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FROM: VICTOR M. McCREE

SUBJECT: CHAPTER 123 UPDATE NOTE #6

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ADVANCED BOILING WATER REACTOR PROGRAM
San Jose, California

December 5, 1991

To: Roger Pedersen

Subject: Chapter 12 Update Note # 6

From: H.A. Careway via Jack Fox

This is a short unofficial update note on my progress on ABWR Chapter 12. Work on Chapter 12 is complete except updating of the figures in Section 12.3. The completed Table 12.2-5 is attached along with section 12.4. This then is my last update note until I get into redoing the figures.

Table 12.2-5 Radiation Sources

a. Radiation Sources

Source Table	For	Drawing	Location	Approximate Geometry
12.2-6	RHR Heat Exchanger	12.3-1	(R1,RF) (R6,RA) (R6,RF)	Rt Cylndr (r=0.9m,l=7m)
12.2-8	RCIC Turbine	12.3-1	(R6,RC)	Rt Cylndr (r=0.5m,l=0.7m)
12.2-9	CUW Filter Demineralizer	12.3-3	(R2,RB)	2 Tanks, Rt Cylndr (r=0.6m,l=3.3m)
12.2-10	RWCU Regen Heat Exchanger	12.3-2	(R1,RC)	Rt Cylndr (r=0.4m,l=6.8m)
12.2-11	RWCU Non-Regen Heat Exchanger	12.3-1	(R1,RC)	Rt Cylndr (r=0.4m,l=5.5m)
12.2-13.1	LCW Collector Tank	12.3-37	ITEM 7	2 Tanks, Rt Cylndr (r=4.m,l=9.4m)
12.2-13.2	LCW Filter	12.3-39	ITEM 12	Rt Cylndr (r=0.5m,l=2.5m)
12.2-13.3	LCW Demineralizer	12.3-39	ITEM 11	Rt Cylndr (r=0.6m,l=2.8m)
12.2-13.4	LCW Sample Tank	12.3-38	ITEM 8	2 Tanks, Rt Cylndr (r=4.m,l=9.4m)
12.2-13.5	HCW Collector Tank	12.3-37	ITEM 13	Rt Cylndr (r=2.2m,l=4.3m)
12.2-13.6	HCW Demineralizer	12.3-39	ITEM 20	Rt Cylndr (r=0.6m,l=2.8m)
12.2-14	Offgas	12.3-50	(TF,T2)	Tank 1, Rt Cylndr (r=0.6m,l=7.6m) Tanks 2-9, Rt Cylndr (r=1.1m,l=7.6m)
12.2-29	Steam Jet Air Ejector	12.3-51	(TF,T2)	Rt Cylndr (r=0.15m,l=4.6m) Rt Cylndr (r=0.76m,l=6.1m) Rt Cylndr (r=0.2m,l=4.6m)
12.2-14	Offgas Recombiner	12.3-51	(TF,T2)	Rt Cylndr (r=1.4m,l=7m)
12.2-15.1	CUW Backwash Receiving Tank	12.3-1	(R2,RB)	Rt Cylndr (r=2.2m,l=5.7m)
12.2-15.2	CF Backwash Receiving Tank	12.3-49	(TD,T4)	Rt Cylndr (r=2.2m,l=5.7m)
12.2-15.3	Phase Separator	12.3-38	ITEM 30	2 Tanks, Rt Cylndr (r=2.4m,l=6.0m)
12.2-15.4	Spent Resin Storage Tank	12.3-38	ITEM 31	Rt Cylndr (r=2.0m,l=5.7m)
12.2-15.5	Concentrated Waste Tank	12.3-37	ITEM 35	Rt Cylndr (r=1.5m,l=4.4m)
12.2-15.6	Sol Dryer Feed Tank	12.3-41	ITEM 39	Rt Cylndr (r=1.6m,l=3.2m)
12.2-15.7	Sol Dryer (outlet)	12.3-39	ITEM 55	Rt Cylndr (r=0.2m,l=3.2m)
12.2-15.8	Sol Peletizer	12.3-38	ITEM 58	Rt Cylndr (r=0.4m,l=2.5m)
12.2-15.9	Sol Mist Separator (steam)	12.3-39	ITEM 56	Rt Cylndr (r=0.1m,l=2.8m)
12.2-15.10	Sol Condenser	12.3-40	ITEM 57	Rt Cylndr (r=0.2m,l=1.4m)
12.2-15.11	Sol Drum	12.3-39	(2,D)	Rt Cylndr (r=0.3m,l=0.8m) Box (1.5mx1.5mx1m)
12.2-16	FPC Filter Demineralizer	12.3-3	(R2,RB)	Rt Cylndr (r=0.7m,l=3.4m)
12.2-17	Supp Pool Cleanup System[c]	12.3-3	(R2,RA)	Rt Cylndr (r=0.7m,l=3.4m)
12.2-18	Control Rod Drive System[a]	12.3-2	(R4,RF)	Distributed Source
12.2-24	Transverse Incore Probe	12.3-2	(R4,RB)	Distributed Source
12.2-25	Reactor Internal Pumps[b]	12.3-2	(RF,R1)	Distributed Source
12.2-25	RIP Heat Exchanger	1.2-3b	El 3000	Rt Cylndr (r=0.322m,l=2.9m)
12.2-26	Turbine Mositure Sep/Reheater	12.3-52	(T6,TE)	Rt Cylndr (r=1.8m,l=31.m)
12.2-27	Turbine Condenser	12.3-53	(TD,TG)	Distributed Source
12.2-?8	Condenser Filter/Demineralizer			
	Filter	12.3-51	(TC-T2)	3 Tanks, Rt Cylndr (r=1.4m,l=6.1m)
	Demineralizer	12.3-51	(TC,T3)	6 Tanks, Rt Cylndr(r=1.7m,l=5.1m)
Applicant	Spent Fuel Storage	12.3-6	(R4,RF)	See Drawings
12.?-?0	SGTS Filter Train	12.3-7	(R2,RB)	surface, (3.66m x 2.54m)[d]

Notes

[a] Maintenance Facility
[b] Maintenance Facility, see Figure 1.2-3B Elevation 3000 for drywell location
[c] Suppression pool clean up F/D uses second of Fuel Pool F/D
[d] Surface area of HEPA and charcoal filter

B. Source Geometry

Component	Assumed Shielding Source Geometry
RHR Heat Exchanger	Homogenous source over volume of heat exchanger
RCIC Turbine	Homogenous source over volume of turbine
CUW Filter Demineralizer	80% of source in first 15cm, remainder dispersed over volume.
RWCU Regen Heat Exchanger	Homogenous source over volume of exchanger
RWCU Non-Regen Heat Exchanger	Homogenous Source over volume of exchanger
LCW Collector Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
LCW Filter	Homogenous source over volume of filter
LCW Demineralizer	80% of source in first 15cm, rest evenly dispersed over volume
LCW Sample Tank	Homogenous source over volume of tank
HCW Collector Tank	Homogenous source over volume of tank
HCW Demineralizer	80% of source in first 15cm, rest evenly dispersed over volume
Offgas	90% of source in first tank in first (upper) 30 cm, rest evenenly dispersed. Remaining tanks, homogenous source over tank volume.
Steam Jet Air Ejector[b]	Homogenous source over volume of ejector
Offgas Recombiner[b]	Homogenous source over subcomponent, see Figure 12.2-14[a]
CUW Backwash Receiving Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
CF Backwash Receiving Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
Phase Separator	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Spent Resin Storage Tank	Homogenous source over volume of tank
Concentrated Waste Tank	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Sol Dryer Feed Tank	Source evenly dispersed over volume
Sol Dryer (outlet)	Source evenly dispersed over volume
Sol Peletizer	Source evenly dispersed over volume
Sol Mist Separator (steam)	Source evenly dispersed over volume
Sol Condenser	Source evenly dispersed over volume
Sol Drum	Source evenly dispersed over volume
FPC Filter Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Suppression Pool Cleanup System	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Control Rod Drive System	Exposure dependent, assume evenly dispered over length of blade
Transverse Incore Probe	Point or line geometry, see Table 12.2-24
Reactor Internal Pumps	Cylindrical source coupled to water bearing components
RIP Heat Exchanger	Homogenous source over volume of exchanger
Turbine Mositure Sep/Reheater	Homogenous source over volume of component
Turbine Condenser	Homogenous source over volume of condenser
Condenser Filter/Demineralizer	
Filter	Source evenly dispersed over volume of filter
Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Spent Fuel Storage	Applicant
SGTS Filter Train	90% Particulates on HEPA filter, remaining on charcoal filter

Notes

[a]See Offgas Recombiner Description, Subsection 11.3, use inventory for preheater, recombiner, condenser and cooler for recombiner inventory for shielding applications.
[b]Radiation levels in SJAE and Recombiner highly dependent upon power level. Actual measurements on SJAE condenser contact dose rate are 20Rads/hr at 100% power and less than 5mRad/hr at 20% power.

C. Shielding Geometry in meters

Component	Room Dimensions			Wall Thickness in meters[e]					
	Length	Width	Height	East	West	North	South	Floor	Ceiling
RHR Heat Exchanger	12.6	5.6	5.6	0.8	0.6	0.6	0.6	Ground	0.8
RCIC Turbine	14.6	7.8	5.6	0.8	2	0.6	0.6	Ground	0.8
CUW Filter Demineralizer	2.8	3	7.4	0.8	1	0.8	1	0.5	Hatch
RWCU Regen Heat Exchanger	7.7	3.6	6	1.4	1.4	1	1.4[a]	0.8	0.5
RWCU Non-Regen Heat Exchanger	7.4	4.4	5.6	1	1	1	1[a]	Ground	0.8
LCW Collector Tank	19	1	13	1.2	0.8	0.8	1.2	Ground	0.8
LCW Filter	16.4	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
LCW Demineralizer[b]	19.6	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
LCW Sample Tank	19	10	13	1.2	0.8	1.2	0.8	Ground	0.8
HCW Collector Tank	9	11.2	5.4	0.8	0.8	0.8	1.2	Ground	0.8
HCW Demineralizer[b]	19.6	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
Offgas	9.1	11	16	1	1	1	1	2.5	1
Steam Jet Air Ejector and Recombiner Room	9.1	14.2	7	1	1	1	1	1	1
CUW Backwash Receiving Tank	6.6	7.4	5.6	1	0.8	0.8	1	Ground	0.8
CF Backwash Receiving Tank	5	5	25	1	1	1	1	2.5	Hatch
Phase Separator	16	8.4	4.6	0.8	0.8	0.8	1.2	0.8	0.8
Spent Resin Storage Tank	6.4	6.4	4.6	0.8	0.8	0.8	0.8	0.8	0.8
Concentrated Waste Tank	4.6	5	5.4	0.8	0.8	1.2	0.8	Ground	0.8
Sol Dryer Feed Tank	9.4	7.2	6.2	0.8	0.8	0.8	0.8	0.8	0.8
Sol Dryer (outlet)[c]	9.2	5.2	8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Peletizer	9.2	5.2	6.8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Mist Separator (steam)[c]	[illegible] 2	5.2	8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Condenser	[illegible]	7.2	6.2	0.8	0.8	0.8	0.8	0.8	0.8
Sol Drum	3.2	3	8	0.8	0.8	0.8	0.8	0.8	0.8
FPC Filter Demineralizer	3.2	3.2	7.4	0.8	1	0.8	0.8	0.5	Hatch
Suppression Pool Cleanup Sys	3.2	3.2	7.4	0.5	0.8	0.8	0.8	0.5	Hatch
Control Rod Drive System[f]	7.3	33.4	5.8	0.6	0.6	0.6	0.6	0.8	0.6
Transverse Incore Probe	4	7.3	2.7	1	1	1	1	Mezz	0.6
Reactor Internal Pumps[f]	8.2	8.5	5.8	0.6	0.6	0.6	0.6	0.8	0.6
RIP Heat Exchanger	Primary Containment								
Turbine Moisture Sep/Reheater	12.4	47.6	8.5	1	1	1	1	1	1
Turbine Condenser	14.2	36	25	3.5	2.5	1	1	2.5	Turbine
Condenser Filter	5	21.1	8	2.5[a]	1	1	1	1	Hatch
Condenser Demineralizer	9.8	17.3	9	1	1	1	1.6	1	1
Spent Fuel Storage	9.4	14	4.1	2	2	2	2	2	7.4[d]
SGTS Filter Train	14.4	5	8.2	0.2	0.5	0.2	0.2	2	0.6

Notes

[a] Moveable Wall
[b] LCW and HCW Demineralizer share same room
[c] Solid dryer and Mist Separator share same room
[d] 7.4 meter water depth above fuel elements
[e] North refers to plant 0 degree orientation, east = 90 degrees
[f] Maintenance Facility

D. Pipe Chase Detail

Pipe Space (PS)	Level	Location	System	Number Pipes	Size[a]	Source[b]	Shield Wall Thickness in meters East	West	North	South
RHR(A)	1F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
	B1F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
			RCIC	1	356x333	SP	0.6	PC	0.6	0.6
	B2F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
			RCIC	1	356X333	SP	0.6	PC	0.6	0.6
	B3F	(RC,RA)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.5	PC	0.6	0.6
			RCIC	1	356X333	SP	0.6	PC	0.6	0.6
RHR(B)	1F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B1F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B2F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B3F	(RE,R2)	RHR	1	273x237	RC	PC	0.6	0.5	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
RHR(C)	1F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B1F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B2F	(RE,R6)	RHR	1	273x2[illegible]7	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B3F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	[illegible]	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
FPC/CUW	2F	(RB,R3)	FPC	2	273x255	1% RC	1.2	1.2	1.2	1.2
	1F	(RB,R3)	FPC	2	273x255	1% RC	1.2	1.2	1.2	1.2
			CUW	1	219x189	RC	1.6	1.2	1.2	1.2
	B1F	(RB,R3)	FPC	2	273x255	1% RC	1.2	1.2	1.2	1.2
			CUW	1	219x189	RC	1.6	1.2	1.2	1.2
	B3F	(RB,R2)	CUW	2	168x140	RC	0.6	0.6	0.8	0.8
MSL/FDW	1F	(RB,R4)	MSL	4	711x640	RS	1.6	1.6	1.6	1.6
			FDW	4	550x480	10% RS[c]	1.6	1.6	1.6	1.6
SPCU	B2F	(RC,R2)	SPCU	1	219x203	SP	PC	0.8	0.8	0.8

Notes

[a]Pipe size given as outside diamter in millimeters and inside diameter in millimeters.
[b]Source is defined by RC= reactor coolant water, see Tables 11.2-2 through 11.2-5. RS is reactor steam, see Tables 11.2-1 and 4. SP=Suppression pool water = 10% RC (normal operations), Reg Guide 1.7 (LOCA conditions).
[c]No N-16 or noble gases in feedwater.

Values referred to as typical for BWR operations are taken from references 1 through 4 which are a compendium of maintenance and work tasks for BWR-6, GESSAR.

12.4.1 Drywell Dose

The following provides the basis by which the drywell dose estimates for occupational exposure were made.

(1) The Main Steam Isolation Valves are located in the upper drywell area (4 valves) and in the reactor building outboard of the primary containment isolation wall (4 valves). These valves require periodic testing and maintenance to insure proper action and leak tightness. Typical values for BWR's for maintenance of these valves is 4,000 hours of drywell and 5,000 hours of reactor building work in effective radiation fields of 13.5 mRem/hr and 3.6 mRem/hr respectively. The ABWR design incorporates three specific features to reduce occupational exposure in the MSIV maintenance area: (1) improved water chemistry with lower overall contamination rates, (2) improved maintenance procedures with some procedures automated, and (3) reduced radiation fields, primarily due to the absence of the recirculation piping. Each area is discussed below.

Beginning in the early 1980's the BWR Owner's Group began an extensive study of the causes for failure of MSIV's to meet the technical leakage specification limits and extensive person-hours required to maintain these valves. As a result of these studies, the ABWR will use the latest technology for valve maintenance including mechanical aids for valve disassembly and assembly, automated lapping devices, and slightly relaxed leakage specifications to delete unnecessary maintenance. As a result of these aids, it is estimated that overall maintenance hours will be reduced by 50-60 percent.

Early studies on dose rates during MSIV maintenance showed increases in dose rate directly proportional to recirculation line activity. The ABWR has deleted the recirculation lines entirely thereby removing the singly most significant source of radiation in the drywell. The second most significant dose for MSIV operations will be the deposited and suspended activity in the feedwater lines. The deposited activity in the feedwater lines is expected to be lower than typical BWRs owing to an enhanced condensate system with full clean up of all condensate water, a 2% reactor water clean up system, and titanium condenser tubes. Additionally, the ABWR is designed to limit the use of cobalt bearing materials on moving components which have historically been identified as major sources of in water contamination. Overall, the feedwater line radiation is expected to be a factor of two lower than current BWRs. Because of these factors, it is expected that the effective dose rate in the drywell will be 2mRem/hr and 1.5mRem/hr in the steam tunnel outboard of the primary containment.

(2) Drywell valve and pump maintenance other than the MSIVs consists primarily of maintaining the Safety Relief Valves (SRVs) which for the most part consist of minor maintenance or removal of valves to a maintenance facility. Overall typical values for a BWR for these tasks are 1,450 person-hours per year in an effective radiation field of 17mRem/hr. In the ABWR, the primary source of radiation exposure, the recirculation lines and pumps, have been removed. Overall the reduction in drywell dose level is for these types of maintenance is expected to be a factor of two or 9mRem/hr. Overhead tracks and in place removal equipment is provided in the ABWR for an estimated person-power reduction to 1,150 person-hour per year broken down into 200 person-hours for 18 SRV maintenance at 6mRem/hr, 200 person-hours per year to pull and replace 3 RIPs with one heat exchanger at 25mRem/hr, and the remainder on miscellaneous valves at 5mRem/hr.

(3) Control Rod Drive maintenance is significantly reduced in the ABWR with the introduction of Fine Motion Control Rod Drives (FMCRD). Based upon European experience, two FMCRDs will be replaced and repaired per outage along with twenty motors. Estimated work will consist of 64 person-hours under vessel preparation, 40 person-hours FMCRD removal and reinstallation, 200 person hours motor removal and installation, and 64 person-hours cleanup. Typical under vessel effective dose rates are 17mRem/hr but because of the removal of the recirculation pumps and lines has been reduced to 8mRem/hr.

(4) The LPRM/TIP system assumes the servicing of two sensors per year and is based upon a total of 200 person-hours per year at an effective dose rate of 60mRem/hr which is typical for BWR operations.

(5) Inservice Inspection consists of primarily NDE examination of vessel and piping systems and welds. Typical BWR values are 2400 person-hours per year at 12mRem/hr effective exposure rate. ABWR inservice inspection is estimated based upon the following:

Elimination of recirculation lines and pumps with the following savings:

Elimination of 14 nozzle inspections at 2 per year, saving 360 person hours

Elimination of shield penetration and shield plug removal saving 240 person hours per year

Reduction on weld inspection on recirculation lines estimated at 240 person hour per year

Reduction in drywell dose by 50% with the provision that the feedwater line dose is more than half the recirculation line dose and general drywell dose level and therefore removal of recirculation line inspection is estimated to be weighted at twice the general drywell dose rate.

Overall it is estimated that by use of automated turtles for inspection person-hour expended in ISI will be reduced by a factor of two.

The ABWR uses a forged ring pressure vessel in comparison to older plate welded vessels reducing the total vessel weld length inspection by 30% and the total weld inspection by 10%.

The ABWR design incorporates specific access into inspection areas past insulation areas with an estimated savings of 120 person-hours.

Overall person-hours reduction is 1,200 person-hours at approximately half the typical effective dose rate or 6 mRem/hr.

(6) Other drywell work includes items such as minor valve maintenance, instrumentation work, and all other drywell work. Typical BWR work in this area estimates 5,500 person-hours per year at 17 mRem/hr. Overall reduction in this effort due to ABWR design improvements are:

Significant savings in total hours are estimated due to removal of the recirculation lines with miscellaneous recirculation line work such as line snubbers, fewer drywell cooling units, and less assembly/disassembly work on insulation due to the use of automated units. Overall it is estimated that 2,000 person hours savings can be made.

Overall reduction in the dryw... removal results in the reduction of the overall upper drywell dose rate to 3 mRem/hr a... ...ver drywell dose rate to 6 mRem/hr since the components involved such as drywell coolers typically do not carry radioactive inventory. Assuming that of the remaining 3,500 person-hour, 2,000 is upper drywell work and 1,500 is lower drywell work at their respective effective dose rates.

12.4.2 Reactor Building Dose

The following provides the basis by which the reactor building dose estimates for occupational exposure were made.

(1) Vessel access and reassembly typically requires 4500 person-hours of work at an effective dose rate of 3 mr/hr. The ABWR work will involve the use of an stud tensioner for a 96 bolt top head. The projected time to remove 96 bolts with this equipment is between 600 to 1200 person-hours. Due to the larger ABWR vessel and expected reduced water contamination with the improved clean up system, the estimated projected effective dose rate is 2 mRem/hr.

(2) ABWR refuelling is accomplished via an automated refuelling bridge. All operations for refuelling are accomplished from an enclosed automation center off the refuelling floor. Time for refuelling is reduced from a typical 4,400 person-hours down to 2,000 person and from an effective dose rate of 2.5 mRem/hr to less than 0.6mRem/hr.

(3) RHR/RWCU maintenance work consists of inspections for two pumps per year in each system. In the RHR system this consumes 150 person-hours per year at an effective dose rate of 40mRem/hr. In the RWCU system this typically uses 1400 person-hours per year at an effective dose rate of 14mRem/hr. ABWR will used canned pumps for both system with an estimated reduction in maintenance to 100 person-hours per pump. With improved water chemistry and overall reductions in reactor water concentrations due to the two percent cleanup system the effective dose rate is estimated at two-thirds the typical value for these system.

(4) FMCRD rebuilding estimates are taken from similar work done in Europe since no significant U.S. data exists to date. Two drives will be rebuilt at an effective dose rate of 5 mRem/hr and 30-60 hours per drive.

(5) Instrumentation work typically requires 1,000 person-hours of work per year at an effective dose rate of 5.0 mRem/hr. ABWR should take about the same effort in instrumentation, however because of the increased emphasis and improved water chemistry systems, should reduce the effective dose rate to two-thirds the typical value or 3.4mRem/hr.

(6) All other work in the reactor building typically takes 7,400 person-hours per year at an effective dose rate of 2.8mRem/hr. This work includes all valve work, RIP rebuild work, minor maintenance, and CRD hydraulic line work. The major task in this area is the hydraulic control units which require 5,000 person-hours per year at an effective dose rate of 3.3mRem/hr. With the use of the FMCRD units, an additional savings of 2,000 person-hours is anticipated. In addition, the ABWR reactor building has been design to provide for ease of maintenance with overhead lifts, coordinated hatch

ways and ample space to maintain in place equipment. In addition, with the exception of one tank and the pressure vessel, all the equipment in the reactor building is removable with those pieces which can be expected to be moved being palatalized. Because of these factors, an overall reduction in work of 1,000 person-hours is estimated. Because of the improved water chemistry the overall effective dose rate is anticipated at two-thirds the typical BWR dose rate.

12.4.3 Radwaste Building Dose

Radwaste building work consists of pump and valve maintenance, shipment handling, radwaste management, and general clean up activity. Typically, 6,700 hours are expended per year at an effective dose rate of 5.5mRem/hr. The ABWR radwaste building is designed along the same lines as newer radwaste facilities overseas. The building incorporates enhanced remote control and shielding for handling of resin materials which is expected to reduce overall maintenance by 1500 to 2000 hour per year at significantly reduced dose levels. In addition, radwaste pumps for ABWR are expected to utilize air driven, rack mounted pumps. Such pumps which are designed to handle slurries have been proven to show much longer life times between maintenance and being basically a very small portable pump, can be readily replaced. Replaced pumps are then subject to intense chemical decontamination prior to maintenance and repair. Overseas utilities have reported occupational exposures typically less than 1 person-rem per year using this design. For ABWR assuming 2,000 hours reduction in maintenance due to remote handling and an additional 500 hours reduction for pump replacement, 4,200 hours per year are estimated with reduced effective dose rates of 2.5mRem/hr owing primarily to remotting those jobs involving high radiation exposure.

12.4.4 Turbine Building Dose

(1) Typical BWR valve maintenance in the turbine building uses 1,150 hours per year at an effective dose rate of 9.5mRem/hr. The valve maintenance requirements for ABWR do not vary significantly over current plants, therefore the total hours for this type of work is assumed as approximately the same excepting minor adjustments for improved valves, maintenance jigs, and automated devices will lower the estimated maintenance time to 1,000 hours. The effective dose rate of 9.5 mRem/hr is estimated at one half this value due to basically improvements in BWR fuel over the generation of fuel from which this data was taken bringing the effective dose rate down to 4.7mRem/hr. In addition, beta shielding is recommended for work on valving where possible which it is estimated will reduce the overall effective dose rate by an additional 10% to 4.3mRem/hr.

(2) In a similar fashion the turbine maintenance work typically requires 18,500 hours of work at an effective dose rate of 0.3mRem/hr. With additional operational improvements in automating turbine maintenance overall work is estimated to be reduced to 15,500 hours. The effective dose rate for the turbine is not expected to be as sensitive to fuel performance as will the turbines but is estimated to reflect a decrease in dose to 0.2mRem/hr for turbine overhaul work.

(3) Work on the turbine hall condensate system typically requires 2,000 hours per year at an effective dose rate of 7.5mrem/hr. The condensate system in ABWR uses hollow-fiber filled filters which require half the maintenance of typical system. In addition, with the plant incorporating Fe control in the feedwater system and a significant reduction in cobalt bearing materials, the overall effective dose rate is estimated at half the above value.

(4) Other work in the turbine building typically takes 13,140 hours per year at an effective dose rate of 0.1mRem/hr. Only minor changes can be assumed with ABWR with some remote operations and slight reductions in operating exposures. For the ABWR it is estimated that a 10% reduction can be realized with improving technology with no significant change in dose rate.

12.4.5 Work at Power

Work at power typically requires 5,000 hours per year at an effective dose rate of 6.6mRem/hr for the BWR. This category covers literally all aspects of plant maintenance performed during normal operations from health physics coverage to surveillance, to minor equipment adjustment, and minor equipment repair. Overall the ABWR has been designed with more automated and remotted equipment. It is expected that items of routine monitoring will be performed by camera or additional instrumentation. Most equipment in ABWR is palatalized which permits quick and easy replacement and removal for decontamination and repair. Therefore a reduction in actual hours need at power is estimate at 1,000 hours less than the typical value. In the area of effective dose rate, the ABWR is expected to have significantly lower general radiation levels over current plants owing to more stringent water chemistry controls, a full flow condensate flow system, a 2% clean up water program, titanium condenser tubes, Fe feedwater control, and low cobalt usage. In addition, the ABWR is the most compartmentalized BWR design which (1) permits better shielding in specific work areas, and (2) lowers collateral radiation contamination. Overall then it is estimated that the effective dose rate for work at power will be two thirds the typical rate or 4.5mRem/hr.

12.4.6 References

1. Knecht, P.D., "BWR/6 Drywell and Containment Maintenance and testing Access Time Estimates", GE Report NEDE-23819, May 1978.

2. Knecht, P.D., "Maintenance Access Time Estimates, BWR/6 Radwaste Building", GE Report NEDE-23996-2, May 1979.

3. Knecht, P.D., "Maintenance Access Time Estimates, BWR/6 Auxiliary and Fuel Buildings", GE Report NEDE-23996-1, May 1979.

4. "Study of Advanced BWR Features, Plant Definition/Feasibility Results", Volume III, Appendix Part G, GE NEDE-24679, Oct 1979.

Table 12.4-1

PROJECTED ANNUAL RADIATION EXPOSURE

Operation Task	SSAR Section	Hours per year	mRem/hr	Person-Rem/yr
Dr well				
MSIV	12.4.1(1)	4,200	1.8	7.4
SRV,RIP,etc	12.4.1(2)	1,150	8.7	10.0
FMCRD	12.4.1(3)	370	8.1	3.0
LPRM/TIP	12.4.1(4)	200	60.5	12.1
ISI	12.4.1(5)	1,200	6.0	7.2
Other	12.4.1(6)	3,500	4.3	15.0
	Total	10.620		54.7
Reactor Building				
Vessel	12.4.2(1)	1,200	1.5	1.8
Refueling	12.4.2(2)	2,000	0.6	1.2
RHR/RWCU	12.4.2(3)	400	9.0	3.6
FMCRD	12.4.2(4)	120	5.0	0.6
Instrument	12.4.2(5)	1,000	3.4	3.4
Other	12.4.2(6)	4,400	1.8	8.0
	Total	9,120		73.3
Radwaste Building	12.4.3	4,200	2.5	10.5
Turbine Building				
Valve Maint	12.4.4(1)	1,000	4.3	4.3
Turbine Ovrhl	12.4.4(2)	15,500	0.2	3.1
Condensate	12.4.4(3)	1,000	3.8	3.8
Other	12.4.4(4)	11,800	0.1	1.2
	Total	29,300		12.4
Work at Power	12.4.5	4,000	4.5	18.0
	Totals	48,120		114.2

ADVANCED BOILING WATER REACTOR PROGRAM
San Jose, California

November 18, 1991

To: Roger Pedersen

Subject: Chapter 12 Update Note # 5

From: H.A. Careway via Jack Fox

This is a short unofficial update note on my progress on ABWR Chapter 12.

1. Work on Table 12.2-5 continues with the table complete except piping dimensions for four systems. The piping engineer is now off vacation and should complete his task this week.

2. Section 12.4 is well on its way to being done. The current draft of 12.4 is attached.

3. New drawings for the turbine building were received. They may be updated before my Jan 92 estimate, but the plan is still to update all the drawings in Chapter 12, section 3 in January 1992. When the drawings are updated, larger scale copies (at least my working draft) will be sent to you.

Values referred to as typical for BWR operations are taken from references 1 through 4 which are a compendium of maintenance and work tasks for BWR-6, GESSAR.

12.4.1 Drywell Dose

The following provides the basis by which the drywell dose estimates for occupational exposure were made.

(1) The Main Steam Isolation Valves are located in the upper drywell area (4 valves) and in the reactor building outboard of the primary containment isolation wall (4 valves). These valves require periodic testing and maintenance to insure proper action and leak tightness. Typical values for BWR's for maintenance of these valves is 4,000 hours of drywell and 5,000 hours of reactor building work in effective radiation fields of 13.5 mRem/hr and 3.6 mRem/hr respectively. The ABWR design incorporates three specific features to reduce occupational exposure in the MSIV maintenance area: (1) improved water chemistry with lower overall contamination rates, (2) improved maintenance procedures with some procedures automated, and (3) reduced radiation fields, primarily due to the absence of the recirculation piping. Each area is discussed below.

Beginning in the early 1980's the BWR Owner's Group began an extensive study of the causes for failure of MSIV's to meet the technical leakage specification limits and extensive person-hours required to maintain these valves. As a result of these studies, the ABWR will use the latest technology for valve maintenance including mechanical aids for valve disassembly and assembly, automated lapping devices, and slightly relaxed leakage specifications to delete unnecessary maintenance. As a result of these aids, it is estimated that overall maintenance hours will be reduced by 50-60 percent.

Early studies on dose rates during MSIV maintenance showed increases in dose rate directly proportional to recirculation line activity. The ABWR has deleted the recirculation lines entirely thereby removing the singly most significant source of radiation in the drywell. The second most significant dose for MSIV operations will be the deposited and suspended activity in the feedwater lines. The deposited activity in the feedwater lines is expected to be lower than typical BWRs owing to an enhanced condensate system with full clean up of all condensate water, a 2% reactor water clean up system, and titanium condenser tubes. Additionally, the ABWR is designed to limit the use of cobalt bearing materials on moving components which have historically been identified as major sources of in water contamination. Overall, the feedwater line radiation is expected to be a factor of two lower than current BWRs. Because of these factors, it is expected that the effective dose rate in the drywell will be 2mRem/hr and 1.5mRem/hr in the steam tunnel outboard of the primary containment.

(2) Drywell valve and pump maintenance other than the MSIVs consists primarily of maintaining the Safety Relief Valves (SRVs) which for the most part consist of minor maintenance or removal of valves to a maintenance facility. Overall typical values for a BWR for these tasks are 1,450 person-hours per year in an effective radiation field of 17mRem/hr. In the ABWR, the primary source of radiation exposure, the recirculation lines and pumps, have been removed. Overall the reduction in drywell dose level is for these types of maintenance is expected to be a factor of two or 9mRem/hr. Overhead tracks and in place removal equipment is provided in the ABWR for an estimated person-power reduction to 1,150 person-hour per year broken down into 200 person-hours for 18 SRV maintenance at 6mRem/hr, 200 person-hours per year to pull and replace 3 RIPs with one heat exchanger at 25mRem/hr, and the remainder on miscellaneous valves at 5mRem/hr.

(3) Control Rod Drive maintenance is significantly reduced in the ABWR with the introduction of Fine Motion Control Rod Drives (FMCRD). Based upon European experience, two FMCRDs will be replaced and repaired per outage along with twenty motors. Estimated work will consist of 64 person-hours under vessel preparation, 40 person-hours FMCRD removal and reinstallation, 200 person hours motor removal and installation, and 64 person-hours cleanup. Typical under vessel effective dose rates are 17mRem/hr but because of the removal of the recirculation pumps and lines has been reduced to 8mRem/hr.

(4) The LPRM/TIP system assumes the servicing of two sensors per year and is based upon a total of 200 person-hours per year at an effective dose rate of 60mRem/hr which is typical for BWR operations.

(5) Inservice Inspection consists of primarily NDE examination of vessel and piping systems and welds. Typical BWR values are 2400 person-hours per year at 12mRem/hr effective exposure rate. ABWR inservice inspection is estimated based upon the following:

Elimination of recirculation lines and pumps with the following savings:

Elimination of 14 nozzle inspections at 2 per year, saving 360 person hours

Elimination of shield penetration and shield plug removal saving 240 person hours per year

Reduction on weld inspection on recirculation lines estimated at 240 person hour per year

Reduction in drywell dose by 50% with the provision that the feedwater line dose is more than half the recirculation line dose and general drywell dose level and therefore removal of recirculation line inspection is estimated to be weighted at twice the general drywell dose rate.

Overall it is estimated that by use of automated turtles for inspection person-hour expended in ISI will be reduced by a factor of two.

The ABWR uses a forged ring pressure vessel in comparison to older plate welded vessels reducing the total vessel weld length inspection by 30% and the total weld inspection by 10%.

The ABWR design incorporates specific access into inspection areas past insulation areas with an estimated savings of 120 person-hours.

Overall person-hours reduction is 1,200 person-hours at approximately half the typical effective dose rate or 6 mRem/hr.

(6) Other drywell work includes items such as minor valve maintenance, instrumentation work, and all other drywell work. Typical BWR work in this area estimates 5,500 person-hours per year at 17 mRem/hr. Overall reduction in this effort due to ABWR design improvements are:

Significant savings in total hours are estimated due to removal of the recirculation lines with miscellaneous recirculation line work such as line snubbers, fewer drywell cooling units, and less assembly/disassembly work on insulation due to the use of automated units. Overall it is estimated that 2,000 person hours savings can be made.

Overall reduction in the drywell due to removal results in the reduction of the overall upper drywell dose rate to 3 mRem/hr and the lower drywell dose rate to 6 mRem/hr since the components involved such as drywell coolers typically do not carry radioactive inventory. Assuming that of the remaining 3,500 person-hour, 2,0C^ is upper drywell work and 1,500 is lower drywell work at their respective effective dose rates.

12.4.2 Reactor Building Dose

The following provides the basis by which the reactor building dose estimates for occupational exposure were made.

(1) Vessel access and reassembly typically requires 4500 person-hours of work at an effective dose rate of 3 mr/hr. The ABWR work will involve the use of an stud tensioner for a 96 bolt top head. The projected time to remove 96 bolts with this equipment is between 600 to 1200 person-hours. Due to the larger ABWR vessel and expected reduced water contamination with the improved clean up system, the estimated projected effective dose rate is 2 mRem/hr.

(2) ABWR refuelling is accomplished via an automated refuelling bridge. All operations for refuelling are accomplished from an enclosed automation center off the refuelling floor. Time for refuelling is reduced from a typical 4,400 person-hours down to 2,000 person and from an effective dose rate of 2.5 mRem/hr to less than 0.6mRem/hr.

(3) RHR/RWCU maintenance work consists of inspections for two pumps per year in each system. In the RHR system this cons ies 150 person-hours per year at an effective dose rate of 40mRem/hr. In the RWCU sy. em this typically uses 1400 person-hours per year at an effective dose rate of 14mRem/hr. ABWR will used canned pumps for both system with an estimated reduction in maintenance to 100 person-hours per pump. With improved water chemistry and overall reductions in reactor water concentrations due to the two percent cleanup system the effective dose rate is estimated at two-thirds the typical value for these system.

(4) FMCRD rebuilding estimates are taken from similar work done in Europe since no significant U.S. data exists to date. Two drives will be rebuilt at an effective dose rate of 5 mRem/hr and 30-60 hours per drive.

(5) Instrumentation work typically requires 1,000 person-hours of work per year at an effective dose rate of 5.0 mRem/hr. ABWR should take about the same effort in instrumentation, however because of the increased emphasis and improved water chemistry systems, should reduce the effective dose rate to two-thirds the typical value or 3.4mRem/hr.

(6) All other work in the reactor building typically takes 7,400 person-hours per year at an effective dose rate of 2.8mRem/hr. This work includes all valve work, RIP rebuild work, minor maintenance, and CRD hydraulic line work. The major task in this area is the hydraulic control units which require 5,000 person-hours per year at an effective dose rate of 3.3mRem/hr. With the use of the FMCRD units, an additional savings of 2,000 person-hours is anticipated. In addition, the ABWR reactor building has been design to provide for ease of maintenance with overhead lifts, coordinated hatch

ways and ample space to maintain in place equipment. In addition, with the exception of one tank and the pressure vessel, all the equipment in the reactor building is removable with those pieces which can be expected to be moved being palatalized. Because of these factors, an overall reduction in work of 1,000 person-hours is estimated. Because of the improved water chemistry the overall effective dose rate is anticipated at two-thirds the typical BWR dose rate.

12.4.3 Radwaste Building Dose

Radwaste building work consists of pump and valve maintenance, shipment handling, radwaste management, and general clean up activity. Typically, 6,700 hours are expended per year at an effective dose rate of 5.5mRem/hr. The ABWR radwaste building is designed along the same lines as newer radwaste facilities overseas. The building incorporates enhanced remote control and shielding for handling of resin materials which is expected to reduce overall maintenance by 1500 to 2000 hour per year at significantly reduced dose levels. In addition, radwaste pumps for ABWR are expected to utilize air driven, rack mounted pumps. Such pumps which are designed to handle slurries have been proven to show much longer life times between maintenance and being basically a very small portable pump, can be readily replaced. Replaced pumps are then subject to intense chemical decontamination prior to maintenance and repair. Overseas utilities have reported occupational exposures typically less than 1 person-rem per year using this design. For ABWR assuming 2,000 hours reduction in maintenance due to remote handling and an additional 500 hours reduction for pump replacement, 4,200 hours per year are estimated with reduced effective dose rates of 2.5mRem/hr owing primarily to remotting those jobs involving high radiation exposure.

12.4.4 Turbine Building Dose

(1) Typical BWR valve maintenance in the turbine building uses 1,150 hours per year at an effective dose rate of 9.5mRem/hr. The valve maintenance requirements for ABWR do not vary significantly over current plants, therefore the total hours for this type of work is assumed as approximately the same excepting minor adjustments for improved valves, maintenance jigs, and automated devices will lower the estimated maintenance time to 1,000 hours. The effective dose rate of 9.5 mRem/hr is estimated at one half this value due to basically improvements in BWR fuel over the generation of fuel from which this data was taken bringing the effective dose rate down to 4.7mRem/hr. In addition, beta shielding is recommended for work on valving where possible which it is estimated will reduce the overall effective dose rate by an additional 10% to 4.3mRem/hr.

(2) In a similar fashion the turbine maintenance work typically requires 18,500 hours of work at an effective dose rate of 0.3mRem/hr. With additional operational improvements in automating turbine maintenance overall work is estimated to be reduced to 15,500 hours. The effective dose rate for the turbine is not expected to be as sensitive to fuel performance as will the turbines but is estimated to reflect a decrease in dose to 0.2mRem/hr for turbine overhaul work.

(3) Work on the turbine hall condensate system typically requires 2,000 hours per year at an effective dose rate of 7.5mrem/hr. The condensate system in ABWR uses hollow-fiber filled filters which require half the maintenance of typical system. In addition, with the plant incorporating Fe control in the feedwater system and a significant reduction in cobalt bearing materials, the overall effective dose rate is estimated at half the above value.

(4) Other work in the turbine building typically takes 13,140 hours per year at an effective dose rate of 0.1mRem/hr. Only minor changes can be assumed with ABWR with some remote operations and slight reductions in operating exposures. For the ABWR it is estimated that a 10% reduction can be realized with improving technology with no significant change in dose rate.

12.4.5 Work at Power

Work at power typically requires 5,000 hours per year at an effective dose rate of 6.6mRem/hr for the BWR. This category covers literally all aspects of plant maintenance performed during normal operations from health physics coverage to surveillance, to minor equipment adjustment, and minor equipment repair. Overall the ABWR has been designed with more automated and remotted equipment. It is expected that items of routine monitoring will be performed by camera or additional instrumentation. Most equipment in ABWR is palatalized which permits quick and easy replacement and removal for decontamination and repair. Therefore a reduction in actual hours need at power is estimate at 1,000 hours less than the typical value. In the area of effective dose rate, the ABWR is expected to have significantly lower general radiation levels over current plants owing to more stringent water chemistry controls, a full flow condensate flow system, a 2% clean up water program, titanium condenser tubes, Fe feedwater control, and low cobalt usage. In addition, the ABWR is the most compartmentalized BWR design which (1) permits better shielding in specific work areas, and (2) lowers collateral radiation contamination. Overall then it is estimated that the effective dose rate for work at power will be two thirds the typical rate or 4.5mRem/hr.

12.4.6 References

1. Knecht, P.D., "BWR/6 Drywell and Containment Maintenance and testing Access Time Estimates", GE Report NEDE-23819, May 1978.

2. Knecht, P.D., "Maintenance Access Time Estimates, BWR/6 Radwaste Building" GE Report NEDE-23996-2, May 1979.

3. Knecht, P.D., "Maintenance Access Time Estimates, BWR/6 Auxiliary and Fuel Buildings", GE Report NEDE-23996-1, May 1979.

4. "Study of Advanced BWR Features, Plant Definition/Feasibility Results", Volume III, Appendix Part G, GE NEDE-24679, Oct 1979.

Table 12.4-1

PROJECTED ANNUAL RADIATION EXPOSURE

Operation Task	SSAR Section	Hours per year	mRem/hr	Person-Rem/yr
Drywell				
MSIV	12.4.1(1)	4,200	1.8	7.4
SRV,RIP,etc	12.4.1(2)	1,150	8.7	10.0
FMCRD	12.4.1(3)	370	8.1	3.0
LPRM/TIP	12.4.1(4)	200	60.5	12.1
ISI	12.4.1(5)	1,200	6.0	7.2
Other	12.4.1(6)	3,500	4.3	15.0
	Total	10,620		54.7
Reactor Building				
Vessel	12.4.2(1)	1,200	1.5	1.8
Refueling	12.4.2(2)	2,000	0.6	1.2
RHR/RWCU	12.4.2(3)	400	9.0	3.6
FMCRD	12.4.2(4)	120	5.0	0.6
Instrument	12.4.2(5)	1,000	3.4	3.4
Other	12.4.2(6)	4,400	1.8	8.0
	Total	9,120		73.3
Radwaste Building	12.4.3	4,200	2.5	10.5
Turbine Building				
Valve Maint	12.4.4(1)	1,000	4.3	4.3
Turbine Ovrhl	12.4.4(2)	15,500	0.2	3.1
Condensate	12.4.4(3)	1,000	3.8	3.8
Other	12.4.4(4)	11,800	0.1	1.2
	Total	29,300		12.4
Work at Power	12.4.5	4,000	4.5	18.0
	Totals	48,120		114.2

ADVANCED BOILING WATER REACTOR PROGRAM
San Jose, California

November 8, 1991

To: Roger Pedersen

Subject: Chapter 12 Update Note # 4

From: H.A. Careway via Jack Fox

This is a short unofficial update note on my progress on ABWR Chapter 12.

Completed SGTS inventory, see Table 12.2-30 attached.

The following is a general update on the current outstanding items.

Original Due Date	Item to be completed.	Current Status	New Date
1. Oct 31	Section 12.4 on Occupational exposure will be expanded to include rational and basis for choosing radiation levels and occupational exposure times. Detailed discussions will be given for each major item in Table 12.4-1.	Only 10% complete.	Nov 19
2. Oct 17	Table 12.2-5 will be expanced to further define the radiation sources in the plant. For each source in the plant, the best estimate of the source geometry will be given along with a detailed description of the radiation shielding surrounding each source.	95% completed. Awaiting geometry definition on SGTS and piping sizing on RCIC, CUW, FPCU, and SPCU pipes. SGTS, Recombiner and SJAE tables were added as a result of this activity.	Nov 18
3. Oct 24	All pipe chases will be reviewed and as complete description of the pipes and fluid contents will be provided. In the case where chases carrying small pipes has not yet been detailed, a reasonable estimated will be provided.	This item has been combined with item 2 above. Only the radioative pipe chases will appear in the table. There are a large number of pipe chases, especially	see 2.

		along the Reactor Building outer wall which carry non-radioative fluids. The new drawings (see items 9 and 10) will indicate these as non-radioactive pipe chases.	
4. Oct 25	A detailed evaluation of the TIP system and its shielding especially with respect to personal work areas in the lower drywell will be supplied. Additional detailed drawings will be supplied to fully describe the 3-D shields.	The shielding in the drywell area was found to be inadequate in the event of inadvertent movement of the TIP during outages. A design change has been requested to interlock close the TIP ball valves when the reactor is not in "RUN" mode.	Jan 92
5. Oct 15	Further details on personal access and shielding will be supplied on the areas between the control building and the turbine bulding. Details on shielding for the main steam lines will be provided.	A new section 12.3.2.3 was added describing the steam line and building interface. It cannot be determined whether there is access between the buildings at this time. Preliminary calculations also indicate a maximum dose rate of 7mRem/hr in between the buildings which may mean an increase in the minimum shielding thickness of 1.6 meters.	Nov 19
6. Oct 15	Detailed sketch with source description will be provided of the upper drywell in respect to fuel handling and the potential for radiation exposure to workers in the upper drywell from a fuel drop accident.	Complete. Based upon the NRC analysis, a proposed change has been submitted to provide more shielding in the upper drywell. Date for submittal of modification to NRC is unknown.	Jan 92

7. Oct 25	Complete detailed drawings will be supplied of the drywell area outling major radiation areas and sources.	Detailed drawings are given in Chapter 1. A set of these drawings will be added to Chpater 12 for refueling operations only.	Jan 92
8. Oct 25	Current design will be reviewed as to possibility of missing radiation sources. In particular, the drywell will be reviewed in detail and items such as the RIP heat exchangers will be investigated for potential worker exposure.	Completed. SGTS Filter train, SJAE, Recombiner, RIP Heat Exchanger added to Table 12.2-5.	
9. Oct 31	Additional detail will be supplied on the radwaste building as available. Detail not available will be supplied as interface requirement.	Completed. See Table 12.2-5. Radwaste builing drawings will be updated to conform to latest changes.	Jan 92
10. Oct 31	Additional drawing will be supplied on the Turbine building to more completely detail radiation source expeciall in and around the offgas system.	Additional detail has been added as Table 12.2-5. Turbine building drawings will be updated with general update in Jan 92.	Jan 92

Table 12.2-30

Stand-by Gas Treatment System Inventory

Isotope	Curies	Isotope	Curies
I-131	1.5E-02	Y-91	8.5E-04
I-132	1.5E-03	Y-92	3.6E-04
I-133	1.1E-02	Y-93	6.7E-04
I-134	1.0E-03	Zr-95	1.9E-04
I-135	4.8E-03	Nb-95	1.0E-04
		Mo-99	2.0E-03
		Tc-99m	1.9E-04
Na-24	1.7E-02	Ru-103	2.9E-04
P-32	7.4E-03	Rh-103m	2.9E-04
Cr-51	4.4E-01	Ru-106	4.0E-04
Mn-54	5.4E-02	Rh-106	4.0E-04
Mn-56	1.5E-02	Ag-110m	1.1E-10
Fe-55	1.8E+00	Te-129m	4.9E-04
Fe-59	3.5E-03	Te-131m	4.6E-05
Co-58	3.7E-02	Te-132	1.2E-05
Co-60	9.6E-01	Cs-134	6.2E-03
Ni-63	4.7E-04	Cs-136	8.7E-05
Cu-64	6.0E-03	Cs-137	3.3E-02
Zn-65	1.8E-02	Cs-138	1.0E-04
Rb-89	2.5E-05	Ba-140	1.9E-03
Sr-89	1.9E-03	La-140	1.9E-03
Sr-90	3.2E-03	Ce-141	3.6E-04
Y-90	3.2E-03	Ce-144	3.1E-04
Sr-91	6.2E-04	Pr-144	3.1E-04
Sr-92	4.7E-04	W-187	1.1E-04
		Np-239	7.0E-03

ADVANCED BOILING WATER REACTOR PROGRAM
San Jose, California

November 4, 1991

To: Roger Pedersen

Subject: Chapter 12 Update Note # 3

From: H.A. Careway via Jack Fox

This is a short unofficial update note on my progress on ABWR Chapter 12.

The entire week was spent in developing the data for Table 12.2-29 on the Steam Jet Air Ejector inventory. The draft table is attached.

Table 12.2-29

Steam Jet Air Ejector Inventory in Curies

Isotope	1st Stage Ejector	Condenser	2nd Stage Ejector
Kr-83m	6.8E-04	2.0E-02	2.0E-03
Kr-85m	1.2E-03	3.7E-02	3.7E-03
Kr-85	4.0E-06	1.2E-04	1.2E-05
Kr-87	4.0E-03	1.2E-01	1.2E-02
Kr-88	4.0E-03	1.2E-01	1.2E-02
Kr-89	2.5E-02	7.5E-01	7.5E-02
Kr-90	4.5E-02	1.4E+00	1.4E-01
Kr-91	3.0E-02	8.9E-01	8.9E-02
Kr-92	1.5E-03	4.6E-02	4.6E-03
Kr-93	7.9E-05	2.4E-03	2.4E-04
Kr-94	2.1E-17	6.4E-16	6.4E-17
Kr-95	4.0E-10	1.2E-08	1.2E-09
Kr-97	1.5E-25	4.5E-24	4.5E-25
Total KR	1.1E-01	3.3E+00	3.3E-01
Xe-131m	3.0E-06	9.0E-05	9.0E-06
Xe-133m	5.8E-05	1.7E-03	1.7E-04
Xe-133	1.6E-03	4.9E-02	4.9E-03
Xe-135m	5.2E-03	1.5E-01	1.5E-02
Xe-135	4.4E-03	1.3E-01	1.3E-02
Xe-137	2.9E-02	8.7E-01	8.7E-02
Xe-138	1.8E-02	5.3E-01	5.3E-02
Xe-139	4.7E-02	1.4E+00	1.4E-01
Xe-140	3.6E-02	1.1E+00	1.1E-01
Xe-141	8.5E-04	2.6E-02	2.6E-03
Xe-142	5.0E-05	1.5E-03	1.5E-04
Xe-143	2.2E-13	6.7E-12	6.7E-13
Xe-144	1.1E-07	3.3E-06	3.3E-07
Total XE	1.4E-01	4.3E+00	4.3E-01
Noble Gas Totals	1.1E-01	7.6E+00	7.6E-01
N-16[a]	3.5E-01	1.3E+01	1.3E+00

Notes:

[a] Value given is estimated N-16 inventory at 100% power. Value varies in an unknown fashion with power. Based upon operating measurements, the value for N-16 at 20% power is close to zero.

ADVANCED BOILING W' · R REACTOR PROGRAM
San Jose, California

October 28, 1991

To: Roger Pedersen

Subject: Chapter 12 Update Note # 2

From: H.A. Careway via Jack Fox

This is a short unofficial update note on my progress on ABWR Chapter 12.

General Radiation Sources

The last sentence of subsection 12.2.1.2 will be replaced with the following to better describe Table 12.2-5.

> Table 12.2-5 presents an overview of the radioactive sources found in the ABWR excluding the reactor pressure vessel. This table is divided into four sections. The first section lists all major radioactive sources, the table which provides the source term information for the component, and the figure in section 12.3 (or chapter 1) in which the component location is shown along with coordinates for the component. In addition, the approximate geometry of the component is supplied. This geometry in most cases is only approximate and represents an generic application as compared to specific details for a vendor supplied component. The second section of Table 12.2-5 gives for each component the estimated source distribution in each component. Again this is estimated and will depend on final design parameters with vendor specific application. The third section of Table 12.2-5 lists room dimensions and wall thickness for each component. This data is taken from the arrangement drawings and represents minimal values. Actual wall dimensions may vary according to ITAC requirements or final construction requirements. The fourth section of Table 12.2-5 lists pipe chases, the major pipe routing through these chases, and piping data. Only chases carrying significant radioactive sources are listed.
>
> Some areas of the plant show shielded areas without any designation to any radioactive component. These are primarily areas found around the primary containment boundary. For example, in Figure 12.3-5 at coordinate (RF,R4) a shielded area is shown with break down walls without any designated component. This area represents shielded penetration areas for non-radioactive components and can be cross referenced to Figure 1.2-13. Reference to Figure 1.2-13a shows electrical penetrations from the primary containment into the shielded area at (RF,R4) on Figure 12.3-5.

The latest update to Table 12.2-5 is attached. Work on this table has halted temporarily due to the two people I need to answer specific questions on the SGTS and the piping systems are on vacation. They will be back second week in November at which time the table will be completed.

Main Steam Tunnel

New Section: 12.3.2.3

(6) Main Steam Tunnel

The main steam tunnel extends from the primary containment boundary in the reactor building through the control building into the turbine building up to the turbine stop valves. The primary purpose of the steam tunnel is to shield the plant complex from N-16 gamma shine in the main steam lines. A minimum of 1.6 meters of concrete or its equivalent (other material or distance) is required on any ray pathway from the main steam lines to any point which may be inhabited during normal operations. The design of the steam tunnel is shown on figures 1.2-14, 1.2-15, 1.2-20, 1.2-21, and 1.2-28. The tunnel is classified as Seismic Category I in the reactor building and in the control building and is designed to UBC Seismic Standards in the turbine building. The interface between the buildings provides for a bayonet connection to permit differential building motion during seismic events and shielding in the areas between the buildings. The exact details on the bayonet design are not shown on the referenced arrangement drawings but requires complete shielding in the building interface area. The tunnel also serves a secondary purpose as a relief and release pathway for high energy events in the reactor building. Any high energy event (line break) in the reactor building will through a series of blow out pannels, vent into the steam tunnel and from the steam tunnel through the tunnel vent shaft to the turbine building (see Figure 1.2-28) for processing to the plant stack. See Subsection 6.2.3.3.1 for a more complete description of this function.

Table 12.2-5 Radiation Sources

a. Radiation Sources

Source Table	For	Drawing	Location	Approximate Geometry
12.2-6	RHR Heat Exchanger	12.3-1	(R1,RF) (R6,RA) (R6,RF)	Rt Cylndr (r=0.9m,l=7m)
12.2-8	RCIC Turbine	12.3-1	(R6,RC)	Rt Cylndr (r=0.5m,l=0.7m)
12.2-9	CUW Filter Demineralizer	12.3-3	(R2,RB)	2 Tanks, Rt Cylndr (r=0.6m,l=3.3m)
12.2-10	RWCU Regen Heat Exchanger	12.3-2	(R1,RC)	Rt Cylndr (r=0.4m,l=6.8m)
12.2-11	RWCU Non-Regen Heat Exchanger	12.3-1	(R1,RC)	Rt Cylndr (r=0.4m,l=5.5m)
12.2-13.1	LCW Collector Tank	12.3-37	ITEM 7	2 Tanks, Rt Cylndr (r=4.m,l=9.4m)
12.2-13.2	LCW Filter	12.3-39	ITEM 12	Rt Cylndr (r=0.5m,l=2.5m)
12.2-13.3	LCW Demineralizer	12.3-39	ITEM 11	Rt Cylndr (r=0.6m,l=2.8m)
12.2-13.4	LCW Sample Tank	12.3-38	ITEM 8	2 Tanks, Rt Cylndr (r=4.m,l=9.4m)
12.2-13.5	HCW Collector Tank	12.3-37	ITEM 13	Rt Cylndr (r=2.2m,l=4.3m)
12.2-13.6	HCW Demineralizer	12.3-39	ITEM 20	Rt Cylndr (r=0.6m,l=2.8m)
12.2-14	Offgas	12.3-50	(TF,T2)	Tank 1, Rt Cylndr (r=0.6m,l=7.6m) Tanks 2-9, Rt Cylndr (r=1.1m,l=7.6m)
12.2-29	Steam Jet Air Ejector	12.3-51	(TF,T2)	Rt Cylndr (r=0.15m,l=4.6m) Rt Cylndr (r=0.76m,l=6.1m) Rt Cylndr (r=0.2m,l=4.6m)
12.2-14	Offgas Recombiner	12.3-51	(TF,T2)	Rt Cylndr (r=1.4m,l=7m)
12.2-15.1	CUW Backwash Receiving Tank	12.3-1	(R2,RB)	Rt Cylndr (r=2.2m,l=5.7m)
12.2-15.2	CF Backwash Receiving Tank	12.3-49	(TD,T4)	Rt Cylndr (r=2.2m,l=5.7m)
12.2-15.3	Phase Separator	12.3-38	ITEM 30	2 Tanks, Rt Cylndr (r=2.4m,l=6.0m)
12.2-15.4	Spent Resin Storage Tank	12.3-38	ITEM 31	Rt Cylndr (r=2.0m,l=5.7m)
12.2-15.5	Concentrated Waste Tank	12.3-37	ITEM 35	Rt Cylndr (r=1.5m,l=4.4m)
12.2-15.6	Sol Dryer Feed Tank	12.3-41	ITEM 39	Rt Cylndr (r=1.6m,l=3.2m)
12.2-15.7	Sol Dryer (outlet)	12.3-39	ITEM 55	Rt Cylndr (r=0.2m,l=3.2m)
12.2-15.8	Sol Peletizer	12.3-38	ITEM 58	Rt Cylndr (r=0.4m,l=2.5m)
12.2-15.9	Sol Mist Separator (steam)	12.3-39	ITEM 56	Rt Cylndr (r=0.1m,l=2.8m)
12.2-15.10	Sol Condenser	12.3-40	ITEM 57	Rt Cylndr (r=0.2m,l=1.4m)
12.2-15.11	Sol Drum	12.3-39	(2,D)	Rt Cylndr (r=0.3m,l=0.8m) Box (1.5mx1.5mx1m)
12.2-16	FPC Filter Demineralizer	12.3-3	(R2,RB)	Rt Cylndr (r=0.7m,l=3.4m)
12.2-17	Supp Pool Cleanup System[c]	12.3-3	(R2,RA)	Rt Cylndr (r=0.7m,l=3.4m)
12.2-18	Control Rod Drive System[a]	12.3-2	(R4,RF)	Distributed Source
12.2-24	Transverse Incore Probe	12.3-2	(R4,RB)	Distributed Source
12.2-25	Reactor Internal Pumps[b]	12.3-2	(RF,R1)	Distributed Source
12.2-25	RIP Heat Exchanger	1.2-3b	El 3000	Rt Cylndr (r=0.322m,l=2.9m)
12.2-26	Turbine Mositure Sep/Reheater	12.3-52	(T6,TE)	Rt Cylndr (r=1.8m,l=31.m)
12.2-27	Turbine Condenser	12.3-53	(TD,TG)	Distributed Source
12.2-28	Condenser Filter/Demineralizer			
	Filter	12.3-51	(TC-T2)	3 Tanks, Rt Cylndr (r=1.4m,l=6.1m)
	Demineralizer	12.3-51	(TC,T3)	6 Tanks, Rt Cylndr(r=1.7m,l=5.1m)
Applicant	Spent Fuel Storage	12.3-6	(R4,RF)	See Drawings
12.2-30	SGTS Filter Train	12.3-7	(R2,RB)	HEPA

Notes

[a] Maintenance Facility
[b] Maintenance Facility, see Figure 1.2-3B Elevation 3000 for drywell location
[c] Suppression pool clean up F/D uses second of Fuel Pool F/D

B. Source Geometry

Component	Assumed Shielding Source Geometry
RHR Heat Exchanger	Homogenous source over volume of heat exchanger
RCIC Turbine	Homogenous source over volume of turbine
CUW Filter Demineralizer	80% of source in first 15cm, remainder dispersed over volume.
RWCU Regen Heat Exchanger	Homogenous source over volume of exchanger
RWCU Non-Regen Heat Exchanger	Homogenous Source over volume of exchanger
LCW Collector Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
LCW Filter	Homogenous source over volume of filter
LCW Demineralizer	80% of source in first 15cm, rest evenly dispersed over volume
LCW Sample Tank	Homogenous source over volume of tank
HCW Collector Tank	Homogenous source over volume of tank
HCW Demineralizer	80% of source in first 15cm, rest evenly dispersed over volume
Offgas	90% of source in first tank in first (upper) 30 cm, rest evenenly dispersed. Remaining tanks, homogenous source over tank volume.
Steam Jet Air Ejector[b]	Homogenous source over volume of ejector
Offgas Recombiner[b]	Homogenous source over subcomponent, see Figure 12.2-14[a]
CUW Backwash Receiving Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
CF Backwash Receiving Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
Phase Separator	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Spent Resin Storage Tank	Homogenous source over volume of tank
Concentrated Waste Tank	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Sol Dryer Feed Tank	Source evenly dispersed over volume
Sol Dryer (outlet)	Source evenly dispersed over volume
Sol Peletizer	Source evenly dispersed over volume
Sol Mist Separator (steam)	Source evenly dispersed over volume
Sol Condenser	Source evenly dispersed over volume
Sol Drum	Source evenly dispersed over volume
FPC Filter Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Suppression Pool Cleanup System	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Control Rod Drive System	Exposure dependent, assume evenly dispered over length of blade
Transverse Incore Probe	Point or line geometry, see Table 12.2-24
Reactor Internal Pumps	Cylindrical source coupled to water bearing components
RIP Heat Exchanger	Homogenous source over volume of exchanger
Turbine Mositure Sep/Reheater	Homogenous source over volume of component
Turbine Condenser	Homogenous source over volume of condenser
Condenser Filter/Demineralizer	
Filter	Source evenly sispersed over volume of filter
Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Spent Fuel Storage	Applicant
SGTS Filter Train	90% Particulates on HEPA filter, remaining on charcoal filter

Notes

[a]See Offgas Recombiner Description, Subsection 11.3, use inventory for preheater, recombiner, condenser and cooler for recombiner inventory for shielding applications.
[b]Radiation levels in SJAE and Recombiner highly dependent upon power level. Actual measurements on SJAE condenser contact dose rate are 20Rads/hr at 100% power and less than 5mRad/hr at 20% power.

C. Shielding Geometry in meters

Component	Room Dimensions			Wall Thickness in meters[e]					
	Length	Width	Height	East	West	North	South	Floor	Ceiling
RHR Heat Exchanger	12.6	5.6	5.6	0.8	0.6	0.6	0.6	Ground	0.8
RCIC Turbine	14.6	7.8	5.6	0.8	2	0.6	0.6	Ground	0.8
CUW Filter Demineralizer	2.8	3	7.4	0.8	1	0.8	1	0.5	Hatch
RWCU Regen Heat Exchanger	7.7	3.6	6	1.4	1.4	1	1.4[a]	0.8	0.5
RWCU Non-Regen Heat Exchanger	7.4	4.4	5.6	1	1	1	1[a]	Ground	0.8
LCW Collector Tank	19	1	13	1.2	0.8	0.8	1.2	Ground	0.8
LCW Filter	16.4	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
LCW Demineralizer[b]	19.6	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
LCW Sample Tank	19	10	13	1.2	0.8	1.2	0.8	Ground	0.8
HCW Collector Tank	9	11.2	5.4	0.8	0.8	0.8	1.2	Ground	0.8
HCW Demineralizer[b]	19.6	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
Offgas	9.1	11	16	1	1	1	1	2.5	1
Steam Jet Air Ejector and Recombiner Room	9.1	14.2	7	1	1	1	1	1	1
CUW Backwash Receiving Tank	6.6	7.4	5.6	1	0.8	0.8	1	Ground	0.8
CF Backwash Receiving Tank	5	5	25	1	1	1	1	2.5	Hatch
Phase Separator	16	8.4	4.6	0.8	0.8	0.8	1.2	0.8	0.8
Spent Resin Storage Tank	6.4	6.4	4.6	0.8	0.8	0.8	0.8	0.8	0.8
Concentrated Waste Tank	4.6	5	5.4	0.8	0.8	1.2	0.8	Ground	0.8
Sol Dryer Feed Tank	9.4	7.2	6.2	0.8	0.8	0.8	0.8	0.8	0.8
Sol Dryer (outlet)[c]	9.2	5.2	8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Peletizer	9.2	5.2	6.8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Mist Separator (steam)[c]	9.2	5.2	8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Condenser	4.2	7.2	6.2	0.8	0.8	0.8	0.8	0.8	0.8
Sol Drum	3.2	3	8	0.8	0.8	0.8	0.8	0.8	0.8
FPC Filter Demineralizer	3.2	3.2	7.4	0.8	1	0.8	.8	0.5	Hatch
Suppression Pool Cleanup Sys	3.2	3.2	7.4	0.5	0.8	0.8	0.8	0.5	Hatch
Control Rod Drive System[f]	7.6	33.4	5.8	0.6	0.6	0.6	0.6	0.8	0.6
Transverse Incore Probe	4	7.3	2.7	1	1	1	1	Mezz	0.6
Reactor Internal Pumps[f]	8.2	8.5	5.8	0.6	0.6	0.6	0.6	0.8	0.6
RIP Heat Exchanger	Primary Containment								
Turbine Moisture Sep/Reheater	12.4	47.6	8.5	1	1	1	1	1	1
Turbine Condenser	14.2	36	25	3.5	2.5	1	1	2.5	Turbine
Condenser Filter	5	21.1	8	2.5[d]	1	1	1	1	Hatch
Condenser Demineralizer	9.8	17.3	9	1	1	1	1.6	1	1
Spent Fuel Storage	9.4	14	4.1	2	2	2	2	2	7.4[d]
SGTS Filter Train	14.4	5	8.2	0.2	0.5	0.2	0.2	2	0.6

Notes

[a] Moveable Wall
[b] LCW and HCW Demineralizer share same room
[c] Solid dryer and Mist Separator share same room
[d] 7.4 meter water depth above fuel elements
[e] North refers to plant 0 degree orientation, east = 90 degrees
[f] Maintenance Facility

D. Pipe Chase Detail

Pipe Space (PS)	Level	Location	System	Number Pipes	Size[a]	Source[b]	Shield Wall Thickness in meters East	West	North	South
RHR(A)	1F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC			RS	0.6	PC	0.6	0.6
	B1F	(PC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC			RS	0.6	PC	0.6	0.6
	B2F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC			RS	0.6	PC	0.6	0.6
	B3F	(RC,RA)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC			RS	0.6	PC	0.6	0.6
RHR(B)	1F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B1F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B2F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B3F	(RE,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
RHR(C)	1F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B1F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B2F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B3F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
CRD-A	B2F	(RB,R3)	CRD	Control rod drive lines						
CRD-B	B2F	(RB,R5)	CRD	Control rod drive lines						
CRD-C	B2F	(RF,R3)	CRD	Control rod drive lines						
CRD-D	B2F	(RF,R5)	CRD	Control rod drive lines						
FPC/CUW	2F	(RB,R3)	FPC			1% RC	1.2	1.2	1.2	1.2
	1F	(RB,R3)	FPC			1% RC	1.2	1.2	1.2	1.2
			CUW							
	B1F	(RB,R3)	FPC			1% RC				
			CUW							
MSL/FDW	1F	(RB,R4)	MSL							
			FDW							
SPCU										

Notes

[a]Pipe size given as outside diamter in millimeters and inside diameter in millimeters.
[b]Source is defined by RC= reactor coolant water, see Tables 11.2-2 through 11.2-5. RS is reactor steam, see Tables 11.2-1 and 4.

ADVANCED BOILING WATER REACTOR PROGRAM
San Jose, California

October 18, 1991

To: Roger Pedersen

Subject: Chapter 12 Update Note

From: H.A. Careway via Jack Fox

This is a short unofficial update note on my progress on ABWR Chapter 12.

General Radiation Sources

By now you should have received Amendment 18 to the SSAR which contains the first issuance of Table 12.2-5. This table is being expanded to include shielding data and pipe chases. Attached to this note is my current working draft of this table. If you find that I am leaving out something I said I would provide or feel the format is wrong, let me know.

Upper Drywell and Fuel Handling Accident

After our phone conversation, I took this problem to my management. Currently the plan is to add a lip onto the upper drywell structure to shield against a dropped fuel bundle. The lip will involve a one inch steel plate and 6-8 inches of concrete. We still have much work to do on this and this is only in the conceptual stage but we are working on it. A sketch is attached to better show the idea.

Transverse Incore Probe

There is no way I can see to shield workers from an inadvertent motion of the TIP. But I did find out that there is a ball valve on each TIP line coming out of the TIP room. I have requested and there is formal design activity now to interlock these ball valves such that when the master run switch is not in run, the valves are locked closed to stop TIP motion beyond the valves. Final approval and an amendment to the SSAR maybe mid-November. (Side note: SBWR has no TIP system!!!!)

General Arrangement

I've been told there is another updated set of arrangement drawings coming out. When they do, I'll update all the Chapter 12 drawings No major changes, just some door movement, etc.

Table 12.2-5 Radiation Sources

a. Radiation Sources

Source Table	For	Drawing	Location	Approximate Geometry
12.2-6	RHR Heat Exchanger	12.3-1	(R1,RF) (R6,RA) (R6,RF)	Rt Cylndr (r=0.9m,l=7m)
12.2-8	RCIC Turbine	12.3-1	(R6,RC)	Rt Cylndr (r=0.5m,l=0.7m)
12.2-9	CUW Filter Demineralizer	12.3-3	(R2,RB)	2 Tanks, Rt Cylndr (r=0.6m,l=3.3m)
12.2-10	RWCU Regen Heat Exchanger	12.3-2	(R1,RC)	Rt Cylndr (r=0.4m,l=6.8m)
12.2-11	RWCU Non-Regen Heat Exchanger	12.3-1	(R1,RC)	Rt Cylndr (r=0.4m,l=5.5m)
12.2-13.1	LCW Collector Tank	12.3-37	ITEM 7	2 Tanks, Rt Cylndr (r=4.m,l=9.4m)
12.2-13.2	LCW Filter	12.3-39	ITEM 12	Rt Cylndr (r=0.5m,l=2.5m)
12.2-13.3	LCW Demineralizer	12.3-39	ITEM 11	Rt Cylndr (r=0.6m,l=2.8m)
12.2-13.4	LCW Sample Tank	12.3-38	ITEM 8	2 Tanks, Rt Cylndr (r=4.m,l=9.4m)
12.2-13.5	HCW Collector Tank	12.3-37	ITEM 13	Rt Cylndr (r=2.2m,l=4.3m)
12.2-13.6	HCW Demineralizer	12.3-39	ITEM 20	Rt Cylndr (r=0.6m,l=2.8m)
12.2-14	Offgas	12.3-50	(TF,T2)	Tank 1, Rt Cylndr (r=0.6m,l=7.6m) Tanks 2-9, Rt Cylndr (r=1.1m,l=7.6m)
12.2-29	Steam Jet Air Ejector	12.3-51	(TF,T2)	Rt Cylndr (r=0.15m,l=4.6m) Rt Cylndr (r=0.76m,l=6.1m) Rt Cylndr (r=0.2m,l=4.6m)
12.2-14	Offgas Recombiner	12.3-51	(TF,T2)	Rt Cylndr (r=1.4m,l=7m)
12.2-15.1	CUW Backwash Receiving Tank	12.3-1	(R2,RB)	Rt Cylndr (r=2.2m,l=5.7m)
12.2-15.2	CF Backwash Receiving Tank	12.3-49	(TD,T4)	Rt Cylndr (r=2.2m,l=5.7m)
12.2-15.3	Phase Separator	12.3-38	ITEM 30	2 Tanks, Rt Cylndr (r=2.4m,l=6.0m)
12.2-15.4	Spent Resin Storage Tank	12.3-38	ITEM 31	Rt Cylndr (r=2.0m,l=5.7m)
12.2-15.5	Concentrated Waste Tank	12.3-37	ITEM 35	Rt Cylndr (r=1.5m,l=4.4m)
12.2-15.6	Sol Dryer Feed Tank	12.3-41	ITEM 39	Rt Cylndr (r=1.6m,l=3.2m)
12.2-15.7	Sol Dryer (outlet)	12.3-39	ITEM 55	Rt Cylndr (r=0.2m,l=3.2m)
12.2-15.8	Sol Peletizer	12.3-38	ITEM 58	Rt Cylndr (r=0.4m,l=2.5m)
12.2-15.9	Sol Mist Separator (steam)	12.3-39	ITEM 56	Rt Cylndr (r=0.1m,l=2.8m)
12.2-15.10	Sol Condenser	12.3-40	ITEM 57	Rt Cylndr (r=0.2m,l=1.4m)
12.2-15.11	Sol Drum	12.3-39	(2,D)	Rt Cylndr (r=0.3m,l=0.8m) Box (1.5mx1.5mx1m)
12.2-16	FPC Filter Demineralizer	12.3-3	(R2,RB)	Rt Cylndr (r=0.7m,l=3.4m)
12.2-17	Supp Pool Cleanup System[c]	12.3-3	(R2,RA)	Rt Cylndr (r=0.7m,l=3.4m)
12.2-18	Control Rod Drive System[a]	12.3-2	(R4,RF)	Distributed Source
12.2-24	Transverse Incore Probe	12.3-2	(R4,RB)	Distributed Source
12.2-25	Reactor Internal Pumps[b]	12.3-2	(RF,R1)	Distributed Source
12.2-25	RIP Heat Exchanger	1.2-3b	El 3000	
12.2-26	Turbine Mositure Sep/Reheater	12.3-52	(T6,TE)	Rt Cylndr (r=1.8m,l=31.m)
12.2-27	Turbine Condenser	12.3-53	(TD,TG)	Distributed Source
12.2-28	Condenser Filter/Demineralizer			
	Filter	12.3-51	(TC-T2)	3 Tanks, Rt Cylndr (r=1.4m,l=6.1m)
	Demineralizer	12.3-51	(TC,T3)	6 Tanks, Rt Cylndr(r=1.7m,l=5.1m)
Applicant	Spent Fuel Storage	12.3-6	(R4,RF)	See Drawings
12.2-30	SGTS Filter Train	12.3-7	(R2,RB)	HEPA

Notes

[a] Maintenance Facility
[b] Maintenance Facility, see Figure 1.2-3B Elevation 3000 for drywell location
[c] Suppression pool clean up F/D uses second of Fuel Pool F/D

B. Source Geometry

Component	Assumed Shielding Source Geometry
RHR Heat Exchanger	Homogenous source over volume of heat exchanger
RCIC Turbine	Homogenous source over volume of turbine
CUW Filter Demineralizer	80% of source in first 15cm, remainder dispersed over volume.
RWCU Regen Heat Exchanger	Homogenous source over volume of exchanger
RWCU Non-Regen Heat Exchanger	Homogenous Source over volume of exchanger
LCW Collector Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
LCW Filter	Homogenous source over volume of filter
LCW Demineralizer	80% of source in first 15cm, rest evenly dispersed over volume
LCW Sample Tank	Homogenous source over volume of tank
HCW Collector Tank	Homogenous source over volume of tank
HCW Demineralizer	80% of source in first 15cm, rest evenly dispersed over volume
Offgas	90% of source in first tank in first (upper) 30 cm, rest evenenly dispersed. Remaining tanks, homogenous source over tank volume.
Steam Jet Air Ejector[b]	Homogenous source over volume of ejector
Offgas Recombiner[b]	Homogenous source over subcomponent, see Figure 12.2-14[a]
CUW Backwash Receiving Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
CF Backwash Receiving Tank	80% non solubles in slurry on tank bottom, rest evenly dispersed in volume
Phase Separator	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Spent Resin Storage Tank	Homogenous source over volume of tank
Concentrated Waste Tank	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Sol Dryer Feed Tank	Source evenly dispersed over volume
Sol Dryer (outlet)	Source evenly dispersed over volume
Sol Peletizer	Source evenly dispersed over volume
Sol Mist Separator (steam)	Source evenly dispersed over volume
Sol Condenser	Source evenly dispersed over volume
Sol Drum	Source evenly dispersed over volume
FPC Filter Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Suppression Pool Cleanup System	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Control Rod Drive System	Exposure dependent, assume evenly dispered over length of blade
Transverse In-core Probe	Point or line geometry, see Table 12.2-24
Reactor Internal Pumps	Cylindrical source coupled to water bearing components
RIP Heat Exchanger	Homogenous source over volume of exchanger
Turbine Mositure Sep/Reheater	Homogenous source over volume of component
Turbine Condenser	Homogenous source over volume of condenser
Condenser Filter/Demineralizer	
Filter	Source evenly sispersed over volume of filter
Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Spent Fuel Storage	Applicant
SGTS Filter Train	90% Particulates on HEPA filter, remaining on charcoal filter

Notes

[a]See Offgas Recombiner Description, Subsection 11.3, use inventory for preheater, recombiner, condenser and cooler for recombiner inventory for shielding applications.
[b]Radiation levels in SJAE and Recombiner highly dependent upon power level. Actual measurements on SJAE condenser contact dose rate are 20Rads/hr at 100% power and less than 5mRad/hr at 20% power.

C. Shielding Geometry in meters

Component	Room Dimensions			Wall Thicknesses[e]					
	Length	Width	Height	East	West	North	South	Floor	Ceiling
RHR Heat Exchanger	12.6	5.6	5.6	0.8	0.6	0.6	0.6	Ground	0.8
RCI: Turbine	14.6	7.8	5.6	0.8	2	0.6	0.6	Ground	0.8
CUW Filter Demineralizer	2.8	3	7.4	0.8	1	0.8	1	0.5	Hatch
RWCU Regen Heat Exchanger	7.7	3.6	6	1.4	1.4	1	1.4[a]	0.8	0.5
RWCU Non-Regen Heat Exchanger	7.4	4.4	5.6	1	1	1	1[a]	Ground	0.8
LCW Collector Tank	19	1	13	1.2	0.8	0.8	1.2	Ground	0.8
LCW Filter	.6.4	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
LCW Demineralizer[b]	19.6	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
LCW Sample Tank	19	10	13	1.2	0.8	1.2	0.8	Ground	0.8
HCW Collector Tank	9	11.2	5.4	0.8	0.8	0.8	1.2	Ground	0.8
HCW Demineralizer[b]	19.6	10.6	8	0.8	0.8	0.8	0.8	0.8	0.8
Offgas	9.1	11	16	1	1	1	1	2.5	1
Steam Jet Air Ejector and Recombiner Room	9.1	14.2	7	1	1	1	1	1	1
CUW Backwash Receiving Tank	6.6	7.4	5.6	1	0.8	0.8	1	Ground	0.8
CF Backwash Receiving Tank	5	5	25	1	1	1	1	2.5	Hatch
Phase Separator	16	8.4	4.6	0.8	0.8	0.8	1.2	0.8	0.8
Spent Resin Storage Tank	6.4	6.4	4.6	0.8	0.8	0.8	0.8	0.8	0.8
Concentrated Waste Tank	4.6	5	5.4	0.8	0.8	1.2	0.8	Ground	0.8
Sol Dryer Feed Tank	9.4	7.2	6.2	0.8	0.8	0.8	0.8	0.8	0.8
Sol Dryer (outlet)[c]	9.2	5.2	8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Peletizer	9.2	5.2	6.8	0.8	0.8	0.8	0.8	0.8	0.8
Sol Mist Separator (steam)[c]	9.2	5.2	8	0.8	0.8	0.8	0.ß	0.8	0.8
Sol Condenser	4.2	7.2	6.2	0.8	0.8	0.8	0.8	0.8	0.8
Sol Drum	3.2	3	8	0.8	0.8	0.8	0.8	0.8	0.8
FPC Filter Demineralizer	3.2	3.2	7.4	0.8	1	0.8	0.8	0.5	Hatch
Suppression Pool Cleanup Sys	3.2	3.2	7.4	0.5	0.8	0.8	0.8	0.5	Hatch
Control Rod Drive System[f]	7.6	33.4	5.8	0.6	0.6	0.6	0.6	0.8	0.6
Transverse Incore Probe	4	7.3	2.7	1	1	1	1	Mezz	0.6
Reactor Internal Pumps[f]	8.2	8.5							
RIP Heat Exchanger	Primary Containment								
Turbine Moisture Sep/Reheater	12.4	47.6	R.5	1	1	1	1	1	1
Turbine Condenser	14.2	36	25	3.5	2.5	1	1	2.5	Turbine
Condenser Filter	5	21.1	8	2.5[a]	1	1	1	1	Hatch
Condenser Demineralizer	9.8	17.3	9	1	1	1	1.6	1	1
Spent Fuel Storage	9.4	14	4.1	2	2	2	2	2	7 4[d]
SGTS Filter Train	14.4	5	8.2	0.2	0.5	0.2	0.2	2	0.6

Notes

[a] Moveable Wall
[b] LCW and HCW Demineralizer share same room
[c] Solid dryer and Mist Separator share same room
[d] 7.4 meter water depth above fuel elements
[e] North refers to plant 0 degree orientation, east = 90 degre:
[f] Maintenance Facility

D. Pipe Chase Detail

Pipe Space (PS)	Level	Location	System	Number Pipes	Size	Source	Shield Wall Thickness in meters East	West	North	South
RHR(A)	1F	(RC,R6)	RHR RCIC							
	B1F	(RC,R6)	RHR RCIC							
	B2F	(RC,R6)	RHR RCIC							
	B3F	(RC,RA)	RHR RCIC							
RHR(B)	1F	(RD,R2)	RHR HPCF							
	B1F	(RD,R2)	RHR HPCF							
	B2F	(RD,R2)	RHR HPCF							
	B3F	(RE,R2)	RHR HPCF							
RHR(C)	1F	(RE,R6)	RHR HPCF							
	B1F	(RE,R6)	RHR HPCF							
	B2F	(RE,R6)	RHR HPCF							
	B3F	(RE,R6)	RHR HPCF							
CRD-A	B2F	(RB,R3)	CRD	Control rod drive lines						
CRD-B	B2F	(RB,R5)	CRD	Control rod drive lines						
CRD-C	B2F	(RF,R3)	CRD	Control rod drive lines						
CRD-D	B2F	(RF,R5)	CRD	Control rod drive lines						
FPC/CUW	2F	(RB,R3)	FPC							
	1F	(RB,R3)	FPC CUW							
	B1F	(RB,R3)	FPC[a] CUW							
MSL/FDW	1F	(RB,R4)	MSL FDW							

ABWR UPPER DRYWELL

All Dimensions wrt
Vessel Zero
Dimensions in centimeters

Vessel Head Thck
Nominal 10.0
Max 11.5
Vessel Wall Thck
Min 17.78

Vessel Radius
Nominal 353.05
Max 355.6