DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE
Radiological Health Laboratory
1901 Chapman Avenue
Rockville, Maryland

WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES

Refer to: DRH:TOB

December 3, 1965

50-237
(formal)

Mr. Edson G. Case
Assistant Director
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Case:

The Plant Design and Analysis Report which the Public Health Service received from the Atomic Energy Commission on the Dresden II reactor to be built by the Commonwealth Edison Company has been reviewed by the Nuclear Facilities Environmental Analysis Section for items of public health interest. A report based on this review, was prepared by the Section and submitted to the Illinois State Department of Health for their use.

For your information, the principal comments arising from this review are summarized on the attached sheets. Should you or members of your staff have any questions regarding any of these comments please feel free to contact us.

Sincerely yours,

for Ernest D. Harward
Chief, Nuclear Facilities Environmental
Analysis Section
Technical Operations Branch
Division of Radiological Health

Enclosure

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SUMMARY OF COMMENTS ON DRESDEN II

REACTOR PLANT DESIGN AND ANALYSIS REPORT

Comments prepared by the Nuclear Facilities Environmental Analysis Section, Technical Operations Branch, Division of Radiological Health, with the assistance of the Technical Services Branch, Division of Water Supply and Pollution Control.

1. The review showed that there was no analysis done on the possible doses to the population resulting from contamination of the milk/food chain. We feel that a detailed analysis of possible population exposures through the milk/food chain as a result of normal operations with leaking fuel elements and under incident conditions should be made. The Nuclear Facilities Environmental Analysis Section has made such an analysis. Our calculations show that the presence of ^{131}I in the gaseous effluent under conditions of normal operation with leaking fuel elements could possibly result in a concentration exceeding the Radiation Concentration Guide for ^{131}I specified by the Federal Radiation Council in Report No. 2. For example, calculations were made which show that only approximately 3.5×10^{-3}% of a possible average anticipated gaseous activity (5000 μCi/sec based on Dresden I operating data) released from the stack under normal operating conditions with leaking fuel elements need be ^{131}I for milk from a dairy farm 5 miles from the facility to exceed the FRC's Radiation Concentration Guide of 100 picocuries of ^{131}I per liter of milk. This calculation is shown in Attachment A.

2. It is our opinion that there should be an analysis of the various accidents to determine the thyroid exposures that would be experienced by a 1-year-old child, the critical receptor specified by the FRC.

Calculations were presented in our report showing that there could be a possible thyroid dose to a 1-year-old child from ^{131}I in milk as high as 292 rems for the "Maximum Credible Accident" selected by the applicant, and as high as 20,200 rems for the "Worst Hypothetical Accident" based on TID-14844. This calculation is shown in Attachment B.

3. It was recommended that an Emergency Action Plan be developed by the applicant and coordinated with the Illinois State Department of Health. It was also recommended that the State Department of Health document the existence or lack of existence of dairy cattle in the environs of the facility. This would constitute the first step in the formulation of an Emergency Action Plan to be used in the event of an accident at the Dresden Nuclear Power Station.

4. Although considerable time remains for the development of gaseous effluent monitoring technical specifications, consideration should be given to an iodine stack monitor with gaseous effluent control based on iodine if there are dairy cattle in the environs of the Dresden Nuclear Power Station. It would also be advantageous to have a detailed description of the present gaseous effluent monitoring equipment in the Dresden I plant.

5. It was recommended that there be an investigation of the effect of the additional heat burden from Dresden II which might magnify already existing thermal pollution problems in the Illinois River.

ATTACHMENT A

Thyroid Dose Due to Normal Operation with

Leaking Fuel Elements

To illustrate possible hazards resulting from the operation of Dresden II with leaking fuel elements, the following analysis is presented based on methods shown in the paper, Prediction of Iodine-131 in Milk for Protective Action Planning, G. E. Stigall and A. G. Leary, presented before the Radiological Health Section, American Public Health Association, October 19, 1965, and which is to be published in Nuclear Safety in the near future.

Chamberlain (Quarterly Journal of the Meteorological Society, 85, p. 750, 1959) has reported that for conditions of a continuous source, one liter of milk would contain the same activity as was deposited on 0.21 m^2 of grass. This value is highly dependent on the productivity of the land and the effective half-life on the ground of the ^{131}I. Therefore, it is conceivable for this value to vary by a factor as large as 5.

The Federal Radiation Council's Radiation Protection Guide (upper limit of Range II) is 100 pCi/day (average annually) total intake of ^{131}I. Assuming an average one liter per day milk consumption and that all of the ^{131}I intake is from milk, the ground concentration should then not exceed 476 pCi/m^2 based on Chamberlain's ratio.

The applicant in the Safety and Accident Analysis Section of the Plant Design and Analysis Report used a velocity of deposition for halogens of 2.3 cm/sec for a neutral atmosphere with a 10 mph wind. The following equation can then be used to calculate the average air concentration, assuming a neutral atmosphere is representative of the average stability conditions, which corresponds with an equilibrium ^{131}I ground concentration of 476 pCi/m^2:

$$\omega = \frac{V_g \chi}{\lambda}(1-e^{-\lambda t})$$

assuming equilibrium conditions i.e. $\lambda t \rightarrow \propto$

$$\omega = \frac{V_g \chi}{\lambda}$$

where:

ω = ground concentration in activity per unit area.

V_g = velocity of deposition in length per unit time.

λ = effective ground decay constant in $time^{-1}$.

χ = air concentration in activity per unit volume.

$$476 = \frac{0.023\ \chi}{1.6x10^{-6}}$$

$$\chi = 3.31x10^{-2}\ pCi/m^3$$

Hence an average concentration of $3.31x10^{-2}$ pCi/m^3 could result in concentrations in milk of approximately 100 pCi/liter. An effective half-life for the ground of 5 days was used in the above calculation. Values ranging from 3.5 to 5.5 days have been presented in the literature.

The average air concentration resulting from a unit stack discharge was calculated by the applicant using the following equation:*

*Reference: Meteorology and Atomic Energy, GPO, AECU 3066 (July 1955).

$$\chi/Q_o = \frac{Q/Q_o}{2\pi\ \sigma_y\ \sigma_z\ \bar{u}}\ e^{-\frac{1}{2}}\left(\frac{y^2}{\sigma_y^2} + \frac{z^2}{\sigma_z^2}\right)$$

where:

χ/Q_o = integrated air concentration (χ) per unit activity release (Q_o), µCi-sec/cc per curie released

Q/Q_o = correction for depletion (halogens and particulates only)

y = distance from centerline crosswind, m.

z = height of plume above ground, m.

The χ/Q_o value computed by the applicant for halogens with a neutral atmosphere and 10 mph wind is 2.0×10^{-7} µCi-sec/cc per curie released, at a distance five miles from the source.

Using the value of $\chi = 3.31 \times 10^{-2}$ pCi/m^3

$$Q_o = \frac{3.31 \times 10^{-2}}{2.0 \times 10^{-7}} \times 10^{-12} = 1.76 \times 10^{-7} \text{ Ci/sec}$$

$$Q_o = 1.76 \times 10^{-1} \text{ µCi/sec}$$

Thus a release of 1.76×10^{-1} µCi/sec of ^{131}I, under the meteorological conditions outlined by the applicant could result in a ^{131}I concentration in milk equalling the 100 pCi/liter of ^{131}I specified as the ^{131}I Radiological Concentration Guide by the Federal Radiation Council.

The gross average release rate of fission products at Dresden I in 1962 was 2500 µCi/sec. If the same release rate also occurred at Dresden II (proposed power is 3-1/2 times that of Dresden I) at the same time as Dresden I was releasing at this rate (total average annual release equal 5000 µCi/sec), only 3.5×10^{-3}% of this gross release rate need be ^{131}I (based on the release rate for ^{131}I of 0.176 μCi/sec) for a dairy farm five miles from the facility to possibly exceed the FRC's Radiation Concentration Guide of 100 pCi/liter of milk. It becomes quite apparent that the applicant should present the postulated isotopic composition of the fission products that would be released if the facility were operated with fuel leaks and monitor for ^{131}I once operation begins in order to control the stack releases based on a ^{131}I release rate limit. Also, any analysis of this point by the applicant should consider potential ^{131}I contamination of crops produced in the environs of the facility.

ATTACHMENT B

Thyroid Dose from Iodine Contaminated Milk

The following calculations by NFEAS staff members show thyroid doses from iodine contaminated milk which might be received by the Federal Radiation Council's critical receptor, a one-year-old child, in the event of a major release of fission products at Dresden II.

G. Wehman in his paper, "Comparison of Ingestion to Inhalation Dose to Man from ^{131}I," Health Physics, 9, 1221-1222 (Dec. 1963), presents the following ratio:

$$\frac{\text{Thyroid dose to an adult from milk}}{\text{Thyroid dose to an adult from inhalation}} = 133 \text{ to } 450$$

where it is assumed the adult drinks 1 liter of milk per day. If a one-year-old child were to drink milk with the same ^{131}I concentration as milk consumed by an adult, where both are assumed to drink 1 liter of milk per day, the one-year-old child's thyroid dose would be 10 times greater than the adult's thyroid dose due to the one-year-old child's thyroid weighing one-tenth the adult's thyroid. Changing the above ratio to compensate for this factor, the following relationship is arrived at:

$$\frac{\text{Thyroid dose to a one-year-old child from milk}}{\text{Thyroid dose to an adult from inhalation}} = 1330 \text{ to } 4500$$

The fact that the above ratios are not constant, but vary over a range of values, is attributed to the variation in grazing conditions under which the relationship was determined. Also it was assumed in the above ratio that the point of reference is a pasture and the period of inhalation by the adult is the same as the period of deposition of iodine on the pasture which produces the milk consumed by the child.

Results of calculations for both the MCA and the "Worst Hypothetical Accident" using the above ratio of 1330 to 4500 are presented in Table I and II for various meteorological conditions and wind speeds. Comparison of these results against the Federal Radiation Council's "Protective Action Guides" of 10 rems for a population group and 30 rems for an individual from FRC Report No. 5, demonstrates the need for development of a protective action plan, including emergency surveillance capability, by the Illinois State Health Department.

Table I

Child's Thyroid Dose from Milk

Refueling Accident

Dose (rems)

Distance (miles)	MS-2	N-2	N-10	U-2	U-10
1	-	4.76-16.2	4.94-16.6	56.5-292	19.4-65.5
5	0.76-2.56	23.9-80.6	5.04-17.0	9.3-31.4	1.9-6.4
9	3.32-11.2	12.0-40.5	2.28-7.69	4.14-13.9	0.855-2.88
12	6.5-21.9	7.31-24.6	1.62-5.45	2.37-8.0	0.57-1.92

Table II

Child's Thyroid Dose from Milk

Worst "Hypothetical" Accident

Dose (rems)

Distance (miles)	MS-2	N-2	N-10	U-2	U-10
1	-	329-1110	329-1110	6000-20200	1404-4850
5	27.6-92.9	1620-5405	329-1110	600-2020	132-444
9	114-382	776-2620	144-482	251-846	60-202
12	227-766	514-1730	95.5-322	167-564	32.8-111