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HEALTH CONSULTATION FOR K-65 SILOS FERNALD ENVIRONMENTAL MANAGEMENT PROJECT (FEMP) - FERNALD, HAMILTON COUNTY, OHIO - CERCLIS NO. OH6890008976

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REPORT

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HEALTH CONSULTATION

FOR K-65 SILOS

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT (FEMP)

FERNALD, HAMILTON COUNTY, OHIO

CERCLIS NO. OH6890008976

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Office of Regional Operations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members.

This document has previously been released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The health consultation has now been reissued. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conlusions previously issued.

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MAY 1995

Prepared by

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Federal Facilities Assessment Branch
Energy Section B

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BACKGROUND AND STATEMENT OF ISSUES

Statement of Issues:

The Agency for Toxic Substances and Disease Registry (ATSDR) initiated this health consultation addressing radon emissions from the Fernald Environmental Management Project (FEMP), Fernald, Ohio, in response to concerns expressed by members of the community surrounding the site. This consultation evaluates the public health implications of radon emissions from the FEMP after the Department of Energy (DOE) completed a removal action on the K-65 Silos. In 1991, DOE placed a layer of bentonite clay in the headspace of K-65 Silos 1 and 2. DOE reported that this work resulted in lower levels of radon gas and related contaminant emissions from the silos [1]. To address citizens' concerns about the adequacy of the removal action and address whether current radon emissions from the site pose a public health hazard, ATSDR enlisted the assistance of the National Air and Radiation Environmental Laboratory (NAREL) of the United States Environmental Protection Agency (EPA), through an interagency agreement, to monitor environmental radon. In this health consultation, ATSDR evaluates the data we collected as well as selected DOE radon monitoring data.

This health consultation addresses the following issues:

1) *Are radon releases from the FEMP during the monitoring period of public health concern?*

2) *What are the results of the ATSDR/NAREL sampling thus far?*

3) *Is DOE's radon monitoring program adequate and are quality assurance procedures sufficient to ensure the quality of the data?*

Background:

FEMP, formerly called the Feed Materials Production Center (FMPC), was constructed by the Atomic Energy Commission (AEC) to produce the quality and amount of uranium metal needed for postwar defense purposes. The site was operated by contractors for DOE and its predecessors from 1951 until late 1989. The FMPC produced most of the uranium metal products used by other DOE facilities, including the plants at Hanford, Savannah River, and Oak Ridge.

In accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Fernald was placed on the National Priorities List (NPL) in November 1989. In February 1991, DOE announced formal closure of the plant, effective June 1991. In August 1991, the site was renamed the FEMP to reflect its change of mission to environmental restoration of the site and local area [1].

In accordance with an amended consent agreement, FEMP and EPA divided the plant into six work areas called Operable Units (OUs). Operable Unit 4 (OU4) consists of four large cylindrical concrete waste storage tanks, designated Silos 1, 2, 3, and 4. These silos are situated approximately 200 feet east of Paddy's Run Creek on the western edge of the former production area. The nearest residence is approximately 1,200 feet from the silos.

The silos were constructed above ground level in 1952 for the temporary storage of radium-bearing residues created from processing pitchblende, a uranium-rich ore. Silos 1 and 2 are called the K-65 silos because they are used to store residues from the K-65 uranium ore refinement process. Silos 1 and 2 presently contain 2,630 curies[1] (Ci)(97.3 terabecquerels[2]--TBq) and 1,140 Ci (42.2 TBq), respectively, of radium-226 (Ra-226), which decays to radon-222 (Rn-222). Silo 3 contains 450 Ci (16.7 TBq) of thorium-230 (Th-230), which also decays to Rn-222 [3]. FEMP reports that Silo 4 has never been used and is empty except for standing water which contains low concentrations of uranium and inorganic chemicals. FEMP does not consider Silo 4 to be a source of contaminant releases [4].

FEMP conducted several studies on the silos since their initial construction. These studies indicate the silos had structural problems and emitted high levels of radon [5]. As a result, in 1964 FEMP constructed earthen berms against the outer faces of the silo walls to bolster them and retard radon emissions. In

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[1] One curie = 3.7×10^{10} disintegrations per second.

[2] A terabecquerel is 1×10^{12} becquerels. One becquerel = 1 disintegration per second.

1983, FEMP enlarged the berms [5]. Other efforts to stabilize Silos 1 and 2 have included installation of protective dome caps over the center of the silo domes (January 1986), application of rigid, insulating polyurethane foam over the exterior surface of the domes (December 1987), and construction and operation of a radon removal system using charcoal adsorption (1987) [5].

In 1991, FEMP conducted a CERCLA removal action to further reduce fugitive emissions. With the concurrence of EPA and the Ohio Environmental Protection Agency (OEPA), FEMP installed a layer of bentonite clay approximately one foot thick in the headspace area between the concrete dome cover of each K-65 silo and its contents to reduce radon accumulation in the headspaces and thus reduce radon emissions to the environment. The clay caps are also intended to serve as a protective shield should a dome structure fail or if the silo is damaged by severe weather [3]. FEMP reported in its 1992 Fernald Site Environmental Report that radon concentrations in the silo headspaces had been reduced substantially since the bentonite seal was placed in the K-65 silos [1].

In addition to the silos, other sources of radon gas from the site include any areas contaminated with uranium, radium, or thorium. These include surface soils and the soil under the OU1 waste pits. However, the quantity of radon-producing wastes in the OU4 silos far exceeds the quantity in other areas [1].

In 1992, ATSDR entered into an interagency agreement with NAREL to conduct limited off-site environmental sampling at DOE Superfund sites where there is known or suspected off-site radiological contamination. Subsequently, ATSDR and NAREL prepared the *Work Plan for Environmental Studies Near the Fernald Environmental Management Project* [6], which included the plans for the off-site air monitoring reported here.

ATSDR/NAREL AIR MONITORING

Procedures:

We began off-site air monitoring in December 1993 by placing long-term electret ion chambers[3] (EICs) at six locations around the site and at one background location. (See Figure 1 for the locations of the EICs.) Duplicate EICs were set up at two of the seven locations. (The EICs measure radon exposure over a period of time. A voltage drop on an electret plate within the detector is proportional to the radon concentration in air. The voltage

[3] The long-term electret ion chambers used in this monitoring program are Electret-Passive Environmental Radon Measurement Systems (E-PERMs), a trademark device manufactured by Rad Elec, Inc.

drop is caused by the alpha particle from radon decay within the detector and, to a lesser extent, by penetrating gamma radiation originating outside the EIC [8].) We placed the EICs in specially designed housings to minimize the possibility of direct moisture affecting their operation. We placed six thermoluminescent dosimeters[4] (TLDs), in two sets of three, next to the EIC in each housing. (The TLDs measure gamma radiation near the EIC so that the EIC readings can be corrected for a slight response to gamma radiation.) We then secured the housings and monitoring devices to upright objects, such as trees, on the property of consenting owners.

On March 15 and 16, 1994, we removed the EICs from their housings and recorded the voltage and condition of each EIC. We then replaced the EICs in their protective housing to continue exposing them to the air for the next three months. We also removed one set of TLDs from each housing at the time of reading the EIC voltages and shipped them to the manufacturer for analysis. We followed this same procedure on June 14, 1994, to collect the data for the March through June period.

[4] Thermoluminescent dosimeters manufactured by Landauer, Inc., of Glenwood, Il.

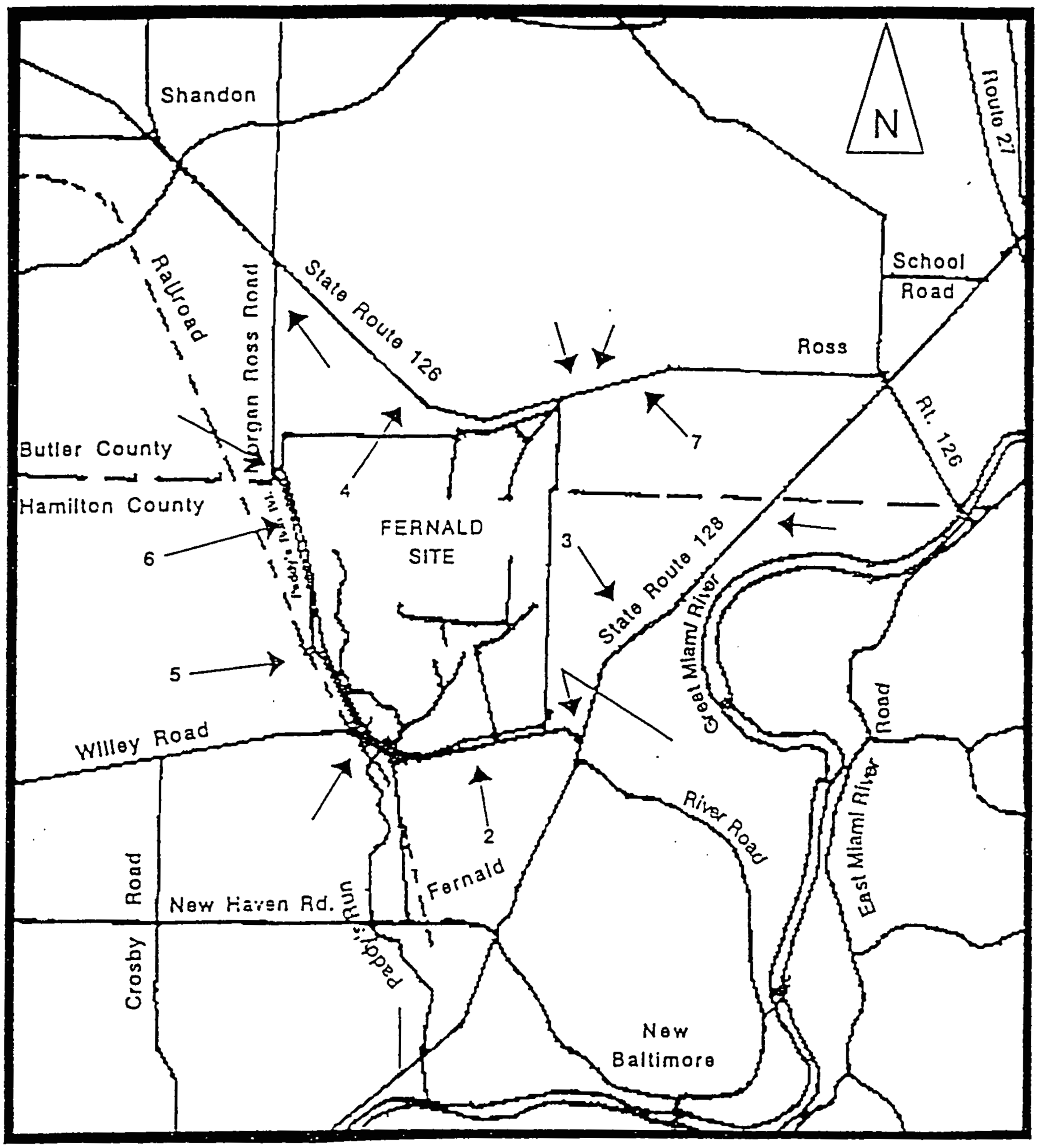

FIGURE 1.

LOCATIONS OF ATSDR/NAREL ELECTRET ION CHAMBERS (EICS).

Location 1 (not shown) is the EIC background site.

Locations 2 through 7 are the original six monitoring sites.

Seven unnumbered arrows are the locations of EICs added in June 1994.

Results:

We calculated the average radon concentration for each EIC for each sample period, and the results are shown in Table 1.

Table 1
ATSDR/NAREL Ambient Radon Concentrations

EIC Location Number	Direction and Distance (miles) from Center of K-65 Silos 1 and 2	Average Radon Concentration for First 3-Month Period[a]		Average Radon Concentration for Second 3-Month Period[b]	
		pCi/L[c]	mBq/L[d]	pCi/L[c]	mBq/L[d]
1[e]	S, 6.1	0.5	18.5	1.0	37.0
2	SE, 1.0	0.5	18.5	1.1	40.7
3	E, 1.0	0.5	18.5	1.1	40.7
4	NNE, 0.8	2.7	99.9	1.2	44.4
5	SW, 0.5	0.9	33.3	0.2	7.4
6	NW, 0.5	7.9[f]	292.3[f]	0.5[f]	18.5[f]
7	NE, 1.5	0.5	18.5	0.4	14.8

(a) December 7-8, 1993 through March 15-16, 1994.
(b) March 15-16, 1994 through June 14, 1994.
(c) pCi/L = picocuries per liter.
(d) mBq/L = millibecquerels per liter.
(e) Location 1 is the background location.
(f) The EIC that recorded these data failed during subsequent spot field testing and these numbers are not considered reliable.

During the first 3-month period, ambient radon concentrations ranged from 0.5 to 7.9 pCi/L (18.5 - 292.3 mBq/L). Elevated radon concentrations were recorded at EICs 4 and 6. Ambient radon concentrations during the second period ranged from 0.2 to 1.2 pCi/L (7.4-44.4 mBq/L). The values in the second three months are comparable to the natural background concentration of radon measured.

Quality Assurance:

During the initial phase of the screening program, quality control measures included prior testing of EIC units, duplication of EICs at two locations, duplicate readings of initial and final EIC voltages, and triplicate TLDs within the EIC housing units. However, the elevated readings during the initial three months underscored the need for greater quality assurance measures because these readings were recorded at locations without duplicate EIC units and we had no internal means of verifying these data.

To improve quality assurance, we increased the scope of our ambient radon screening around the FEMP. In June 1994, we placed EICs at seven additional locations (13 total, plus background) and placed duplicate detectors at locations where elevated readings occurred. (See Figure 1, seven unnumbered arrows, for locations where EICs were added in June 1994.)

In September 1994, we relocated the EIC at location 7 closer to the FEMP fenceline and added detectors to each location. (There are now a total of three detectors at each site except the background location which has two detectors.) At this time, we also replaced the EIC that produced the highest reading (7.9 pCi/L) because it failed during a spot field test. We read the charge on this EIC on two consecutive days and noted that the charge had dropped significantly on the second day; we noted no drop in the charge of two co-located EICs. The charge on the suspect EIC was so low that no further testing was possible. This behavior indicates the EIC was not performing correctly and so we replaced it. Therefore, we do not think the reading of 7.9 pCi/L is reliable.

INVESTIGATION OF ELEVATED READINGS

We compared FEMP monitoring data to our EIC data for the period coinciding with our screening program to determine whether the FEMP data support our elevated readings.

FEMP monitors ambient radon on site around the Production Area and the silos, at the site boundary, and off site at three area residences and four background locations [1]. They use two types of monitoring devices to measure ambient radon on and off site: alpha-scintillation detectors[5], and alpha-track etch detectors. The alpha-scintillation detectors collect radon measurements hourly [7]. The alpha-track etch detectors, like the EICs,

[5] Model AB-5 Portable Radiation Monitors manufactured by the Pylon Electronic Development Company, Ltd.

provide integrated long-term radon measurements; FEMP exchanges these detectors every three months.

The alpha-scintillation detectors are the primary radon monitoring system for the FEMP because they provide hourly data. The data collected by the alpha-scintillation detectors are more useful than those collected by the alpha-track etch detectors because they can establish radon release times more precisely than data collected and averaged over three months. The less expensive alpha-track etch detectors are the backup radon monitoring system for the FEMP. We are more interested in the hourly data because of its greater precision.

The FEMP alpha-track etch detector data (3-month averages) at the three off-site residences do not show elevated radon concentrations [10].

The FEMP alpha-scintillation detectors (hourly data) show some extremely high, but erratic readings [11]. (See Table 2 for the alpha-scintillation detector data.) Since these detectors were exposed to temperatures below their recommended operating temperature for over 10% of the December 1993 through March 1994 period (and nearly 25% of the time during January 1994), the data recorded during cold weather periods (below -10° Celsius[6]) cannot be considered reliable [7]. Therefore, we looked at the hourly data again, after eliminating the readings recorded below -10 degrees Celsius.

When the alpha-scintillation detectors were operating at temperatures within their operating range (above -10° Celsius), some of the data (averaged over the three months) are similar in magnitude to our elevated readings; however, these particular data are from the monitors located on site near the K-65 silos, whereas our data are collected outside the FEMP fenceline. The alpha-scintillation data recorded at the FEMP fenceline, when averaged over three months, are at background levels. Therefore, none of the FEMP data support either of our two elevated readings recorded during the first 3-month ATSDR/NAREL monitoring period.

However, the FEMP data do not necessarily refute our elevated readings either. This is because there are gaps in the alpha-scintillation data when the temperatures dipped below -10 degrees Celsius (data we consider unreliable as discussed above) and when the alpha-scintillation detectors were otherwise missing or not operable[7] during parts of the 3-month period from January though

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[6] -10° Celsius is +14° Fahrenheit.

[7] The alpha-scintillation detector at location AMS-1 was out of commission due to monitor malfunction for a period of six days from January 19 through January 25, 1994. The unit at AMS-6 was out of commission due to

March 1994. Each of these data gaps represents periods when hourly radon monitoring was not conducted for these locations. These data gaps may include periods when radon was detected at our EIC monitors (i.e., our two elevated readings) and not recorded at FEMP's monitors.

Table 2
Average DOE Alpha-Scintillation Detector Readings[a]

Monitor Identification	Data at All Temperatures		Data at Temperatures Greater Than -10° Celsius[b]	
	pCi/L[c]	mBq/L[d]	pCi/L[c]	mBq/L[d]
AMS-1	16.8	621	0.7	24
AMS-5	11.2	415	0.5	20
AMS-6	3.4	126	0.6	22
AMS-7	14.0	517	0.7	26
K65-NW	30.6	1133	2.5	91
K65-SW	8.8	324	1.7	64
K65-NE	23.1	854	5.9	220
K65-SE	6.4	237	2.8	102
Meteorological Tower	34.1	1261	0.8	31
Background	4.0	147	1.4	53

(a) January through March, 1994.
(b) - 10° Celsius = 14° Fahrenheit.
(c) pCi/L = picocuries per liter.
(d) mBq/L = millibecquerels per liter.

operator error from February 7 through February 16, 1994. It may have been out of commission until February 21, 1994, based on the abnormally low instrument reading during the period of the 16th through the 21st. Finally, the alpha-scintillation detector at the meteorological tower was removed and transferred to a different location on March 1, 1994. A replacement detector was put at this location, but not until March 14.

DISCUSSION

ATSDR and NAREL's radon monitoring program is designed to evaluate whether current radon releases from the site pose a public health hazard. We recognize that many residents are interested in how much radon they might have breathed in the past; however, our radon monitoring program does not address this question. Also; our program is not a comparative study of releases before and after the bentonite caps were placed on the silos, nor is it a study of historic radon releases from the site. These later questions are properly the domain of other studies[8]. We are interested in current radon releases because many people expressed distrust of DOE's radon monitoring data and because the remediation of the K-65 Silos is scheduled to begin soon.

Both our radon screening and FEMP's monitoring show low levels of radon were released from the FEMP during the early months of 1994. However, based on our calculations of potential exposures to the radon we measured, we do not believe that any of these radon levels are of public health concern.

The primary adverse health effect from long term exposure to radon and its short-lived decay products (progeny) is lung cancer [9]. Inhalation of radon and its progeny is the only important exposure pathway. The likelihood of developing lung cancer from exposure to radon and its progeny is related to the total amount of radon and progeny breathed. Short term exposures to high levels of radon are not known to cause acute adverse health effects.

To explore the worst-case exposure scenario for the elevated radon concentrations that we measured during the first 3-month monitoring period, we estimated the radiation dose[9] a person would have received based on our highest reliable radon reading of 2.7 pCi/L (99.9 mBq/L). The dose from this exposure was estimated to be 40 millirems (mrem). The calculations assume that a person was exposed 24 hours per day for the 96-day measurement period. We do not think exposures exceeded three months, since measured radon levels were not elevated during the second 3-month monitoring period.

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[8] The Centers for Disease Control and Prevention and the Radiological Assessments Corporation are addressing historic radon releases in the Fernald Dosimetry Reconstruction Project. As far as we know, no one has conducted a comparative study of radon emissions before and after the bentonite caps were placed on the K-65 Silos.

[9] We calculated an effective dose to the lung as defined by the International Commission on Radiological Protection (ICRP) in ICRP Publication 60 [12]. The methodology used to estimate this dose is based on information obtained from ICRP Publication 65 [13].

To put the 40 mrem dose in perspective, the Committee on the Biological Effects of Ionizing Radiations estimates that people in the United States receive a total average effective radiation dose of approximately 300 mrem/year from naturally occurring sources [14]. An additional radiation dose of 60 mrem per year is contributed from consumer products and medical uses of radiation. Studies of populations residing in areas of high natural background radiation (600-800 mrem/year) have been unable to show that these populations exhibit higher cancer rates than populations living in low background areas. Finally; an excess number of malignancies (statistically significant at the 95% level) resulting from radiation exposures has been found only in populations exposed to radiation at effective doses exceeding 20,000 mrem. From these comparisons we conclude that the radon released from the FEMP during the initial period of our monitoring did not pose a health hazard.

We have questions about the reliability of the data generated by both our initial radon screening and FEMP's radon monitoring programs. However, the inadequacies we have identified do not invalidate all of the data that has been collected, only some of it.

Although our screening resulted in two EIC readings above background levels during the December 1993 to March 1994 period, we have reason to question the reliability of the higher reading (7.9 pCi/L). Both high readings were collected from EICs where duplicate EICs were not in use. Subsequently, when we field-tested the EIC that was located where the higher reading occurred, the EIC failed the test. This result indicates the 7.9 pCi/L is not reliable.

We compared FEMP's radon monitoring data to ours to see if their data support ours. Their data neither support nor refute our data. The FEMP data indicate there were low levels of radon released from the site, but we don't know how much because their hourly monitors were not always operational and much of their data were collected when the detectors were operating outside their recommended temperature range.

We consider that the FEMP hourly radon monitoring program is an important part of their overall environmental monitoring program because of the large quantity of radon-producing wastes stored in the K-65 silos. FEMP does not employ duplicate hourly monitors at monitor locations and their data indicate they do not have backup equipment available for alpha-scintillation detectors that fail. Therefore, we are recommending that FEMP reevaluate their radon monitoring program and improve the quality assurance of their hourly radon monitoring.

As we continue our program to address community health concerns about potential radon releases from the K-65 silos, we recognize the need to improve the reliability of our system and to correct the previously noted deficiencies. To this end, we have set up triplicate EICs at all our monitoring locations around the FEMP. We are also planning to add different kinds of monitors to see if we can improve on the reliability of the equipment we are using. Measuring outdoor radon is a relatively uncharted domain that presents many challenges. Nonetheless, we will continue in our efforts to improve our radon monitoring and thus, the quality and the reliability of the data we collect.

At this time, it is likely that we will continue our radon screening program through September 1996.

CONCLUSIONS

1) Radon releases from the FEMP during the monitoring period do not appear to be a public health concern.

2) The highest radon measurement obtained during the initial phase of the ATSDR and NAREL screening program apparently represents an equipment failure, rather than a real radon exposure.

3) The FEMP radon monitoring program is deficient because a) the hourly radon monitoring equipment is unreliable when it is employed outside of its operational temperature range; b) FEMP does not obtain duplicate hourly radon measurements; and c) FEMP does not maintain backup hourly radon monitoring equipment to replace inoperable detectors.

RECOMMENDATIONS

1. FEMP should modify their hourly monitors so that they can be made to reliably operate throughout the range of environmental temperatures expected in the area. If this cannot be accomplished, FEMP should supplement the existing hourly monitoring equipment with hourly radon monitoring equipment capable of operating during periods of expected cold weather.

2. FEMP should employ sufficient backup equipment and quality assurance procedures to ensure the reliability of their data.

   a. FEMP should place duplicate hourly radon monitors at several locations.

   b. FEMP should maintain backup, or spare, hourly radon detectors to replace failed monitors.

   c. FEMP should review their hourly radon monitoring data on a regular basis to ensure proper equipment operations.

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