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December 21, 1990
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Charles L. Miller, Director
Standardization Project Directorate
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Differences Between the EPRI Utility Requirements Document and the System 80+™ Standard Design

References: (1) Letter, C. L. Miller (NRC) to E. H. Kennedy (C-E), dated November 6, 1990
(2) Letter LD-90-060, E. H. Kennedy (C-E) to T. V. Wambach (NRC), dated August 28, 1990

Dear Mr. Miller:

This letter responds to your request [Reference (1)] to discuss in more detail the differences between certain provisions of the EPRI ALWR Utility Requirements Document and the System 80+ Standard Design. Enclosure I responds to your request. In addition, a number of differences identified in Appendix A of our draft LRB document [Reference (2)] have been removed, either due to a change in the design/analysis or a change in the application of the EPRI criteria. Enclosure II provides, for your information, a listing of the previously identified differences which have been removed. Notwithstanding these differences, the System 80+ design continues to have a very high degree of compliance with EPRI criteria.

If you have any questions on the attached material, please call me or Mr. S. Ritterbusch of my staff at (203) 285-5206.

Sincerely,

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Enclosure I

DIFFERENCES BETWEEN THE SYSTEM 80™ DESIGN AND THE EPRI EVOLUTIONARY PLANT REQUIREMENTS DOCUMENT* AS OF DECEMBER, 1990

1. Hot Leg Temperature: The EPRI URD, Chapter 3, paragraph 3.2.3, states "The reactor coolant system shall be designed so the average hot leg temperature is no higher than 600F."

The EPRI criterion (600F) was selected based on the following considerations:

1. Increased thermal margin in the reactor core
2. Reduced likelihood of steam generator tube failure due to stress corrosion cracking.

The System 80+ design has a maximum hot leg temperature of 615F (compared to 620F for the System 80 design). The EPRI considerations are satisfied in the following manner:

1. The System 80+ design meets the EPRI criterion for 15% thermal margin in the reactor core

2. Corrosion resistance of the steam generator tubes has been addressed by specifying thermally-treated Alloy 690 (in lieu of Alloy 600). Laboratory testing of Alloy 690 has shown it to be highly resistant to stress corrosion cracking at operating conditions.

To maintain equivalent plant efficiency and performance when the hot leg temperature is decreased, the steam generator size must be increased. Primarily as a result of this consideration, the System 80+ steam generator heat transfer area has been increased by about 10%. The steam generator size cannot be increased significantly more than this amount and still remain within proven manufacturing capabilities. Also, increases in steam generator size and accompanying increases in secondary side inventory make the consequences of steam line break accidents more adverse.

Based on the above considerations, C-E believes that a hot leg temperature of 615F represents an optimal balance.

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* Based on the EPRI URD as of mid-summer, 1990. The EPRI URD Roll-up Document submitted to the NRC has been held proprietary by EPRI and has not been released to Combustion Engineering.

2. Skirt-type Component Supports: The EPRI URD, Chapter 3, paragraph 2.2.6, states "Major reactor coolant system equipment supports shall use pedestal type or open frame supports in preference to skirt mountings, which more severely limit access."

As in previous C-E designs, the System 80+ design uses skirt type supports for the two steam generators and the pressurizer. Reasons for this design decision include use of a proven design, inherent strength of the skirt design, and absence of experience indicating problems with access for inspection. The steam generator skirt is small compared to the diameter of the steam generator and does not restrict access to any nozzles or manways. The pressurizer support skirt is a full-diameter skirt and permits access to the heater nozzles (from below).

3. Redundant Feedwater Isolation Valves: The EPRI URD, Chapter 2, paragraph 4.2.2.4, states "Double valve feedwater isolation is required. The feedwater control valve (Chapter 3) serves as one of these valves."

The System 80+ design retains redundant feedwater isolation valves in addition to the control valve and two check valves in each feedwater line for the following reasons. First, use of double feedwater isolation valves requires no reliance on check valves or control valves to meet the single failure criterion in events such as a feedwater line break. Second, double isolation valves ensure a safety-related means to terminate a steam generator overfill transient, without making the control valves or check valves safety-grade. Finally, two isolation valves provide a tighter shutoff since control valves are not typically designed for isolation.

4. Main Steam Isolation on Pressure Rate-of-change: The EPRI URD, Chapter 2, paragraph 3.5.3, states "High containment pressure and low steamline pressure ... to signal the MSIVs to close. During periods of low steamline pressure, high steamline pressure rate shall be used ...."

The System 80+ design includes a main steam isolation signal on low steam generator pressure. The actuation setpoint is manually variable when steamline pressure is being decreased and automatically variable when the pressure is being increased. This design provides equivalent protection to that for actuation on pressure rate-of-change. This System 80+ design feature has been used in operating plants and provides protection over the full range of conditions.

5. Containment Geometry: The EPRI URD, Chapter 6, paragraph 4.3.4.1, states "The primary containment structure shall be a large

dry type containment with cylindrical steel pressure vessel (150-foot internal diameter) ...." The corresponding rationale indicates that other designs, including steel spheres, have been employed successfully and could meet the ALWR top-tier criteria.

The System 80+ design includes a spherical steel pressure vessel with a 200-foot diameter. C-E believes that the spherical containment offers operational, constructability, and cost advantages and meets all EPRI URD functional criteria. For example, the operating floor is located at the elevation of maximum diameter (200 feet) which provides significantly more open floor space for maintenance and other operation activities than the 150-foot cylindrical design.

6. Hatch at Operating Floor Level: The EPRI URD, Chapter 6, paragraph 4.3.4.7, states "A maintenance hatch shall be provided at grade ...." The corresponding rationale indicates that the concern is to provide space at the operating deck level for other activities.

The System 80+ maintenance hatch is located at the level of the operating floor, 54 feet above grade. Location at this elevation results from use of the spherical geometry (which provides large maintenance and laydown areas at the operating deck level) and general arrangement considerations such as selection of embedment depth and convenient access to the maintenance bay for truck loading and off-loading. The large floor area at the operating deck level ensures that maintenance and other activities will not be inhibited by activity in the vicinity of the equipment hatch. While there is a difference from the EPRI criterion, the intent of the criterion indicated in the rationale is met by providing maintenance-staging floor area in the adjacent maintenance/outage building at the elevation of the containment operating deck. The adjacent maintenance building includes equipment for handling heavy components and truck access at grade level.

7. Source Term for Radioactivity Release Predictions: The EPRI URD, Chapter 1, paragraph 2.4.1.2, states "... source term ... shall be somewhat more realistic than analyses to date on current LWRs."

The System 80+ design currently uses, for the design basis safety analysis, the same source term methodolgy approved by NRC staff and used to date on current LWRs. Realistic source term methodology is used, however, for severe accident calculations.

There are significant benefits to plant operation and siting when a realistic source term is used (e.g., a larger allowable containment leak rate, a smaller Exclusion Area Boundary) and C-E supports and encourages EPRI and the NRC staff to continue their efforts to agree upon more realistic source term assumptions for design basis safety analysis calculations. Such agreement has not yet been obtained, as indicated in the draft SER for Chapter 5 of the EPRI URD. Therefore, the current System 80+ safety analysis uses NRC-approved methodology. C-E strongly encourages continued efforts to reach concurrence on realistic source term assumptions, especially for the evolutionary LWRs. It is anticipated that the System 80+ safety analysis would be revised to reflect more realistic methodology if concurrence between EPRI and NRC staff is obtained prior to the certification of the System 80+ Standard Design.

8. Containment Design Leak Rate: The EPRI URD, Chapter 1, paragraph 2.4.1.1, states "It shall be demonstrated that 10CFR100 exposure limits can be met with a containment design leak rate of not less than .5 percent ...."

The System 80+ Chapter 15 offsite and control room dose analysis is based on a design leak rate of 0.34%. This represents a relaxation from current values of typically 0.1%. A larger leak rate would be justified if more realistic source term assumptions were implemented, as indicated in item (7) above on the source term.

9. Alloy 690 for Pressurizer Heaters: The EPRI URD, Chapter 1. paragraph 5.3.1.3.1.3, states "... use of Alloy 690 shall be restricted to steam generator tube applications."

The System 80+ design also uses Alloy 690 for pressurizer heater sleeves. Use of Alloy 690 decreases the potential for stress corrosion cracking, relative to previously used materials, and it is considered to be highly resistant to stress corrosion cracking, based on laboratory tests.

10. Pressurizer Heater Sleeve Replacement Method: The EPRI URD, Chapter 3, paragraph 3.4.3.4.5, states "The design and arrangement of pressurizer heater sleeves shall allow replacement of bundles of heater sleeves without cutting and welding on the pressurizer shell.

The System 80+ design uses Alloy 690 for pressurizer heater sleeves to minimize the possibility of having to replace them due to corrosion. C-E believes that use of Alloy 690 decreases the need for heater sleeve replacement and, therefore, current removal and replacement techniques are considered adequate.

11. Feedwater Heater Location: The EPRI URD, Chapter 2, paragraph 4.3.1.5, states "All low pressure feedwater heaters ... shall be located within the condenser neck."

In the System 80+ reference design, only the first stage is located inside the condenser neck. This is a proven design and does not result in an overly congested condenser design. Sufficient space is provided such that location of the heaters outside the condenser will not hamper plant maintenance operations.

12. Turbine Exhaust Connection: The EPRI URD, Chapter 2, paragraph 4.4.3.13, states "A stainless steel expansion joint ... shall be provided. A solid connection is permitted if the condenser is spring-mounted."

The System 80+ design allows for either a flexible rubber seal or a rigid seal with a spring-mounted condenser. The experience database for the rubber seals does not merit, in C-E's opinion, preclusion of their use.

13. Number of Feedwater Heating Stages: The EPRI URD, Chapter 2, paragraph 4.3.1.4, states "Seven heating stages ... shall be used for the PWR."

The System 80+ reference design uses six feedwater heaters. For the most efficient plant operation, the actual number of feedwater heaters will be determined by a site-specific heat balance.

14. Atmospheric Dump Valve Control: The EPRI URD, Chapter 2, paragraph 3.4.3.3.1, states "Each main steam line shall be provided with ... two PORVs for a two-loop plant."

The System 80+ design includes safety grade, manually controlled (from the control room) dump valves which are used only for plant cooldown and decay heat removal under post-accident conditions. A control grade, automatic steam dump and bypass system (with a total capacity of 55% of full power steam flow) is provided for control of over-pressure conditions. In conjunction with the Reactor Power Cutback System, the System 80+ design can accomodate a 100% load rejection and, therefore, automatic operation of the dump valves is not necessary.

15. Third Main Feedwater Pump: The EPRI URD, Chapter 2, paragraph 4.3.5.1, states "The feedwater system shall include three main feed pumps, ... All three pumps shall be normally operating." The corresponding rationale indicates that such an arrangement requires the pumps to be run somewhat below their design point, but this arrangement is preferrable because it provides a smoother transient following a pump trip and lessens the risk of a plant trip. The rationale also indicates that an arrangement of two operating pumps with an installed spare has the advantage of running the pumps at their design point.

The System 80+ design includes three installed main feed pumps, with two operating and the third in standby status. Keeping the third pump in standby status reduces wear and tear and maintenance. Also, running the two operating pumps at their design point is more efficient. The System 80+ design includes the proven Reactor Power Cutback System to respond to plant transients and decrease the likelihood of a plant trip during events such as the loss of a main feedwater pump. If one of the main feedwater pumps is lost the Reactor Power Cutback System would decrease reactor power to about 75% until the spare feedwater pump is brought on line (each of the feedwater pumps has adequate capacity at runout conditions to support 75% reactor power).

16. Location of Control Room Support Facilities: The EPRI URD, Chapter 10, paragraph 4.9.1, states "The main control room shall include within its security boundary... An operator's area, including a restroom and kitchen...."

The System 80+ design has the non-critical control room operator support facilities close to and easily accessible from the control room, but outside its security boundary. This reduces the potential impact of failures in the non-safety plumbing and electrical systems from affecting the control room and minimizes the need for special venting of drain lines. It also minimizes personnel activity within the control room security boundary, including food and janitorial services.

17. Advanced Control Complex Design: The EPRI URD, Chapter 10, paragraph 2.2.10, states "... Each work station shall have the full capability to perform main control room functions ...."

It is C-E's understanding that in order to comply with the above criterion, each work station would have to have the capability to perform all control and monitoring functions for the plant. Because computer failures or seismic events could impact the entire man-machine interface for all work stations, the work station and supporting computers must be qualified (safety-related). Otherwise, the safe shutdown and other control functions would likely have to be performed at a separate, qualified station (which the operator would not use in day-to-day operations).

C-E has taken a more conservative approach. The System 80+ Advanced Control Complex (called Nuplex 80+™) integrates spatially distributed (and dedicated), seismically qualified monitoring and control panels with non-qualified compact work stations. This approach meets all regulatory criteria for separation and independence of redundant safety system channels. The Nuplex 80+ design ensures that, under accident conditions, the operator will be familiar with the instrumentation used for accident monitoring and mitigation since that same instrumentation is used for day-to-day operations. The Nuplex 80 + design also uses proven, off-the-shelf digital computer components which are configured for improved online testing, mode-dependent alarm prioritization, validated signal display, and core thermal margin monitoring. Use of existing technology ensures that Nuplex 80+ is an evolutionary design (vs. revolutionary) which is compatible with existing training and maintenance programs, while at the same time, components are configured using state-of-the-art human factors methodology.

18. Use of Sound Powered Phones: The EPRI URD, Chapter 10, paragraph 4.6.2, states "Portable, Wireless Communication... shall be designed as the primary, dedicated means of communication ...." and "... fixed telephone stations shall be provided ... to support general communication needs." Also, "These systems ... may be supplemented with additional communication systems such as sound-powered phones ...."

The System 80+ design includes sound-powered phones as the primary means of communication. Separate, dedicated circuits are provided for maintenance, refueling, and emergency activities. Reliance on sound-powered phones avoids problems which have been experienced with wireless communication, e.g., interference with control systems and continuous coverage. Wireless phones can be used, however, where needed to ensure communication access to all locations.

19. Separate Switchyards: The EPRI URD, Chapter 11, paragraph 3.3.4, states "The main and reserve off-site power circuits shall be connected to switching stations which are independent and separate."

The off-site power system is site-specific. Therefore, the System 80+ design includes only a conceptual design in the safety analysis report. The interface requirements provided for the off-site power system do not preclude separate switchyards, but separation is not required. Separate and independent power lines are required, however. While separate switchyards may be desirable for some sites, there may be site-specific considerations for using a single switchyard.

20. Control Room Pressure Boundary for the HVAC: The EPRI URD, Chapter 6, paragraph 4.2.5.1, states that "All air conditioning... equipment required for the control room shall be located within... the control room pressure envelope." The rationale states that the intent is to eliminate in-leakage of unfiltered air [presumably into the control room] and to minimize out-leakage.

The System 80+ control room HVAC equipment is located outside the control room pressure boundary to provide shielding for the filters which may become radioactive subsequent to an accident. It should be noted that locating the HVAC equipment inside the control room pressure boundary would not eliminate the potential for in-leakage since there would still be penetrations for intake air and refrigeration equipment.

21. No Fuel Damage for Loss of All Feedwater and No Operator Action: The EPRI URD, Chapter 1, paragraph 2.3.3.2, states "There shall be no fuel damage for at least two hours after sustained loss of all feedwater with no operator action (PWRs only)."

The analysis for assessing compliance with this criterion shows that core uncovery would not occur for at least 90 minutes. Extension beyond this time would require a larger reactor coolant system volume. This would result in more severe mass and energy releases to the containment during a LOCA and a corresponding increase in the containment volume. It is believed that the System 80+ design represents an optimal balance between containment size, reactor coolant system volume, and margin to fuel damage for loss of feedwater events.

22. Safety Depressurization System Capacity: The EPRI URD, Chapter 5, paragraph 5.5.2.3.2, states "The SDVS bleed paths shall have sufficient total flow capacity... to prevent core uncovery following a TLOFW [total loss of feedwater] if feed and bleed is delayed up to 60 minutes from the time the primary safety valves lift. Analyses shall show a margin to core uncovery of at least two feet, using best estimate methods."

The analysis for assessing compliance with this criterion shows that, for the SDS valve size selected, feed and bleed would have to be initiated at about 30 minutes to maintain a two-foot cover of water above the core. Based on engineering judgment, it was decided to not have an SDS valve size larger than the size of the ASME Code pressurizer safety valves. The primary considerations in this judgment were 1) restricting reactor coolant system thermal-hydraulic perturbations when the SDS is used and 2) minimizing the loss of coolant should the SDS remain open longer than intended. It is believed that 30 minutes is sufficient time for trained operators to initiate feed and bleed.

23. Reactor Vessel Level Measurement: The EPRI URD, Chapter 1, Appendix B, Section 2.4.1.1, states "... it is unnecessary to specify a reactor pressure vessel (RPV level instrumentation system for the ALWR." The EPRI URD, Chapter 4, parargaph 6.3.3.2, states "The instrumentation ... shall provide for detection of voiding in the upper head of the RPV."

The System 80+ design includes the Reactor Vessel Level Measurement System for detecting voids in the reactor vessel upper head and determining an equivalent liquid level.

DIFFERENCES WHICH NO LONGER EXIST BETWEEN THE EPRI URD AND THE SYSTEM 80+ STANDARD DESIGN

1. Anti-ejection Latch for Control Element Assemblies (CEAs): The System 80+ design does not have anti-ejection latches. An early version of the EPRI Utility Requirements Document (URD) considered the use of anti-ejection latches to lower the probabability of a CEA ejection and remove the need to analyze the event in the design basis safety analysis. The current EPRI URD does not include a recommendation for such latches. There is, therefore, no longer a deviation.

2. Location of Steam Generator Handholes: The EPRI URD, Chapter 3, paragraph 4.4.1.4.2, states "Access openings and/or inspection ports shall be provided in the secondary shell in the vicinity of the tube sheet surface." The corresponding rationale states "... openings may be needed at each tube support elevation to inspect for sludge accumulation and OD corrosion ...."

The System 80+ steam generators have handholes at the tube sheet elevation and thus the design is in compliance with the EPRI URD.

With respect to the supporting rationale on the potential need for inspection ports at tube support elevations above the tubesheet, it should be noted that C-E's "eggcrate" tube supports have more favorable thermal-hydraulic characteristics than those of other vendors in operating plants. Moreover, the eggcrate supports for the System 80+ design are of Type 409 stainless steel, which is resistant to chemical attack that produces denting. Inspection ports at elevations above the tubesheet have, therefore, no practical application in the current C-E design. Recent communication with EPRI has confirmed that the C-E design meets the EPRI URD and is consistent with the supporting rationale.

3. Cross-connection Between Trains of the Emergency Feedwater System: The EPRI URD, Chapter 5, paragraph 5.3.3.1.3, states "Arrangement of the four pumps in two divisions shall minimize cross-connections between individual trains ...."

The System 80+ design includes a cross-connection between the discharge lines of each pump. This provides a more reliable system for scenarios that go beyond a single failure.

In addition, a cross-connection between divisions allows either of the motor-driven pumps to feed either steam generator when the steam generators are depressurized (the turbine driven pumps are not available when the steam generators are depressurized).

Since the motor-driven emergency feedwater pumps are credited for keeping the steam generator tubes covered with water during long-term post-LOCA conditions, the cross-connection between the motor-driven pumps is required to meet the single failure criterion. This minimizes the potential for escape of radioactive leakage from the primary system.

In summary, these cross-connections make the system more reliable and are required for safety reasons. Therefore, this design complies with the EPRI URD.

4. Separate Power Supply Transformers for Safety Channels: The EPRI URD, Chapter 11, paragraph 7.3.1.5, states that "...vital AC power supply system shall minimize the number of system components...." The rationale for this criterion references Figure 11.7-1 as a way of meeting the criterion. Figure 11.7-1 shows a single transformer that powers both safety channels within a division.

The System 80+ design includes an additional transformer within each division such that each safety channel in that division can be powered from a different transformer. This is required to meet channel separation criteria and ensures that a single transformer failure cannot affect more than one safety channel. Therefore, this design meets the EPRI criterion to minimize the number of components in this system. The rationale for the EPRI criterion indicates that use of a common transformer is acceptable for an ALWR, but use of more than one transformer is not precluded.

5. Offset of the Reactor Coolant System from the Containment Center: The EPRI URD, Chapter 6, paragraph 4.3.4.2, states that "...RCS loop offset dimension from containment centerline shall be optimized for cylindrical containments to provide a large laydown space...." The corresponding rationale indicates that a 15- to 20-foot offset is feasible.

The System 80+ containment is a 200-foot spherical steel pressure vessel surrounded by a shield building. Because the operating floor is at the elevation where the diameter is 200 feet, there is ample laydown area without offsetting the reactor coolant system from the containment centerline. The EPRI criterion is applicable to cylindrical (not spherical) containments. The System 80+ design, however, meets the intent of the EPRI URD.

6. Emergency Diesel Generator Start Time: The EPRI URD, Chapter 11, paragraph 5.3.2.1, states "... combined starting and relevant load sequencing time of each EDG shall be less than 40 seconds...."

In the System 80+ design the diesels start and begin accepting load within 20 seconds and critical emergency equipment is loaded within an additional 20 seconds. Therefore, this design meets the EPRI URD criterion.

7. Neoprene and Poly-vinyl Chloride Insulation Inside Buildings: The EPRI URD, Chapter 11, paragraph 2.6.3.2, states "...polyvinyl chloride (PVC) and neoprene shall not be used ...."

The System 80+ procurement specifications for components inside buildings will state that PVC and neoprene insulation should not be used.

8. Containment Purge Valve Closure Time: The EPRI URD, Chapter 1, Table 1.2-5, states "Automatic actuation or isolation of fluid systems.... shall not be required in less than 30 seconds."

Recent calculations have confirmed that the purge valve closure time for System 80+ has been increased to 30 seconds from the previous value of 5 seconds. The previous estimate of the System 80+ closure time was based on a conservative estimate rather than on a specific calculation. The System 80+ design, therefore, meets the EPRI criterion.