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March 20, 1984
RBG- 17,339
File Code G9.5, G9.8.6.2

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Denton:

River Bend Station Unit 1
Docket No. 50-458

Enclosed for your review are Gulf States Utilities Company's (GSU) supplemented responses to open items identified by the Nuclear Regulatory Commission's Radiological Assessment Branch (RAB) and addressed in GSU's November 22, 1983 and February 7, 1984 letters from J. E. Booker to H. R. Denton. Attachment 1 is a summary listing of the items being supplemented. Attachment 2 provides the response and reference material for each supplemented item. Where indicated, these responses will be provided in a future amendment to the FSAR.

Sincerely,

William J. Reed Jr.

for J. E. Booker
Manager - Engineering
Nuclear Fuels & Licensing
River Bend Nuclear Group

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JEB/ERG/RJK/je

Attachments - 40 copies

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Attachment 1

Supplemental RAB Information

Item	DSER Section	Related Question	SUBJECT	FSAR Change
2.	12.2.2 pg. 12-5	Q471.20	Accident Source Terms-II.B.2	Amendments 7,11 and Enclosure 1
7.	12.4 pg. 12-10	Q471.21	Occupational Dose Assessment and Improvements	Amendments 3,11 and Enclosure 2

Attachment 2

Supplemental Information

2. The RBS preliminary results of its radiation and shielding design review pertaining to NUREG-0737 TMI Action Item II.B.2, "Plant Shielding", is provided in Enclosure 1. The final results of the review are anticipated to be available during September, 1984. This information will be provided in an amendment to new FSAR Section 12.3.2.4.

7. The assessment of compliance with Regulatory Guide 8.19, Rev. 1, "Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants - Design Stage Man-Rem Estimates", for RBS is provided in Enclosure 2. The revision to Section 12.4 will be provided in a future FSAR amendment.

Enclosure 1

12.3.2.4 RADIATION AND SHIELDING DESIGN REVIEW

In accordance with NUREG-0737, Item II.B.2, a radiation level and shielding design review is performed for post-accident radiation environments in areas required for accident assessment and mitigation. The source terms used in the review are provided in Table 12.2-19 as follows:

1. Initial LOCA release to containment atmosphere consists of 50 percent of core iodines and 100 percent of core noble gases.

2. Initial LOCA release to the reactor coolant system consists of 50 percent of core iodines and 1 percent of core particulates.

Distribution of sources to areas outside the containment structure is consistent with FSAR Section 15.6.5, Design Basis Assumptions, and/or parameters limited by technical specifications. In addition to these sources, the following factors are being considered which affect the estimated accumulated doses to personnel:

1. Anticipated time post-accident when access is required.

2. Anticipated time spent in vital access areas to perform necessary functions.

3. Anticipated times on access routes to and from the vital access areas.

Table 12.3-5 lists the vital functions and areas, and the corresponding locations and access routes which form the current basis for the radiation level and shield design review within the restricted access boundary.

The exposure of emergency site personnel during the accident will be maintained in accordance with the guidelines in GDC 19. The final vital area access evaluation will be provided in a later FSAR amendment.

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TABLE 12.3-5

SUMMARY OF VITAL AREA ACCESS EVALUATION (NUREG - 0737, ITEM II.B.2)

ITEM	VITAL FUNCTION AND AREA	LOCATION	ACCESS PATH	ASSUMED OCCUPANCY TIME	COMMENTS
1.	SECURITY CONTROL FOR PLANT ACCESS/ EGRESS				
a.	PERSONNEL ACCESS POINT	N.E. OF PLANT SITE	N/A	AS REQUIRED TO ENTER OR EXIT THE PROTECTED AREA BOUNDARY.	NOT FOR CONTINUOS OCCUPANCY DURING EARLY POST-LOCA PERIODS. PERSONNEL WILL ENTER AND EXIT THE PROTECTED AREA BOUNDARY AT ONE OF THESE PLANT ACCESS POINTS BASED UPON METEOROLOGICAL DISPERSION CONDITIONS.
b.	ALTERNATE ACCESS POINT	SOUTH OF PLANT SITE NEAR THE RAILROAD TRACKS	N/A	AS REQUIRED TO ENTER OR EXIT THE PROTECTED AREA BOUNDARY.	
2.	MAIN CONTROL ROOM	CONTROL BLDG. el. 136 ft.	N/A	CONTINUOUS FOR DURATION OF EVENT*, FROM TIME t=0 TO t=30 DAYS.	NONE
3.	EMERGENCY RESPONSE FACILITIES				
a.	TECHNICAL SUPPORT CENTER (TSC)	SERVICES BLDG. el. 123 ft. 6 in.	N/A	CONTINUOUS FOR DURATION OF EVENT*, FROM TIME t=0 TO t=30 DAYS.	NONE
b.	OPERATIONAL SUPPORT CENTER (OSC)	SERVICES BLDG. el. 123 ft. 6 in.	N/A	CONTINUOUS FOR DURATION OF EVENT, FROM t=0 TO t=30 DAYS.	THE TSC IS THE DESIGNATED OSC BACKUP. THIS BACKUP WILL BE REQUIRED FOR A NUMBER OF DAYS IMMEDIATELY AFTER THE EVENT. IN ACCORDANCE WITH NUREG-0696, THERE IS NO REQUIREMENT FOR CONTINUOUS OCCUPANCY OF THE OSC; HOWEVER, EMERGENCY PROCEDURES WILL INCLUDE PROVISIONS FOR EVACUATION OF PERSONNEL IF CONTINUOUS OCCUPANCY IS NOT POSSIBLE.

*CONTINUOUS BASED ON STANDARD REVIEW PLAN 6.4 OCCUPANCY FACTORS.

TABLE 12.3-5 (CONT'D)

SUMMARY OF VITAL AREA ACCESS EVALUATION (NUREG-0737, ITEM II.B.2)

ITEM	VITAL FUNCTION AND AREA	LOCATION	ACCESS PATH	ASSUMED OCCUPANCY TIME	COMMENTS
c.	EMERGENCY OPERATIONS FACILITY (EOF)	TRAINING BLDG.	N/A	CONTINUOUS FOR DURATION OF EVENT, FROM t=0 to t=30 DAYS.	HABITABILITY OF THE EOF IS PROVIDED WITH A SHIELDING PROTECTION FACTOR OF 5 AND REMOVABLE HEPA FILTERS FOR THE VENTILATION SYSTEM AS REQUIRED BY NUREG-0696.
4.	POST-ACCIDENT SAMPLING AND MONITORING				
a.	POST-ACCIDENT SAMPLE (PASS) PANEL				
	1) WET SECTION (GRAB SAMPLE)	AUX. BLDG. el. 114 ft. 0 in.	OSC TO BREEZEWAY TO AUX. BLDG., el. 114 ft. 0 in. SAMPLE IS THEN TAKEN TO THE SERVICES BLDG. LAB, OR ENVIRONMENTAL LAB.	TO BE PROVIDED LATER	THE PANEL AND LOCAL RADIATION SHIELDING IS CURRENTLY UNDER REVIEW TO MEET DOSE CRITERIA. IT IS ASSUMED THAT ACCESS TO THE PASS PANEL WILL NOT OCCUR DURING THE FIRST HOUR AFTER THE ACCIDENT.
	2) CONTROL PANEL	TO BE PROVIDED LATER.			
b.	MAIN PLANT EXHAUST DUCT RADIATION MONITORS (GRAB SAMPLE)	AUX. BLDG. el. 170 ft. 0 in.	OSC TO AUX. BLDG. EAST STAIR TOWER TO el. 170 ft. 0 in., SAMPLE IS THEN TAKEN TO SERVICES BLDG. LAB, OR ENVIRONMENTAL LAB.	TO BE PROVIDED LATER	SHIELDING IS CURRENTLY BEING EVALUATED. IT IS ASSUMED THAT ACCESS WILL NOT BE REQUIRED DURING THE FIRST HOUR AFTER THE ACCIDENT.

TABLE 12.3-5 (CONT'D)
SUMMARY OF VITAL AREA ACCESS EVALUATION (NUREG-0737, ITEM II.B.2)

ITEM	VITAL FUNCTION AND AREA	LOCATION	ACCESS PATH	ASSUMED OCCUPANCY TIME	COMMENTS
c.	POST-ACCIDENT SAMPLE ANALYSIS				
	1) HEALTH PHYSICS/ CHEMISTRY LAB	SERVICES BLDG.	N/A	INTERMITTENT, AS REQUIRED FOR SAMPLE ANALYSIS FOR DURATION OF EVENT	THE TRAINING BLDG. CHEMISTRY LAB AND THE ENVIRONMENTAL LAB WILL BE BACKUP FACILITIES, DEPENDING ON HABITABILITY OF THE SERVICES BLDG. FOLLOWING THE EVENT. TIME-MOTION STUDIES ARE BEING PERFORMED TO DETERMINE OCCUPANCY REQUIREMENTS IN THE CHEMISTRY LAB FOR POST-ACCIDENT SAMPLE ANALYSIS USING THE GE PASS PANEL. SAMPLE PREPARATION IN THE LAB WILL BE PERFORMED IN A SHIELDED STORAGE AREA WITH 1.5 ft. THICK WALLS, CEILINGS, AND FLOOR.

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12.4 DOSE ASSESSMENT

Radiation exposures in the plant are primarily from components and equipment containing radioactive fluids, and to a lesser extent from the presence of airborne radionuclides. In-plant radiation exposures during normal operation and anticipated operational occurrences are discussed in Section 12.4.1. Radiation exposures at other onsite locations outside the plant which arise from onsite radioactive sources, the presence of N-16 in the plant, and radioactive gaseous effluents are discussed in Section 12.4.2.

Dose assessment is the estimation of occupational radiation exposure at River Bend Station (RBS) to verify that the plant design features and proposed methods of operation ensure that radiation exposures are as low as reasonably achievable (ALARA). The dose assessment involves the estimates of occupancy times, dose rates inplant areas, and the number of personnel involved in the following general categories: reactor operation and surveillance, routine maintenance, waste processing, refueling, in-service inspection, and special maintenance.

Radiation exposures to operating personnel are within 10CFR20 limits. Radiation protection design features described in Section 12.3 and health physics program outlined in Section 12.5 assure that the occupational radiation exposures (ORE) to operating personnel during operation and ancitipated operational occurrences are ALARA.

The dose assessment evaluation process is aimed at eliminating unnecessary exposures and to consider cost-effective dose reducing methods to minimize the necessary operational exposures.

12.4.1 Exposures Within the Plant

The occupational radiation dose assessment for River Bend Station was performed using the guidelines of Regulatory Guide 8.19[3]. The bases for the annual man-rem estimates was operating data from similar BWR plants taking into account the design improvements that impact the occupational radiation exposure at RBS. The projected radiation dose rates throughout the plant facilities are based on assumed radiation conditions after five years of plant operation and the design radiation dose rates from FSAR Section 12.3. Operational data from several BWR's[4] showing the average annual man-rem per unit over several operating years to be 948 man-rem per year is presented in Table 12.4-1. This data indicates that in recent years, occupational radiation exposures have been much larger than the radiation exposures reported for operating BWR plants in the mid-1970's. The primary reason for the increase in radiation exposure has been the increase in manpower necessary to support the expanding special maintenance activities.

Distribution of annual occupational radiation exposures suggested in Regulatory Guide 8.19[3] work functions is given in Table 12.4-3 for all BWR's over several years. The average values indicate that operating BWR plants have approximately 76% annual occupational

exposure attributed to routine maintenance (40%) and special maintenance (36%). In recent years, plant modifications attributed to feedwater sparger repairs, inspection, repair and replacement of recirculation piping, Three Mile Island lessons-learned modifications, and increased snubber and pipe hanger inspections have contributed to the growing amount of occupational radiation exposures associated with special maintenance work functions. Design features described in Sections 12.1 and 12.3 for the RBS BWR/6 plant should minimize the special maintenance work experienced at earlier-designed operating BWR plants.

Design improvements for RBS that are expected to reduce the occupational radiation exposures include the following:

a. Incorporation of flush connections on the CRD scram discharge volume header permits condensate flushing of piping to minimize corrosion product holdup in a high personnel access area.

b. Use of filtered condensate water for CRD hydraulic fluid and for the reactor recirculation pump seal purge provides a clean water source that should extend pump seal life.

c. Installation of permanent hoisting system and access platforms for the recirculation pumps, main steam isolation valves and safety-relief valves minimizes maintenance time in drywell.

d. Improved refueling platform makes fuel handling activities move efficient so less time is spent on the platform.

e. A multi-stud tensioner reduces the amount of man-hours necessary to handle the reactor vessel head studs.

f. A new handling tool and platform for the removal of CRD's from beneath the reactor vessel reduces the crew size and the time spent in the high radiation area.

g. Improved fuel design minimizes the buildup of radiation levels near reactor coolant systems and reduces the amount of fuel assembly sipping activities.

h. Improved piping material for the recirculation system eliminates the special maintenance which was required on older BWR recirculation piping due to stress corrosion cracking.

i. Inservice inspection access is improved by remote equipment development and by access doors and plug in the biological shield for reactor vessel weld inspection.

j. Installation of a positive pressure leakage control system for the main steam line isolation valves should reduce the surveillance and maintenance activities related to technical specification requirements for leakage.

k. Use of separate shielded cubicles for locating redundant components and highly radioactive components minimizes radiation exposures during maintenance activities.

l. Use of mechanical snubbers should reduce the frequency of inspection necessary in comparison to the hydraulic operated snubbers.

m. Installation of a CRD flush tank and filter system removes highly radioactive corrosion and fission products from the CRD internals prior to rebuilding.

The occupational radiation exposure for RBS can be determined for each of the Regulatory Guide 8.19[(3)] work function categories by estimating the occupancy time and the manpower requirements involved for each of the six radiation zones defined in Section 12.3. Table 12.4-4 shows the expected occupancy times and anticipated manpower needs for reactor operations and surveillance, routine maintenance, waste processing, refueling and inservice inspection. The annual man-rem for each work function can be estimated by assuming an average dose rate for each radiation zone and assuming that there are 2080 working hours per year for each person for the operations and surveillance, routine maintenance and waste processing work activities. Refueling activities are assumed to be based on 160 hours per year for each person and inservice inspection is based on 192 hours per year each person. These man-hour estimates are consistent with those reported for operating BWR plants and predicted based on GE experience[(5)]. The average dose rates for each radiation zone are used in Table 12.4-4 as more realistic estimates of the actual radiation environment that workers would experience rather than the maximum dose rates which were determined for shielding design criteria based on very conservative source term assumptions. The estimated occupational radiation doses are summarized for each category in Table 12.4-5 which gives an overall estimate for RBS as 827.5 man-rem per year. The special maintenance contribution was estimated to be 298.7 man-rem based on previous operational BWR experience as shown in Table 12.4-3 out of which special maintenance comprises approximately 36% of the total annual man-rem. It is anticipated that special maintenance work activities will be significantly reduced for RBS based on the BWR/6 design improvements and the RBS design features. Table 12.4-5 also provides the percentage distribution of the total annual occupational dose for each work function which is consistent with the average distributions as calculated from operating BWR data shown in Table 12.4-3.

A further estimate of the occupational exposures was made by identifying specific tasks within each of the six work function categories. Various data from operating plants and current publications (References 2 through 10) were used to identify tasks, estimated manpower needs and radiation levels expected. Tables 12.4-6 through 12.4-11 provide the estimates of occupational exposures based on the identification of specific tasks within each of the six work function categories: routine operations and surveillance, routine

maintenance, waste processing, refueling, inservice inspection, and special maintenance. Table 12.4-12 summarizes the occupational dose estimates for the six work functions. A comparison between Tables 12.4-12 and 12.4-5 show that the dose estimates based on the identification of specific tasks are consistent but tend to be less than the dose estimates based on occupancy times for each radiation zone for the general work function classification. The only inconsistent estimate is the special maintenance work function. It is difficult to predict all the possible special maintenance work at RBS since there is little operating experience associated with BWR/6 plants. Operating experience at older BWR's (Tables 12.4-1, 12.4-3 and 12.4-5) has shown that the special maintenance dose is approximately 36% of the total annual average man-rem (948 man-rem/year) which would predict a value of 342 man-rem for special maintenance work only. Design improvements and features previously discussed should reduce the special maintenance man-rem estimate for River Bend Station to a range of 80 to 290 man-rem per year.

RBS has also evaluated the personnel exposure resulting from the actuation of SRV's based on Reference 2. The safety relief valve discharge event considered in the analysis is the Type 2 isolation event, in which the reactor pressure is initially controlled by the cyclic lifting of the SRVs. All SRV's are assumed to open with the low set relief valves remaining open following the closure of the other valves. Design basis radiation sources for normal operation are used in the analysis. Normal ventilation in containment is assumed and airborne concentrations are not corrected for plateout on the walls. This evaluation determined the dose to an operator located in the TIP drive area who leaves this area, following the isolation event and exits the containment at the personnel hatch on elevation 114 ft. It is assumed that the operator takes 4 minutes to exit the containment. A nonhomogeneous distribution of design basis airborne sources within the first 4 minutes following the event is assumed which is consistent with the reference study. The whole body and lens of eye dose calculated for this event is 140 mrem. The beta skin and thyroid doses are 390 mrem and 0.80 mrem, respectively.

12.4.2 Exposures at Locations Outside the Plant Structures

Radiation exposures at locations outside the plant arise from: 1) onsite radioactive sources outside plant buildings, 2) direct and air-scatter (skyshine) contributions due to the presence of N-16 in the plant buildings, and 3) release of gaseous effluents from the plant. The dose due to N-16 is the predominant contributor. Estimated doses for the restricted area boundary are summarized in Table 12.4-2. These estimates meet the dose guidelines of 10CFR20 and 40CFR190.

12.4.2.1 Dose Due to Radiation Sources Outside Plant Buildings

The only onsite source which exists outside of plant buildings with the potential for a direct radiation dose contribution to persons outside of plant structures is the condensate storage tank. However,

the minimal activity within the tank produces a negligible dose rate at the RAB.

12.4.2.2 N-16 Dose Contributions

Dose contributions due to N-16 are evaluated for both direct and air-scatter (skyshine) components.

Skyshine doses are due to air scattering of the high-energy gammas emitted by decaying N-16 present in reactor steam in the steam lines, turbines, and moisture separators. These doses have been evaluated by using the methods and data of RP-8A(1). The layout of the turbine building walls and floors used in the dose evaluation is given in Fig. 12.3-6 through 12.3-8. Data regarding the source term and the major shields providing skyshine shielding are as follows:

1. Expected specific activity of N-16 in the reactor steam is 50 Ci/gm at the reactor pressure vessel outlet nozzle (see Section 11.1).

2. A 24-in thick concrete floor is located above the moisture separator-reheaters.

3. There are 4-ft thick concrete outside shield walls below the above floors, which are 30-ft 6-in high. There are 4-in thick vertical steel skirts attached to the above floors inboard of the moisture separator reheaters.

4. A 4-in thick steel plate is located between the turbine and generator.

5. The combined intermediate valve regions are enclosed by the moisture separator-reheater cubicles, 4-ft thick concrete outside shield walls, 2-ft thick concrete floor overhead, and 3-ft thick end walls.

The minimum distance from the Unit 1 turbine building to the RAB is 2,760 ft, in NNE direction. The dose rate at this distance is estimated to be 1 mrem/yr from N-16 direct and air scattered contributions, based on the model in RP-8A(1).

12.4.2.3 Exposures Due to Airborne Activity

Dose rates resulting from airborne activity at the RAB, based on 2,000 hr/yr occupancy, are listed in Table 12.4-2.

12.4.3 Exposure to Construction Workers

RBS is a single-unit plant, therefore, estimated annual doses to construction workers due to radiation from an existing operating plant is not applicable.

RBS FSAR

Reference - 12.4

1. Radiation Shielding Design and Analysis Approach for Light Water Reactor Power Plants, RP-8A. Stone & Webster Engineering Corporation, Boston, MA, May 1975.

2. Mark III Containment Dose Reduction Study, GE22A5718, Revision 1, January 29, 1980.

3. Regulatory Guide 8.19 Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants Design Stage Man-Rem Estimates Revision 1, June 1979

4. NUREG-0713, Volume 4 Occupational Radiation Exposure at Commercial Nuclear Power Reactor 1982, December 1983

5. NEDO-24606 Occupational Radiation Exposure, General Electric Company, January 1979.

6. "An Assessment of Engineering Techniques for Reducing Occupational Radiation Exposure at Operating Nuclear Power Plants", Atomic Industrial Forum, February 1980

7. Pelletier, C.A., etal., "Compilation and Analysis of Data on Occupational Radiation Exposure Experiment at Operating Nuclear Power Plants". AIF/NESP-005, September 1979

8. NUREG/CR-0446, "Determining Effectiveness of ALARA Design and Operational Features", Hall, T.M., April 1979

9. EPRI NP-1842, "Occupational Radiation Exposure Reduction Technology Planning Study", Stone & Webster Corporation, May 1981

10. Pettit, P.J., "Compendium of Design Features to Reduce Occupational Radiation Exposure at Nuclear Power Plants", AIF/NESP-020, April 1981

Table 12.4-1

Operational Man-Rem per Year for
Selected BWR Plants

	1974	1975	1976	1977	1978	1979	1980	1981	1982
1. Dresden 1,2, 3	1662	3423	1680	1693	1529	1800	2105	2802	2923
2. Monticello	349	1353	263	1000	375	157	531	1004	993
3. Nine Mile Point	824	681	428	1383	314	1497	591	1592	1264
4. Peach Bottom 2,3	-	228	840	2036	1317	1388	2302	2506	1977
5. Quad Cities 1,2	482	1618	1651	1031	1618	2158	4838	3146	3757
6. Vermont Yankee	216	153	411	258	339	1170	1338	731	205
7. Pilgrim 1	-	798	2648	3142	1327	1015	3626	1836	1539
8. Millstone Point 1	1430	2022	1194	392	1239	1793	2158	1496	929
9. Oyster Creek	984	1140	1078	1614	1279	467	1733	917	865
10. Brunswick 1,2	-	-	-	-	1004	2602	3870	2638	3792
11. Brown Ferry 1,2,3	-	-	-	-	1792	1667	1825	2380	2220
12. Fitzpatrick	-	-	-	1080	909	859	2040	1425	1190
Average Man-Rem/Unit	594	878	784	974	686	872	1419	1183	1140

Overall average of 948 man-rem/year-unit

Reference: NUREG-0713 Volume 4

RBS FSAR

TABLE 12.4-2

ESTIMATED DOSES AT LOCATIONS
OUTSIDE THE PLANT STRUCTURES
(MREM/YR)

Location	N-16	Condensate Storage Tank	Airborne	Total
Restricted Area Boundary				
Whole Body	1	neg.	1	2
Skin	-	neg.	3	3

Table 12.4-3

Distribution of Annual Man-Rem By
Work Functions Based on Operating BWR Data

Work function	1978 Percentage	1979 Percentage	1980 Percentage	1981 Percentage	1982 Percentage	Average
Reactor Operations and Surveillance	12.3	13.4	7.6	7.5	9.1	10.0
Routine Maintenance	43.2	39.3	42.8	42.2	33.7	40.2
Waste Processing	5.8	4.3	3.1	11.0	6.2	6.1
Refueling	2.0	4.4	5.2	2.5	2.7	3.4
Inservice Inspection	2.6	7.3	3.3	3.7	4.3	4.2
Special Maintenance	34.1	31.2	38.1	33.1	44.0	36.1

References:

NUREG-0594, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors, 1978", November, 1979.

NUREG-0713, Volume 1, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors, 1979", March 1981.

NUREG-0713, Volume 2, "Occupational Radiation Exposure of Commercial Nuclear Power Reactors, 1980", December, 1981.

NUREG-0713, Volume 3, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors, 1981", November, 1982.

NUREG-0713, Volume 4, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors, 1982", December, 1983.

Table 12.4-4

Estimates of Occupancy Times In-Plant Radiation Areas
and Occupational Radiation Dose

Function	Radiation Zone	Average Dose Rate (Mrem/hr)	Occupancy (%)	Number of Persons	Annual Doses (Man-Rem/Yr)
Reactor Operations	I	0.2	70.0	32	9.3
and	II	1.0	20.0	32	13.3
Surveillance(1)	III	2.5	6.0	32	10.0
	IV	10.0	3.0	32	20.0
	V	50.0	0.9	32	30.0
	VI	100.0	0.1	32	6.7
				Total	89.3
Routine	I	0.2	70.0	47	13.7
Maintenance(1)	II	1.0	12.0	47	11.7
	III	2.5	10.0	47	24.4
	IV	10.0	5.0	47	48.9
	V	50.0	2.0	47	97.8
	VI	100.0	1.0	47	97.8
				Total	294.3
Waste	I	0.2	90.0	10	3.7
Processing(1)	II	1.0	5.0	10	1.0
	III	2.5	3.0	10	1.6
	IV	10.0	1.4	10	2.9
	V	50.0	0.5	10	5.2
	VI	100.0	0.1	10	2.1
				Total	16.5
Refueling(2)	I	0.2	30.0	44	0.4
	II	1.0	20.0	44	1.4
	III	2.5	24.0	44	4.2
	IV	10.0	22.0	44	15.5
	V	50.0	3.0	44	10.6
	VI	100.0	1.0	44	7.0
				Total	39.1
Inservice Inspection(3)	I	0.2	5.0	28	0.1
	II	1.0	10.0	28	0.5
	III	2.5	20.0	28	2.7
	IV	10.0	50.0	28	26.9
	V	50.0	10.0	28	26.9
	VI	100.0	5.0	28	26.9
				Total	84.0

(1) based on 2080 hours/yr-person
(2) based on 160 hours/yr-person
(3) based on 192 hours/yr-person

Table 12.4-5

Estimated Occupational Radiation Dose By
Work Functions for RBS

Function	Annual Dose (Men-rem/yr-unit)	Percentage of Total Dose
Reactor Operations and Surveillance	89.3	10.8
Routine Maintenance	294.3	35.6
Waste Processing	16.5	2.0
Refueling	44.7	5.4
Inservice Inspection	84.0	10.1
Special Maintenance	298.7	36.1
TOTAL	827.5	100.0

(1) Special maintenance man-rem is estimated from assuming that special maintenance is approximately 36% of total annual occupational radiation dose (Table 12.4-2).

Table 12.4-6

Occupational Dose Estimates During Routine
Operations and Surveillance

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
1. Main Control Room	0.1	8	3	-	1/shift	2.6	-
2. Auxiliary Control Room	0.1	8	6	-	1/day	1.8	-
3. Surveillance							
turbine	20.0	0.1	1	-	1/shift	2.2	-
feedwater heaters	10.0	0.5	1	-	1/shift	5.5	-
feedwater pumps	10.0	0.2	1	-	1/shift	2.2	-
Misc Turbine Bldg.	2.0	1.0	1	-	1/shift	2.2	-
ECCS cubicles	5.0	0.5	1	-	1/shift	2.7	-
RWCU pumps	50.0	0.05	1	-	1/shift	2.7	-
Misc Aux Bldg	2.0	1.0	1	-	1/shift	2.2	-
FPC pumps	5.0	0.05	1	-	1/shift	0.3	-
Misc Fuel Bldg	1.0	1.0	1	-	1/shift	1.1	-
CRD HCU's	5.0	0.5	1	-	1/shift	2.7	-
SLC system	2.0	0.1	1	-	1/shift	0.2	-
RWC heat exchangers	20.0	0.05	1	-	1/shift	1.1	-
TIP area	10.0	0.1	1	-	1/shift	1.1	-
Misc contaiument	5.0	1.0	1	-	1/shift	5.5	-
Condensate demins	5.0	0.1	1	-	1/shift	0.5	-
Offgas process	10.0	0.1	1	-	1/shift	1.1	-
4. Samples in Containment	5.0	1.0	1	-	1/shift	5.5	-
5. Sample stations in other bldgs.	1.0	2.0	1	-	1/shift	2.2	-
6. Radiation protection surveys	100.0	1.0	1	-	1/week	5.2	-
	10.0	2.0	1	-	1/day	7.3	-
	2.0	4.0	1	-	1/day	2.9	-

Table 12.4-6 (cont'd.)

Occupational Dose Estimates During Routine
Operations and Surveillance

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
7. Radiochemistry lab activities	0.1	6.0	10	-	1/day	2.2	-
8. Radiation Protection lab activities	0.1	8.0	9	-	1/day	2.6	-
					TOTAL	65.6	

Table 12.4-7

Occupational Dose Estimates During Routine Maintenance

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
1. RWCU Filter demin percent	2.5	2.0	1	-	1/week	0.3	-
2. RWCU holding pumps, valves	20.0	0.5	2	-	1/week	1.0	-
3. RWCU pumps valves	100.0	1.0	2	-	1/week	10.4	-
4. TIP system	10.0	2.0	2	1	1/month	0.7	-
5. CRD HCU's, control stations	5.0	1.0	1	-	1/day	1.8	-
6. Reactor recirc. pump valves	50.0	50.0	2	10	1/year	5.0	25.0
7. Drywell and Containment Utilization	5.0	7.0	2	-	1/year	0.1	-
8. HVAC in other buildings	1.0	1.0	1	-	1/day	0.4	-
9. Radiation Monitors drywell, containment	5.0	50.0	2	-	1/year	1.3	-
10. Radiation Monitors other buildings	2.0	150.0	2	-	1/year	0.6	-
11. ECCS pumps,	25.0	0.5	2	-	1/week	1.3	-
valves, instuments	2.0	4.0	2	-	1/week	0.8	-
12. Reactor Plant cooling Water	2.0	1.0	2	-	1/week	0.2	-
13. Turbine Plant cooling water	1.0	1.0	2	-	1/week	0.1	-

Table 12.4-7 (cont'd.)

Occupational Dose Estimates During Routine Maintenance

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
14. Feedwater pumps condensate pumps	2.0	2.0	2	-	1/week	0.4	-
15. Feedwater heaters MSR's	5.0	0.5	2	-	1/week	0.3	-
16. CRD pumps, filters	2.0	2.0	1	-	1/week	0.2	-
17. Fuel pool cooling components	5.0	0.5	2	-	1/week	0.3	-
18. Fuel pool cleanup components	10.0	1.0	2	-	1/week	1.0	-
19. Condensate demin-eralizers	2.0	1.5	2	-	1/day	2.2	-
20. Offgas components	5.0	1.0	2	-	1/day	3.7	-
21. I&C Preventive maintenance	1.0	8.0	10	-	1/day	29.2	-
22. Electrical preventive Maintenance	2.0	8.0	4	-	1/day	23.4	-
23. Mechanical preventive Maintenance	5.0	8.0	7	-	1/day	102.2	-
				TOTAL		212	25.0

Table 12.4-8

Occupational Dose Estimates During Waste Processing

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
1. Operation of liquid radwaste system	0.2	8	2	-	1/day	1.2	-
2. Surveillance of radwaste equipment	10.	0.5	1	-	1/day	1.8	-
	2.5	1.0	1	-	1/day	0.9	-
3. Operation of waste solidification system	50.	1	-	1	1/week	-	2.6
	2.0	32	-	1	1/week	-	3.3
4. DAW compecting	2.0	32	1	-	1/week	3.3	-
5. Chemistry and radiation protection support	2.5	2	2	-	1/day	3.7	-
				TOTAL		16.8	5.9

Table 12.4-9

Occupational Dose Esimates During Refueling

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
1. Reactor vessel head and internals removal, installation	20	32	6	14	1/year	3.8	9.0
2. Fuel handling and transfer	2.5	160	6	6	1/year	2.4	2.4
3. Fuel sipping	5.0	200	1	2	1/year	1.0	2.0
4. Radiation protection coverage	3.0	160	3	6	1/year	1.4	2.9
					TOTAL	24.9	16.3

Table 12.4-10

Occupational Dose Estimates During Inservice Inspection

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers Utility	Number of Workers Contractor	Frequency	Dose (man-rem/year) Utility	Dose (man-rem/year) Contractor
1. Providing access in drywell: moving platforms, insulation equipment.	100	20	-	2	1/year	-	4.0
	20	20	-	4	1/year	-	1.6
2. Reactor vessel and piping in drywell	100	50	-	6	1/year	-	30.0
	20	150	-	6	1/year	-	18.0
3. Piping in containment and other buildings	20	20	-	6	1/year	-	2.4
	5	170	-	8	1/year	-	6.8
4. Snubbers and pipe hangers	100	20	-	2	1/year	-	4.0
	20	60	-	6	1/year	-	7.2
	5	120	-	12	1/year	-	7.2
					TOTAL		81.2

Table 12.4-11

Occupational Dose Estimates During Special Maintenance

Activity	Average Dose Rate (mren/hr)	Exposure Time (hours)	Number of Workers		Frequency	Dose (man-rem/year)	
			Utility	Contractor		Utility	Contractor
1. Servicing CRD							
under vessel	100	32	2	4	1/year	6.4	12.8
rebuild room	10	56	3	3	1/year	1.7	1.7
2. Servicing in-cores under vessel	100	20	1	2	1/year	2.0	4.0
3. MSIV repair	75	50	2	4	1/year	7.5	15.0
4. Turbine repair	5	250	10	15	1/3 years	4.2	6.3
5. Recirculation flow control valve repair	50	50	-	4	1/year	-	10.0
6. RHR Heat Exhanger	50	50	2	2	1/year	5.0	5.0
					TOTAL	81.6	54.8

Enclosure 2 (cont'd.)

Table 12.4-12

Summary of Occupational Dose Estimates From Detailed Work Function Tasks

function	Annual Dose (man-rem/year)
Reactor Operations and Surveillance	65.6
Routine Maintenance	212.
Waste Processing	16.8
Refueling	24.9
Inservice Inspection	81.2
Special Maintenance	81.6[1]
TOTAL	482 man-rem/year

(1) A more realistic special maintenance dose estimate is approximately 36% of total man-rem which would predict:

special maintenance	226	man-rem/year
revised total	629	man-rem/year