PMVictoriaESPPEm Resource

From: Terry, Tomeka
Sent: Tuesday, March 08, 2011 5:32 PM
To: VictoriaESP Resource
Subject: FW: Summary of VCS mPower information for Friday call
Attachments: VCS mPower references - 3.8.11.pdf

From: Joshua.Trembley@exeloncorp.com [mailto:Joshua.Trembley@exeloncorp.com]
Sent: Tuesday, March 08, 2011 4:43 PM
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Subject: Summary of VCS mPower information for Friday call

Tomeka,

Please find attached a summary of VCS ER discussions regarding the mPower, as well as a few relevant items related the ongoing safety review. Note that all of the information in the attachment has been previously submitted to the docket via the ESP application or subsequent clarification / RAI response correspondence.

Hopefully, the summary will help facilitate the discussion during the Friday call.

Thank you very much. Please let me know if you have questions.

Have a good afternoon,
JT

610-765-5345

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1. 1.1.3 Reactor Information (p. 1.1-2)

This ESP application is intended to demonstrate the suitability of the VCS site for construction and operation of a nuclear power generating facility. No specific plant design has been chosen for the VCS site. Instead, a set of plant design parameters has been developed to envelop future site development. The reactor technologies upon which this set of plant design parameters is based include:

- Advanced Boiling Water Reactor (ABWR) (General Electric and Toshiba designs)
- Advanced Passive Pressurized Water Reactor (AP1000) (Westinghouse design)
- Economic Simplified Boiling Water Reactor (ESBWR) (General Electric–Hitachi design)
- Advanced Pressurized Water Reactor (APWR) (Mitsubishi design)
- mPower (Babcock & Wilcox design)

Selection of a reactor to be used at the VCS site will not be limited to those listed above. The final selected reactor may be a future design that is bounded by the surrogate plant design reflected in Table 3.1-1.

2. 2.7.6.1 Regulatory Basis and Technical Approach (p. 2.7-32)

The reactor building design has been used to calculate the minimum building cross-sectional area, a required input to the model, as called for in NUREG/CR-2919 (U.S. NRC Sep 1982). Although the turbine building is larger, using the reactor building is more conservative because a smaller area results in higher X/Q values. The height of the reactor buildings for modeling purposes is 24.38 meters. The resulting cross-sectional area was determined by multiplying the height by the width of the reactor building (51.80 meters). The area used is 1263 square meters (from the mPower design).

3. 3.1.2 Power Plant Design (p. 3.1-1, bottom)

The power block and common support buildings will be designed to integrate into the overall station design. Each conventional unit will have a single control room and operating staff. The modular units, which are designed to be stand-alone units, are arranged in groups of two units in adjacent buildings. Because of the limited level of information available at this time about mPower technology, it is assumed that each unit will have its own control room; sharing a common control room between two units may be considered later.

4. 3.1.3 ER Design Parameters (p. 3.1-3)

Same Text as ER 1.1.3

5. 3.2 Reactor Power Conversion System (p. 3.2-1)

The site has a potential for development of up to 1500 MWe gross, with twelve units of the modular mPower design, or up to approximately 3400 MWe (gross), with two units (power blocks) of the other technologies, dependent on the selected technology. Each unit is powered by one reactor.

6. 3.2.1 Reactor Description (p. 3.2-1)

The VCS site has been designed to allow incremental addition of new units. Since the number of units could vary from 1 to 12, the unit arrangement will be developed as part of the COL application for the selected technology. Figure 3.1-2 shows the location for the new units. The space allocated for construction is sized to allow construction of up to 2 conventional advanced LWR units or 12 modular units, depending on the selected technology. The size of the reactor, based on the technologies considered, varies from 425 MWt up to 4500 MWt for each unit. The reactor and associated turbines and power conversion equipment would allow generation of a gross electrical output per unit of 125 MWe up to 1700 MWe, depending on the condenser design (series or parallel configuration). Since the auxiliary loads vary for each technology and even for the same technology based on the design features, the net output would be determined at the COL stage. All of the proposed reactors use uranium as their fissile material. Enrichment of the uranium would vary based on the reactor type deployed, ranging from 2 percent to 5 percent enriched U-235.The peak fuel rod exposure at end of life varies from 55,000 to 68,000 megawatt-days per metric ton of uranium (MWD/MTU). Maximum average discharged batch burn-up is based on the specific plant design but would be in the range of 46,000 to 60,000 MWD/MTU.

Fuel design and total quantity of uranium is specific to the reactor design selected. The largest core assembly of a single unit contains 1132 fuel assemblies with a total uranium dioxide fuel weight of 184,867 kg.

7. Table 3.3-1 VCS Water Use – Enveloping Data (p. 3.3-4)

(a) Flow rates are for a 2 unit site using ABWR, ESBWR, AP1000, or APWR technologies or 12 mPower units.

8. Table 3.5-1 Composite Release Activities in Liquid Effluents (Ci/yr) per VCS Unit (p. 3.5-3)

Note: The release activity of a given radionuclide is the highest of the activities for that radionuclide from a composite of all the reactor technologies considered for the ESP. These values are per reactor, except for mPower. For mPower, the activities from six reactors are considered when arriving at the composite values.

9. Table 3.5-2 Composite Release Activities in Gaseous Effluents (Ci/yr) per VCS Unit (p. 3.5-5)

Note:The release activity of a given radionuclide is the highest of the activities for that radionuclide from a composite of all the reactor technologies considered for the ESP. These values are per reactor, except for mPower. For mPower, with the exception of C-14, the activities from six reactors are considered when arriving at the composite values. As the source for mPower is still being developed, the design currently uses the C-14 activity provided in NUREG-0017 for a 3400 MWt PWR, using no scaling to adjust for the much lower thermal power of the mPower. However, multiplying this value times six to account for six mPower reactors (a total of 2550 MWt) would be overly conservative. As such, the next highest C-14 release (ESBWR), which is greater than that in NUREG-0017, is used to represent the six mPower reactors in the composite gaseous source term.

10. 3.8 Transportation of Radioactive Materials (p. 3.8-1)

Operation of nuclear power units at the VCS site will require transportation of unirradiated fuel, irradiated fuel (spent nuclear fuel), and radioactive waste. The subsections that follow describe transportation of these three types of radioactive materials. Subsection 5.7.2 addresses the conditions in subparagraphs 10 CFR 51.52(a)(1) through (5) regarding use of Table S-4 to characterize the impacts of radioactive materials transportation and provides an analysis of the radiological impacts from incident-free transportation of these materials. Section 7.4 addresses radiological transportation accidents. The data currently available for the mPower reactor will not support an evaluation of radioactive materials transportation. Should Exelon select the mPower technology for VCS, an evaluation of radioactive materials transportation will be provided as part of the COL application.

11. 4.5.2 Radiation Sources (p. 4.5-1)

The main sources of gaseous effluents could include the power cycle offgas system and the ventilation systems of buildings housing radioactive systems and components such as the reactor building, the turbine building, and the radwaste building. The postulated isotopic activities in gaseous effluents from an operating unit are shown in Table 3.5-2. Table 3.5-2 is a composite of the individual expected gaseous effluent activities for the various reactor types identified (i.e, ABWR, ESBWR, AP1000, APWR, and mPower) and represents the highest activity for these reactor technologies on a per radionuclide basis.

12. Table 5.4-1 Liquid Pathway Parameters (p. 5.4-8)

Release Source Terms / See Table 3.5-1 / Table 3.5-1 shows the activity releases by isotope, assumed for one conventional or six mPower units.

13. Table 5.4-2 Gaseous Pathway Parameters (p. 5.4-11)

Release Source Terms / See Table 3.5-2 / Table 3.5-2 shows the activity releases by isotope, assumed for one conventional or six mPower units.

14. Tables 5.4-4 through 5.4-9

(a) "Unit" refers to one conventional unit or six modular mPower reactors.

15. Table 5.4-8 Gaseous Pathway Doses for Maximally Exposed Individuals

(a) "Site" refers to two conventional units or 12 modular mPower reactors.

16. 5.7.1 Uranium Fuel Cycle Impacts (p. 5.7-1)

Table S-3 of 10 CFR 51.51(b) is used to assess environmental impacts resulting from the uranium fuel cycle. Its values are normalized for a reference 1000 MWe LWR at 80 percent capacity factor. The 10 CFR 51.51(b) Table S-3 values are reproduced as the “Reference Reactor” column in Table 5.7-1. The LWR technologies being considered to demonstrate VCS site suitability include the ABWR, the ESBWR, the AP1000, the APWR, and the mPower. The standard configuration for each of these reactor technologies is as follows. The ABWR is a single-unit, 1371 MWe reactor. The ESBWR is a single-unit, 1594 MWe reactor. The AP1000 is a single-unit, 1117 MWe reactor. The APWR is a single-unit, 1600–1700 MWe reactor. The mPower is a 6-module configuration, 125 MWe per module, for a total of 750 MWe. The APWR represents the bounding case for gross electrical output. The APWR was analyzed with an estimated gross electrical output of 1700 MWe1 operating at 96.3 percent capacity factor. The results of this analysis for a two-unit plant are also included in Table 5.7-1.

17. 5.7.2 Transportation of Radioactive Materials (p. 5.7-8)

Transport of radioactive materials is an important activity associated with operating new reactors at VCS. The analysis in this section is based on the LWR technologies described in Section 3.2 and radioactive waste management systems described in Section 3.5. Information regarding preparation and packaging of the radioactive materials for transport offsite can be found in Section 3.8. The data currently available for the mPower reactor will not support an evaluation of radioactive materials transportation. Should Exelon select the mPower technology for the VCS, an evaluation of radioactive materials transportation will be provided as part of the COL application.

18. 5.7.2.1 Transportation Assessment (p. 5.7-8)

To analyze the impacts of transporting LWR fuel and radioactive waste for comparison to Table S-4, the characteristics for the LWRs were normalized to a reference reactor-year. The reference reactor is an 1100 MWe reactor that has an 80 percent capacity factor, for an electrical output of 880 MWe per year. The advanced LWR technology being considered to demonstrate the VCS site suitability include the ABWR, the ESBWR, the AP1000, the APWR, and the mPower.

19. 7.1.1 Selection of Accidents (p. 7.1-1)

The set of accidents selected focuses on four light water reactor (LWR) designs: AP1000, APWR, ABWR, and ESBWR. Two versions of the ABWR (GE and Toshiba) are being considered for the VCS site, but the evaluation of this section applies to both versions. These four designs have been chosen because these are standard designs that have recognized bases for postulated accident analyses. The mPower technology is still in the early stages of design, thus the accidents are not as well defined as those for the other LWRs. The mPower design is standard LWR technology, and its core will have a relatively small thermal output. Thus, the core source term will be bounded by those for the other technologies. Based on this, the accident consequences associated with the mPower reactor are considered to be bounded by those for the other four reactor types. If the mPower (or another reactor technology not previously evaluated) is selected for the ESP site, the COL application would verify that the accident doses are bounded by those provided in the ESP or would provide a complete evaluation of accident radiological consequences compared with regulatory limits.

20. Letter from Exelon to USNRC - Additional Information - Accident Analysis Clarifications in Support of Early Site Permit Application (NP-10-0007, dated May 6, 2010)

Design Basis Accidents

Since Babcock & Wilcox (B&W) mPower reactor design source terms originally provided to Exelon represent preliminary design values at this time, Exelon commits to revise the VCS ESPA Site Safety Analysis Report (SSAR) Section 15.1 and Environmental Report (ER) Section 7.1.1 to remove the existing statements that the core source terms for the B&W mPower reactor design will be bounded by those for the other technologies proposed in the Plant Parameter Envelope (PPE). This revision will be included in the next periodic update of the VCS ESPA SSAR and ER.

21. Letter from Exelon to USNRC - Additional Information - Accident Analysis Clarifications (NP-11-0003, dated January 13, 2011)

The set of accidents selected focuses on four light water reactor (LWR) designs: AP1000, APWR, ABWR, and ESBWR. Two versions of the ABWR (GE and Toshiba) are being considered for the VCS site, but the evaluation of this section ~~applies to both versions~~ is based upon the source term associated with the ABWR certified design. These four designs have been chosen because these are standard designs that have recognized bases for postulated accident analyses. The mPower technology is still in the early stages of design, thus the accidents are not as well defined as those for the other LWRs. The mPower design is standard LWR technology, ~~and its core will have a relatively small thermal output. Thus, the core source term will be bounded by those for the other technologies. Based on this, the accident consequences associated with the mPower reactor are considered to be bounded by those for the other four reactor types~~and given its relatively small thermal output, the accident consequences associated with the mPower reactor are considered to be bounded by those for the other four reactor types. If the mPower (or another reactor technology not previously evaluated) is selected for the ESP site, the COL application would verify that the accident doses are bounded by those provided in the ESP or would provide a complete evaluation of accident radiological consequences compared with regulatory limits.

22. 7.2 Severe Accidents (p. 7.2-1)

As described in Chapter 3, Exelon's ESP analyses are based on the following reactor types: ESBWR, ABWR, AP1000, APWR, and mPower. For the severe accident analysis, Exelon selected the ESBWR and ABWR to represent the entire suite of advanced light water reactor technologies. Exelon believes this representative approach is appropriate because:

- Unlike for safety analyses, a representative analysis is acceptable under the National Environmental Policy Act.
- In its 1985 policy statement on severe accidents (50 FR 32138), NRC stated its expectation that new reactors would achieve a higher standard of severe accident safety performance than the earlier designs. This has proven to be true as severe accident risks from new reactor design certification applications and ESP/COL applications are compared to license renewal applications. The greatest risk associated with a new generation reactor design (for which data is available) is well below that of the already low risk associated with the existing fleet undergoing license renewal.

23. 7.4 Transportation Accidents (p. 7.4-1)

Subsection 5.7.2.2 describes the methodology used to analyze the impacts of transportation of radioactive materials. Subsection 7.4.1 describes the radiological impacts of transportation accidents. The nonradiological impacts of transportation accidents are addressed in Subsection 7.4.2. The data currently available for the mPower reactor will not support an evaluation of radioactive materials transportation. Should Exelon select the mPower technology for VCS, an evaluation of radioactive materials transportation will be provided as part of the COL application.

24. 9.3.2.4 Screening Process to Identify Candidate Sites (p. 9.3-6)

The inclusion of ABWR, AP1000, APWR, and mPower in the ESP as potential technologies for the VCS site had a negligible impact on water consumption and did not affect the outcome of the siting evaluation.

25. Letter from Exelon to USNRC - Response to Request for Additional Information Letter No. 2 (NP-11-0001, dated January 11, 2011)

RAI 02.03.05-5:

Question:
SSAR Section 2.3.5.1 provides the cross-sectional area and reactor building height for the mPower design. These measurements are then stated to be used as input for use in the XOQDDQ computer program. In order for the staff to evaluate whether this is a conservative assumption, please provide a listing of the reactor heights and containment cross-sectional areas of the other reactor designs being considered.

Response:
The following table presents the building dimensions that were considered to determine the bounding case for the XOQDOQ analysis. The bounding case was chosen based on the dimensions presented in the table and the understanding that larger cross sectional areas and heights are associated with larger building wakes and greater turbulent diffusion—that is, the smaller the cross sectional area and height, the less effect the potential building will have on turbulence, and thus, the more conservative the selection. Therefore, as indicated in Table 1, the mPower design was selected to most conservatively represent the parameters which would likely bound a chosen plant design. It should be noted that when considering the mPower design, the height and width were taken from the Reactor Service Building, as this building provides the largest potential source of turbulent diffusion resulting from building wakes from the mPower design.

Table 1: Building Height and Cross Sectional Areas for Various Reactor Types or Technologies

	Reactor Building[a]	
Technology	Height (m)	Cross Sectional Area (m^2)
ESBWR	48	2352
ABWR	37.8	2139
AP1000	69.7	2636
APWR	69.93	3092
mPower[b]	24.38	1263

[a]Grey shading represents bounding parameters used in the ESP analysis.
[b]mPower height and area are from the Reactor Service Building.

26. Attachment to e-mail from A. Williamson (NRC) to J.Trembley (Exelon), dated 2/10/2011: References for Electronic Reading Room

Accidents

A technical description including drawings of the mPower Small Modular Reactor (SMR). This should include all safety-related systems, such as the reactor coolant system, secondary coolant system, auxiliary coolant system, residual heat removal system, emergency core coolant systems, reactor containment systems, and any SAMDAs envisioned.

Input and output files from applicant's MACCS2 code runs for severe accident consequence assessment.

Calculation packages that describe how the applicant performed radiological dose consequence calculations for DBAs and severe accidents. This should include the specific source terms for the five reactor types being considered at VCS.