GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

April 19, 1994

Docket No. 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Schedule - **Radiation Protection Modifications to SSAR and CDM**

Dear Chet:

Enclosed are SSAR and CDM markups modifying selected pages of SSAR Chapter 12 and CDM Section 3.2.

Please provide a copy of this transmittal to Roger Pedersen.

Sincerely,

[signature] for

Jack Fox
Advanced Reactor Programs

cc:	Alan Beard	(GE)
	Hal Careway	(GE)
	Norman Fletcher	(DOE)
	Roy Louison	(GE)
	Joe Quirk	(GE)

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SSAR MARKUPS

(5) Separation of more highly radioactive equipment from less radioactive equipment and provision of separate shielded compartments for adjacent items of radioactive equipment.

(6) Provision of access hatches for installation or removal of plant components.

(7) Provision of design features such as the Reactor Water Cleanup (CUW) System and the condensate demineralizer to minimize crud buildup.

12.1.2.2 Equipment Design Considerations for ALARA Exposures

12.1.2.2.1 General Design Criteria

No specific instructions have been given to component designers and engineers regarding ALARA design as provided by specific Acceptance Criterion II.2 of SRP Section 12.1. However, the engineering design procedures require that the component design engineer consider the applicable Regulatory Guides (including Regulatory Guide 8.8) as a part of the design criteria. In this way, the radiation problems of a component or system are considered. A summary survey of the components designs was made to determine the factors considered. The following paragraphs cite some examples of design considerations made to implement ALARA.

12.1.2.2.2 Equipment Design Considerations to Limit Time Spent in Radiation Areas

(1) Equipment is designed to be operated and have its instrumentation and controls in accessible areas both during normal and abnormal operating conditions. Equipment such as the CUW System and the Fuel Pool Cleanup (FPC) System are remotely operated, including the backwashing and precoat operations.

(2) Equipment is designed to facilitate maintenance. Equipment such as the RHR heat exchanger is designed with an excess of tubes in order to permit plugging of some tubes. The heat exchanger has drains to allow draining of the shell-side water. Some of the valves have stem packing of the cartridge type that can be easily replaced. Refueling tools are designed for drainage and with smooth surfaces in order to reduce contamination. Vessel and piping insulation is of an easily removable type.

(3) The material selected for use in the system have been chosen to fulfill the environmental requirements. Valves, for example, use grafoil stem packing to reduce leakage and maintenance.

(4) Past experience has been factored into current designs. The steam relief valves have been redesigned as a result of inservice testing.

12.2.1.2.1.1.3 Core Boundary Neutron Fluxes

Table 12.2-2 presents peak axial neutron multigroup fluxes at the core equivalent radius. The core-equivalent radius is a hypothetical boundary enclosing an area equal to the area of the fuel bundles and the coolant space between them. The peak axial flux occurs adjacent to the portion of the core with the greatest power. While the flux within any given energy group is not known within a factor of 2, the total calculated core boundary flux is estimated to be within ±50%.

12.2.1.2.1.1.4 Gamma Ray Source Energy Spectra

Table 12.2-3 presents average gamma ray energy spectra thermal per watt of reactor power in both core and non-core regions. In Table 12.2-3, part A, the energy spectra in the core are presented. The energy spectra in the core represent the average gamma ray energy released by energy group in $J/cm^3/s/MW$ thermal. The energy spectra in $J/s/MW$ thermal$/cm^3$ can be used with the total core power and power distributions to obtain the source in any part of the core.

The gamma ray energy spectra include the fission gamma rays, the fission product gamma ray and the gamma rays resulting from inelastic neutron scattering and thermal neutron capture. The total gamma ray energy released in the core is estimated to be accurate to within ±10%. The energy release rate above 0.06 J may be in error by as much as a factor of ±2.

Table 12.2-3, part B, gives a gamma ray energy spectrum in J/s/W in spent fuel as a function of time after operation. The data were prepared from tables of fission product decay gamma fitted to integral measurements for operation times of 10^8 s, or approximately 3.2 years. To obtain shutdown sources in the core the gamma ray energy spectra are combined with the core thermal power and power distributions. Shutdown sources in a single fuel element can be obtained by using the gamma ray energy spectra and the thermal power the element contained during operation.

Table 12.2-3, part C, gives the gamma ray energy spectra in the cylindrical regions of the reactor from the core through the vessel. The energy spectra are given in terms of $J/cm^3/s/W$ at the inside surface and outside surfaces of the region. This energy spectrum, multiplied by the core thermal power, is the gamma ray source. The point on the inside surface of the region is the maximum point within the region. In the radial direction, the variation in source intensity may be approximated by an exponential fit to the data on the inside and outside surfaces of the region. The axial variation in a region can be estimated by using the core axial variation. The uncertainty in the gamma ray energy spectra is due primarily to the uncertainty in the neutron flux in these regions. The uncertainty in the neutron flux is estimated to vary from approximately ±50% at the core boundary to a factor of ±3 at the outside of the vessel. The calculations were carried out with voids beyond the vessel.

Table 12.2-20 Comparison of Airborne Concentrations with 10CFR20 Concentration Limits

Nuclide	Annual Average Airborne		Maximum Technical Specification (MBq/cm³)	10CFR20 MPC
	Release (MBq/yr)	Concentration (MBq/cm³)		
Kr-83m	3.1E+01	2.0E–18	5.2E–17	1.1E–09
Kr-85m	7.8E+05	4.8E–14	7.0E–13	3.7E–09
Kr-85	2.1E+07	1.3E–12	1.3E–12	1.1E–08
Kr-87	9.3E+05	5.9E–14	1.6E–12	7.4E–10
Kr-88	1.4E+06	8.9E–14	2.4E–12	7.4E–10
Kr-89	8.9E+06	5.5E–13	1.5E–11	1.1E–09
Kr-90	1.2E+01	7.8E–19	2.1E–17	1.1E–09
Xe-131m	1.9E+06	1.2E–13	1.2E–13	1.5E–08
Xe-133m	3.2E+03	2.0E–16	3.3E–16	1.1E–08
Xe-133	8.9E+07	5.5E–12	4.1E–11	1.1E–08
Xe-135m	1.5E+07	9.2E–13	2.4E–11	1.1E–09
Xe-135	1.7E+07	1.0E–12	2.8E–11	3.7E–09
Xe-137	1.9E+07	1.2E–12	3.1E–11	1.1E–09
Xe-138	1.6E+07	1.0E–12	2.5E–11	1.1E–09
Xe-139	1.5E+01	9.6E–19	2.6E–17	1.1E–09
I-131	9.6E+03	5.9E–16	1.8E–14	3.7E–12
I-132	8.1E+04	5.2E–15	1.6E–13	1.1E–11
I-133	6.3E+04	4.1E–15	1.2E–13	1.5E–11
I-134	1.4E+05	8.9E–15	2.7E–13	2.2E–11
I-135	8.9E+04	5.5E–15	1.7E–13	3.7E–11
H-3	2.6E+06	1.6E–13	1.6E–13	7.4E–09
C-14	3.4E+05	2.2E–14	2.2E–14	3.7E–09
Na-24	1.5E+02	9.2E–18	9.2E–18	1.8E–10
P-32	3.4E+01	2.2E–18	2.2E–18	7.4E–11
Ar-41	2.5E+05	1.6E–14	1.6E–14	1.5E–09
Cr-51	1.3E+03	8.1E–17	1.9E–16	1.5E–08

Table 12.2-20 Comparison of Airborne Concentrations with 10CFR20 Concentration Limits (Continued)

Nuclide	Annual Average Airborne		Maximum Technical Specification (MBq/cm³)	10CFR20 MPC
	Release (MBq/yr)	Concentration (MBq/cm³)		
Mn-54	1.8E+02	1.1E-17	3.1E-16	3.7E-10
Mn-56	1.3E+02	8.5E-18	8.5E-18	7.4E-10
Fe-55	2.4E+02	1.5E-17	1.5E-17	1.1E-09
Fe-59	2.4E+01	1.5E-18	3.4E-17	1.8E-10
Co-58	8.9E+01	5.5E-18	8.5E-17	1.1E-09
Co-60	4.0E+02	2.5E-17	5.9E-16	3.7E-10
Ni-63	2.4E-01	1.5E-20	1.5E-20	7.4E-11
Cu-64	3.7E+02	2.3E-17	2.3E-17	1.5E-09
Zn-65	3.0E+02	1.9E-17	4.8E-16	7.4E-11
Rb-89	1.6E+00	9.6E-20	9.6E-20	1.1E-09
Sr-89	2.1E+02	1.3E-17	3.5E-20	1.1E-11
Sr-90	2.5E+00	1.6E-19	1.6E-18	1.1E-12
Y-90	1.7E+00	1.1E-19	1.1E-19	1.1E-10
Sr-91	3.7E+01	2.4E-18	2.4E-18	3.3E-10
Sr-92	2.9E+01	1.8E-18	1.8E-18	3.7E-10
Y-91	8.9E+00	5.5E-19	5.5E-19	3.7E-11
Y-92	2.3E+01	1.4E-18	1.4E-18	3.7E-10
Y-93	4.1E+01	2.6E-18	2.6E-18	1.8E-10
Zr-95	4.4E+01	2.9E-18	8.5E-17	3.7E-11
Nb-95	6.3E+01	4.1E-18	1.1E-16	1.1E-10
Mo-99	5.6E+02	3.5E-17	8.1E-16	2.6E-10
Tc-99m	1.1E+01	7.4E-19	7.4E-19	1.8E-08
Ru-103	1.8E+01	1.1E-18	2.6E-17	1.1E-10
Rh-103m	4.1E+00	2.7E-19	2.7E-19	7.4E-08
Ru-106	7.0E-01	4.4E-20	4.4E-20	7.4E-12
Rh-106	7.0E-01	4.4E-20	4.4E-20	1.1E-09

Table 12.2-20 Comparison of Airborne Concentrations with 10CFR20 Concentration Limits (Continued)

Nuclide	Annual Average Airborne Release (MBq/yr)	Annual Average Airborne Concentration (MBq/cm^3)	Maximum Technical Specification (MBq/cm^3)	10CFR20 MPC
Ag-110m	2.4E−02	1.6E−21	4.8E−20	1.1E−11
Sb-124	6.0E+00	4.1E−19	1.0E−17	2.6E−11
Te-129m	8.1E+00	5.2E−19	5.2E−19	3.7E−11
Te-131m	2.8E+00	1.8E−19	1.8E−19	2.2E−10
Te-132	7.0E−01	4.4E−20	4.4E−20	1.5E−10
Cs-134	6.3E+00	4.1E−19	4.1E−19	1.5E−11
Cs-136	3.0E+00	1.9E−19	1.9E−19	2.2E−10
Cs-137	1.7E+01	1.1E−18	1.1E−18	1.8E−11
Cs-138	6.3E+00	4.1E−19	4.1E−19	1.1E−09
Ba-140	4.8E+02	3.1E−17	8.1E−16	3.7E−11
La-140	6.7E+01	4.1E−18	4.1E−18	1.5E-10
Ce-141	3.0E+02	2.0E−17	5.9E−16	1.8E−10
Ce-144	7.0E−01	4.4E−20	4.4E−20	7.4E−12
Pr-144	7.0E−01	4.4E−20	4.4E−20	1.1E-09
W-187	7.0E+00	4.4E−19	4.4E−19	3.7E−10
Np-239	4.4E+02	2.7E−17	2.7E−17	7.4E−10

Table 12.2-27 Activity in the Turbine Condenser

Isotopes	MBq	Isotopes	MBq
KR-83M	2.6E–01	NA-24	3.9E–03
KR-85M	4.5E–01	P-32	7.7E–05
KR-85	1.8E–03	CR-51	2.3E–03
KR-87	1.5E+00	MN-54	2.7E–05
KR-88	1.5E+00	MN-56	2.1E–02
KR-89	7.8E+00	FE-55	3.8E–04
KR-90	7.9E+00	FE-59	1.1E–05
KR-91	2.2E+00	CO-58	7.7E–05
XE-131M	1.5E–03	CO-60	1.5E–04
XE-133M	2.2E–02	NI-63	3.8E–07
XE-133	6.4E–01	CU-64	1.2E–02
XE-135M	1.9E+00	ZN-65	7.7E–05
XE-135	1.7E+00	SR-89	3.8E–05
XE-137	9.8E+00	SR-90	2.7E–06
XE-138	6.6E+00	Y-90	2.7E–06
XE-139	9.3E+00	SR-91	1.6E–03
XE-140	3.6E+00	SR-92	4.3E–03
XE-144	3.9E–03	Y-91	1.5E–05
Total	**5.5E+01**	Y-92	2.5E–03
		Y-93	1.6E–03
I-131	2.8E–02	ZR-95	3.0E–06
I-132	2.4E–01	NB-95	3.0E–06
I-133	1.9E–01	MO-99	7.7E–04
I-134	4.1E–01	TC-99M	7.7E–04
I-135	2.7E–01	RU-103	7.7E–06
Total	**1.1E+00**	RH-103M	7.7E–06
		RU-106	1.1E–06

Table 12.2-27 Activity in the Turbine Condenser (Continued)

Isotopes	MBq	Isotopes	MBq
RB-89	8.5E+01	RH-106	4.1E–02
CS-134	3.7E–01	AG-110M	1.4E–02
CS-136	2.6E–01	TE-129M	5.6E–01
CS-137	1.0E+00	TE-131M	1.4E+00
CS-138	1.7E+02	TE-132	1.4E–01
Total	2.6E+02	BA-140	5.6E+00
		LA-140	5.6E+00
N-16	1.4E+07	CE-141	4.1E–01
		CE-144	4.1E–02
H-3	4.4E+04	PR-144	4.1E–02
		W-187	4.4E+00
		NP-239	1.1E+02
		Total	**2.0E+03** *

* Includes isotopes from previous page (right hand side)

area. The relationship between radiation zone designations and accessibility requirements is presented in the following tabulation:

Zone Designation	Dose Rate (µGy/h)	Access Description
A	≤6	Uncontrolled, unlimited access
B	< 10	Controlled, unlimited access
C	< 50	Controlled, limited access, 20 h/wk
D	< 250	Controlled, limited access, 4 h/wk
E	< 1.0E+04	Controlled, limited access, 1 h/wk
F	≥ 1.0E+04	Controlled infrequent access. Authorization required.

The dose rate applicable for a particular zone is based on operating experience and represents design dose rates in a particular zone, and should not be interpreted as the expected dose rates which would apply in all portions of that zone, or for all types of work within that zone, or at all periods of entry into the zone. Large BWR plants have been in operation for three decades, and operating experience with similar design basis numbers shows that only a small fraction of the 10CFR20 maximum permissible dose is received in such zones from radiation sources controlled by equipment layout or the structural shielding provided. Therefore, on a practical basis, a radiation zoning approach as described above accomplishes the as low as reasonably achievable objectives for doses as required by 10CFR20.1(c). The radiation zone maps for this plant with zone designations as described in the preceding tabulations are contained in Figures 12.3-1 through 12.3-3, 12.3-5 through 12.3-11, and 12.3-37 through 12.3-53.

Access to areas in the plant is controlled and regulated by the zoning of a given area. Areas with dose rates such that an individual would receive a dose in excess of 1 mGy in a period of one hour are locked and posted with "High Radiation Area" signs. Entry to these areas is on a controlled basis. Areas in which an individual would receive a dose in excess of 50 µGy up to 1 mGy within a period of one hour are posted with signs indicating that this is a radiation area and include, in certain cases, barriers such as ropes or doors.

CDM MARKUPS

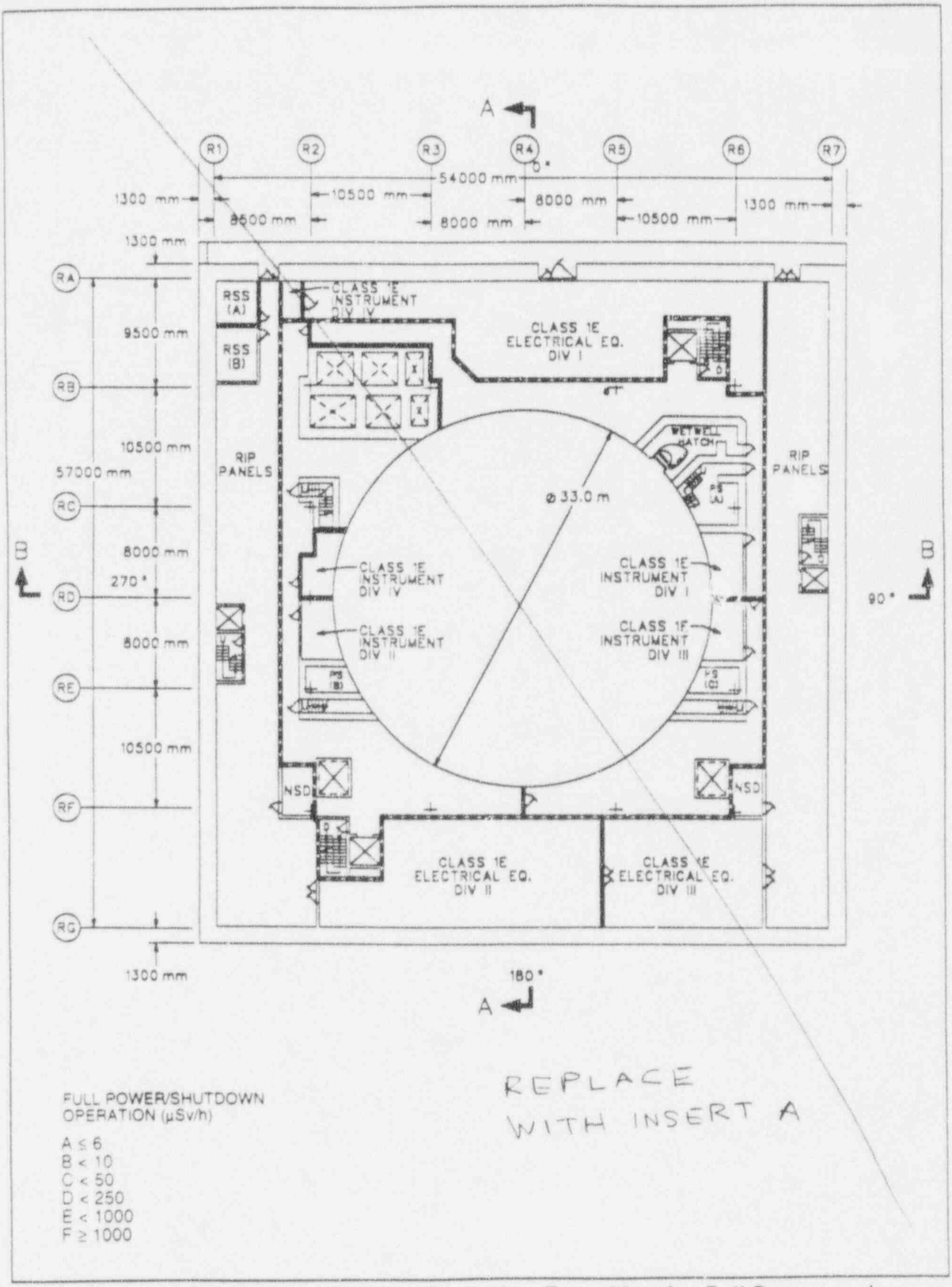
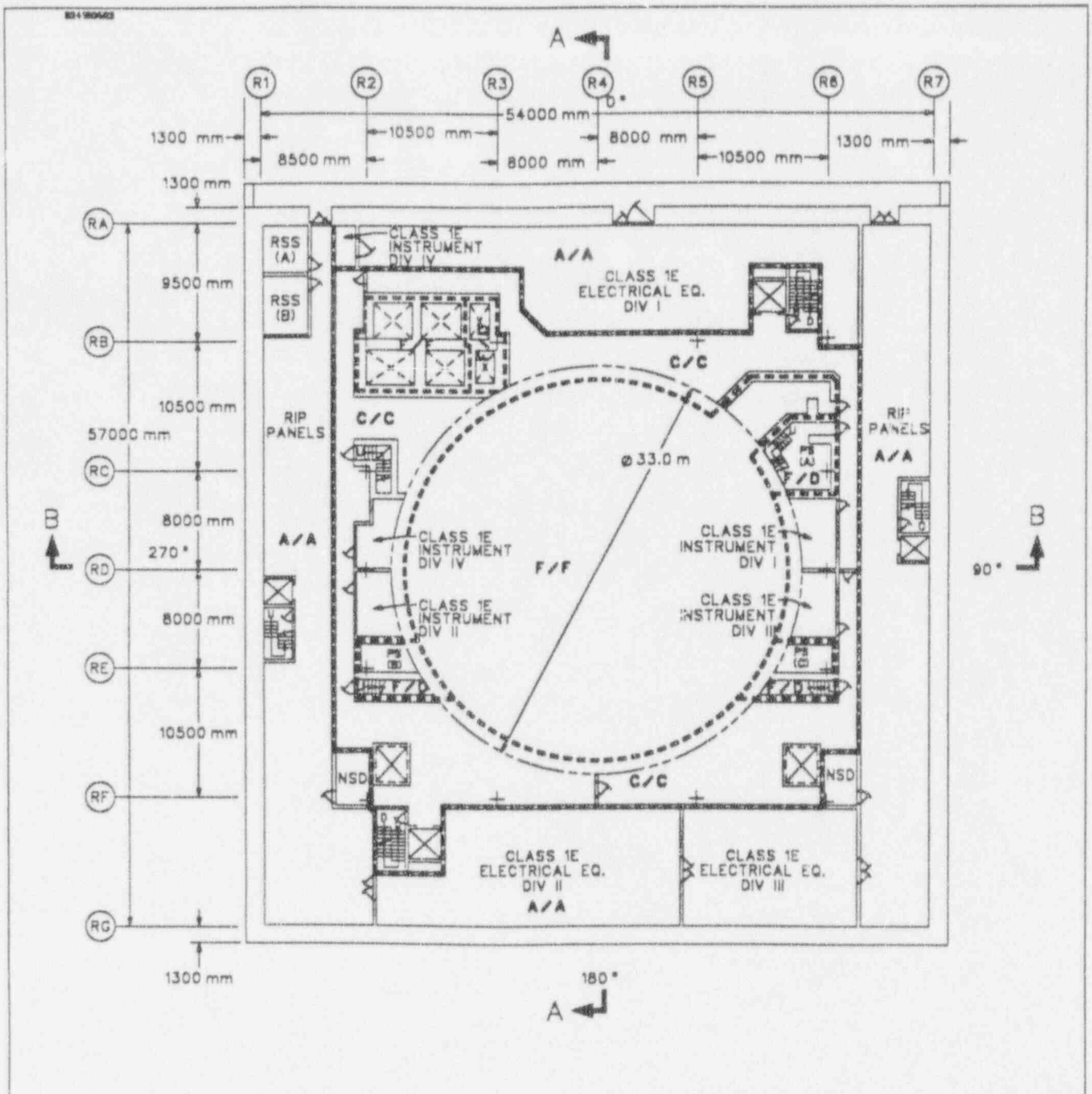


Figure 3.2g Reactor Building Radiation Zone Map for Full Power and Shutdown Operations, Floor B1F—Elevation 4800 mm

INSERT A



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R3
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RF
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270°
8000 mm
10500 mm
1300 mm
RSS (A)
RSS (B)
CLASS 1E INSTRUMENT DIV IV
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CLASS 1E ELECTRICAL EQ. DIV I
C/C
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C/C
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RIP PANELS
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B
B
A/A
CLASS 1E INSTRUMENT DIV IV
F/F
CLASS 1E INSTRUMENT DIV I
90°
CLASS 1E INSTRUMENT DIV II
CLASS 1E INSTRUMENT DIV III
NSD
C/C
NSD
CLASS 1E ELECTRICAL EQ. DIV II
A/A
CLASS 1E ELECTRICAL EQ. DIV III
180°
A
A

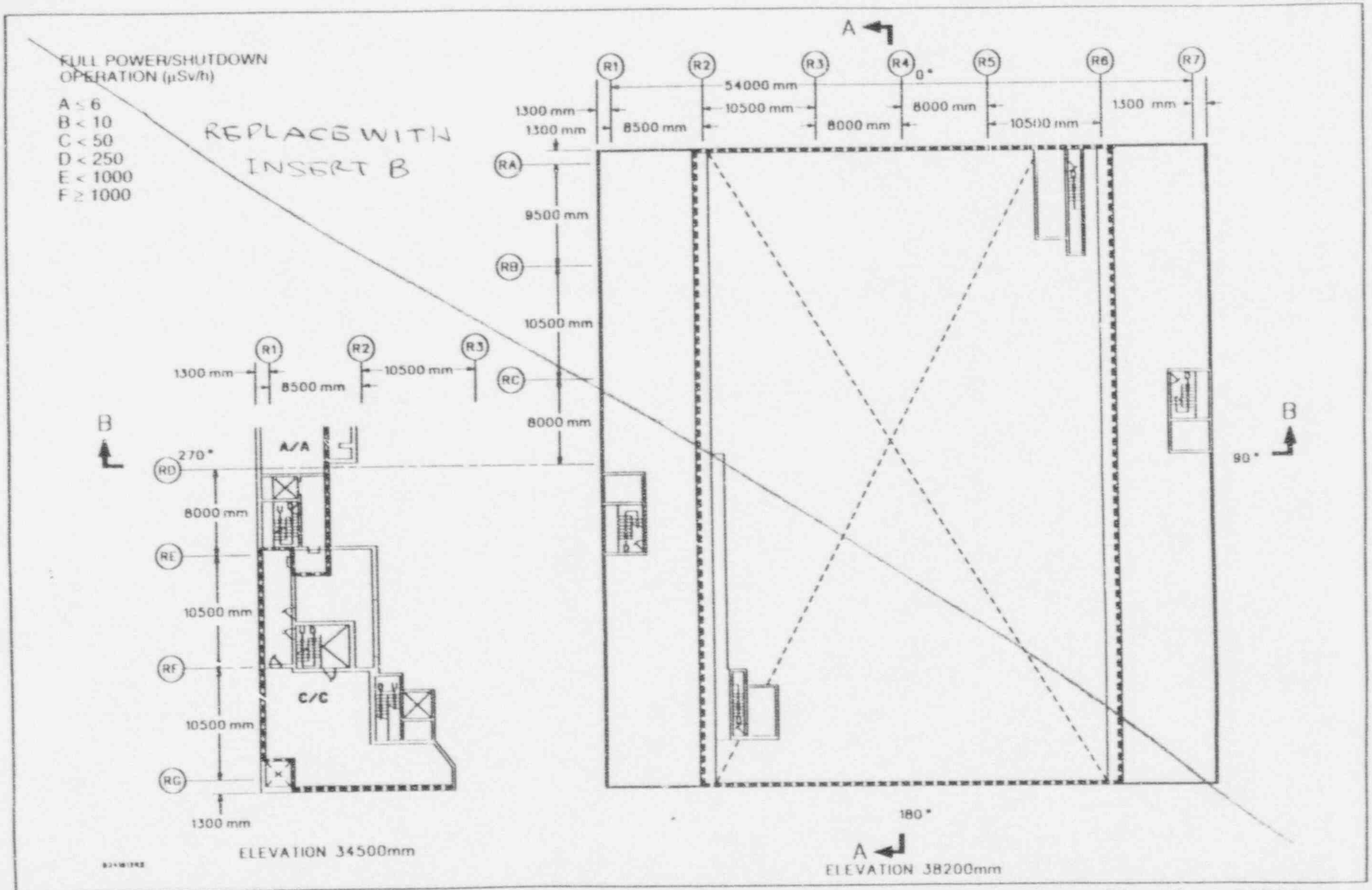
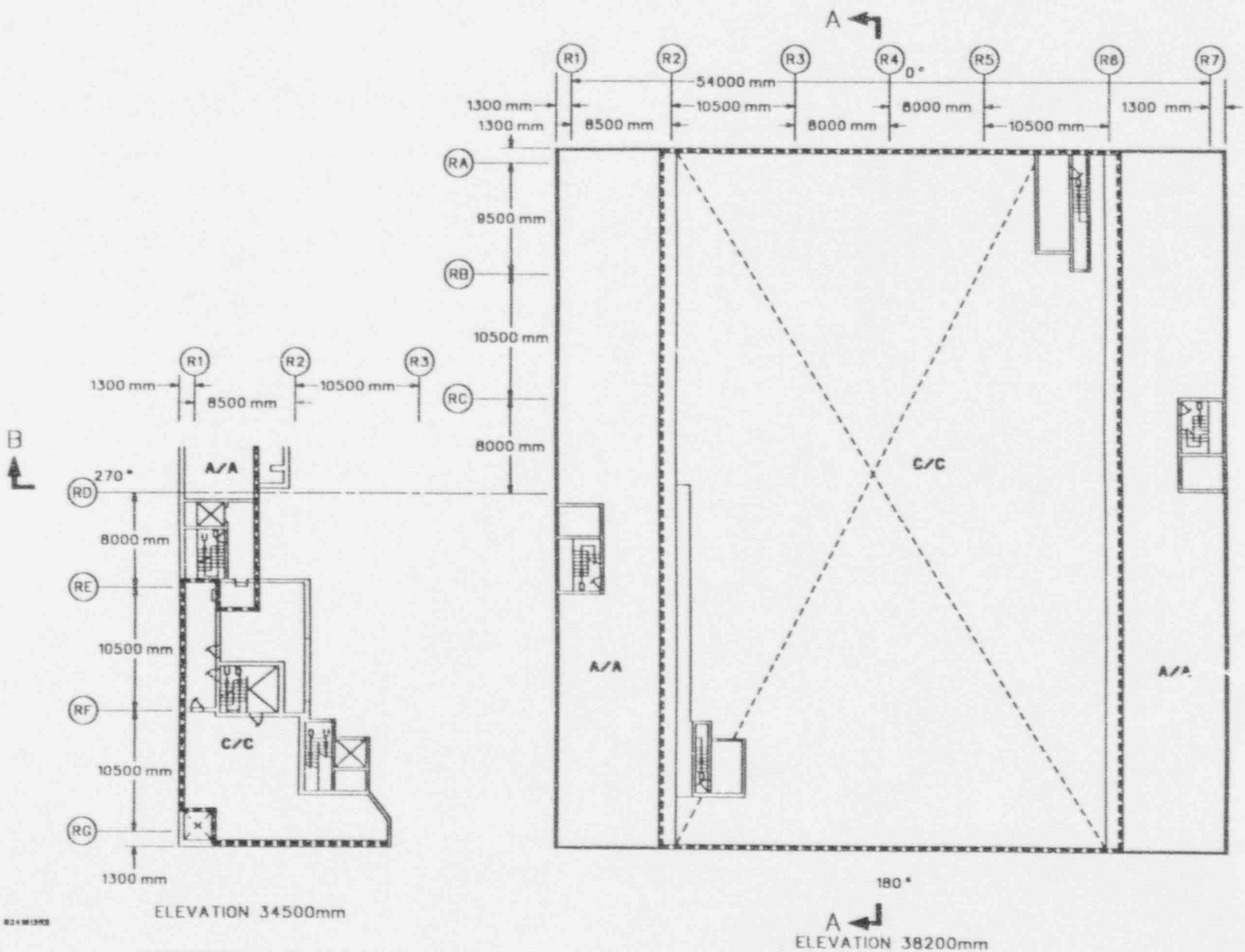


Figure 3.2n Reactor Building Radiation Zone Map for Full Power and Shutdown Operations—Elevations 34500 mm and 38200 mm

INSERT B


A
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ELEVATION 34500mm