AREVA NP Inc.,

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Technical Data Record

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NGNP Conceptual Design Power Level and Number of Loops Trade Study Plan

Safety Related? ☐ YES ☒ NO

Does this document contain assumptions requiring verification? ☐ YES ☒ NO

Signature Block

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1.0 INTRODUCTION

One of the most important factors in the commercial viability of a new nuclear reactor is its suitability to marketplace demand. Integral to an ideal fit is an appropriate reactor power level, which will dictate the number and size of potential applications. Successfully choosing this parameter requires extensive analysis of the reactor and its full gamut of feasibility and safety requirements as well as a very innovative and informed view of the marketplace.

This plan defines the objective and scope of the NGNP Power Level and Number of Loops Trade Study to ensure the appropriate NGNP reactor power level and configuration are selected.

Trade Study Definition: The ultimate objective of the planned study is to determine the optimum prismatic reactor power level to produce electricity and/or process heat. The planned study will also determine the best design and number of loops needed to transport the energy based on this power level.

Scope of Issues to be Addressed: The planned study will evaluate reactor power level and number of loops by identifying and examining all key issues and considering any new issues or priorities. This evaluation will occur in two phases, a candidate section phase followed by an optimization phase, both of which will be conducted by quantitative and qualitative evaluation.

2.0 REQUIREMENTS

This trade study is conducted as part of a series of trade studies listed in the NGNP conceptual design work plan, PD-3001047-000 (Ref. 3) to establish the NGNP conceptual design parameters.

According to the statement of work (Ref. 2), the planned study is an NQA-1 applicable work task, therefore the NQA-1-2000 (Ref. 1) applies. The project quality assurance plan, QA-3000719-000 (Ref. 4), governs this work, and the final deliverable will be a technical document prepared in accordance with 0412-59 (Ref. 5).

The planned study will also take into account the applicable requirements which will be outlined in the Plant Design Requirements Document, according to the work plan (Ref. 3).

3.0 STRATEGIC OBJECTIVES

To support successful commercial deployment of HTR technology, the NGNP must be economic, feasible, reliable, flexible, timely, and safe.

4.0 FRAMEWORK / APPROACH

4.1 Summary

A list of alternative power levels will be developed and evaluated against a series of criteria defined to determine the optimum power level. The evaluation will occur in two phases; the first phase will narrow the field by selecting a candidate power level to investigate further, and the second phase will involve optimizing that power level to a more precise value. Both phases will involve data acquisition and qualitative and quantitative assessment.

For the resulting power level, the best design and number of loops will then be determined.

4.2 Assumptions

The planned study will be conducted based on the following assumptions about the NGNP design:

1. It uses a prismatic design.
2. It is capable of cogeneration, providing both electricity and process heat.
3. It uses a conventional steam cycle (e.g. 550°C) with a steam generator in the primary loop and secondary steam for energy transfer to steam turbines or process heat tertiary loops.
4. The reactor outlet temperature is 750°C.
5. The vessel material is SA508/SA533.
6. The upper limit of the reactor vessel outer diameter (at flange) is 8.4 m, due to manufacturing limitations.
7. The startup date is 2021.

4.3 Alternatives

The first step in the planned work is to develop a complete list of power levels for consideration. This list will include all existing prismatic designs as well as variations to them (based on changes to the number of fuel columns and fuel blocks per column, vessel diameter, power density, etc.).

As part of this step, the factors that determined the selection for each power level will be identified (such as peak fuel temperature, material considerations, passive safety systems, etc.). This information will be gleaned primarily from existing evaluations and studies.

4.4 Criteria

In the course of evaluating the power level alternatives and the factors that determined them, a list of important factors or criteria will be developed. This list will be expanded to include all criteria necessary to meet the requirements and objectives stated in Sections 2 and 3.

Obvious high level criteria include:

- Economics / Commercialization Potential
- Safety / Licensing
- Flexibility / Availability / Operability
- Feasibility / Project Risk

The full list of criteria will be ranked and weighted.

4.5 Two Phase Approach

Due to the broad range of power levels considered, a two phase approach is adopted for this study. The first phase will reduce the wide range of power level options and associated configurations down to a particular candidate power level. Then the second phase will examine optimization of that power level within a narrow range. For example, the first phase might consider whether the focus should be on a 600 MWt or 300 MWt reactor. The second phase could then determine the specific power level in the range of 300 MWt best optimizes the plant configuration. Two phases are appropriate, because the driving considerations are not the same for the two questions.

The first phase of the evaluation will involve evaluating the full list of alternatives against the full list of criteria, and will be based on analysis and engineering judgment. The outcome of this evaluation will be a single candidate power level to be investigated further.

The second phase of the evaluation will involve fully identifying the information needed, taking into account detailed plant considerations, and requesting this data from the appropriate sources. The results of these efforts will be incorporated into a more detailed matrix for evaluation to arrive at the optimized power level.

For each phase of evaluation, the appropriate decision-making tools will be selected and implemented.

In evaluating the various safety limitations, uncertainties and margins must be adequately considered. For this trade study, it will be necessary to rely on engineering judgement when addressing these uncertainties. Later in the design process, they will be considered in detail using more rigorous uncertainty analysis.

4.6 Number of Loops

The number of primary heat transport loops is another key outcome objective of this trade study. Based on the optimized power level selected, the appropriate number of loops will be determined. There are two viable options to be considered:

- single loop system
- dual loop system

5.0 SCHEDULE

According to the work plan (Ref. 3), this task is scheduled to consume 1200 hours. Based on this duration the target completion date will be October 30, 2009.

The schedule is shown in the following figure, and includes key steps of the analysis and interactions with the prismatic team members and with the customer.

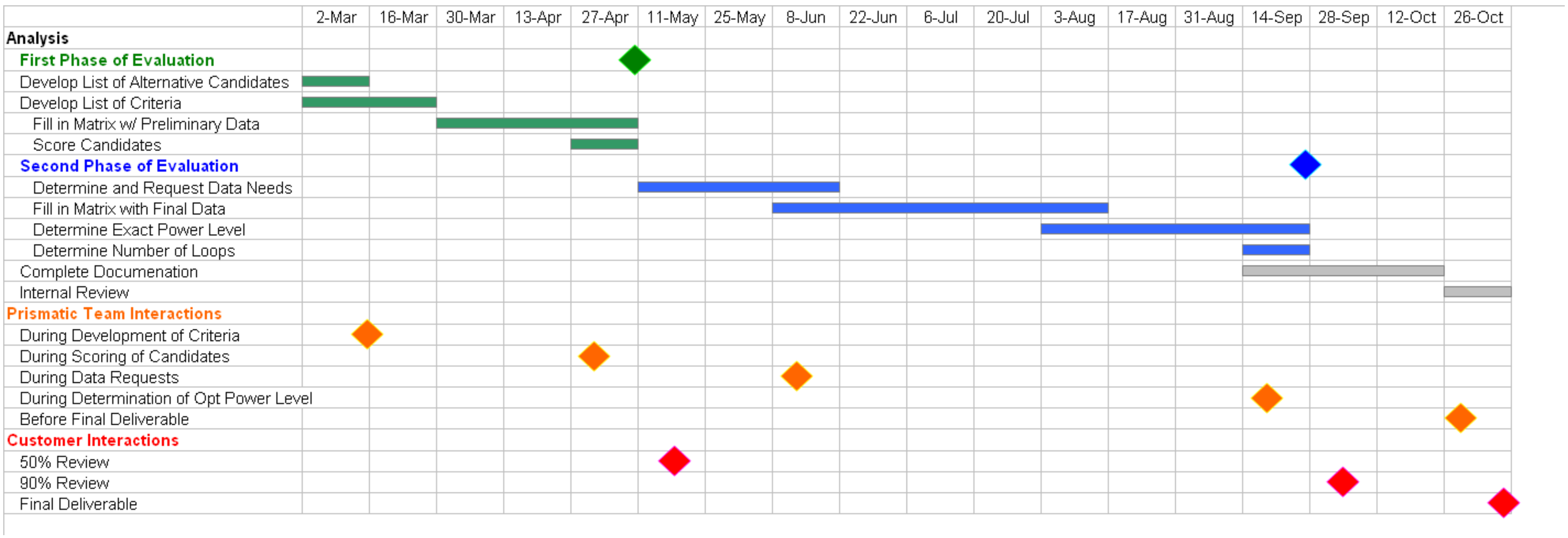

Figure 5-1: Schedule

6.0 REFERENCES

1. ASME NQA-1 2000, *Quality Assurance Requirements for Nuclear Facility Applications*.
2. *Initial Conceptual Design Tasks for the NGNP*, SOW-7059, Idaho National Laboratory.
3. *NGNP Engineering Conceptual Design Work Plan*, PD-3001047-00, AREVA Federal Services, LLC.
4. *Next Generation Nuclear Power with Hydrogen Production Conceptual Design Studies Phase B, Project Quality Assurance Plan*, AREVA Federal Services, LLC, QA-3000719, Rev. 0
5. *Engineering Technical Documents*, 0412-59, Rev. 016, AREVA NP.