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Washington, D.C. 20260

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ENVIRONMENTAL PROTECTION
AGENCY

AUG 27 1984

CENTRAL DOCKET
SECTION

Dear Jay:

Attached is a short report on the relationship between cumulative ore production, estimated radon release, and the number of underground uranium mines. This report was prepared at your request to provide additional information to aid you in formulating the exemption criteria. If you need additional information, please call me or Gary Bruno (375-4453).

Very truly yours,

C. H. Bloomster
Manager
Advanced Technology Economics

CHB:be
Attach.

CUMULATIVE ORE PRODUCTION AND RADON RELEASE INFORMATION FOR UNDERGROUND URANIUM MINES

Information on cumulative ore production has been compiled, as requested, for active underground uranium mines. This information will be useful in the evaluation of potential criteria for the exemption of small underground uranium mines from proposed radon emission standards.

Data on the number of active underground uranium mines and their breakdown by cumulative ore production categories are shown in Table 1. The same data are shown graphically in Figure 1. Since the cumulative ore production data was given as ranges, the upper bound of each range was used as a plotting point in the graph. In the greater than 100,000 tons category, the upper bound used represents the cumulative tonnage of the largest active underground uranium mine for which data is available. As indicated in the figure, a total of 191 or 75% of the mines listed as active as of 1/1/79 fall in the 100,000 or less cumulative tonnage/mine category. Conversely, 64 or 25% of the mines have tonnages greater than 100,000 cumulative tons ore.

Also shown in Figure 1 are the corresponding estimated radon releases for selected cumulative tonnages. These releases were calculated by using the emission rate factor of 0.44×10^{-2} Ci/yr per cumulative ton of ore. To help put these radon releases into perspective, some comparative information will be given for the 44.0 Ci/yr (10,000 tons ore) and 440.0 Ci/yr (100,000 tons ore) radon releases.

Recent work by P. O. Jackson, et al. at Battelle, Pacific Northwest Laboratories indicates that the average natural radon emanation rate from the earth's surface is $0.8 + 0.7$ pCi/m²-sec. In two examples, they have calculated that a mine releasing 2.3 Ci/yr corresponds to the natural emanation rate of a circular area having a 170 meter radius. A mine releasing 8,300 Ci/yr corresponds to an area with a 10,000 meter radius. The mathematical relationship between these two examples can be used to calculate the comparable areas of natural emanation for our examples here. A release rate of 44.0 Ci/yr would correspond to an area having approximately a 745 meter radius. A release rate of 440.0 Ci/yr would equal an area with approximately a 2,350 meter radius.

Compared in other terms, these release rates (from Figure 1) can be related to the downwind distance required for their dispersion to the proposed standard of 0.2 pCi/l above background. For the very conservative Gaussian dispersion model, as outlined in a previous memo to you dated April 1984, where the wind was assumed to blow continuously in one direction only and at an actual average speed of 3.96 m/sec, a downwind distance of about 1.1 km would be required for dispersion in the 44.0 Ci/yr case. A downwind distance of about 5.4 km would be required for dispersion in the 440.0 Ci/yr case.

The distances for dispersion of these release rates will be less if a less conservative dispersion model is used. If the wind is assumed to blow randomly and for an equal amount of time in each of 16 compass directions (22.5 degrees each compass direction), then the downwind distance required for dispersion to the proposed standard in the 44.0 Ci/yr case would be about 0.45 km. The distance required in the 440.0 Ci/yr case would be about 1.8 km. In this less conservative model, the pollutant is assumed to blow into each of 16

sectors, thus less pollutant is available for ultimate dispersion in any one particular direction. These estimated dispersion distances are summarized in Table 2.

A breakdown of mine size categories and their estimated percentage of total industry emissions is shown in Table 3. As indicated, 95% of the estimated total industry radon release is emitted by the 64 largest mines (25% of total mines), each producing greater than 100,000 cumulative tons ore or greater than 440.0 Ci/yr emission. Conversely, the remaining mines, each producing less than 100,000 cumulative tons ore or less than 440.0 Ci/yr emission, emit only 5% of the total estimated industry radon release.

It would seem that the boundaries of concern for the amounts of radon released from an underground uranium mine should be in the range of 44.0 Ci/yr to 440 Ci/yr. As indicated in Figure 1, these rates correspond to cumulative tonnages per mine of between 10,000 and 100,000 tons ore.

**TABLE 1. Breakdown of Underground Uranium Mines
by Cumulative Ore Production**

	Production Category (Tons Ore)			
	<100	100- 1,000	1,000- 100,000	> 100,000
Number of mines (Active as of January 1, 1979)	3	23	165	64
Cumulative Number of Mines	3	26	191	255

Source: "Active Uranium Mines in the U.S.", compiled by U.S. Department of Energy, Grand Junction, Colorado, 1979. As found in EPA, 1983, Potential Health and Environmental Hazards of Uranium Mine Wastes, Report to the Congress of the U.S., Appendix E, Vol. 3, EPA, Office of Radiation Programs, Montgomery, Alabama.

TABLE 2. Dispersion Distances of Radon Releases

Radon Release (Ci/yr)	Downwind Distance (km) ^a	
	Conservative Dispersion Model	Less-Conservative Dispersion Model
44.0	1.1	0.45
440.0	5.4	

(a) Downwind distance required for a radon release from a mine vent to be dispersed to the proposed EPA limit of 0.2 pCi/l above background.

TABLE 3. Mine Size Categories and Percentages of Industry Emissions (a)

<u>Size Category</u> <u>(1,000 Tons Ore)</u>	<u>No. of</u> <u>Mines</u>	<u>% of</u> <u>Mines</u>	<u>Average</u> <u>Ci/yr</u> <u>per Mine</u>	<u>% of</u> <u>Emissions Per</u> <u>Size Category</u>	<u>Total Estimated</u> <u>Emissions Per</u> <u>Size Category</u>
1,000 - 4,700	25	10	8,800	76	220,000
100 - 1,000	39	15	1,400	19	55,000
10 - 100	82	33	140	4	12,000
1 - 10	83	33	14	1	1,000
0.1 - 1	23	9	1.4	0	0
Totals	225	100		100	288,000

(a) Data on the number of mines and size categories are from the DOE, Grand Junction, Colorado as of 1/1/79.

FIGURE 1

CUMULATIVE
OPERATIONAL AND RADIO
RELEASE FOR UNDERGROUND
OPERATIONS



CUMULATIVE NO. OF
ACTIVE MINES (AS OF 1-1-79)

3

100

100

0.44 9.71

50 100 150 200 250
CUMULATIVE NO. OF MINES (ACTIVE AS OF 1-1-79)