussed.
References might be added every time you mention or use one specific correlation, just in case someone wants to compare your calculations or your assumptions on the limiting conditions.
A more detailed description of the code-implementation part might be included, to justify the results you insert as plots, and for the reproducibility of your work, which is always a fundamental aspect in a scientific work.
Some theoretical background could be added, especially related to the meaning of DNB phenomena, and why the DNBR it's used to describe safety margin and indeed which are these safety margins. Are these fulfilled or not? (Comments in relation to the figure could be appreciated).

Task 6 (ILO4b)

GOAL: calculate maximum cladding and fuel pellet temperature

GRADE: 2

Explanation of grading and evidences of achieving respective ILO

This last section requires the calculation of radial and axial temperature profile in a hot channel, to identify any possible hot spots or excesses of safety margins.
The authors overall made a remarkable job in the computational part, being able to compare several different correlations for the possible heat transfer coefficients, necessary in modeling this power exchange, keeping also into account the presence of a rod bundle. However, some key aspects are still lacking. In particular, in the previous section it is mentioned that using the reported peaking factor, a two-phase flow is reached in the coolant. However, no model for two phase flow convection are implemented in this section, whereas in fig.25 it's specified that the temperature never overcomes the saturation condition, leading to absence of two phase mixture. This point should be clarified for a better coherence of the entire project.
Moreover, the heat transfer in the helium gap has been implemented as a convection mechanism. However, the helium is not flowing, while it's usually inserted at an high pressure, thus requiring a heat conduction approach. (Maybe some natural convection is included, but scrolling several literature models, it's always negligible). For helium thermal conductivity you can search in the available literature a proper correlation that fulfill the pressure and temperature limit related to helium. (I will add the paper we used if you want to have a comparison [1])
In section 6.4, while performing the fuel pellet temperature analysis, a linear assumption for the heat transfer coefficient is obtained through a linear fitting. The authors here show good control and skills over mathematical and physical concepts, simplifying the computation without introducing big inaccuracies.
Finally, in the discussion of the results (section 6.5), a clear and well structured analysis is included. Possible coherent explanations associated to the high temperature of coolant are provided, while the safety limits are respected in the fuel region.
Consequently, in this section the authors show a wide control over the topic, being able to overcome obstacles and problems with reasonable assumptions. Still, some additional work is necessary to reach optimal results.

Suggestions for improvements and other comments

To improve the work performed in this last sections, a list of possible suggestions follow in this paragraph.

- Concerning the cladding and helium heat conduction, it would be interesting to implement a radial discretization, which might help to have a final more precise radial temperature profile. This can be done with an additional iteration for each cell in vertical axes;
- A more detailed discussion and explanation of the *coding part* could be reported as an appendix or while describing the model (to improve reproducibility) ;
- Is there a reason why you chose as final correlation for the radial profile the Markoczy one?;
- Add references for the used correlations;

References

[1] H. Petersen. "The properties of helium: Density, specific heats, viscosity, and thermal conductivity at pressures from 1 to 100 bar and from room temperature to about 1800 K". *In: Danish Atomic Energy Commission* (1970)