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52-002

MEMORANDUM FOR: Robert C. Pierson, Director
Associate Directorate for Advanced Reactors
and License Renewal
Office of Nuclear Reactor Regulation

FROM: LeMoine Cunningham, Chief
Radiation Protection Branch
Division of Radiation Protection
and Emergency Preparedness
Office of Nuclear Reactor Regulation

SUBJECT: REVIEW OF CESSAR SYSTEM 80+ DRAFT SAFETY EVALUATION REPORT (DSER) FOR CHAPTER 12, SECTIONS 12.1-12.5

As requested in your July 9, 1992, memorandum from R. Pierson to L. Cunningham, the Facilities Radiation Protection Section of the Radiation Protection Branch has completed its review of Chapter 12 of the CESSAR System 80+ DSER. Since this version of our DSER input has been modified by the technical editor and the project manager, we reviewed it in detail to ensure that our technical input had been accurately incorporated and that all of our identified open and COL items were adequately addressed. Our initial DSER input for Chapter 12 (dated April 22, 1992) identified all outstanding issues as "open items." Enclosure 1 to this memorandum further categorizes these outstanding issues into "open items" and "COL items." This list includes some items not initially identified in our April 22, 1992 memorandum. Enclosure 2 is a marked-up copy of our DSER input containing our comments. This review was performed by Charles Hinson, Facility Radiation Protection Section, Radiation Protection Branch.

/s/

LeMoine J. Cunningham, Chief
Radiation Protection Branch
Division of Radiation Protection
and Emergency Preparedness
Office of Nuclear Reactor Regulation

Enclosures: As stated

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Enclosure 1

## CHAPTER 12 "OPEN ITEMS"

| Item Number | Issue/Section |
|---|---|
| 12.1.2-1 | Applicability of ALARA Guidelines Manual (12.1.2) |
| 12.2.1-1 | Description of contained sources and shielding (12.1.2 and 12.2.1) |
| 12.2.2-1 | Description of sources of airborne radioactivity (12.2.2)<br>Listing of plant airborne radioactivity levels (12.3.3)<br>Description of airborne monitor sensitivities for plant areas (12.3.4) |
| 12.2.3-1 | Listing of post-accident source terms (II.B.2) (12.2.3)<br>Listing of post-accident vital areas (12.3.1)<br>Listing of post-accident dose rates and integrated doses to personnel in vital areas (12.3.1)<br>Description of post-accident shielding (12.3.2) |
| 12.3.1-1 | Radiation zone layout drawings for all areas (12.3.1) |
| 12.3.1-2 | Depiction of major personnel traffic patterns on plant layout drawings (12.3.1) |
| 12.3.1-3 | Locations of personnel locker/changeout rooms on plant layout drawings (12.3.1) |
| 12.3.1-4 | Location of worker access control points on plant layout drawings (12.3.1) |
| 12.3.1-5 | Accessibility to various plant areas (12.3.1) |
| 12.3.1-6 | Access to and dose rates in the vicinity of the spent fuel transfer tube (12.3.1) |
| 12.3.1-7 | Radiation zoning designation of the primary chemistry lab area (12.3.1) |
| 12.3.2-1 | Identification of high radiation areas (12.3.2) |
| 12.3.4-1 | Location of area radiation monitors (12.3.4) |
| 12.3.4-2 | Location of containment high range area monitors (12.3.4) |
| 12.3.4-3 | Location of airborne radioactivity monitors (12.3.4) |

| | |
|---|---|
| 12.3.4-4 | Airborne radioactivity monitoring system compliance with ANSI N13-1-1969 (12.3.4) |
| 12.4-1 | Inadequacy of dose assessment (12.4) |
| 12.4-2 | Listing of inplant personnel exposures due to airborne radioactivity (12.4) |

CHAPTER 12 "COL ITEMS"

| | |
|---|---|
| 12.1.1-1 | Description of operational ALARA policy (12.1.1) |
| 12.1.2-1 | Use of experience from past designs and from operating plants to develop improved radiation protection design (12.1.2) |
| 12.1.3-1 | Compliance with Regulatory Guides (12.1.3) |
| 12.3.4-1 | Exact location of area radiation monitors (12.3.4) |
| 12.3.4-2 | Listing of specific equipment and procedures to ensure compliance with Section III.D.3.3 of NUREG-0737 (12.3.4) |

# 12 RADIATION PROTECTION

Chapter 12 of Combustion Engineering's Standard Safety Analysis Report for design certification for the System 80+ plant design (hereafter identified as the CESSAR) describes the radiation protection measures of the plant design and operating policies. The staff evaluated this information against the criteria given in Chapter 12 of NUREG-0800 (Standard Review Plan, SRP). The radiation protection measures incorporated into the System 80+ design are intended to ensure that internal and external radiation exposures to station personnel, contractors, and the general population, resulting from plant conditions, including anticipated operational occurrences (AOOs), will be within acceptable limits of regulatory criteria and will be as low as is reasonably achievable (ALARA).

The basis of the staff's acceptance of the material reviewed is that doses to personnel will be maintained within the limits of 10 CFR Part 20, "Standards for Protection Against Radiation." The applicant's radiation protection design and program features must also be consistent with the guidelines of Regulatory Guide (RG) 8.8, "Information Relevant To Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable" (Revision 3).

On the basis of its review of CESSAR Chapter 12, the staff finds that the applicant has not given us sufficient information to conclude that the radiation protection measures incorporated in the design will offer reasonable assurance that occupational doses will be maintained ALARA and within the limits of 10 CFR Part 20 during plant operations.

The bases for the staff's conclusions follow.

## 12.1 Ensuring That Occupational Radiation Doses Are As Low As Is Reasonably Achievable

The staff has reviewed the information in the CESSAR for adherence to the guidelines in RG 1.70, "Standard Format and Content of Safety Analysis Reports

for Nuclear Power Plants," and against the criteria in SRP Section 12.1, regarding the radiation protection aspects of the System 80+ design. The staff reviewed CESSAR Section 12.1 to ensure that the applicant had either committed to adhere to the criteria of the regulatory guides and staff positions referenced in SRP Section 12.1 or had provided acceptable alternatives. In addition, the staff selectively reviewed the CESSAR against acceptance criteria of the SRP using the review procedures given there.

12.1.1 The Applicant's Policy Considerations

In CESSAR Section 12.1.1, the applicant describes the design, construction, and operational policies it has implemented to ensure that the ALARA philosophy is factored into each stage of the System 80+ design process. The applicant commits to ensure that the System 80+ plant will be designed and constructed in a manner consistent with the guidelines of RG 8.8. This will be achieved by reviewing plant design during the design phase and inspecting the shielding and piping layout during the construction phase. These policy considerations are consistent with the guidelines of RG 8.8 and are acceptable.

The detailed policy considerations regarding plant operations are outside the scope of this review. The operational ALARA policy forms the basis for the station ALARA manual. In order to maintain doses to plant personnel ALARA, the combined operating license (COL) applicant will review all plant procedures, their revisions, and modification plans that involve personnel radiation exposure to ensure that procedures and plant incorporate the ALARA philosophy. The COL applicant's operational ALARA policy will conform to the requirements of RG 8.8, RG 1.8, "Qualification and Training of Personnel for Nuclear Power Plants" (Revision 2), and RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposure As Low As Is Reasonably Achievable." COL applicants seeking an operating license by referencing the System 80+ certified design will be required to address these operational considerations to ensure radiation doses are ALARA. This is a COL action item (COL Item 12.1.1-1).

12.1.2 Design Considerations

The objectives of the general design considerations and shielding are to minimize the time employees need to spend in radiation areas and to minimize radiation levels in routinely occupied plant areas housing equipment that requires personnel attention. The applicant states that these design considerations will be consistent with the guidelines in RG 8.8 and RG 8.10.

Additional functions of the plant shielding are to (1) ensure that occupational radiation exposures are maintained ALARA, (2) maintain radiation exposure to control room operators within the limits of 10 CFR Part 50 (Appendix A, Criterion 19) following an accident, and (3) protect certain components from excessive activation or excessive exposure to radiation. The applicant states that it will not provide a detailed shielding analysis as part of the certification document since plant components have not been procured and pipe routing is not complete. This ~~is an~~ which is further discussed in Section 12.2.1 open item (Open Item 12.[redacted]2.1-1). The COL applicant will submit a detailed shielding analysis. The COL applicant's radiation protection staff will assess the station design during design and construction. The applicant's staff will also ensure that the final design incorporates lessons learned from previous nuclear plant designs. This is a COL action item (COL Item 12.1.2-1).

The System 80+ design will incorporate numerous design features to satisfy the design objectives of plant radiation protection program. The use of highly reliable equipment will reduce the frequency of maintenance and the associated personnel exposure. One example of this is the use of reliable extended service lighting in high-radiation areas to reduce the frequency of relamping. Careful attention will be paid to environmental qualification of equipment to withstand such environmental conditions as radiation, humidity, and temperature. Electrical components containing radiation-sensitive materials will be well shielded or located in low-radiation areas. Metals in contact with the reactor coolant will have cobalt impurities of no more than 0.20 weight percent and will have a low nickel content. This will minimize the production of cobalt-60 and cobalt-58, which are the major sources of radiation exposure during shutdown, maintenance, and inspection activities. Adequate spacing and

laydown areas around equipment will facilitate access for maintenance and inspection activities. A transport path and adequate rigging will also be provided for removal and replacement of equipment. Radioactive systems will be separated from non-radioactive systems, and high-radiation sources will be located in separate shielded cubicles. Equipment requiring periodic servicing or maintenance (pumps, valves, and control panels) will be separated from more radioactive sources (tanks and piping). Valves located in high-radiation areas will be equipped with reach rods or motor operators will minimize operator exposure. Tanks, valves, and piping will be designed with smooth interior surfaces; drains will be located at a low point; and flushing connections will minimize the buildup of crud in these components. Systems that produce radioactive waste will be located close to radwaste processing systems to minimize the length of piping runs carrying highly radioactive material. This will also minimize the potential for pipe plugging. These design features are consistent with the guidelines in RG 8.8 and are acceptable.

In addition to the design features just described, the System 80+ design incorporates several design features that represent an improvement over the design features used at many currently operating plants. Blanket-type thermal insulation for components carrying radioactive fluids will utilize Velcro™ fasteners to facilitate removal, thereby reducing personnel exposures. Robotic technology will be used to perform maintenance and surveillance in high-radiation areas. The System 80+ design will minimize the use of evaporators; these have historically required frequent maintenance exposing operating and maintenance personnel to substantial levels of radiation. These features, intended to minimize personnel exposures, comply with the guidelines of RG 8.8, and are acceptable.

Many of the features described, as well as additional guidance for general design features, are provided in the System 80+ Design Certification ALARA Guideline Manual. The staff is not sure if this document is part of the CESSAR Certification Document. If it is part of the Certification Document, then it should be referenced as such in the appropriate parts of CESSAR Sections 12.1, 12.3, and 12.4. In addition, this ALARA Guideline Manual

should differentiate between those design features that will be incorporated into the System 80+ design and those features that are only listed as potential System 80+ design features. If the ALARA Guideline Manual is not considered to be part of the CESSAR Certification Document, then those design features described herein that will be incorporated into the System 80+ design must be added to the appropriate parts of CESSAR Sections 12.1, 12.3, and 12.4. Without the addition of this information, these CESSAR sections do not meet the acceptance criteria of the SRP (NUREG-0800) with respect to the description of plant ALARA design features. This is an open item (Open Item 12.1.2-1).

12.1.3 Operational Considerations

The System 80+ radiation protection program will ensure that radiation exposures to employees are maintained ALARA in accordance with the recommendations of RG 8.8 and RG 8.10. Most exposure to radioactivity at operating plants occurs from maintenance and inspection activities that take place during plant outages. Those outage activities that could involve significant radiation exposure will be carefully planned by radiation protection personnel, will utilize previous operating experience, when applicable, and will be performed using appropriate exposure reduction techniques. Management will appropriately change techniques or procedures to reduce exposures during activities that require such reduction.

To reduce doses during outage activities, systems and major pieces of equipment subject to crud buildup will be equipped with connections to flush and/or chemically decontaminate the system or piece of equipment to reduce the crud levels. Mockups will be used to train plant personnel before they engage in potentially high-dose jobs. Sound-powered telephones or closed-circuit television will be used during high-dose jobs to permit supervisors to communicate with workers and yet avoid exposure to an area that has higher radiation levels. Entry-exit areas will be established in lower radiation areas to minimize dose when workers don and remove protective clothing. These operational considerations comply with the guidance in RG 8.8 and are acceptable.

SRP Section 12 lists many regulatory guides that the COL applicant should address. These regulatory guides ~~presently addressed in CESSAR Chapter 12~~ are listed below. The COL applicant who uses alternative guidance should state the specific alternate guidance used.

RG 8.2, "Guide for Administrative Practices in Radiation Monitoring."
RG 8.3, "Film Badge Performance Criteria."
RG 8.7, "Occupational Radiation Exposure Records System."
RG 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program."
RG 8.15, "Acceptable Programs for Respiratory Protection."
RG 8.20, "Applications of Bioassay for I-125 and I-131."
RG 8.26, "Applications of Bioassay for Fission and Activation Products."
RG 8.27, "Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants."
RG 8.28, "Audible-Alarm Dosimeters."
RG 8.29, "Instructions Concerning Risks From Occupational Radiation Exposure."

The staff is developing new regulatory guides pertaining to CESSAR Chapter 12 in connection with the revised 10 CFR Part 20. These guides will be addressed when this draft becomes the final safety evaluation report. At that time, the COL applicant should state whether it will follow the guidance in these new regulatory guides. This is a COL action item (COL Item 12.1.3-1).

The applicant's policy and design considerations meet the criteria of SRP Section 12.1 and are acceptable. However, the submittal of detailed operational considerations regarding the implementation of a radiation protection program is outside the scope of the System 80+ Certification Document. COL applicants seeking an operating license by referencing the System 80+ certified design will be required to address these operational considerations to the level of detail recommended in RG 1.70 (as discussed herein in Section 12.1.1).

## 12.2 Radiation Sources

The staff reviewed the descriptions of the radiation sources given in CESSAR Section 12.2 and CESSAR Chapter 11 for completeness against the guidelines in RG 1.70, and against the criteria given in SRP Section 12.2. The contained source terms were used as the basis for the radiation design calculations. The airborne radioactive source terms were used in the design of ventilation systems and for assessing personnel dose. The staff ensured that the applicant had either (1) committed to follow the guidelines of the regulatory guides and staff positions given in SRP Section 12.2 or (2) gave acceptable alternatives.

### 12.2.1 Contained Sources

In CESSAR Section 12.2.1, the applicant describes plant components that can become significant sources of radiation during plant operations, including shutdown. To calculate the source terms used for shielding design, the applicant assumed 0.25-percent fuel cladding defects at full-power operation. The principal source of radiation in the containment, other than the reactor core, is the reactor coolant system. Sources of radiation in the reactor coolant system are fission products released from defective fuel cladding, activation products, and corrosion products. Of these radiation sources, the activation product nitrogen-16 (N-16) is the predominant radionuclide in the reactor coolant pumps, steam generators, and reactor coolant piping during plant operations. The staff reviewed the applicant's estimates of N-16 activity levels in various parts of the reactor coolant system and found them comparable to activity levels measured at operating plants. Following plant shutdown, the predominant long-term sources of radiation in the containment are the spent fuel assemblies.

The CESSAR also lists all large contained sources of radiation in the reactor building subsphere and nuclear annex, and in the fuel, turbine, auxiliary, and radwaste buildings. For each of these contained sources, the CESSAR lists the associated maximum activity levels by isotope. The CESSAR does not contain sufficient source-term characterization (i.e., component geometry,

component and cubicle dimensions, composition of adjacent shielding, etc.) of contained sources for the staff to perform confirmatory shielding calculations to determine dose rates in potentially occupied areas adjacent to these components. The applicant states that the required information will not be provided as part of the certification since the components in question have not been procured and the locations of the shielding penetrations will not be known until the equipment is procured. Since the staff has insufficient information to confirm that these contained sources have been adequately shielded, as is required by General Design Criterion (GDC) 61 of 10 CFR Part 50, this is an open item (Open Item 12.2.1-1).

12.2.2 Airborne Radioactive Material Sources

In CESSAR Section 12.2.2, the applicant discusses the sources of airborne radioactivity for the System 80+ design. Airborne radioactive source terms are used in the design of ventilation systems and for personnel dose assessment. RG 1.70 states that this section should include a tabulation of the calculated concentrations of airborne radioactive material, by nuclides, expected during normal operation and AOOs, for equipment cubicles, corridors, and operating areas normally occupied by operating personnel. The applicant states that it will not tabulate the airborne radioactivity levels in various areas of the plant accessed by plant personnel as part of this certification since this analysis is dependent upon completion of detailed pipe routing and the preparation of plant operating procedures (both of which will be submitted by the COL applicant). Since the staff has insufficient information to determine if the System 80+ design plant can be operated within the limits of 10 CFR 20.103, this is an open item (Open Item 12.2.2-1). Additional information which should be addressed in the closure of this open item is discussed in Section 12.3.4.

12.2.3 Sources Used in NUREG-0737 Post-Accident Shielding Review

The initial core releases that will be used to determine post-accident radiation levels will be equivalent to the source terms recommended in RG 1.4, RG 1.7, and SRP Section 15.65. This is in accordance with

10 CFR 50.34(f)(2)(vii) (Item II.B.2 of NUREG-0660 and NUREG-0737). However, Item II.B.2 of NUREG-0737 also states that applicants should identify systems that contain high levels of radioactivity in post-accident situations. CESSAR Section 12.2.3 does not contain a listing of such post-accident sources. The applicant states that the COL applicant will perform a radiation and shielding design review that conforms with Item II.B.2 of NUREG-0737. Since these post-accident source terms are not included in the System 80+ Design Certification, this is an open item (Open Item 12.2.3-1).

The applicants must provide an acceptable DAC/ITAAC program for the requested source term descriptions detailed in the three sections above (12.2.1, 12.2.2, and 12.2.3) before the staff can complete its review of CESSAR Section 12.2. ~~This is an open item (Open Item 12.2.3-2).~~ Additional information which should be addressed in Open Item 12.2.3-1 is discussed in Sections 12.3.1 and 12.3.2.

## 12.3 Radiation Protection Design

The staff reviewed the facility design features, shielding, ventilation, and radiation and airborne monitoring instrumentation contained in the CESSAR for adherence to the guidelines in RG 1.70 and the criteria in SRP Section 12.3. The review ensured that the applicant had either committed to follow the guidelines of the regulatory guides and staff positions referenced in SRP Section 12.3, or gave acceptable alternatives. In addition, the staff selectively reviewed the CESSAR against the acceptance criteria of the SRP using the review procedures given there.

### 12.3.1 Facility Design Features

The facility design features incorporated into the System 80+ design are intended to help maintain occupational radiation exposures ALARA in accordance with the guidance in RG 8.8. The design features are based on the ALARA design considerations described in CESSAR Section 12.1.

The reactor coolant pumps (RCPs) for the System 80+ design will utilize

cartridge-type RCP seals that are reliable and easy to replace. Permanent platforms around the RCPs will further facilitate seal replacement, thereby reducing maintenance time and exposure. Steam generators in the System 80+ plant will be designed to utilize automatic/robotic equipment for inspection and maintenance activities. In addition, these steam generators will have adequate pull and laydown areas, permanent platforms, hand-holes, 53cm (21-inch) manways, and removable insulation to enhance accessibility and reduce overall exposure during maintenance and inspection activities. Mechanical snubbers rather than hydraulic snubbers will be used in radiation areas to reduce maintenance and inspection needs. Slurry piping systems will have remote backflushing capabilities to reduce personnel exposure during servicing. Pumps and connected piping will be flanged, where feasible, to facilitate pump removal. Floor drains connecting rooms that have significantly different airborne radioactivity levels will be separated or provided with traps to prevent cross-contamination.

In addition to designing equipment to comply with ALARA guidelines, the layout will be designed to reduce personnel exposures. Adequate work and laydown space will be provided at each inspection and maintenance station. In order to improve worker efficiency, adequate illumination and support services (e.g., power, service, air, water, ventilation, and communications) will be available at work stations. High-pressure water will be available to clean refueling canal surfaces following refuelings. Tube pull areas for components that handle radioactive fluids will be designed with curbs, drains, and coated floors to prevent the spread of contamination in the event of spills. Valves associated with highly radioactive components will be separated from other components and will be located in shielded valve galleries. Radioactive piping will not be field routed, but will be routed through pipe chases to minimize personnel exposures. As described, equipment and layout design features conform with the guidelines of RG 8.8 for maintaining occupational radiation exposures ALARA; the staff finds them acceptable.

The System 80+ design incorporates several features to minimize the buildup, transport, and deposition of activated corrosion products in the reactor coolant and auxiliary systems. Materials in contact with the primary coolant

will have low cobalt impurities and low nickel content in order to reduce the amounts of cobalt-60 and cobalt-58 introduced in the reactor coolant system. Cobalt and nickel levels will be reduced or eliminated in bearing journals, valve seats, and steam generator tubes. Crud traps in welds will be minimized by using butt welds in lieu of socket welds. Pump casing drain lines and valves in radioactive service will have smooth internal surfaces to minimize internal radioactivity deposition. Tanks containing radioactive liquid will have drain pipes connected at the lowest part of the tank and will have a convex or sloped-bottom design to minimize radioactivity deposition. Piping systems used to transport process resins will be designed to minimize pipe plugging. Equipment and piping containing radioactive materials will have provisions for draining and flushing. These methods for reducing crud are based on the guidelines in RG 8.8 and are acceptable.

At the request of the staff, the applicant provided oversized drawings of the plant layout from CESSAR that indicate radiation zones used in the plant design. The five radiation zones serve as a basis for classifying occupancy and access restrictions for various areas within the plant during normal operations and accident conditions. On this basis, maximum design dose rates are established for each zone and used as input for shielding of the respective zones. This method of plant zoning is consistent with the guidance in RG 1.70 and the SRP and is generally acceptable to the staff. However, since the applicant has not given the staff sufficient information regarding shielding design (see Section 12.3.2), the staff is unable to verify the zone designations given in the CESSAR. In addition, the applicant must include plant layout drawings (preferably oversized) in CESSAR Chapter 12 depicting the five radiation zones for both normal and accident conditions. These plant layout drawings should incorporate revisions made to correct the following deficiencies identified in the oversize drawings that the applicant submitted:

(1) Plant layout drawings do not contain detailed elevation and zone designations for the radwaste, turbine, and service buildings.

(2) Plant layout drawings do not indicate major personnel traffic patterns used to access plant areas during normal operations and used to access

vital areas during post-accident conditions.

(3) Plant layout drawings do not indicate locations of personnel locker/changeout rooms.

(4) Plant layout drawings do not indicate locations of worker access control points. The main radiation control area (RCA) access on level 115+6 of the reactor building contains no uncontaminated exit point to the uncontrolled area.

(5) There appear to be many rooms in the maintenance/outage area that can only be accessed by traveling through areas that have higher radiation zone designations.

(6) Plant layout drawings do not include detailed drawings of the areas surrounding the spent fuel transfer tube (on elevation 115+6) that are accessible to plant personnel. These drawings should include maximum dose rates expected in these areas during transfer of spent fuel assemblies.

(7) The primary chemistry lab area on elevation 50 should be designated as no more than a radiation zone 2 area (it is presently a zone 3 area) since it will be frequently occupied.

These seven deficiencies are open items (Open Items 12.3.1-1 through 12.3.1-7). X

Section II.B.2 of NUREG-0737 describes source-term information that should be used to calculate post-accident radiation levels. This section also states that the post-accident plant dose rates should be such that the dose to plant personnel should not exceed $5 \times 10^{-2}$ sieverts (5 rem) whole body, or its equivalent to any part of the body, for the duration of the accident (per GDC 19). The dose rate in areas requiring continuous occupancy (vital areas) should be less than ~~15~~ $15 \times 10^{-5}$ sieverts/hr (15 mrem/hour) (averaged over 30 days). X In the CESSAR, the applicant states that personnel exposures will meet GDC 19 and NUREG-0737 guidelines. Item II.B.2 of NUREG-0737 also recommends that the

CESSAR include a listing of all vital areas (areas requiring continuous occupancy during the course of an accident) in the plant. The CESSAR provides only a partial listing of System 80+ vital areas (the control room, technical support center, and diesel generator building). The applicant must amend the CESSAR to provide a complete listing of areas requiring continuous occupancy following an accident. This ~~is an open item (Open Item 12.3.1-2).~~ information should be included as part the applicant's response to Open Item 12.2.3-1 (see Section 12.2.3).

In addition, the CESSAR must include a summary of the integrated doses to personnel in each of the areas requiring either continuous occupancy or infrequent access for the duration of the accident (these doses should include exposure received while in transit between vital areas) and a listing of the dose rates in these areas 1 hour, 1 day, 1 week, and 1 month following an accident. Non-compliance with Item II.B.2 of NUREG-0737 was defined as an open item in Section 12.2.3 (Open Item 12.2.3-1). As part of the response to this open item, the applicant should also provide information on post-accident dose rates and integrated doses to personnel in vital areas.

12.3.2 Shielding

The objective of the plant's radiation shielding is to protect plant personnel and the public against radiation exposure from the various sources of ionizing radiation in the plant during normal operation (including AOOs and maintenance) and during accident conditions. The System 80+ design also includes shielding, where required, to mitigate the possibility of radiation damage to materials. Radioactive components and piping will be separated from non-radioactive components and piping to minimize exposure during maintenance and inspection activities. Major radioactive piping will be located in shielded pipe chases. Where applicable, pumps and other support equipment for components that contain radioactive material will be located outside the component cubicle in separate shielded cubicles. Shielded compartments will have labyrinth entrances to minimize radiation streaming directly through access openings. Cubicles containing radioactive materials will be shielded overhead to minimize skyshine. Penetrations will be located so there will not be a direct line from the radioactive source to adjacent areas that may have employees in them. Space will be allocated, where needed, for the erection of

temporary shielding. These shielding techniques comply with the shielding guidelines contained in RG 8.8 and they are acceptable.

The applicant has stated that the Certification Document will not include a description of the physical dimensions and compositions of the radiation shielding utilized in the System 80+ design since this information will not be available at the time of design certification. RG 1.70 and the acceptance criteria of the SRP require that this information be provided to permit the staff to conduct confirmatory calculations of shielding effectiveness. Therefore, the staff cannot conclude that the System 80+ design meets the radiation dose requirements of 10 CFR Part 20 or 10 CFR 50.34(f)(2)(vii) (Item II.B.2 of NUREG-0660 and NUREG-0737). The applicant should respond to this request as part of its response to Open Item 12.2.3-1.

There have been several instances of overexposures or near overexposures at pressurized-water reactors (PWRs) in recent years. ~~Such~~ Several overexposures have occurred in the vicinity of the spent fuel transfer tube. Personnel working in areas adjacent to the spent fuel transfer tube can be exposed to potentially lethal levels of radiation when spent fuel assemblies pass through this tube. Personnel overexposures have also occurred at the reactor cavity. The applicant should identify any accessible plant areas where, during normal operation and AOOs, personnel could receive 1 ~~Gy~~ Gray (100 rad) or more in one hour. In addition, the applicant should describe any plant design considerations incorporated to prevent personnel from receiving potentially lethal overexposures. This is an open item (Open Item 12.3.2-1).

The SRP states that the applicant must describe how the shield parameters were determined, including pertinent codes, assumptions, and techniques to be used in the shielding calculations. In response to an August 3, 1991, staff request, the applicant has amended the CESSAR to describe the shielding codes to be used to determine the adequacy of the station shielding design. The applicant will use the shielding codes ANISN, DOT, MORSE, and SABINE to verify the effectiveness of the primary shield (around the reactor core). The CESSAR also describes shielding codes used to verify gamma-source shielding elsewhere in the plant. These commonly used shielding calculational codes are accept-

able to the staff.

12.3.3 Ventilation

The System 80+ ventilation systems are designed to protect personnel and equipment from extreme environmental conditions and to ensure that personnel exposure to airborne radioactivity levels is minimized and maintained ALARA. Design features incorporated to maintain personnel exposures ALARA include:

(1) supplying ventilation air directly to the clean areas of the plant and exhausting the air from the potentially contaminated areas, thereby creating a positive flow of air from the clean areas to the potentially contaminated area

(2) appropriate use of negative or positive pressure in plant areas to prevent exfiltration or infiltration of possible airborne radioactive contamination, respectively

(3) a dual fresh-air-filtered intake system for the control room ventilation designed so that a source of uncontaminated air is available regardless of wind direction

These design criteria adhere to the guidelines of RG 8.8 and are acceptable to the staff. However, as noted in Section 12.2.2, the applicant has not submitted the concentrations of airborne radioactive contamination in cubicles, rooms, and corridors. Therefore, the staff cannot conclude that the System 80+ ventilation system design meets the acceptance criteria of the SRP, and will be adequate to maintain personnel exposures within the limits of 10 CFR Part 20. The lack of airborne source-term information was identified as an open item in Section 12.2.2 (Open Item 12.2.2-1).

12.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

The area radiation monitoring equipment will serve to alert operators and other station personnel of changing or abnormally high radiation conditions in

the plant to prevent possible personnel overexposures. Control room displays will provide information on monitor readings, alarm set points, and operating status. The area radiation monitors will consist of microprocessors and Geiger-Mueller tubes or ionization chambers for detecting gamma-radiation. Some plant areas may require extended or high-range detector configurations to cover special operational or post-accident monitoring functions. Area radiation monitors will have both local visual and audible alarms. Area radiation monitors located in high noise areas may have additional visual indication, as needed, to ensure that nearby personnel promptly recognize high-radiation conditions. Area radiation monitors will be calibrated once per refueling cycle. This description of the System 80+ area radiation monitoring system meets the acceptance criteria in SRP Section 12.3 and is acceptable.

The applicant states that the area radiation monitors will be located according to the potential for significant radiation levels in an area and on the expected occupancy of the area. Area radiation monitors will also be located in areas in which post-accident access to safety-related equipment may be required and around new fuel handling and storage areas for criticality accident detection to meet the requirements of 10 CFR 70.24. One of the acceptance criteria SRP Section 12.3 states that the CESSAR should give the locations of fixed area radiation monitors in accordance with ANSI/ANS-HPSSC-6.8.1. The applicant states that the location of the area radiation monitors will not be indicated on the plant layout drawings or given in the CESSAR ~~which is an acceptance criteria of SRP Section 12.3~~. The applicant states that the monitor locations cannot be determined until information on pipe routing, equipment location, and equipment leak rates is known. However, since the area radiation zones are known, the applicant should be able to indicate the approximate locations of the area radiation monitors on the drawings showing plant radiation zones.

The lack of information on the location of area radiation monitors is an open item. Applicants seeking an operating license by referencing the System 80+ certified design will provide the exact locations of these radiation monitors (COL Item 12.3.4-1).

(Open Item 12.3.4-1)

Section II.F.1-3 of NUREG-0737 recommends that the reactor containment be equipped with two physically separated radiation monitoring systems that are capable of measuring up to $10^5$ sieverts/hr ($10^7$ R/hr) in the containment following an accident. In the CESSAR, the applicant states that the System 80+ design will incorporate two physically separated and electrically independent ion chambers located inside the reactor containment to measure high range gamma radiation. The applicant states that the design and qualification of these monitors comply with the guidelines of RG 1.97. In response to an August 3, 1991, staff request, the applicant states that the high-range containment area monitors will also meet all of the recommendations of 10 CFR 50.34(f)(2)(xvii) (Item II.F.1-3 of NUREG-0660 and NUREG-0737), including detector range, response, redundancy, separation, in-situ calibration, and environmental design qualification. However, since the applicant has not located these high-range monitors on the plant layout drawings, the staff cannot conclude that the System 80+ design meets the acceptance criteria of the SRP. This is an open item (Open Item 12.3.4-2). X

The airborne radiation monitoring equipment will be placed in selected areas and ventilation systems to give plant operating personnel continuous information about the airborne radioactivity levels throughout the plant. The applicant states that the airborne radioactivity monitors will be located upstream of the filter trains so that they monitor representative radioactivity concentrations from the areas being sampled. However, the airflow diagrams in the CESSAR do not indicate the locations of the airborne radioactivity monitors. This is an open item (Open Item 12.3.4-3). X

In response to an August 3, 1991, staff request, the applicant states that plant airborne radioactivity monitors will be able to detect one maximum permissible concentration (MPC) of particulate and iodine activity in less than two hours in the containment atmosphere or in the nuclear annex building exhaust. This monitor sensitivity of two MPC-hours is well within the ten MPC-hour sensitivity criteria in SRP Section 12.3. SRP Section 12.3, however, states that the CESSAR must provide the criteria and methods for obtaining representative in-plant airborne radioactivity concentrations in all work areas. The applicant states that there is insufficient design information to

discuss the dilution of air from specific areas or rooms. Consequently, the CESSAR does not list representative airborne radioactivity concentrations for rooms or other areas that may be occupied by employees. This was identified as an open item in Section 12.2.2 (Open Item 12.2.2-1). As part of the response to this open item, the applicant must also list the sensitivity levels (in MPC-hours for particulate and iodine activity) of the airborne radioactivity monitors for all rooms or areas that may be occupied by plant personnel. The CESSAR also fails to describe how the airborne radioactivity monitoring system complies with the criteria contained in ANSI N13.1-1969 (as referenced in NUREG-0800). This is an open item (Open Item 12.3.4-~~3~~4). X

10 CFR 50.34(f)(2)(xxvii) (Item III.D.3.3 of NUREG-0660 and NUREG-0737) recommends that each applicant provides equipment and associated training and procedures for accurately determining the airborne iodine concentrations in areas within the facility where personnel may be present during an accident. In response to an August 3, 1991, staff inquiry, the applicant states that a portable airborne monitor will be available to allow accurate determination of airborne iodine concentrations in potentially occupied areas which would not be directly covered by fixed instrumentation. The applicant states that this portable airborne monitor will also meet the equipment recommendations given in Item III.D.3.3 of NUREG-0737, including recommendations on sample media, purging, and calibration. This commitment complies with the criteria in Item III.D.3.3 of NUREG-0737. However, applicants seeking an operating license by referencing the CESSAR should provide additional information concerning specific equipment to be used and procedures that will be followed to implement Item III.D.3.3 of NUREG-0737. This is a COL action item (COL Item 12.3.4-~~3~~2). ~~5ret~~ X

## 12.4 Dose Assessment

The staff has reviewed the applicant's dose assessment for the System 80+ design for completeness against the guidelines in RG 1.70, and against the criteria in SRP Section 12.4. This review consisted of ensuring that the applicant has either committed to following the criteria of the regulatory guides and staff positions in SRP Section 12.4, or has provided acceptable

alternatives. In addition, the staff selectively compared the applicant's dose assessment for specific functions against the experience of operating PWRs.

In CESSAR Section 12.4 the applicant describes design features that will be incorporated into the System 80+ design to ensure that occupational radiation exposures are maintained ALARA and no more than the goal of 1 man-centisieverts/year (100 man-rem/year). Many of these ALARA design features were described earlier in CESSAR Chapter 12. In order to reduce the source of cobalt in the primary system, cobalt alloys and cobalt-based hardfacing materials will be minimized in all primary system materials in contact with primary coolant. The use of antimony in RCP journal bearings was a major source of hot particles at the Palo Verde Nuclear Generating Station. The System 80+ design will utilize antimony-free journal bearings in the RCPs. In addition, all other pump parts that are wetted by reactor coolant will be free of antimony. Leakage from the System 80+ fuel is expected to be less than 0.1 percent. The System 80+ design will specify the use of elevated pH levels in the primary system. Elevated pH levels reduce equilibrium corrosion rates and the buildup of activated corrosion products on primary system surfaces. The objective of such features is to reduce the source term, and therefore the radiation levels, in the primary system. Other System 80+ design feature described in this section of the CESSAR include the use of an extended fuel cycle, improved equipment accessibility, and the utilization of more reliable equipment to reduce the frequency of maintenance work. Such features are intended to reduce occupational radiation exposures, and they are acceptable.

The applicant estimates that the average annual collective dose for the System 80+ design will be 64 man-centisieverts (64 man-rem). In arriving at this estimate, the applicant used 1989 dose data, broken down by work group and task, for seven PWRs operated by Duke Power. The resulting dose estimates for each work group and task category were then multiplied by dose reduction factors to obtain dose estimates for the System 80+ design. The applicant states that these dose reduction factors, which were based on engineering judgment, took into account the numerous ALARA design features incorporated into the System 80+ design. The level of detail of the applicant's dose

assessment is not consistent with the level of detail prescribed in the acceptance criteria of the SRP. The applicant's dose assessment also does not meet the intent of RG 8.19. In addition to using historical data, that dose assessment should also consider estimated personnel occupancy factors in each of the five radiation zones, and estimates of the time and number of people needed to perform the various tasks involved in plant operation. In the CESSAR, the applicant should describe the reasons for selecting the seven Duke PWRs as "reference plants." The applicant should also provide a basis for the different dose reduction factors used to arrive at the final dose estimates for the System 80+ plant. The estimated annual dose of 64 man-centisieverts (64 man-rem) for the System 80+ design is well below the 1990 PWR average of 291 man-centisieverts (291 man-rem) per unit. This is an open item (Open Item 12.4-1).

In CESSAR Section 12.4, the applicant should address personnel exposures due to airborne radioactivity. Sections 12.2.2 and 12.3.4 (above) addressed the requirement for the applicant to list the peak airborne radioactivity concentrations for all areas of the plant accessed by plant personnel. Using these airborne concentrations, along with estimated area occupancy rates, the applicant should include a listing, in CESSAR Section 12.4, of inplant personnel exposures due to airborne radioactivity. The applicant states that this information will not be provided as part of the design certification since the information necessary to calculate airborne radioactivity levels is not available at this stage of the design. This is an open item (Open Item 12.4-2).

On the basis of its evaluation, the staff concludes that the applicant's dose assessment for the System 80+ design does not meet the acceptance criteria of the SRP.

12.5 Organization

The organization required to implement an effective health physics program and ensure that radiation exposures are within the limits of 10 CFR Part 20, and are ALARA, is outside the scope of this review. COL applicants seeking an

operating license by referencing the System 80+ certified design will be required to address this concern to the level of detail discussed in RG 1.70. This is a COL action item (COL Item 12.5-1).