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May 22, 1974

Regulatory Docket File

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U.S. ATOMIC ENERGY COMMISSION

Mr. D. L. Ziemann, Chief
Operating Reactors - Branch 2
Directorate of Licensing
Office of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Subject: Dresden Unit 2 - Supplement 1 to Amendment No. 3 to the Full-Term Operating License Application, AEC Dkt 50-237

Dear Mr. Ziemann:

In response to your letter dated February 22, 1974, attached is Amendment No. 3, Supplement 1 to the Dresden Station Unit 2 Application for Conversion from Provisional to Full-Term Operating License. The analyses of control room dose discussed in the attached supplement were done using the criteria established in your letter.

The results do not, in our judgement, reflect a realistic evaluation of the possible control room operator radiation doses in the event of the postulated accidents. Chapter 14 of the Dresden Station Units 2 and 3 Final Safety Analysis Report describes realistic fission product releases and meteorological conditions to be used as criteria for this analysis. Using these criteria, the control room operator doses would be at least a factor of 600 less than those determined by applying your criteria. This realistic analysis is discussed in Section 2.5 of the attached supplement.

In our judgement, the Final Safety Analysis Report criteria and Section 2.5 should be used as a basis for evaluating the adequacy of the plant safeguards.

Three signed originals and 37 copies of this supplement are provided for your review.

Very truly yours,

J.S. Abel
J.S. Abel
Nuclear Licensing Administrator
Boiling Water Reactors

SUBSCRIBED and SWORN to
before me this 22nd day
of May, 1974.

Brenda Pannier
Notary Public

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DRESDEN STATION UNIT 2

Application for Conversion from

Provisional to Full-Term Operating License

AMENDMENT NO. 3

Supplement 1

(Response to AEC Questions Dated February 22, 1974)

COMMONWEALTH EDISON COMPANY

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Question 2. Provide an analysis of the design basis accidents given in 1. above (accidents in all three units should be studies and the most limiting accidents selected for discussion) indicating the thyroid, beta skin, and whole body gamma doses received by control room operators. The information should be provided in two tables. One summarizing the basic assumptions and input data used in the analysis and another summarizing the doses. The following should be provided in the section discussion or the tables:

a. The source terms used for each point of release, including containment leakage, exfiltration if any, vent and stack releases, bypass leakage, penetration leakage, and activity that may be transferred directly into the control building.

b. The location of, and distances between, the points of release and the air intake of the emergency zone (control room).

c. The calculated dilution factors between the source points and the air intake of the emergency zone. Regulatory Guide 1.3 fumigation assumptions should be used to determine X/Q from elevated releases.

d. A discussion, adequately referenced, explaining the methods used to determine the doses.

Thyroid doses should be calculated assuming no protection from breathing apparatus. If an air exchange rate of less than 0.06 volume changes per hour is used (isolated control room) periodic varification tests, to assure maintenance of control room leaktightness, must be performed. In the event the doses exceed the 30 rem guideline limitation of GDC #19, consideration should be given to the installation of charcoal filter units. Preliminary AEC evaluations indicate the need for such filters.

Response <u>2.0 Accident Re-evaluation</u>

This analysis was performed for the Dresden 2 design-basis-accidents postulated in question 1.

<u>2.1 LOCA Analysis</u>

a. Source terms for the accident were taken from TID14844 with a reactor power level of 2527 Mwt. The curie inventory for the reactor core for noble gases and halogens is given in Table 2.1-1.

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b. 100% of the noble gas inventory and 25% of the halogen inventory of the core was assumed to be immediately available for release from the primary containment.

c. The primary containment leak rate was assumed equal to its technical specification value of 1.6%/Day.

d. No mixing in the secondary containment was assumed.

e. The standby gas treatment filter efficiency for halogens was taken as 90%.

f. The control room dimensions were taken as 84'X40'X14.5' yielding a volume of 48,720 ft.^{3} (1379.6 M^3)

g. This analysis assumed in automatic isolation system for the control room, with an air exchange rate of .06 Vol./hr.(.023 M^3/sec) during isolation, and a purging system composed of the regular summer exchange rate of 13,600 cfm (6.4185 M^3/sec).

h. The control room intake is located 130 meters from the Dresden 2&3 chimney. The vertical distance from the centerline of the control room intake to the top of the chimney was taken as 83 meters.

i. Meteorology assumptions: Source, Regulatory Guide 1.3 figures for an elevated release.

Time	X/Q(sec/M^3)
0-.5 hr.	$9.12X10^{-4}$ (fumigation)
.5-8 hr.	$4.0X10^{-7}$ (conservative estimate)

The above dispersion values do not take into account the effect of the turbine building wake on further reducing the concentration at the control room intake.

j. The control room was assumed isolated during the 1/2 hour fumigation condition with the summer air exchange rate being used following this initial time period.

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k. Breathing rate used for the periods are given below.

0-8 hr. $3.47 X 10^{-4} M^3/sec$.

2.2 Fuel Handling Accident Analysis

a. Source Term: In the fuel handling accident (FHA) analysis in question 1., 145 rods were assumed to be damaged. Using a 1.5 relative peaking factor for the damaged rods inventory. This corresponds to 15.493 Mwt. equivalent source term for the Dresden 2 Facility. A 24 hour decay period was assumed before refueling operations begin. The starting inventory for the FHA is then given in Table 2.2-1.

b. 10% of noble gas and halogen inventory in the damaged rods was assumed released into the reactor water.

c. A decontamination factor of 1.0 was assumed for noble gases, and 100 for halogens released into the reactor or water.

d. The composition of halogens in the air above the reactor water was assumed to be 75% inorganic iodine and 25% organic iodine.

e. The standby gas treatment filter efficiency was taken as 90% for inorganic iodines and 70% for organic iodines.

f. All radioactivity released in the accident was assumed to be exhausted from the reactor building in 2 hours. (5 Vol./2 hr.)

Assumptions f.-k. used in the LOCA analysis were also applied.

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2.3 Main Steam Line Break Analysis

a. The main steam line break accident (MSLBA) source terms are the same as used in question 1. A WARLOC line break analysis indicated a total released fluid mass of 30,125 lbs. This lost fluid was assumed to contain the radioactivity concentrations as given in the Tech. Specification, (5 uCi/cc of 'I 131 dose equivalent') plus noble gases concentrations corresponding to an off-gas release rate of 0.1 Ci/sec (after a 30 minute hold-up). The total equivalent curie release from a main steamline break accident for the Dresden 2 facility is given in Table 2.3-1.

b. All the radioactivity is released from the turbine building--volume over a 2 hour period.

c. The control room is isolated over the two hour period and then purged at the end of this period. (air exchange are those given in g. of the LOCA analysis).

d. Breathing rates are the same as in k. of the LOCA analysis.

e. Since the control room for Dresden 2 is located within the turbine building complex, two mutually exclusive paths exist for in leakage into the control room during a MSLBA. The first path includes leakage from the contaminated free air volume of the turbine building thru passageways into the control room. Using a free air volume for the turbine building of $1.7X10^5$ M^3, the initial intake rate into the control room thru this path can be calculated for I 131.

$$\frac{68.31 \text{ Ci.}}{1.7X10^5 \ M^3} \text{ X } 0.023 \ M^3/\text{sec.} = 9.24X10^{-6} \text{ Ci./sec.}$$

A second pathway consists of the normal release of the radioactivity from the top of the turbine building into the turbine building wake. Taking a very conservative cross-sectional area (A) of (Height = 30M. and width 30 M.) A=900 M^2.

$$X/Q = \frac{1.0}{.5A\bar{u}} = \frac{1.0}{(.5)(900 \ M^2)(1.0M/s)} = 2.22\text{-}03 \text{ sec}/M^3$$

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$$(68.31\ \mathrm{Ci.})\times(8.33\times10^{-4}\ \mathrm{T.B.Vol/sec})$$
$$\times(2.22\times10^{-3}\ \mathrm{sec/M^3})0.023\ \mathrm{M^3/sec})=$$
$$2.91\times10^{-6}\ \mathrm{Ci/sec}$$

This simple calculation illustrates that the critical path will be through inseepage of the contaminated turbine building air directly into the control room. In reality, both pathways would occur during the accident with the inseepage term of .06 Vol/hr. being split between the two pathways. This analysis has assumed the more critical pathway (turbine building to control room directly). The turbine building total loss term was taken as 3 vol./hr. (8.33×10^{-4} Vol./sec.)

2.4 Results of Analysis

The results of the analysis for the three design basis accidents are given in Table 2.4-1. The following notes apply to data tabulated.

(1) Gamma immersion dose from finite cloud in control room reference Section 7-5.4 equation 7.76, Meteorology and Atomic Energy 1968.

(2) For beta surface dose plus whole-body gamma, apply D (beta)= 0.23 $\bar{E}$(beta)X from Regulatory Guide 1.3 Multiply by stopping power of tissue relative to air (1.13 from ICRP II, (page 22) and add in finite cloud gamma dose.

(3) Reference Section 7-4.1 of Meteorology and Atomic Energy 1968, for beta skin dose plus addition of finite cloud gamma dose.

(4) Initial concentration in turbine building at start of time interval. (see Table 2.4-1)

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2.5 Evaluation by Dresden SAR Assumptions (Realistic)

The values presented in Table 2.4-1 were obtained using the AEC "Defense in Depth" concept which is required in an AEC licensing application. This evaluation is necessary to demonstrate to the Regulatory Staff, that using their conservative assumptions, the engineering safeguard systems provided in the plant design assure adequate safety margins for any dose received by control room operators during the postulated design-basis-accidents. However, the "Defense in Depth" concept has safety margins built into its conservative assumptions used in the evaluation of the effectiveness of individual safeguards equipment. To evaluate the magnitude of the safety margins inherent in the assumptions specified by the Regulatory Staff for the previous evaluation ("AEC value"), an evaluation of the dose to control operators from the postulated accidents has been performed using More Probable Accident Constraints ("MPAC value").

The results of the MPAC evaluation are presented in Table 2.5-1. The assumptions of safeguards equipment effectiveness used in this analysis are given and justified in Chapter 14 of the Dresden Safety Analysis Report for the loss-of-coolant and fuel handling accidents. Included in the MPAC evaluation, is a conservative estimate of the atmospheric dispersion parameter (X/Q) and an intake rate into the control room equal to the summer intake rate for the duration of the accidents. The automatic isolation system on the control room HVAC system would tend to minimize the dose further, so an upper bound can be placed on the dose to the control room operators by assuming the system is inactive during the course of these accidents.

The main steamline break accident in the MPAC evaluation assumed a 5.5 second closure time for the main steamline isolation valve. An analysis of the accident, using the previously referenced WARLOC report,indicated that the mass of fluid lost in such an accident would include 20,000 lbs. of steam and 10,125 lbs. of reactor water. The concentrations in the reactor water of biologically significant iodines was estimated in Chapter 14 of the Dresden Safety Analysis Report and the "I-131 dose equivalent" concentration was assumed. The concentrations in the reactor steam of the noble gases was assumed

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to correspond to an off gas release rate of 0.1 Ci/sec (after a 30 minute hold-up line). The WARLOC analysis also indicated a rapid release (puff) of approximately 40 percent of the steam/water mixture. The remaining inventory was released as in Section 2.3 with a release assumed to occur from the top of the turbine building. A conservative value of the atmospheric dispersion parameter (X/Q) was used in the MPAC analysis for dispersion in the turbine building wake. Control room HVAC system was assumed to operate in the same manner as given in Section 2.3. Breathing rates for the control room operators were the same as those used in the previous respective sections for all the postulated accidents.

The margins of safety inherent in the Regulatory Staff's conservative assumptions are given in Table 2.5-2. The safety margin for the thyroid dose (the only significant dose in any of the accidents given in Table 2.4-1) range from a factor of 600 for the main steamline break accident to approximately 2 million for the loss-of-coolant accident.

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Table 2.1-1 Reactor Core
Inventory used in LOCA Analysis

Isotope	Curies	Rem/inhaled ci.
I 131	6.339+07	$1.48x10^6$
I 132	9.618+07	$5.35x10^4$
I 133	1.421+08	$4.0x10^5$
I 134	1.661+08	$2.5x10^4$
I 135	1.290+08	$1.24x10^5$
Xe*131	7.194+05	
Xe*133	3.401+6	
Xe 133	1.408+08	
Xe*135	3.861+07	
Xe 135	1.270+08	
Xe 138	1.203+08	
Kr*85	2.954+07	
Kr 85	1.008+06	
Kr 87	1.653+07	
Kr 88	8.332+07	

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Table 2.2-1 Inventroy of Iodine
and Noble Gases in Fuel Elements
Damaged in Fuel Handling Accidents

Isotope	Curies
I 131	3.566+05
I 132	5.767+02
I 133	3.915+05
I 134	5.660-03
I 135	6.556+04
Xe*131	3.637+03
Xe*133	1.542+04
Xe 133	7.569+05
Xe 135	1.260+05
Kr*85	3.992+03
Kr 85	6.178+03
Kr 87	2.815-01
Kr 88	1.261+03

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Table 2.3-1 Radio Isotopes Released
During Main Steamline Break Accidents

Isotope	Curies
I 131	6.831+01
Kr*83	3.552-02
Kr*85	6.284-02
Kr 85	2.049-04
Kr 87	2.049-01
Kr 88	2.049-01
Kr 89	1.352+00
Kr 90	2.869+00
Xe*131	1.558-04
Xe*133	3.006-03
Xe 133	8.511-02
Xe*135	2.705-01
Xe 135	2.282-01
Xe 137	1.558+00
Xe 138	9.236-01
Xe 139	2.910+00
Xe 140	3.115+00

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Table 2.4-1
Summary of Dose Evaluation
LOCA Analysis

Time Interval Hours	(X/Q) sec/M^3	*	Whole-Body Dose(1) Rem	Body-Surface Dose(2) Rem	Skin Dose(3) Rem	Thyroid Rem
0-.5 **	9.12×10^{-4}	I	.0177	.2805	.2196	7.18
.5-8	4.0×10^{-7}	P	.0065	.1056	.0767	4.3
8-720	--	P	--	--	--	--
Total			.0243	.3862	.2964	11.5

FHA Analysis

Time Interval Hours	(X/Q) sec/M^3	*	Whole-Body Dose Rem	Body-Surface Dose Rem	Skin Dose Rem	Thyroid Rem
0-.5 **	9.12×10^{-4}	I	.001445	.03696	.01372	.4206
.5-2.5	4.0×10^{-7}	P	.000295	.00756	.00280	.0862
Total			.00174	.04453	.01652	.5068

MSLBA Analysis

Time Interval	(Xo) I-131(4) ci./M^3	*	Whole-Body Dose Rem	Body Surface Dose Rem	Skin Dose Rem	Thyroid Rem
0-2	4.02×10^{-4}	I	.000207	.002534	.001336	23.55
2-3	7.0×10^{-8}	P	.000007	.000088	.000045	.83
Total			.000214	.002622	.001382	24.38

* Indicate condition of Control Room HVAC system(i.e.) I - isolation mode, inleakage = 48.7 cfm
P - nominal summer intake rate = 13,600 cfm

** A fumigation condition was assumed to exist during this interval.

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Table 5-1
Summary of Dose Evaluation
(MPAC Dose)

LOCA Analysis

Time Interval Hours	(X/Q) sec/M^3	*	Whole-Body Dose(1) Rem	Body-Surface Dose(2) Rem	Skin Dose(3) Rem	Thyroid Rem
0 - 8	4.0×10^{-7}	P	3.0×10^{-7}	5.35×10^{-6}	4.0×10^{-6}	6.34×10^{-6}
8 - 720	---	P	---	---	---	---
Total			3.0×10^{-7}	5.35×10^{-6}	4.0×10^{-6}	

FHA Analysis

Time Interval Hours	(X/Q) sec/M^3	*	Whole-Body Dose(1) Rem	Body-Surface Dose(2) Rem	Skin Dose(3) Rem	Thyroid Rem
0 - 8	4.0×10^{-7}	P	6.66×10^{-7}	1.89×10^{-5}	7.4×10^{-6}	8.2×10^{-6}
8 - 720	---	P	---	---	---	---
Total			6/66x10^{-7}	1.89×10^{-5}	7.4×10^{-6}	8.2×10^{-6}

MSLBA Analysis

Time Interval Hours	(X/Q)** sec/M^3	*	Whole-Body Dose(1) Rem	Body-Surface Dose(2) Rem	Skin Dose(3) Rem	Thyroid Rem
0 - 2	2.22×10^{-3}	I	1.374×10^{-6}	2.454×10^{-5}	1.984×10^{-5}	3.856×10^{-2}
2 - 3	2.22×10^{-3}	P	$.026 \times 10^{-6}$	$.053 \times 10^{-5}$	$.042 \times 10^{-5}$	$.13 \times 10^{-2}$
Total			1.4×10^{-6}	2.507×10^{-5}	2.026×10^{-5}	3.986×10^{-2}

*Indicate condition of Control Room HVAC system (i.e.) I - isolation mode, in leakage = 48.7 cfm
P - nominal summer intake rate = 13,600 cfm

**Conservative value for Turbine-Building Wake X/Q

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TABLE 2.5-2

A COMPARISON OF AEC (CONSERVATIVE) EVALUATION WITH THE MPAC (REALISTIC) EVALUATION FOR THE CONTROL ROOM DOSE ANALYSIS
(AEC VALUE/MPAC VALUE)

POSTULATED ACCIDENT	WHOLE-BODY DOSE RATIO	BODY-SURFACE DOSE RATIO	SKIN DOSE RATIO	THROID DOSE RATIO
LOCA	$8.1X10^4$	$7.22X10^4$	$7.4X10^4$	$1.81X10^6$
FHA	$2.61X10^3$	$2.36X10^3$	$2.23X10^3$	$6.18X10^4$
MSLBA	$1.53X10^2$	$1.05X10^2$	$6.82X10^1$	$6.12X10^2$

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