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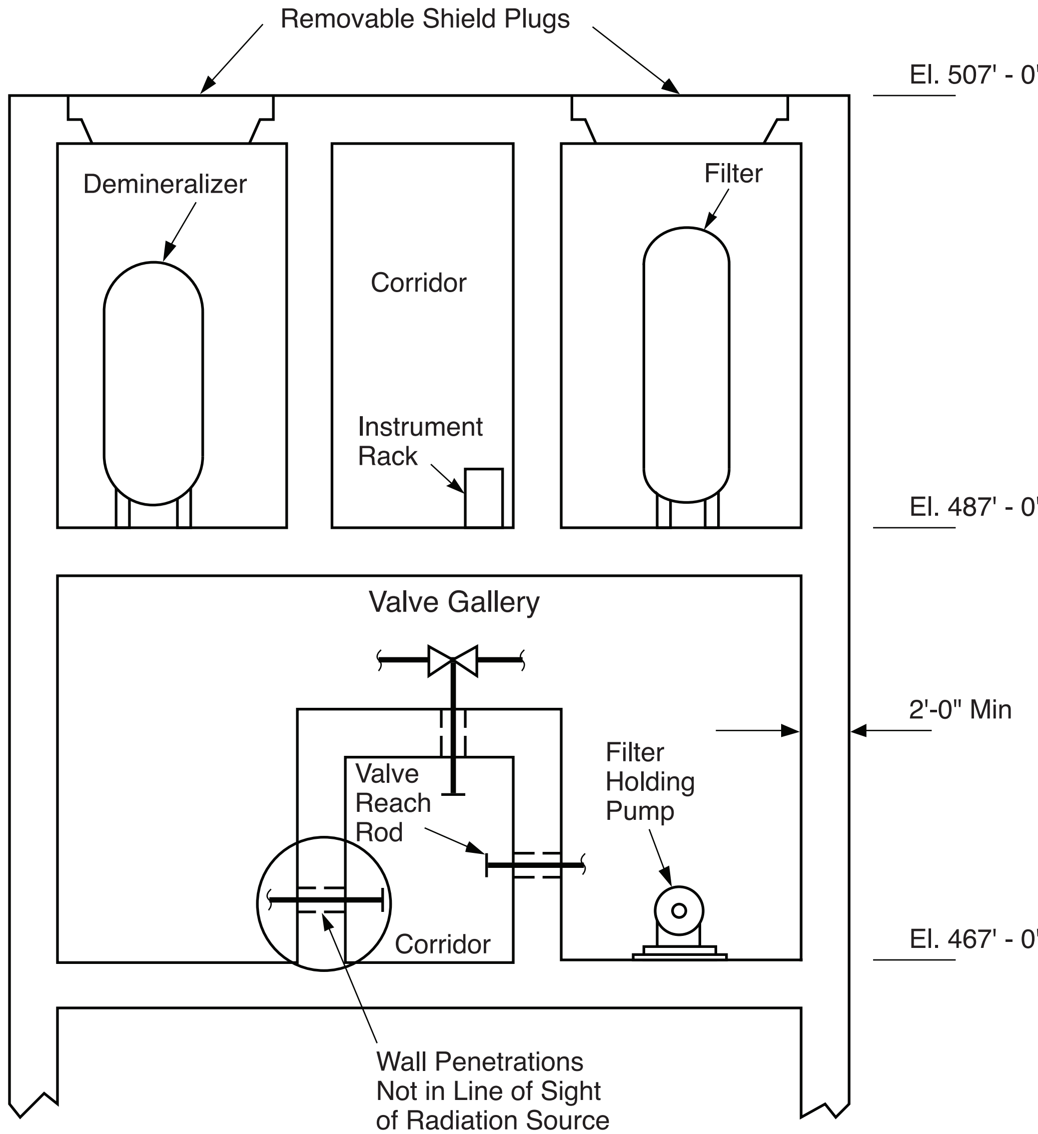
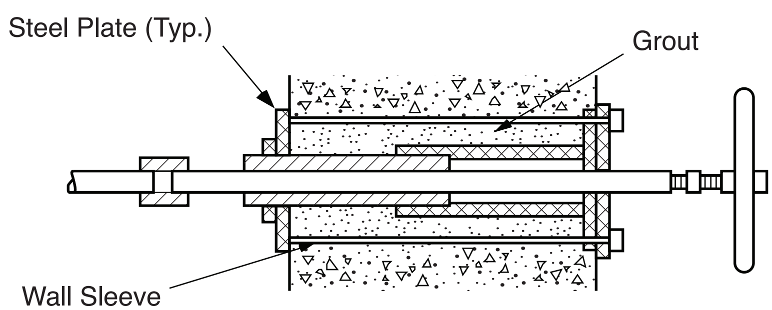
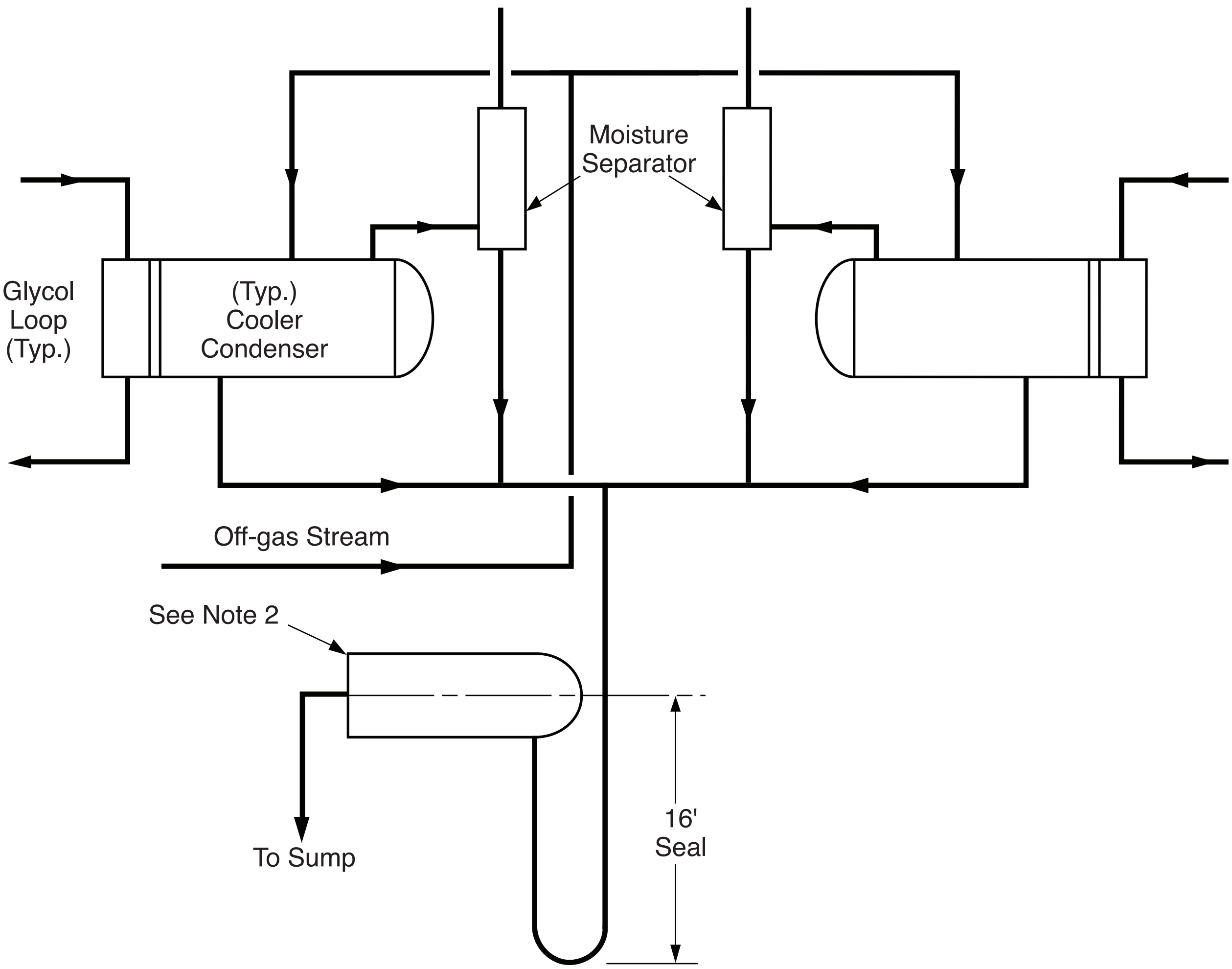




Penetration Detail

Columbia Generating Station Final Safety Analysis Report	Arrangement of Filtration and Demineralization Equipment (Typical)
	Draw. No. 900547.52 / Rev. / Figure 12.3-19

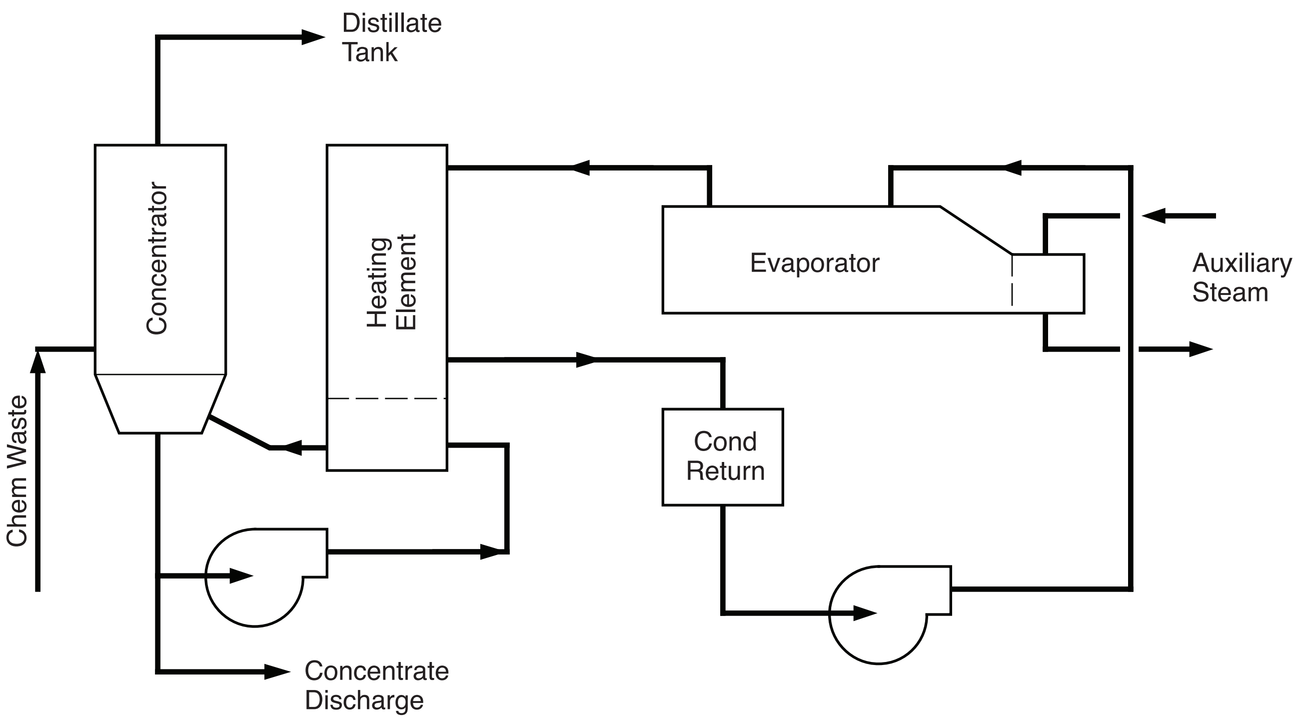


Notes:

1. Valves and instrumentation are not shown to prevent clutter.

2. Overflow volume in the enlarged discharge section is sufficient to restore loop seal following a pressure surge.

Columbia Generating Station **Final Safety Analysis Report**	**Schematic Arrangement of the Cooler Condenser Loop Seal**
	Draw. No. **900547.53** Rev. Figure **12.3-20**

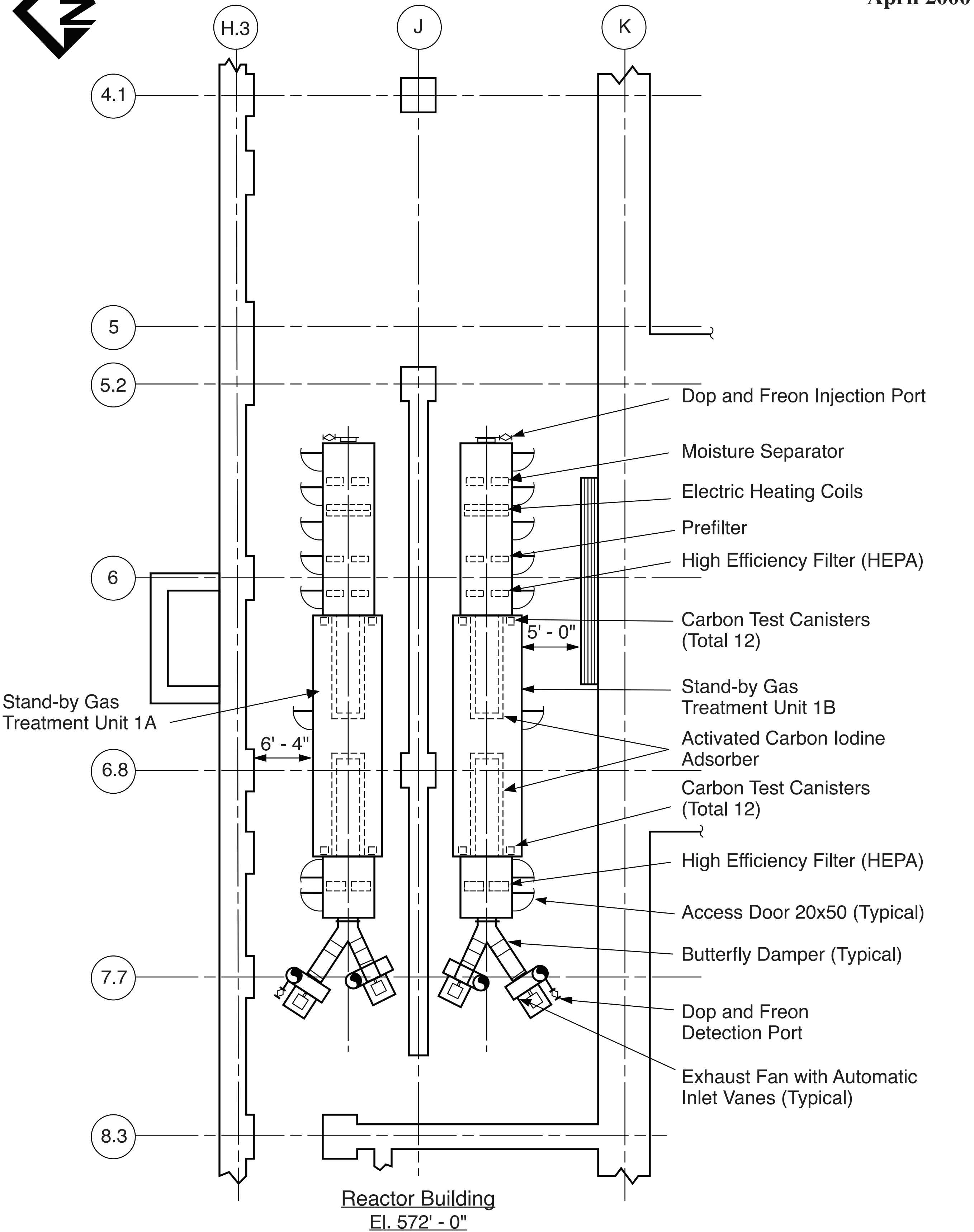


Columbia Generating Station
Final Safety Analysis Report

Decontamination Concentrator Steam Supply Arrangement

Draw. No. 900547.54 | Rev. | Figure 12.3-21

Figure Not Available For Public Viewing

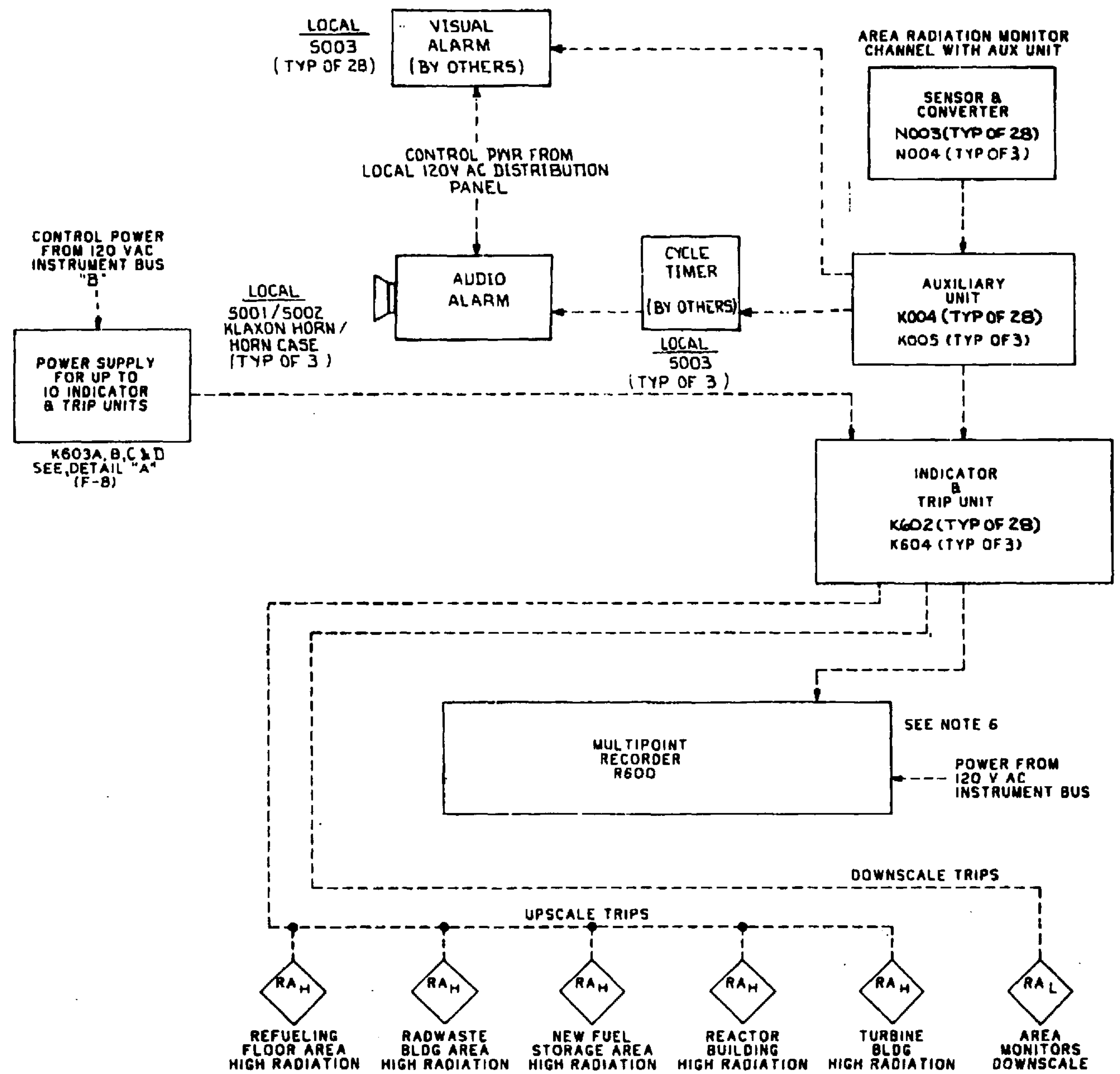


Columbia Generating Station
Final Safety Analysis Report

Layout of the Standby Gas Treatment System Filter Units

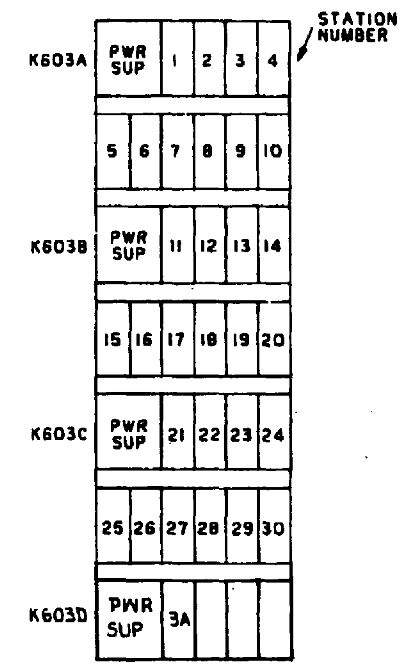
Draw. No. 900547.56 | Rev. | Figure 12.3-23

GENERAL ELECTRIC
919D693AD AREA RADIATION MONITORING SYS
HANFORD 2 238X173AD
FCF 239X247AD (021-1010)



RANGE	QUANTITY (NOTE 1)		
MR / HR	SENSOR & CONVERTER	AUX UNIT	INDICATOR & TRIP UNIT
.01-100			
0.1-1000			
$1-10^4$	N003 (28)	K004 (28)	K602 (28)
10^2-10^6	N004 (3)	K005 (3)	K604 (3)

TABLE 1



INDICATOR & TRIP UNITS FOR EACH STATION
PANEL D21-P600 (H13-P673)
DETAIL "A"

NOTES:

1. RANGES CHOSEN BY PURCHASER ARE SHOWN ON D21-3050
2. REMOVED
3. REMOVED
4. CHANNEL CALIBRATED BY USE OF CALIBRATION UNIT K003. (NOT SHOWN)
5. FOR LOCATION & IDENTIFICATION OF INSTRUMENTS SEE INSTRUMENT DATA SHEET D21-3050.
6. RECORDERS ARE LOCATED IN PROCESS RADIATION RECORDER VERTICAL BOARD. (H13-P600)

REFERENCE DOCUMENTS	MPL ITEM NO.
1. DES SPEC SPECIAL WIRE & CABLE	A62-4010
2. DES SPEC AREA RADIATION MONITORING.	D21-4010

Columbia Generating Station
Final Safety Analysis Report

Block Diagram - Area Radiation Monitoring System

Draw. No. 02D21-04,1,1 | Rev. 6 | Figure 12.3-24

Form No. 960690

12.4 DOSE ASSESSMENT

12.4.1 DESIGN CRITERIA

The criteria for the dose to plant personnel during normal operation and anticipated operational occurrences including refueling, are based on the requirements discussed in 10 CFR Part 20. The design radiation levels during normal operation and refueling are shown in Figures 12.3-5 through 12.3-18. In areas such as the control room and offices, the maximum dose rate does not exceed 1.0 mrem/hr (Zone I radiation level). For personnel who work in controlled radiation areas, radiation Zone II through IV in Figures 12.3-5 through 12.3-18, administrative controls ensure that doses do not exceed the requirements of 10 CFR Part 20.

12.4.2 PERSONNEL DOSE ASSESSMENT BASED ON BWR OPERATING DATA

The italicized information is historical and was provided to support the application for an operating license.

12.4.2.1 General

In general, data (Reference 12.4-1) from operating boiling water reactors (BWRs) have shown that the man-rem exposures to plant personnel are primarily due to the corrosion product isotopes. Of the corrosion product isotopes, ^{60}Co is believed to be the single most important radionuclide.

A review of the data from operating reactors was performed in References 12.4-6 and 12.4-7. Based on this it was concluded that the shielding design, which assumes the GE BWR design base source terms, was adequate to account for the additional radioactivity that will deposit in the lines due to crud.

Chemical cleaning connections were also installed on a number of systems. A chemical cleanup can be performed to reduce the deposits of crud and minimize the increase in radiation levels if needed. Section 12.3.1.3.2 addresses the design features that were incorporated to reduce the buildup of crud.

The variables that have been found to affect plant personnel exposure include the following:

a. *The BWR plants show an increase in total personnel exposure during the first few years of operation,*

b. *The need to minimize plant downtime requires that inspection and repair tasks must be started immediately after plant shutdown when the dose rates from short-lived radionuclides can be significant,* *c. Plant design and equipment layout has a significant effect on personnel dose. Section 12.3.1 discusses the design features used to minimize plant personnel exposure,*

d. Training and experience of plant workers,

e. The extent of maintenance operations required for a specific year, and

f. The extent that a utility uses non-regular or contractor personnel.

12.4.2.2 Personnel Dose from Operating BWR Data

References 12.4-1 through 12.4-5 provide a tabulation of personnel exposures for operating BWRs. Table 12.4-9 tabulates the average personnel exposure for operating BWRs for the period 1969 through 1980. References 12.4-4 and 12.4-5 provide more recent information. The assessments of personnel exposures summarized in Section 12.4.2.3 include this more recent information.

12.4.2.3 Occupancy Factors, Dose Rates, and Estimated Personnel Exposures

A summary of the total estimated man-rem doses broken down by major function is given in Table 12.4-1. More detailed breakdowns are presented in Tables 12.4-2 through 12.4-8 for each of the seven major functions given in Table 12.4-1. These tables are based on the more recent information obtained from industry operating experience. The data from Table 12.4-9 is given for comparison purposes only.

The results of the total estimated man-rem doses will be discussed with reference to six occupational groups as follows:

a. Group 1 - This group includes maintenance personnel such as mechanical, electrical, instrument craftsmen, and Foreman. There are approximately 128 people is this group. Tables 12.4-4 and 12.4-8 provide the functional breakdown of exposures for this occupational group. As can be seen from the tables, 433 total man-rem may be expected.

Routine and special maintenance operations which include control rod drive repairs, residual heat removal (RHR) repairs, snubber maintenance, etc., account for approximately 60% of the average annual personnel dose. One to two rem per year per person is projected for the station maintenance personnel for a maximum total of 256 man-rem per year. Accordingly, the remaining 175 man-rem per year would be expected to be received by non-station maintenance personnel. As discussed in Section 12.3.1, the equipment layout *and design and shielding design are such that the exposures are as low as is reasonably achievable (ALARA).*

b. *Group 2 - This group includes plant operations personnel composed of supervisors, control room staff and plant equipment operators. There are approximately 60 people in this group. Tables 12.4-2, 12.4-3, 12.4-5, and 12.4-6 show the total estimated man-rem for this group. As can be seen, the total is approximately 130 man-rem per year or approximately 2.2 rem per year per man. Personnel in this group will be performing routine and non-routine operation and surveillance, waste processing and refueling operations. In plant operations, personnel are expected to receive approximately one to two rem per year per man for a maximum total of 120 man-rem per year. The remaining 10 man-rem per year may be expected to be received by non-station personnel. As part of this total, the supervisors and control room staff are expected to receive an exposure of less than 500 mrem/yr.*

c. *Group 3 - This group includes health physics and chemistry personnel. There are approximately 53 people in this group. If the plant chemistry personnel spend 1% of their time collecting samples in Zone III sampling stations. They will receive a maximum dose of 723 mrem/yr. Assuming the remainder of their time is spent in Zone I and Zone II areas, the total dose is between 1 and 2 rem per person. The health physics personnel conduct radiation surveys and support maintenance activities which require continuous and pre-job radiation surveys. The exposure to these health physics personnel ranges from 2 to 3 rem/yr. This is based on experience from operating plants. Assuming a dose of 3 rem per person per year and considering 35 health physics people in the group, the total is 105 man-rem per year. Since this group covers virtually all functions delineated in Tables 12.4-2 through 12.4-8, this 105 man-rem is considered to be spread out across all the functions.*

d. *Group 4 - This group includes engineers and technical supervisors. There are approximately 27 people in this group. Personnel in this group will spend most of their time in Zone I areas where exposures are less than 500 mrem/yr. Table 12.4-7 indicates approximately 153 man-rem per year will be experienced for inservice inspection. Plant technical personnel will have a supervising roll in this operation with non-station personnel performing the inspection operations. This supervisory roll will take the personnel into all zone levels during ISI activities and this roll is expected to result in exposure from 1 to 2 rem/yr. Thus, the projected dose estimate for the 27 people in this group is 54 man-rem per year, the balance being accounted for in the non-station personnel.*

e. *Group 5 - This group includes station supervisors such as health physics and chemistry supervisors, shift supervisors, etc. There are approximately 24 people in this group. Station personnel will supervise Group 1 and Group 2 personnel. Their dose is approximately the same as personnel in these groups. With a projected dose estimate of 1 rem per year per person with 24 people in the group, the total dose is 24 man-rem per year.*

f. *Group 6 - This group includes administrative and management personnel. There are approximately 31 people in this group. Personnel in this group spend their time in Zone I radiation areas. The projected dose estimates will be less than 500 mrem/yr. With 31 people in this group and a 500 mrem per man per year the total dose is 15.5 man-rem per year.*

As seen from Table 12.4-1, the total estimated man-rem exposure is 715 man-rem. Groups 3, 5, and 6 are considered to be spread over all the functions. These groups constitute only 15% of the total exposure in any case.

12.4.3 INHALATION EXPOSURES

Airborne radionuclide concentrations in normally occupied areas are, as discussed in Section 12.2.2, well below the limits set by 10 CFR Part 20 and thus inhalation exposures are negligible. In areas where engineering controls or operational procedures do not reduce the airborne radionuclide concentrations sufficiently, additional measures such as access control, limiting exposure time (DAC hours), and respiratory protection devices are used to maintain the total effective dose equivalent (TEDE) ALARA.

12.4.4 SITE BOUNDARY DOSE

Steam handling equipment on the turbine operating floor can contribute to the site boundary dose in two ways: through a direct component and through an air-scattered "skyshine" component. Since the ^{16}N bearing equipment is known, it can be shielded to reduce the direct component. The "skyshine" component reaches the site boundary as a result of those gamma rays which are directed such that they bypass any intercepting shield walls and are scattered by the air to the site boundary.

The calculated results show that the skyshine dose will have its greatest effect on a dose point approximately 1950 m north of the turbine building. The skyshine dose at this point will be approximately 4 mrem/yr. This result is based on a plant capacity factor of 80%.

The main contributors to this dose and their contribution (in percent) are the south moisture-separator reheater (MSR) which contributes 60%, the north MSR which contributes 20%, the cross over lines which contribute 10%, and the turbines and feedwater heaters which contribute 10%.

The dose estimate was computed from a model that represents the ^{16}N gamma leakage by point isotopic sources. This model uses the output from the COHORT Code (Reference 12.4-3) which gives the airscattered dose as a function of distance and source ray angle.

The site boundary dose from liquid and gaseous effluents are discussed in Sections 11.2.3 and 11.3.3.

12.4.5 REFERENCES

12.4-1 Atomic Industrial Forum, Compilation and Analysis of Data on Occupational Radiation Exposure Experienced at Operating Nuclear Power Plants, September 1974.

12.4-2 Ninth Annual Occupational Radiation Exposure Report, NRC, NUREG-0322, Washington, D.C., October 1977.

12.4-3 Tenth Annual Occupational Radiation Exposure Report, NRC, NUREG-0463, Washington, D.C., October 1978.

12.4-4 Occupational Radiation Exposure at Light Water Cooled Power Reactors, Annual Report 1977, NRC, NUREG-0482, Washington, D.C., April 1977.

12.4-5 Occupational Radiation Exposure at Commercial Nuclear Power Reactors, Annual Report 1979 and 1980, Volumes 1-2, NRC, NUREG-0713, December 1981.

12.4-6 NRC Seventh Annual Occupational Radiation Exposure Report 1974, NUREG-75/108, November 1975.

12.4-7 Atomic Industrial Forum, Compilation and Analysis of Data on Occupational Radiation Exposure Experienced at Operating Nuclear Power Plants, September 1974.

Table 12.4-1

Summary of Occupational Dose Estimates

		Man-rem/yr
1.	Routine operation and surveillance	53
2.	Nonroutine operation and surveillance	15
3.	Routine maintenance	288
4.	Waste processing	15
5.	Refueling	48
6.	Inservice inspection	153
7.	Special maintenance	145
	Total	717

Table 12.4-2

Occupational Dose Estimates During Routine Operations and Surveillance

	Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
1.	Walking	0.5	0.5	2	1/shift	= 0.54
2a.	Checking					
	Railroad access	1	1	2	1/shift	= 2.2
	Change rooms	1	1	2	1/shift	
	Relay room	1	1	2	1/shift	
	Motor generator sets	1	1	2	1/shift	
	Battery room	1	1	2	1/shift	
	Computer room	1	1	2	1/shift	
	Switch gear room	1	1	2	1/shift	
	Air conditioning equip.	1	1	2	1/shift	
	Recirc. motor gen.	1	1	2	1/shift	
	RBCCW heat	1	1	2	1/shift	
	Exchangers	1	1	2	1/shift	
	Emergency air comp	1	1	2	1/shift	
	RBCCU pumps	1	1	2	1/shift	
	RBCCW expansion	1	1	2	1/shift	
	Tank	1	1	2	1/shift	
2b.	Mech. vac. pumps	10	0.5	2	1/shift	= 11
	CRD pumps	10	0.5	2	1/shift	
	CRD hydraulic	10	0.5	2	1/shift	
	Cont. units	10	0.5	2	1/shift	
	Refueling floor	10	0.5	2	1/shift	
	CRD filters	10	0.5	2	1/shift	
	RUCV demmo resin	10	0.5	2	1/shift	
	Tanks	10	0.5	2	1/shift	
	RNP pumps	10	0.5	2	1/shift	
	SRMP pumps	10	0.5	2	1/shift	
	Air coolers	10	0.5	2	1/shift	
	IVST racks	10	0.5	2	1/shift	
2c.	CRD storage and repair	15	0.2	2	1/shift	= 3.3
	SGTS	15	0.2	2	1/shift	
	HPCI turbine and pump	15	0.2	2	1/shift	
2d.	RWCU heat exchangers	50	0.1	1	1/shift	= 5.5
	RHR heat exchangers	50	0.1	1	1/shift	
	Acid purple and turbine	50	0.1	1	1/shift	

Table 12.4-2

Occupational Dose Estimates During Routine Operations and Surveillance (Continued)

	Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
	Checking (continued)					
2e	Demin precoat tank	0.2	0.5	1	1/shift	= 0.1
	Precoat pump	0.2	0.5	1	1/shift	
	Waste sample pump	0.2	0.5	1	1/shift	
	Floor drain sample room	0.2	0.5	1	1/shift	
	Waste surge pump	0.2	0.5	1	1/shift	
	Equip. drain sump pump	0.2	0.5	1	1/shift	
	Waste surge pump	0.2	0.5	1	1/shift	
	Waste precoat pump	0.2	0.5	1	1/shift	
	Waste sludge disch. pump	0.2	0.5	1	1/shift	
	Waste filter aid pump	0.2	0.5	1	1/shift	
	Chemical waste pump	0.2	0.5	1	1/shift	
	Floor drain coll. pump	0.2	0.5	1	1/shift	
2f.	Chemical waste tank	50	0.5	1	1/shift	= 1.3
	Spent resin pump	50	0.5	1	1/shift	
	Cond. phase decant pump	50	0.5	1	1/shift	
	Cond. phase sludge	50	0.5	1	1/shift	
	Discharge mixing pump	50	0.5	1	1/shift	
2g.	Floor drain demin.	8	2	1	1/shift	= 0.8
	Waste hopper	8	2	1	1/shift	
	Floor drain filter	8	2	1	1/shift	
2h.	Turbine inst. and controls	0.5	1	2	1/shift	= 1.1
	Gen. CO_2 units	0.5	1	2	1/shift	
	Station air comp.	0.5	1	2	1/shift	
	Heater feed pumps	0.5	1	2	1/shift	
	Demin. pumps and valves	0.5	1	2	1/shift	
	MTG lubrication system	0.5	1	2	1/shift	
	Hatch area above demin. tanks	0.5	1	2	1/shift	
	H_2 seal 2.1 equip.	0.5	1	2	1/shift	
	Health shell pull space	0.5	1	2	1/shift	
	BCCW heat expansion and pumps	0.5	1	2	1/shift	

Table 12.4-2

Occupational Dose Estimates During Routine Operations and Surveillance (Continued)

	Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
	Checking (continued)					
2i	TBCCW expansion tank	5	0.3	1	1/shift	= 1.6
	Ventilation equipment	5	0.3	1	1/shift	
	Demin. precoat and resin tanks	5	0.3	1	1/shift	
	Demin. precoat pumps	5	0.3	1	1/shift	
	Sump pumps	5	0.3	1	1/shift	
	Reactor feed pump turbine	5	0.3	1	1/shift	
	Lub. system	5	0.3	1	1/shift	
	MTG lub oil cooler	5	0.3	1	1/shift	
	Main gen. and exciter	5	0.3	1	1/shift	
	MTG utilizer activators	5	0.3	1	1/shift	
	Stop and throttle valves	5	0.3	1	1/shift	
	Circ. water isol. valves	5	0.3	1	1/shift	
2j.	Heater drain pumps	50	0.2	1	1/shift	= 11.0
	Heater drain flash tanks	50	0.2	1	1/shift	
	Condense water box	50	0.2	1	1/shift	
	Reactor feed pumps and turbines	50	0.2	1	1/shift	
2k.	Drain coolers	15	0.5	1	1/shift	= 14.6
	Feed water heaters	15	0.5	1	1/shift	
	Reheater seal tank	15	0.5	1	1/shift	
	Gland steam condenser	15	0.5	1	1/shift	
	Main turbine	15	0.5	1	1/shift	
	Reheater separators	15	0.5	1	1/shift	
					Total	53.04

Table 12.4-3

Occupational Dose Estimates During Nonroutine Operations and Surveillance

	Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
1.	Operation of equipment:					
1a.	Traversing in-core probe system	2	2	2	3/yr	0.02
1b.	Safety injection system	5	1	1	1/month	0.06
1c.	Feedwater pumps and turbine	1	1	1	1/week	0.05
1d.	Instrument calibration	2	1	1	1/day	0.73
2.	Collection of radioactive samples:					
2a.	Liquid system	10	0.5	1	1/day	1.83
2b.	Gas system	5	0.5	1	1/month	0.03
2c.	Solid system	10	0.5	1	4/yr	0.01
2d.	Radiochemistry	1	1	2	1/day	0.73
2e.	Radwaste operation	3	8	3	1/week	3.75
2f.	Health physics	5	2	2	1/day	7.30
					Total	14.50

Table 12.4-4

Occupational Dose Estimates During Routine Operations and Surveillance

	Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
1.	Minor repairs reactor building	1	20	2	1/week	2.1
2.	Ventilation and air conditioning	0.5	20	1	1/week	0.5
3.	Control rod drive repair	15	200	6	1/yr	18
4.	Reactor water cleanup pump	180	35	3	1/yr	19
5.	Reactor water cleanup valve and heat exchanger	110	45	6	1/yr	30
6.	Residual heat removal system	200	27	8	1/yr	43
7.	Safety relief valves	80	30	5	1/yr	12
8.	Main steam isol. valves	75	100	6	1/yr	45
9.	Recirc. pumps	200	50	3	1/yr	30
10.	Snubber inspector and repair	75	100	5	1/yr	37.5
11.	Misc. turbine bldg. repairs	2	8	1	1/day	5.8
12.	Reactor feed pumps and turbine	10	40	2	2/yr	0.8
13.	Drain coolers	2	40	2	1/yr	0.16
14.	Steam jet air ejectors	10	40	2	2/yr	1.6
15.	Offgas system	2	40	2	6/yr	0.96
16.	MTG actuator	5	40	1	1/yr	0.24
17.	Heater drain flash tanks	2	40	1	1/yr	0.08
18.	Condenser water box	5	20	1	1/yr	0.1
19.	Annual turbine inspection	3	120	10	1/yr	3.6
20.	Misc. radwaste pump repairs	25	40	2	4/yr	8.0
21.	Misc. radwaste valve repairs	10	40	2	6/yr	4.0
22.	Filter and demin.	65	30	3	1/yr	5.9
23.	Centrifuge	50	8	2	4/yr	3.2
24.	Evaporation	85	50	3	1/yr	12.8
25.	Turbine instr. and control	2	10	1	1/week	1.0
26.	Waste solidification	2	40	2	2/yr	0.32
27.	Area monitors	20	40	2	2/yr	0.32
28.	Operate laundry facility	0.5	40	3	1/day	2.2
					Total	288.2

Table 12.4-5

Occupational Dose Estimates During Waste Processing

Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
Radwaste control room	.5	8	1	1/shift	4.4
Sampling and filter changing	15	8	1	1/week	6.2
Panel operator insp. and testing	1	2	1	1/day	0.73
Operation of waste and packaging equipment	2	16	2	1/week	3.3
				Total	14.6

Table 12.4-6

Occupational Dose Estimates During Refueling

	Activity	Aveg. Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
1.	Opening/closing reactor pressure vessel	60	40	10	1/yr	24
2.	Fuel preparation	10	24	2	1/yr	0.48
3.	Refueling	10	100	15	1/yr	15
4.	Fuel handling	2.5	100	4	1/yr	1.0
5.	Fuel sipping	10	120	6	1/yr	7.2
					Total	47.7

Table 12.4-7

Occupational Dose Estimates During Inservice Inspection

Activity	Average Dose Rate (mrem/hr)	Exposure Time (hr)	Number of Workers	Frequency	Dose (man-rem/yr)
1. Removal/replacement of insulation	150	80	4	1/yr	48
2. Installation/removal and ladders	50	40	4	1/yr	8
3. Inspecting inside drywell	150	80	6	1/yr	72
4. Recorder data	50	80	6	1/yr	24
5. Inspecting outside drywell	5	50	2	1/yr	0.5
				Total	153

Table 12.4-8

Occupational Dose Estimates During Special Maintenance

Activity	*Average Dose Rate (mrem/hr)*	*Exposure Time (hr)*	*Number of Workers*	*Frequency*	*Dose (man-rem/yr)*
Sparger replacement	*800*	*60*	*5*	*Should not be necessary*	*---*
CRD replacement	*260*	*35*	*5*	*1/yr*	*45.5*
Turbine overhaul	*5*	*250*	*20*	*1/5 yr*	*5*
Servicing in-core detectors	*15*	*50*	*3*	*1/yr*	*2.3*
Offgas charcoal sys. overhaul	*20*	*100*	*2*	*1/20 yr*	*0.2*
Special maintenance reactor water clearup sys.	*150*	*100*	*8*	*1/10 yr*	*12*
Misc. piping repairs	*80*	*100*	*10*	*1/yr*	*80*
				Total	*145.0*

Table 12.4-9

Summary of Annual Information Reported by Commercial Boiling Water Reactors

1969 - 1980

Year	Number of Reactors Included	Annual Collective Doses (man-rems)	No. of Workers With Measurable Dose	Gross MW-Yrs Electric Generated	Average Dose Per Worker (rems)	Average Collective Dose Per Reactor (man-rems)	Average No. Personnel With Measurable Doses Per Reactor	Average Man-rems Per MW-yr	Average MW-yrs Generated Per Reactor	Average Rated Capacity (MWe) Net
1969	3 (2)	586 (300)	290[a]	192	1.03[a]	195	145[a]	3.1	64	112
1970	6 (4)	764 (510)	1,321[a]	912	0.39[a]	127	330[a]	0.8	152	267
1971	7 (5)	1,784 (1,069)	1,873[a]	1,038	0.57[a]	255	375[a]	1.4	187	339
1972	10 (7)	2,858 (2,130)	2,258[a]	3,058	0.94[a]	286	323[a]	0.9	306	434
1973	12	4,564	5,340	3,394	0.85	380	445	1.3	283	459
1974	14	7,095	8,769	4,059	0.81	507	626	1.7	290	513
1975	18	12,611	14,607	5,789	0.86	701	812	2.2	321	611
1976	23	12,626	17,859	8,586	0.71	549	776	1.5	373	647
1977	23	19,042	21,388	9,098	0.89	828	930	2.1	396	645
1978	25	15,096	20,278	11,774	0.74	604	811	1.3	471	669
1979	25	18,322	25,245	11,671	0.73	733	1,010	1.6	467	669
1980	26	29,530	34,094	10,868	0.87	1,136	1,311	2.7	418	664

[a]During the years 1969 through 1972, all plants reported collective doses but a few did not submit the number of personnel that received measurable doses. The number of reactors that did report doses and number of workers is given in parentheses in the second column. The collective doses shown in parentheses in the third column, as well as the noted numbers in the remaining columns, are all based on the data submitted by the number of reactors shown in parentheses. This correction, and others, changed some of the values from those appearing in earlier NUREG documents.

12.5 RADIATION PROTECTION PROGRAM

12.5.1 ORGANIZATION

Radiation Protection, under the direction of the Radiological Services Manager, implements the Radiation Protection Program (RPP).

Health Physics (HP) is audited for compliance to regulations and to ensure that occupational and public radiation exposures are as low as is reasonably achievable (ALARA). Regulatory Guide 1.8 and ANSI 18.1-1971 have been followed in the selection of HP personnel. Energy Northwest pre-employment practices include screening to determine that plant employees are trustworthy, fit, and qualified to perform their duties safely. The experience and qualifications of the personnel responsible for the RPP and for handling and monitoring radioactive materials including special nuclear source and byproduct materials, are described in Sections 12.5 and 13.1. Also, Section 13.1 describes the minimum qualification requirements for specific plant personnel, using the criteria outlined in Regulatory Guide 1.8 and ANSI 18.1-1971.

The Plant General Manager reports to the Vice President, Operations and has the overall responsibility for the RPP. The Plant General Manager is responsible for ensuring that personnel, facilities, and other resources required to implement the RPP are available. This includes ensuring that the authority to implement an effective RPP is delegated through the management structure, ensuring the program receives the active support of all Energy Northwest personnel, and ensuring production goals, maintenance activities, and work schedules do not adversely affect the ability to provide proper radiological controls. In turn, all plant personnel share the responsibility for ensuring personal radiological safety and are required to follow the rules and procedures established for radiological safety. Specific responsibilities regarding ALARA are described in Section 12.1.

The Operations Manager reports to the Plant General Manager and has the responsibility for ensuring the independence of the RPP from plant operational pressures. The Operations Manager provides the Radiological Services Manager the support necessary for the effective implementation of the RPP.

The Radiological Services Manager (RSM) reports to the Plant General Manager and is responsible for the implementation of the RPP. This position meets the requirements of the Radiation Protection Manager (RPM). The RSM has direct access to the Plant General Manager in all matters relating to radiation safety. The RSM meets the qualifications defined in Regulatory Guide 1.8, and provides the experience and expertise necessary to implement the RPP. RPM responsibilities may be assigned to any Radiation Protection management or supervisory position described in this Chapter provided they meet the requirements of Regulatory Guide 1.8.

The Radiological Services Manager supports the safe, reliable, and economic operations of the plant within applicable laws, standards, codes, regulations, and Energy Northwest policies.

The Radiological Support Supervisor reports to the Radiological Services Manager and directs the activities and monitors the performance of the Radiological Planning Group and the Radiological Support Group. The Radiological Planning Group is responsible for performing ALARA reviews and evaluations to support HP Operations. The Radiological Support Group provides technical support for all aspects of the RPP.

The Radiological Operations Supervisor reports to the Radiological Services Manager and directs the activities and monitors the performance of the Health Physics Craft Supervisors and Rad Material Control/Rad Waste Supervisor.

The Health Physics Craft Supervisors report to the Radiological Operations Supervisor and direct the activities and monitor the performance of HP Technicians. Health Physics Craft Supervisors are responsible for ensuring conditions that have the potential for causing exposure to radiation are identified, posted, and controlled.

The Rad-Material Control and Rad-Waste Supervisor reports to the Radiological Operations Supervisor and is responsible for providing immediate supervision, leadership and technical support to the laborers in the areas of equipment and area decontamination, radioactive material control and inventory and anti-contamination laundry; process, package and transport of radioactive waste material, including mixed waste.

Each individual who has unescorted access to Columbia Generating Station restricted areas is responsible for ensuring personnel radiation safety. This includes strict compliance with radiation protection requirements, procedures, and good radiological work practices. In addition, individuals with escort duties are responsible for the radiological safety of visitors.

12.5.2 EQUIPMENT, INSTRUMENTATION, AND FACILITIES

This section describes the equipment, instrumentation, and facilities available for implementation of the RPP and the criteria used for selection of the instrumentation and equipment. The guidance provided by Regulatory Guides 8.3, 8.4, 8.6, and 8.28 has generally been followed with exceptions noted as follows:

a. Regulatory Guide 8.3, “Film Badge Performance Criteria” will be followed if film badges are used in the plant program; however, other dosimeter types, such as optically stimulated luminescent (OSL) dosimeters, are used as the Dosimeter of Legal Record (DLR) for compliance with 10 CFR 20.1501, 20.1502, and 20.2206;

b. Regulatory Guide 8.4 is implemented for the selection of direct-reading pocket dosimeters as defined in Section 2 of ANSI N13.5-1972 except for C.2.b, which states, "The calibration/response test result should not exceed ±10% of an exposure from a source traceable to the National Bureau of Standards."* This is accepted on the minus side, but is considered excessively stringent on the positive side. Since the error on the positive side results in exposure conservatism to the worker, +20% is a more reasonable limit for rejection of a pocket dosimeter. Vendor literature will be accepted as documentation that performance standards specified in Regulatory Guide 8.4 are met. Continued use of direct-reading pocket dosimeters will be based on their ability to perform acceptably under test conditions for temperature and humidity described in approved Health Physics Instructions as follows: ±2% drift per 24 hr at -10°C and any percent humidity; +2% drift per 24 hr at 50°C and 95% humidity; and +20% and -10% of 80% of calibrated full scale;

c. Regulatory Guide 8.6, "Standard Test Procedure for Geiger-Mueller Counters," will be used as applicable. This guide references ANSI N42.3-1969 (ANSI/IEEE Standard 309-1970) for twelve different tests to Geiger-Mueller counters. Energy Northwest will develop tests and procedures to ensure that Geiger-Mueller tube characteristics are appropriate for planned (or intended) applications. These tests may incorporate plateau characteristics, dead time, efficiency, and operating environment;

d. The majority of direct-reading dosimeters at Columbia Generating Station are electronic dosimeters with audible-alarm capabilities. A program for their appropriate use requires that conditions under which they may not perform adequately be discussed, as well as describing performance specifications which are met.

Electronic dosimeters will not be used to circumvent the initial meter survey required prior to work in an area. Radiation Protection will assign electronic dosimeters only when the working environment is suitable for their use. Individuals required to wear an electronic dosimeter will be provided appropriate instructions either in training or at the time of issue to minimize the risk of improper use. Regulatory Guide 8.28 endorses, with one exception, the performance specifications indicated in ANSI N 13.27 "Performance Specifications for Pocket - Sized Alarming Dosimeters/Ratemeters."

* National Institute of Standards and Technology.

Since credit is taken for the audible-alarm capabilities of the electronic dosimeter, the Energy Northwest program for use of audible-alarm dosimeters complies with Regulatory Guide 8.28 with the following exceptions:

1. Requirement: Section C.2.c of the Regulatory Guide requires a source check of audible-alarm dosimeters each day before use.

   Energy Northwest position: Electronic dosimeters equipped with an automatic electronic test to ensure detector function are not subject to the requirement for a source check each day before use.

2. Requirement: Section C.2.b(1) of the Regulatory Guide specifies that alarm dosimeters should not be used when the alarm may not be heard, such as (a) in a high noise environment, (b) when the user has a pronounced hearing loss, (c) when the user is wearing mufflers over the ears, or (d) when the sound from the dosimeter would be muffled by heavy clothing worn over the dosimeter.

   Energy Northwest position: Electronic dosimeters will be allowed for use when their alarm may not be heard except when they are used to fulfill the alarming dosimeter function described in Technical Specification 5.7. When used in accordance with the Technical Specification, alternative methods of warning are required when the audible alarm may not be heard. Alternative methods include, but are not limited to the following: (1) vibrator, (2) ear phone, (3) flashing light clearly visible to the worker.

The program outlines the performance requirements for electronic dosimeters and details the exception to the ANSI N13.27 criteria, while ensuring that reliable electronic dosimetry is used to facilitate exposure control and the ALARA concept.

12.5.2.1 Criteria for Selection

a. Radiation and contamination survey instrumentation: This equipment was selected to cover the wide range requirements extending from picocurie quantity measurements in the laboratory to the thousand R/hour ranges necessary for emergency dose rate determinations. The laboratory instrumentation was chosen to provide capability for the quantitative and qualitative analyses required to identify and measure the radionuclides encountered in a power reactor. The portable instrumentation includes low level detection capabilities for alpha, beta, and gamma contamination and wide ranges of dose rate measuring instruments for beta, gamma, and neutron radiation. The criteria for quantity selection were to provide adequate available counting time for anticipated demand in the laboratory and sufficient portable instruments to cover normal operational and emergency requirements in all areas of the Columbia Generating Station facility;

b. Airborne radioactivity monitoring: The basic criteria for selection of this equipment were to provide a means for determining radioactive airborne effluents released from the plant, and to effectively monitor airborne radioactivity levels within the plant environs. Provisions have been made for continuing response monitoring of noble gases discharged from gaseous release points from the reactor, radwaste, and turbine building, and for continuous sampling of radioiodines and particulates at these same locations. Internal plant air monitoring instrumentation is used within these buildings with readout locally and in the control room;

c. Area radiation monitoring: This system was designed to provide continuous surveillance of radiation levels throughout the plant with local alarm at predetermined levels, local indication, and control room annunciation and recording. Functions of the system include warning of excessive gamma radiation levels in fuel storage and handling areas, detection of unauthorized or inadvertent movement of radioactive materials in the plant, local alarms to warn personnel in an area of a substantial increase in radiation levels, provision for supervisory information in the control room so that correct decisions may be made in the event of a radiation incident, backup to other systems for detection of abnormal migrations of radioactive materials in or from the process streams, and providing a permanent record of gamma radiation levels at selected locations within the various plant buildings; and

d. Personnel monitoring: Personnel dosimetry devices were chosen to provide a record of exposure received by occupationally exposed individuals at the site who are likely to receive, under normal or accidental conditions, exposures greater than 10% of applicable 10 CFR 20 limits.

   Personnel dosimeter badges (DLRs) containing an OSL dosimeter or other acceptable dosimetry provide the primary legal record of exposure received by personnel. Each person requiring monitoring for record is assigned a badge, which is recorded with the wearer's identification. Results from the badge and the period of exposure are recorded on a document kept as a legal Energy Northwest record. Badges used will be capable of recording exposure over a range of at least 40 mrem to greater than 1000 rem.

   Persons being monitored may be required to wear other dosimetry assigned by the Radiation Protection staff, such as direct reading dosimeters, integrating dose meters, extremity badges, and finger rings.

12.5.2.2 Facilities

Radiation Protection facilities at Columbia Generating Station include the following:

a. Personnel decontamination showers and sinks are located in the radwaste building (487 ft level). Temporary change areas are set up as necessary in areas of the plant to localize and prevent the spread of contamination while performing maintenance activities. Small inventories of protective clothing are stored in the emergency relocation centers, operation and radwaste control rooms, and strategic locations throughout the plant;

b. Monitoring equipment for personnel [e.g., friskers and installed personnel monitors (IPMs)] and tools/personal items [friskers and small article monitors (SAMs)] are provided at the radiological access control areas and various areas within the plant to survey for radioactive contamination;

c. Facilities for personnel exposure monitoring and protection, which include:

    1. Internal dosimetry,
    2. Respiratory protection testing;

d. Medical first aid facilities are equipped to provide care for injuries, including those with radioactive contamination involved; and

e. Facilities for equipment and tool decontamination exist in the radwaste, turbine, and reactor buildings. The locations and facilities are

    1. Radwaste building

    The general decontamination area is shown in Figure 12.3-12, approximate column location Q.4-13.6 at the 467 ft 0 in. level. Facilities include curbing, sink, monorail hoist, and drains. At the 487 ft 0 in. level, Figure 12.3-13, column coordinates R.2-14.0, tools and small equipment can be decontaminated in the hot machine shop. Facilities in the hot machine shop include a bench space and drains. Also, there is a personnel (male/female) decontamination station at the 487 ft 0 in. level, column coordinates K.1-15.9. This facility contains sinks, showers, and a decontamination kit.

2. Turbine building

Figure 12.3-5, columns H-9.5, el. 441 ft 0 in. identifies the turbine building decontamination area. Facilities include a monorail, curb, sink, shower, and drains.

3. Reactor building

The head washdown area is shown in Figure 12.3-18 at column coordinates N-5.8 at the 606 ft 10 in. level and contains a curb and drain.

The CRD room area, Figure 12.3-16, columns M-3.4, 501 ft 0 in. elevation contains a sink, monorail, bench, and storage vault.

4. The office of the RPM is located in the service building. Health Physics Craft Supervisors and HP Technicians are located in locations to provide for ready access by other plant workers and an area to generate and process records.

5. A hot machine shop and a hot instrument shop are provided in the radwaste building for work on contaminated equipment under controlled conditions. A HEPA-filtered vacuum system is installed in the hot machine shop to control airborne radioactivity while working on radioactive equipment. Portable HEPA-filtered vacuum systems are also available.

6. A laboratory complex is provided in the radwaste building consisting of a sample room, hot radiochemistry laboratory, and a counting room where radioactive samples will be qualitatively and/or quantitatively analyzed.

f. A protective clothing storage and distribution facility inside the protected area fence, but outside the power block.

Radiation Protection facilities at the Plant Support Facility/Emergency Operations Facility:

The Energy Northwest Plant Support Facility (PSF) is located 0.75 mile southwest of Columbia Generating Station. It is designed and equipped to provide emergency capabilities in support of Columbia Generating Station and for support of Columbia Generating Station during normal plant operations and maintenance. Support facilities important to HP include:

a. Portable radiation monitoring equipment calibration,
b. Radiological training.

The instrument calibration laboratory is located in the extreme northwest corner of the lower level. It contains an irradiation cubicle that is shielded on all sides and above by 2 ft of concrete. The cubicle entrance is protected by a labyrinth and a lockable gate. Larger open sources are stored and used in the cubicle. The shielded cubicle together with administrative controls such as procedures, radiation work permits, and surveys ensure that calibration laboratory operation will not result in radiation areas in surrounding spaces.

Calibrations are performed in accordance with approved procedures and are traceable, either directly or indirectly, to the National Institute of Standards and Technology (NIST). Available sources are listed in Table 12.2-12.

12.5.2.3 Equipment

Radiation Protection equipment, other than instrumentation, is described in the following:

a. Protective clothing and accessories are provided for personnel required to work in contaminated areas. Clothing requirements for a particular task or area are prescribed by Radiation Protection based on the actual or potential conditions. Available clothing includes, but is not limited to:

    1. Coveralls and laboratory coats,
    2. Gloves - rubber and/or cotton,
    3. Head covers,
    4. Foot protection, and
    5. Plastic suits - with or without supplied air.

b. Respiratory protection equipment is provided for personnel when it is not practicable to apply process controls or other engineering controls to control airborne radioactive contamination. The decision to use respiratory protection equipment is based on maintaining the TEDE ALARA. The respiratory protection program is conducted per the requirements of 10 CFR 20.1701, 1702, 1703, and 1704. Exposure is limited to derived air concentrations (DAC) and annual limit on intake (ALI) values specified in Appendix B, Table 1 of 10 CFR 20. Allowance is made for use of respiratory protective equipment, as prescribed in 20.1703, in limiting an individual's intake of airborne radioactive materials. Among the types of equipment used are:

    1. Full face air purifying respirators,
    2. Airline supplied full face masks (pressure demand regulated), and
    3. Self contained breathing apparatus (pressure demand regulated).

c. Air sampling equipment, in addition to the continuous air monitors, includes high and low volume portable air samplers, low volume constant air samplers, and air samplers with a self-contained power source. Collection media (filters) employed are capable of collecting particulate and radioiodine samples; and

d. Emergency equipment and supplies are maintained in lockers at strategic locations within the plant. These lockers are to be used for a rapid initial response and are not intended to provide the resources for a long term recovery operation. Equipment is stored for field team use at the EOF. Four-wheel drive vehicles, automobiles, and survey kits are available for use by the field team. Locations and types of emergency equipment are listed in the Emergency Plan.

Other than emergency supplies, the primary storage areas for radiation protection equipment are the two Radiation Protection control areas located in the service and radwaste buildings. Temporary storage facilities are set up in localized areas as required.

12.5.2.4 Instrumentation

Typical plant portable radiological instrumentation is described in Table 12.5-1. All of this instrumentation is calibrated at least semiannually when in use except the Condenser R-meter which is calibrated annually. Electronic calibrations of instrument components are performed using test equipment traceable to the NIST. Overall calibration of radiation measuring instruments is performed using radioactive standards traceable to a recognized source in a known, reproducible geometry. Calibration of low level radiation detection instruments is done with a pulse generator.

12.5.3 PROCEDURES

Section 12.1.3 described a process that was incorporated into the preparation and revision of plant procedures which provide a positive method of ensuring Radiation Protection input and ALARA consideration into radiation exposure related activities. The intent of this process is to incorporate the general guidance of appropriate regulatory guides plus the previous experience of power reactor radiation protection work into all applicable plant procedures.

12.5.3.1 Personnel Control Procedures

The Plant Procedures Manual contains the administrative procedures for control of access to radiation areas, high radiation areas, and very high radiation areas. This includes control of time spent within these areas by all plant workers. Basically, the procedures limit entry to these areas to time required for necessary operational maintenance and surveillance activities only. The primary tool used to ensure control and to maintain TEDE ALARA at Columbia

Generating Station is the Radiation Work Permit (RWP). All work performed at Columbia Generating Station in radiologically controlled areas is performed in accordance with an RWP, with the exception of specific activities identified in the implementing plant RWP procedure. The RWP provides current data on radiation levels within the area of interest, any restrictions on allowable work time, protective clothing and respiratory protective requirements, information on special tools or equipment needed, special radiation safety and personnel monitoring requirements, and any other special instructions or radiological hold points necessary. A section of the RWP is used to incorporate the criteria given in Regulatory Guides 8.2, 8.8, and 8.10 into each individual task, even though it has already been included in job procedures through the system for ALARA consideration described in Section 12.1.3. All RWPs require approval from Radiation Protection supervision prior to starting work. In addition, all personnel who perform activities covered by the RWP are required to read, understand, and document their understanding as specified by implementing plant procedures. There are two types of RWPs:

a. Specific RWP is issued for the performance of a particular task or function which falls outside the limitations imposed for General RWPs, and

b. General RWP may be issued to cover repetitive (routine) functions in areas where radiological conditions are known and stable.

In addition to the administrative controls used at Columbia Generating Station, certain physical controls are established which restrict entry to radiation areas, high radiation areas, and very high radiation areas. Radiation areas are posted as required by 10 CFR 20, and high radiation areas and very high radiation areas are locked or otherwise controlled as specified by this same regulation and Technical Specifications.

The plant security control system complements both the administrative and physical entry restraints by allowing access only to personnel with authorization to be in specific plant areas.

12.5.3.2 As Low As Is Reasonably Achievable Procedures

The procedures and processes described below are in addition to those described in Sections 12.1.3 and 12.5.3.1.

They have been developed to ensure that occupational radiation exposures are maintained ALARA. A primary goal of the Columbia Generating Station RPP is the control and reduction of individual and collective radiation exposures. This goal is achieved through training and comprehensive job planning and reviews as follows:

a. Training - ALARA training is required by plant procedures to be included in all applicable radiation training courses. The training applies to individuals whose duties require working with radioactive materials, entering radiation areas, directing the work of others in radiologically controlled areas, or planning work and preparing procedures for work in radiologically controlled areas. ALARA training is commensurate with the individual's duties, responsibilities, and radiation exposure potential. Workers who may enter restricted areas are given specific instructions about prenatal exposure risks to the developing embryo and fetus. This instruction includes the information provided by Regulatory Guide 8.13;

b. Job Planning and Reviews - Plant procedures specify that each job, involving exposure to radiation and/or radioactive materials, receives job planning and/or an ALARA review. The extent of the review is determined by an evaluation of the radiological risks involved. The preliminary job planning and review identifies the need for pre-job briefings and/or job planning meetings to coordinate work efforts and to familiarize personnel with the work and exposure reduction techniques. Pre-job planning may include the following:

1. Job history reviews,
2. Determination of radiological conditions,
3. Determination of exposure estimate, and
4. Interface with planners, schedulers, job supervisor, ALARA.

Additional ALARA reviews are performed by the Senior Site ALARA Committee. The Senior Site ALARA Committee has been developed to ensure participation by a range of plant personnel and provide for an appropriate level of management involvement and direction in ALARA issues. The Senior Site ALARA Committee serves as a review and advisory organization to the Plant General Manager on occupational radiation exposure to personnel.

Plant procedures provide requirements for committee membership, responsibilities, authority, and records of meetings and actions. The Senior Site ALARA Committee is responsible for the review of plant and departmental exposure goals and reviewing and assessing the effectiveness of the radiation exposure control program and the ALARA Program. The Senior Site ALARA Committee may create Working Groups to provide dose reduction methods for tasks which have a significant potential for dose reduction.

As part of pre-job review, ALARA job planning meetings are conducted when significant exposure savings or increased contamination control may result. The planning meetings may include the job supervisor, job planner, Radiation Protection supervision, HP technicians, and key workers. These meetings are used to ensure worker familiarity with procedures, work locations, RWP requirements, unusual hazards, and job-specific ALARA techniques to be employed. The use of mock-ups or dry runs may result from these meetings.

In addition to pre-job ALARA reviews, plant procedures have provisions for work-in-progress ALARA reviews and post-job ALARA reviews. These reviews are coordinated by Radiation Protection and may include discussions with individuals who performed the work, HP technicians, engineers, job supervisors, designers, or others as appropriate;

c. Remote handling tools and/or equipment - use of special tools/equipment for remote handling of radioactive equipment is factored into each applicable work activity; and

d. Exposure records are maintained in a manner that will allow Radiation Protection to tabulate and correlate exposure results to identify problem areas with individuals or activities.

Plant procedures are evaluated to determine the need for an ALARA review. An ALARA review is required for new procedures in which the actions take place in a radiologically controlled area or involve handling radioactive material.

An ALARA review is required for procedure revisions which:

a. Cause entry into a radiation area, high radiation area, or high-high radiation area,
b. Cause opening a contaminated or potentially contaminated system,
c. Significantly increase dose rates, or
d. Significantly increase exposure received.

Radiation Protection requirements, prerequisites, precautions, and ALARA considerations are incorporated into these procedures during the procedure review and approval process. In addition, an RWP is issued for those activities having radiological implications. Special activities such as inservice inspection (ISI), outage, and refueling are reviewed by the Senior Site ALARA Committee and Radiation Protection as appropriate. Special precautions, prerequisites, or requirements may be incorporated into the plant procedures based on these reviews.

12.5.3.3 Radiological Survey Procedures

A radiological survey is defined as an evaluation of radiological conditions and potential hazards. When appropriate, such an evaluation includes a physical survey (e.g., direct radiation and/or contamination surveys).

Routine surveys are conducted in various areas throughout the site to identify, monitor, and control sources of radiation and contamination. Routine surveys are performed on a frequency based on a consideration of potential radiological hazards, personnel occupancy and radiological stability. Included in routine surveys are the following daily checks:

- Check the plant area radiation monitoring system, and
- Check inservice portal, air and other continuously operating radiation/contamination monitors.

Abnormal changes in background and abrupt unexplained increases are investigated.

Nonroutine surveys are performed as the need and conditions dictate. The frequency and extent of these surveys should be determined based on historical data, on the conditions and activities taking place in the area, and on ALARA considerations.

Surveys of normally inaccessible, unoccupied areas are performed after each shutdown or prior to entry into these areas. Postings and survey record sheets are updated as conditions dictate.

Instructions relating to radiation surveys are provided in the Energy Northwest Radiation Protection Procedures.

12.5.3.4 Procedures for Radioactive Contamination Control

This section describes the bases and methods used for the monitoring and control of radioactive contamination on personnel, material, and surfaces.

a. Bases: The methods used for the monitoring and control of Columbia Generating Station licensed radioactive material are based on 10 CFR 20.1101(b), 20.1501, NRC Circular 81-07, and industry-accepted practices. Tools, equipment, and other items with detected quantities of licensed radioactive materials will not be unconditionally released. Detection levels will be based on the ALARA principle.

b. Methods: Personnel and materials will be surveyed in accordance with 10 CFR 20.1501. When physical surveys are performed, they will be conducted using industry-accepted, calibrated, detection instruments and with techniques that are appropriate to the level of risk. Other sections of Chapter 12 cover the selection criteria for contamination survey instruments, contamination monitoring facilities, protective clothing, contamination and radiation controls established through the RWP program, contamination monitoring surveys, ALARA with respect to contamination, and control of airborne radioactive material.

Instructions for monitoring and control of contamination are maintained in the Radiation Protection Procedures.

12.5.3.5 Procedures for Control of Airborne Radioactivity

Evaluation of airborne radioactivity concentrations is done procedurally by several methods. Routine airborne surveys consist of observing the continuous air monitors located in various areas of the plant and also the effluent monitors. These observations are supplemented by grab samples taken on a routine basis and by laboratory analysis of selected particulate and charcoal filters used on the continuous monitors. Special airborne surveys are made with portable samplers when a continuous air monitor indicates increases in airborne radioactivity or to evaluate conditions in a specific area or on a specific job.

The portable air sampling equipment consists of both high and low volume collectors with appropriate media for collecting particulates and radioiodines. These samplers are used for both spot evaluations by collection of grab samples and longer term evaluations by use of low volume samplers to collect over the period of a specific job or activity. Laboratory analysis is made of air samples for gross radioactivity and, where warranted, for specific isotope identification and quantification to determine and record airborne concentrations.

Selected numbers of the routine air samples collected are analyzed for specific isotope content to ensure that the DAC levels are not being approached. Special samples are taken for this purpose whenever unexplained increases occur on continuous air monitors or when gross activity levels indicate there is a potential for exceeding the value specified in 10 CFR 20, Appendix B, Table 1, Column 3 of any isotope present in the mixture.

Airborne radioactive iodine monitoring includes integrated sample collection and laboratory analysis plus portable sampling and analysis. Portable and stationary sampling encompasses iodine collection on charcoal and/or silver zeolite cartridges of nominal dimension of 2-in. disc diameter by 1-in. thickness at calibrated flow rates. Duration of sampling is determined by the anticipated ambient concentration levels whereas a nominal sampling period in excess of 5 minutes is selected to minimize sampling errors. Where gross noble gas concentrations exist, the sample cartridge may be purged in the laboratory with clean filtered air to minimize noble gas interferences. The cartridge will be sealed in a clean plastic bag and taken to the analytical laboratory counting room for analysis.

Areas are barricaded and posted as airborne radioactivity areas whenever average concentrations in that area exceed 0.3 DAC of the values specified in 10 CFR 20, Appendix B to Parts 20.1001-20.2401, Table 1, Column 3. The use of respiratory protection equipment is evaluated when a significant potential for an airborne hazard exists, or when entering an area of unmonitored, unknown airborne contamination.

Various methods for control and reduction of airborne activity are incorporated into Energy Northwest Radiation Protection Procedures, which include proper use of the ventilation system, use of specially designed equipment to collect radioactive airborne contaminants, methods for reducing and containing contamination to prevent it becoming airborne, and methods for cleanup of primary water prior to opening this system.

The respiratory protection program is designed to meet the requirements of 10 CFR 20.1701, 1702, 1703, and 1704. Procedures for fitting, training, maintenance, and testing of the respiratory protection equipment are included. All equipment is required to have appropriate National Institute for Occupational Health and Safety (NIOSH)/Mine Safety and Health Administration (MSHA) approval if available. Unless the requirements are met, the protection factors are not used. Unapproved equipment may be used in some instances where reduction of intake of radioactive material will result, but no protection factor is taken for its use. An example of this is use of charcoal cartridges in atmospheres where radioiodines are present to reduce the inhalation of these materials.

12.5.3.6 Radioactive Material Control Including Special Nuclear Materials (SNM)

Columbia Generating Station has implemented a program to ensure safe radioactive material control which include:

a. Procedures and training for receiving and shipping radioactive materials in accordance with 10 CFR 20.1906,

b. Procedures and training for storing licensed materials in accordance with 10 CFR 20.1801 and 1802,

c. Procedures and training for shielding, handling, and inventory control of sealed and unsealed radioactive sources and SNM,

d. Procedures and training for posting and/or labeling radioactive materials in accordance with 10 CFR 20 requirements,

e. Procedures and training for leak testing sealed radioactive sources in accordance with Technical Specifications, and

f. Procedures and training for disposal of all licensed radioactive materials in accordance with 10 CFR 20, 10 CFR 30, 10 CFR 40, 10 CFR 61, or 10 CFR 70.

g. Procedures and training for activities associated with dry storage cask loading and unloading of spent fuel and the operation of the Independent Spent Fuel Storage Installation for storage of spent fuel in accordance with 10 CFR 72.

Inherent in the above mentioned procedures is direction for handling liquid standard solutions used for calibration of plant instrumentation which include ventilation control, shielding, waste collection, contamination control, and monitoring.

Plant procedures assign the responsibility for control and monitoring of sealed and unsealed sources and byproduct materials to the RPM. The Vice President Engineering is responsible for overall implementation of control of SNM. This is accomplished through a Nuclear Material Manager who is appointed in writing by the Vice President Engineering. The Chemistry Technical Supervisor is responsible for minimization of radioactive waste and the preparation, offsite shipment, and disposal of radioactive materials and radwaste. Monitoring during handling of nuclear materials is provided by Radiation Protection, as appropriate.

12.5.3.7 Personnel Dosimetry Procedures

Section 12.5.2 describes the monitoring devices used to provide the primary legal records of exposure incurred by personnel and additional equipment used to backup and supplement this data. Records of radiation exposure are maintained for each individual for whom personnel monitoring is required by 10 CFR 20.1502. Reports of required monitoring are documented on NRC Form 5 or electronic media containing all the information required by NRC Form 5. Energy Northwest provides these individual radiation exposure records pursuant to the provisions of 10 CFR 19.13.

For monitored individuals, a determination of prior occupational dose is made per the requirements of 10 CFR 20.2104. This includes the dose received during the current year at Columbia Generating Station and other nuclear facilities. This exposure history is documented on NRC Form 4 or equivalent.

All individuals who are monitored for external radiation exposure are monitored for internally deposited radioactivity as follows:

a. Initial, performed prior to the individual entering any radiologically controlled area. Monitoring may be either quantitative (whole body count) or qualitative (passive monitoring).

b. When a worker formally declares pregnancy, a whole body count is performed.

c. At termination of employment at Columbia Generating Station, if the individual has been monitored for external radiation exposure. Monitoring may be either quantitative (whole body count) or qualitative (passive monitoring).

d. Whenever an individual causes an alarm of the passive whole body contamination monitors (portal monitors) and internal deposition is suspected, a quantitative bioassay (whole body count) is performed.

e. Special bioassays as determined by the RPM.

Energy Northwest monitors all adult workers who are likely to exceed 10% of the 10 CFR 20 annual occupational radiation exposure limits for adults. Radiation exposure monitoring for minors (individuals less than 18 years of age) is required if they are likely to exceed 0.1 rem deep dose equivalent in a year. Monitoring for declared pregnant women is required if they are likely to exceed 0.1 rem deep dose equivalent during the entire pregnancy. Monitoring is not required for visitors who enter a restricted area, since they are not likely to exceed 10% of the annual limit. However, confirmatory monitoring of visitors may be performed if directed by Radiation Protection supervision. The determination of whether an individual is likely to exceed 10% of the 10 CFR 20 limit, and thus require monitoring, is based on a prospective evaluation. An evaluation is not required for each individual, but is based on employees with similar job functions.

For internal exposure, monitoring is required if an adult worker is likely to receive, in 1 year, an intake in excess of 10% of the applicable 10 CFR 20 annual limit. The need for internal exposure monitoring of individuals is based on a prospective evaluation which will be updated whenever there is an indication that there has been significant fuel failure.

Since ^{90}Sr and ^{3}H are not measurable by whole body counting, in-vitro bioassay (urinalysis) will be performed when the plant radiation surveillance program indicates a potential need. All results obtained from in-vivo and in-vitro bioassay will be evaluated and become part of the individual's record, as appropriate.

Energy Northwest complies with the adult occupational dose limits identified in 10 CFR 20.1201. An individual is allowed to exceed these 10 CFR 20 exposure limits only in exceptional situations where the dose received is in accordance with the conditions of a planned special exposure, as specified in 10 CFR 20.1206. Records of planned special exposures are maintained and retained per the requirements of 10 CFR 20.2105. Written reports of planned special exposures are submitted to the NRC per the requirements of 10 CFR 20.2204.

In addition to the 10 CFR 20 dose limits, Energy Northwest uses administrative exposure hold points to maintain exposures ALARA. Plant procedures allow an individual to exceed an administrative hold point but, only if a prior approved dose extension is obtained.

Procedurally, DLR badges are processed for radiation workers semiannually at a minimum but may receive interim processing if an abnormal exposure is suspected. Pocket dosimeters and other auxiliary monitoring devices are used to maintain an estimate of an individual's dose during the interim period between processing of DLRs. The use of auxiliary monitoring devices as a permanent record of an individual's dose is restricted to times when DLRs are lost or damaged or give a false result. When a large discrepancy exists between the two devices, it must be established that the DLR is in error before the auxiliary monitoring device result is assigned as the permanent record.

Plant supervisors are notified of their assigned worker's exposure status and are responsible for maintaining these and their own exposure to ALARA and within specified limits.

Personnel dosimeters, that require processing to determine the radiation doses, are processed and evaluated in accordance with the requirements of the National Voluntary Laboratory Accreditation Program (NVLAP).

12.5.3.8 Radiation Protection Surveillance Program

The practices incorporated into the overall structure to ensure that the RPP is maintained at a high level and upgraded to meet new requirements and problems are the following:

a. Section 12.1.1 describes the organization structured to provide assurance that the ALARA policy is effective. It is also pointed out in this section that the plant RPP has several levels of review from a performance standpoint;

b. Section 12.1.3 describes the process for review of plant procedures for ALARA consideration;

c. The RWP program and other records previously described provide a valuable source of information and are used to determine where the occupational radiation exposures are occurring and as a means of review for possible methods of exposure reduction;

d. The Radiological Services Manager and his staff work on an individual and group basis with other plant organizations to determine what their principal sources of exposure are and to look for methods of reducing these exposures;

e. Procedures provide for routine maintenance, calibration, and testing of all radiation instrumentation and equipment. New equipment will be added as necessary for replacement and to supplement that existing. Written procedures are provided for use of equipment where required;

f. Plant facilities are routinely reviewed for possible improvements from a radiation protection standpoint. Section 12.1.3 describes several changes that have been incorporated into plant design for this purpose. Other considerations are additional shielding where practicable, improved ventilation control, additional equipment, and increased physical restriction;

g. The routine and special surveys previously described point out levels of radioactive contamination in plant areas. The Columbia Generating Station staff is committed to maintaining a clean plant and considers it routine procedure to reduce levels of contamination whenever such action will not result in an increase of occupational radiation exposure to personnel;

h. One aspect that is considered important and used in implementing the RPP is the incorporation of previous reactor and power reactor experience in this area. Previously successful methods, procedures, and equipment are used whenever possible; and

i. Training of all personnel who work in the plant in radiation safety practices is mandatory and given a high priority by Energy Northwest and Columbia Generating Station Management. The Training Manager, in conjunction with the Radiological Services Manager, is responsible for development of all training programs, including radiation safety indoctrination.

   Radiation Protection assists in this training by providing instructors for some phases. The degree of training provided each plant worker is dependent on his function and degree of responsibility; however, all radiation workers in the plant are provided training considered necessary or required for their position. The training programs provided are designed to meet the requirements of 10 CFR 19.12 and the guidance of Regulatory Guides 1.8, 8.8, 8.10, 8.27, and 8.29. Clarifications, elaborations, and exceptions in using the above mentioned regulatory guides are located in the Energy Northwest Procedures.

Table 12.5-1

Health Physics Instrumentation

Type	Number Available	Radiation Detected	Sensitivity Range
Ion chamber dose rate survey meter	9	Beta, gamma	0-5E4 mR/hr (gamma) 0-2.E4 mrad/hr (beta) cfx 5R/hr
High range ion chamber dose rate survey meter	2	Gamma	0-1.999E7 mR/hr
Telescoping dose rate survey meter	3	Gamma	0-1.0E3 R/hr
Neutron dose rate survey meter	2	Neutron	0.1-5.0E3 mrem/hr
Contamination survey meter with end window or pancake GM probe	20	Beta, gamma	0-5.0E4 cpm or 0-5.0E5 cpm
Contamination survey meter with scintillation detector	2	Alpha	0-5.0E5 cpm
			0
Condenser R-meter	1	Gamma	0-100 R
Direct reading pocket dosimeters	300	Gamma	0-999 rem
Direct reading pocket dosimeters	200	Gamma	Various ranges 0-500 mR