Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

January 4, 1985

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

Subject: Dresden Station Unit 2
Radiological Effects of
Hydrogen Water Chemistry
NRC Docket No. 50-237

Reference: D. M. Crutchfield letter to D. L. Farrar dated April 7, 1983.

Dear Mr. Denton:

The referenced letter, Safety Evaluation Report for Dresden Unit 2 Cycle 9, requested additional information on the radiological impact of hydrogen water chemistry program. That information is provided as an attachment to this letter.

If you have any further questions regarding this matter, please contact this office.

One signed original and forty (40) copies of this letter and its attachments are provided for your use.

Very truly yours,

B. Rybak

B. Rybak
Nuclear Licensing Administrator

lm

cc: R. Gilbert - NRR
NRC Resident Inspector - Dresden

Attachment

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ATTACHMENT

As required in the Safety Evluation Report for Cycle 9 Dresden Unit 2, Commonwealth Edison submits this radiological report. Dresden Station with the cooperation of Advance Pocess Technology has conducted surveys and collected data since the onset of hydrogen injection in Unit 2. The following addresses the five items listed in the SER (Section 2.8.2).

A. A summary estimate of the additional manual dose incurred by major work functions due to the oxygen suppression system.

An estimate of the additional manual dose incurred due to the operation of hydrogen addition is summarized in Table A-1. The 10 man-rem per year increase estimate was based on an additional 5 man-rem per year incurred in the turbine building plus an additional 7 man-rem outside of the controlled area. Approximately 2 man-rem of exposure is unaccounted for. This dose is absorbed by unbadged personnel outside of Dresden's protected area. The distribution of the additional 10 man-rem among the various work groups is based on increased dose rates due to hydrogen injection for an area and occupancy time for the particular work group.

B. An estimate of potential dose avoided for crack repairs and non-destructive analysis, both annually and over plant life.

Operational and working or maintenance doses are very difficult to predict, particularly for different jobs and at different plants. This is due to a very complex relationship between many factors including shielding, equipment design, radioactive level, type of job, and abilities and inspection has grown dramatically in recent years. This preponderance of data indicates that IGSCC has a tremendous exposure impact that may be divided into the following categories:

1. Crack Repair

The majority of IGSCC related pipe failures prior to 1982 were out of vessel and in small bore piping or very severely stressed welds. The typical repair was to replace the pipe. In 1982 Commonwealth Edison introduced the technique of weld overlay to temporarily repair some flaws. Industry data compiled by General Electric indicates that a "typical" pipe failure would cost a utility approximately 30 man-rem. The 1982 experience at Quad Cities supports this data. Eight welds were repaired or overlaid at a cost of 340 Rem. Dresden Unit 2 experience in 1983 where 6 welds were overlaid with an exposure of 200 Rem supports the 30 Rem figure. Dresden Unit 3 overlaid 61 welds in 1984-5 with the support of a decontamination.

This effort was worth 300 Rem. Thus, decontamination can play a significant role.

Dresden Unit 2 has had a history of small pipe cracks (23 through 1983). Based on a 40 year plant life and this frequency of cracking, Dresden Unit 2 could expect about 40 more cracks to occur over plant life. This would indicate that Dresden should expect to consume approximately 1200 Rem in normal pipe repairs or approximately 1800 Rem total.

2. In Vessel Repairs

   There is a significant amount of 304 SS located inside the vessel. Man-rem exposure for replacing feedwater spargers at Dresden may be applicable here. Dresden Unit 2, used 300 Rem and Unit 3, 375 Rem for this repair. This can be compared to General Electric industry data presenting 300 Rem average.

3. Pipe Replacement

   Several BWR's have experienced such severe cracking in their primary piping that they have elected to replace the pipe. This type of repair has always been done in conjunction with a decontamination. This type of repair and the dose incurred is very dependent on the exact size of repairs. Industrial data to date indicates that replacement may cost between 1000 Rem and 2000 Rem.

4. Inductive Heat Stress Improvement (IHSI)

   IHSI was done at Dresden Unit 3 in 1983. This activity incurred a total exposure of approximately 241 Rem.

5. Inservice Inspection

   Dresden experience with ISI can be summarized as follows:

   a) Dresden Unit 2 - 1983 without decontamination - augmented program - 168.7 Rem

   b) Dresden Unit 3 - 1983-4 with decontamination - I.E. Bulletin 83-02 program - 182.7 Rem

C. A summary of the value impact associated with operation of the system in terms of occupational dose (and other parameters are available, such as cost).

The radioation impacts of hydrogen addition, Inductive Heat Stress Improvement and crack repairs are summarized in Table B-1. A brief review of Table B-1 indicates that in terms of occupational dose for the remaining life of the unit both hydrogen addition (290 Rem) and IHSI (250 Rem) are dose economical when compared to exposure required to replace pipe without hydrogen or IHSI (1800 Rem).

The Dresden ALARA approach to surveillances, inspections, and maintenance in high radiation areas affected by Hydrogen Addition (condenser pit, heater bays, turbine shield, X-AREA, air ejector rooms, etc.) dictates that hydrogen be turned off prior to entrance. The dose impact of conducting normal activities is minimized to no more than that expected without hydrogen. Formal ALARA reviews may be required prior to conducting some work in high radiation areas effected by hydrogen and additional measures may be taken. A typical example of this was repair to a reboiler in the moisture separator bay. Hydrogen was turned off and a load reduction was initiated to reduce working dose.

The hydrogen system at Dresden Unit 2 may be atypical cost because it was installed as a test system in 1981 then upgraded in 1983 and is undergoing further refinement during the current outage. Some of the equipment will have been reworked three times by 1985, while other parts were installed purely as test equipment and have been either removed or abandoned.

The initial system cost an estimated $300,000 in 1981-1982. This system was largely redone and upgraded in 1983 at a cost of $100,000. Additional work planned for the 1984 outage will cost approximately $600,000.

A new hydrogen addition system designed and built once from scratch would cost between $750,000 and $1,250,000 (1984 dollars). This would be independent of any additional shielding requirements or any tests such as the proposed "Mini Test". The cost would be strongly independent upon the mode of hydrogen supply (gaseous liquid, electrolysis, reformation), extent of chemistry monitoring that must be supplied, and other plant specific requirements.

The expense cost of hydrogen/oxygen would be very dependent on the utilities location and choice of supply and flow rate. Liquid hydrogen could cost from approximately 80¢/100 ft^3 while gas can cost 3 times as much. Storage equipment could be leased from a gas supplier or purchased outright. Dresden currently spends approximately $400,000 for merchant hydrogen per year.

Hydrogen produced on site would require large investment cost but low annual expense. Recovery systems as a retrofit could also reduce expenses but at the expense of high installed cost.

For comparison purposes the Dresden Unit 2 system if designed from scratch as an operational not experimental system has an investment cost of $1,000,000. The annual expense cost associated with this is approximately $400,000. The Dresden IHSI program (1983) cost approximately $2,500,000 for comparison purposes.

The repair expense associated with crack repair can vary extensively depending on the extent and type of repair as well as the dose rates. The Dresden Unit 3 weld overlay work in 1983-4, done during a planned, but extended outage with decontamination, cost about $50,000 per weld. The 1982 Quad Cities repair was done midcycle and unplanned without decontamination, involving repair and overlay, cost $2,500,000 per weld. In both of these instances the pipe is ultimately replaced at an additional cost.

Recirculation System replacement costs run into the $50-200 million range depending very strongly on the nature of the system and extent of pre-outage preparation.

Inservice Inspection programs (augmented) can cost as much as $1,000,000 per outage depending again on radiation levels and extent of inspections.

There is a hidden cost involved in crack repairs and even inspections. The majority of this work is done either in a forced outage or on the critical path of a planned outage. The cost of replacement power due to these activities can be extensive and is typically borne by the consumer through fuel adjustment costs. Utilities are very reluctant to divulge replacement power costs as they can vary seasonally as well as with what is available at the time. This cost can be very large, ranging in the hundreds of thousands of dollars on a hot summer day to very little in the Spring and Fall.

D. A summary of permanent Radiation Protection Program changes needed to ensure that ALARA dose result from increased operational dose rates.

Hydrogen additional significantly influences the dose rates in some high radiation areas of the turbine building. This dose rates may increase by 6 to 10 fold. In order to remain consistent with the station's ALARA philosophy the following procedures or changes have been implemented:

1. The entrance to various plant areas have been posted with signs notifying personnel that dose rates may be significantly increased due to hydrogen addition. These areas include:

   a) Low pressure heater bays

   b) High pressuer heater bays

   c) Moisture Separator Areas

   d) Turbine Pipeway

   e) X-Area

   f) Drywell

   g) The area behind the biological shield on the Turbine floor

   h) Steam Jet Air Ejector Rooms

   i) Recombiner Rooms

   j) Condensers

2. Dresden Adminstrative Procedure 12-8, "Access Control of Radiation Areas Significantly Affected by Hydrogen Addition", was prepared. Any individual desiring entry contacts the Shift Engineer, who stops the injection of hydrogen until personnel have vacated the area. A log is maintained to document entry and control access.

3. The turbine building crane cab has been locked and reclassified as a High Radiation Area.

4. The use of a remote crane control device has been initiated. This allows the operation to be stationed beyond the shield wall on the main turbine floor and protects him from radiation fields emanating from the top of the turbine.

5) Removable shield walls have been utilized where existing shielding is inadequate. As an example, at the end of the Unit 2 high pressure turbine a gap between the 3 inch steel shield and the 30 inch concrete wall permits a 60 mR/hr field to exist. A watershield was put into place reducing the dose rate to 10 mR/hr. Lead blankets have also been used to shield steam sample lines, where appropriate.

6. In plant surveys of 26 hydrogen addition points were conducted at monthly intervals. These surveys have provided a good data base and have served as an indication of changing conditions.

E. Facility dose rate surveys which reflect typical operational conditions with and without hydrogen injection at high power.

The impact of hydrogen water chemistry on the facilities dose rate was quantified by examining dose rate surveys taken in plant, on-site and off-site.

In plant dose rate surveys of 26 locations were conducted at regular intervals (either weekly or monthly) by Commonwealth Edison personnel using the Eberline R03 ionization survey meter. In addition, surveys of 32 points using a multiplying ion chamber were conducted by a contracted service. The majority of the survey points has area dose rates below 2 mR/hr. Thus, the contractor concentrated on examining low dose rate areas using an instrument with a sensitivity several orders of magnitude greater than CECo's

In order to assess the effects of hydrogen injection, dose rate measurements were taken under the following conditions: with hydrogen injection, without hydrogen injection and with Unit 2 shutdown. The results of these surveys are summarized in Table E-1.

The data indicates that the three plant areas most significantly influenced by hydrogen injection are the main turbine floor, the area above the main turbine floor and the condensate pump room area. The largest average increase is seen on the turbine deck where dose rates have risen by 450%. Additional decay time in the condenser and hotwell lessen the N-16 contribution in the condenser pump room so the dose rates increased by only 340%.

The area that showed the most significant increase was the turbine crane cab. The radiation shine off the top of the turbine increased the dose rate to the crane operator to as much as 100 mR/hr. This dose rate is a function of positioning over the turbine as well as the amount of hydrogen being injected into the feedwater.

Other areas surveyed in the turbine building realized an insignficant increase in dose rates. All of these areas are well shielded from reactor steam and condensate lines.

Assessment of the contribution of hydrogen water chemistry to environmental dose required the measurement of on-site and off-site points under at least two, preferably three conditions. The measurement conditions include Unit 2: 1) at full power with hydrogen chemistry, 2) at full power without hydrogen water chemistry, and 3) shutdown. Units 1 and 3 were in a shutdown mode during all measurements.

Thirty locations were selected to be surveyed based on their positions relative to a reference point. The reference point, the intersection of the turbine axis and center line between the D-2 low pressure tubines B and C was assumed to be the center of the N-16 source for the environs. Measurements were taken for 5 to 30 minutes using a multiplying ion chamber. Unfortunately, not all locations could be surveyed under all three conditions. See Table E-2.

Based on the data obtained, the contributions from hydogen water chemistry to the environs dose rate is a function of measurement location. Significant variation exists in the dose rate contributions at similar distances. This is due to the shielding effect of various on site structures and the dose contributed from radioactive on-site storage (such as holding tanks).

The dose rates within 750 feet generally follow an expected pattern. Dose rates close to the reactor building are low due to the shielding of the plant walls. As the distance from the reactor building increases the dose rates increase to a maximum and then decrease gradually. The largest contribution found due to hydrogen injection was 25 μR/hr at 440 feet south of the reference point. At distances greater than 1500 feet, the dose rate contribution is typically below 1 μR/hr. Measurements at locations 21, 24 and 28 are considered to be measurement error of momentary background fluctuations.

TABLE A-1

EFFECT OF HYDROGEN WATER CHEMISTRY ON PERCENTANGES OF ANNUAL COLLECTIVE DOSE AT DRESDEN SITE BY WORK FUNCTION

	Hydrogen Water Chemistry Unit 2		Normal Water Chemistry* Unit 2	
WORK FUNCTION	PERCENT OF DOSE	Man-Rem	PERCENT OF DOSE	Man-Rem
Reactor Operations and Surveillance	10.9	212	10.7	207
Routine Maintenance	31.6	616	31.7	613
In-Service Inspection	6.6	128	6.6	128
Special Maintenance	39.5	768	39.6	766
Waste Processing	4.9	95	4.9	95
Refueling	6.5	126	6.5	126
TOTALS	100	1945	100	1935

* Based on Exposure Data 1976-1981

TABLE B-1

SUMMARY OF IGSCC RELATED RADIATION EXPOSURE AT

DRESDEN NUCLEAR POWER STATION [3, 4]

	Annual REM	Remaining Plant Life REM	Total Plant Life REM
Hydrogen Addition	12	290	290
IHSI	0	250	250
Crack Repairs	48	1200	1800
ISI [1]	170	4250	
ISI [2]	50	1250	

1. Augmented inspection, no benefit of hydrogen addition assumed.

2. Reduced inspection program

3. This data is based on plant exposure rates reflected in the 1981, 1982 and 1983 Dresden Unit 2 outages and assumes no escallation of radiation levels.

4. Crack repair estimates are based on hydrogen being 100% effective at mitigating IGSCC. There is very little data available to base a prediction of effectiveness at this time.

TABLE E-1

TURBINE BUILDING DOSE RATE SUMMARY

	DESCRIPTION	METER	D2 OPERATING CONDITION HWC (mR/h)	HWC OFF (mR/h)	SHUTDOWN (mR/h)	DOSE RATE CONTRIBUTION HWC (mR/h)	D2 (mR/h)	HWC INCREASE FACTOR
BASEMENT								
1	Floor of Condensate Pump Room	MIC	1.1	0.5	0.3	0.8	0.2	4.0
2	Wall Next to Condensate Pump A	MIC	6.9	2.2	0.7	6.2	1.5	4.1
3	Condensate Pump C	MIC	3.4	1.5	0.7	2.7	0.8	3.4
4	Hydrogen Flow Control Valves	MIC	0.6	0.2	0.07	0.5	0.13	3.8
5	D2 Condensate Pump A Suction	RO3	9.8	5.0	1.4	8.4	3.6	2.3
6	D2 Condensate Pump B Suction	RO3	10.5	5.0	1.8	8.7	3.2	2.7
7	Stairwell Next to Watertight Door	MIC	0.2	0.07	0.07	0.13	-	-
8	Mezzanine of Condensate Pump Room	MIC	0.8	0.6	0.6	0.2	-	-
9	Instrument Rack 2252-16	MIC	0.7	1.0	1.1	-	-	-
GROUND FLOOR								
10	D2 Condensate Demin Pipe Chase	RO3	1.2	1.0	0.6	0.6	0.4	1.5
11	D2 Condensate Demin Valve Gallery Instrument Rack	MIC	1.0	0.5	0.3	0.7	0.2	3.5
12	D2 Condensate Demin Pipe Chase	MIC	1.1	0.7	0.5	0.6	0.2	3.0
13	D2 Condenser Tube-Pull Area	RO3	0.5	0.3	0.1	0.4	0.2	2.0
14	D2 Ultra-sonic Resin Cleaner Panel	MIC	1.1	1.0	0.9	0.2	0.1	-
15	D3 Condensate Make-Up Pump Area	MIC	2.5	2.4	2.3	0.2	0.1	-
16	D2 Trackway-Control Room Stairs	MIC	0.04	0.02	0.01	0.03	0.01	3.0
17	D2 Corridor-FW Sample Rack 2252-71	MIC	2.5	1.1	1.8	0.7	-	-
18	D2 Corridor-X Area Entrance	RO3	1.6	1.2	1.2	0.4	0	-
19	D2 Corridor-Moisture Separator Wall	RO3	1.2	1.5	1.5	-	0	-
20	D2 Corridor-Make-Up Pump 2B-4320	MIC	3.5	3.4	3.5	-	-	-
21	D2 Corridor-D2/3 Boundary By EIC 23	MIC	2.6	1.8	2.2	0.4	-	-
22	D2/3 Elevator By Reboiler Instr. Rack	MIC	1.1	0.6	0.9	0.2	-	-
23	D2/3 Condensate Treatment Panel	MIC	8.8	8.1	8.8	-	-	-

TABLE E-1

TURBINE BUILDING DOSE RATE SUMMARY (Continued)

DESCRIPTION	METER	D2 OPERATING CONDITION HWC (mR/h)	HWC OFF (mR/h)	SHUTDOWN (mR/h)	DOSE RATE CONTRIBUTION HWC (mR/h)	D2 (mR/h)	HWC INCREASE FACTOR
TURBINE FLOOR (Continued)							
42 D2 Turbine-South Aisle MG Set 2A-202-51	R03	1.1	0.4	0.2	0.9	0.2	4.5
43 D2-A SJAE Gallery	R03	0.4	0.4	0.3	0.1	0.1	-
44 D2-A SJAE Gallery	R03	0.4	0.4	0.3	0.1	0.1	-
45 D3 Turbine Generator Housing Door	MIC	0.04	0.02	0.01	0.03	0.01	3.0
46 D3 Turbine Instrument Rack 2253-19	MIC	0.04	0.02	0.02	0.02	-	-
47 D2-B SJAE Gallery	R03	1.4	2.1	1.8	-	0.3	-
48 D2 Offgas Train Valve Room	MIC	1.9	2.1	2.1	-	-	-
ABOVE TURBINE FLOOR							
49 D2 Turbine Roof (East End)	R03	13	4	0.2	13	4	3.3
50 D2 Turbine Roof (Middle)	R03	61	12	0.2	61	12	5.1
51 D2 Turbine Roof (West End)	R03	61	13	0.2	61	13	4.7
52 Turbine Building South Stairs (601 ft. Crane Rail)	MIC	6.1	2.3	0.2	5.9	2.1	2.8
53 Turbine Building South Stairs (Vent Fan)	R03	1.1	0.4	0.2	0.9	0.2	4.5
54 Turbine Building South Stairs (3rd Level)	R03	0.4	0.4	0.5	-	-	-
55 Turbine Building South Stairs (Vent Sampler)	R03	19	2.7	0.2	19	2.5	7.6

ABBREVIATIONS

MIC-Multiplying Ion Chamber
R03-Eberline Ion Chamber

TABLE E-1

TURBINE BUILDING DOSE RATE SUMMARY (Continued)

DESCRIPTION	METER	D2 OPERATING CONDITION HWC (mR/h)	D2 OPERATING CONDITION HWC OFF (mR/h)	D2 OPERATING CONDITION SHUTDOWN (mR/h)	DOSE RATE CONTRIBUTION HWC (mR/h)	DOSE RATE CONTRIBUTION D2 (mR/h)	HWC INCREASE FACTOR
GROUND FLOOR (Continued)							
24 D2 Corridor-Moisture Separator Room Change Area	R03	0.6	0.4	0.4	0.2	-	-
25 D3 Corridor-FW Sample Rack 2253-71	MIC	2.4	1.8	3.5	-	-	-
MEZZANINE							
26 Turbine Building Sample Panel	MIC	0.6	0.6	0.5	0.1	0.1	-
27 Special Feedwater Sample Equipment	MIC	1.5	1.5	1.8	-	-	-
28 D2 Reactor Water Sample Line	R03	75	100	90	-	10	-
29 D2 Clean-Up Pump Room Entrance	R03	12	14	14	-	0	-
TURBINE FLOOR							
30 D2 Turbine Generator Housing Door	MIC	0.9	0.11	0.02	0.9	0.1	9
31 D2 Turbine Instrument Rack 2252-19	MIC	1.2	0.3	0.03	1.2	0.3	4.0
32 D2 High Pressure Turbine Shield Wall	MIC	4.4	0.9	0.10	4.3	0.8	5.4
33 D2 Turbine-West Walkway	MIC	1.3	0.5	0.3	1.0	0.2	5.0
34 D2 Turbine-West Shield Wall	R03	55	14	0.1	55	14	3.9
35 D2 Turbine-Over West Shield Wall	R03	265	70	0.3	265	70	3.8
36 D2 Turbine-South Shield Wall	R03	1.1	0.3	0.1	1.0	0.2	5.0
37 D2 Turbine-South Shield Wall Over the Top	R03	210	-	0.2	210		
38 D2 Turbine-East Shield Wall	MIC	40	9	0.1	40	9	4.4
39 D2 Turbine-South Aisle MG Set 2A	MIC	0.8	0.3	0.03	0.8	0.3	2.7
40 D2 Turbine-West Walkway (Superv. Shack)	MIC	1.2	0.3	0.1	1.1	0.2	5.5
41 D3 Turbine-South Aisle MG Set 3A	MIC	0.09	0.04	0.01	0.08	0.03	2.7

TABLE E-2

ENVIRONS DOSE RATE SUMMARY

LOCATION	DISTANCE AND[1] DIRECTION (ft)	UNIT-2 OPERATING CONDITION[2]			HWC DOSE RATE CONTRIBUTION (μR/h)
		HWC (μR/h)	HWC OFF (μR/h)	SHUTDOWN (μR/h)	
1	460 SE	49	32	29	17
2	440 S	82	57	63	25
3	480 S	26	19	26	7
4	400 S	33	29	26	4
5	320 SW	26	24	19	2
6	680 SW	13	10	10	3
7	490 W	31	24	16	7
8	700 W	15	11	10	4
9	580 NW	29		13	13
10	500 N	29		18	9
11	410 N	29		18	9
12	370 NE	40		24	13
13	730 E	63		79	< 1
14	820 E	16		16	< 1
15	910 SE	13	8	9	5
16	1000 S	9	8	8	1
17	1100 W	11	8	7	3
18	1200 NW	10	8	8	2
19	970 N	12		8	3
20	1500 N	8		7	1
21	1300 E	22		12	8
22	1400 S	8	8	8	< 1
23	1700 W	8	7	6	1
24	2200 W	7		5	2
25	2000 N	8		8	< 1
26	1800 NE	7		7	< 1
27	1900 E	10		10	< 1
28	2700 W	7		5	2
29	2500 N	8		7	1
30	2900 N	6		6	< 1

(1) Approximate Distance From D-2 Turbine

(2) Units 1 And 3 Were Shut Down For All Measurements