

SEC Petition Evaluation Report Petition SEC-00171

Report Rev #: 0

Report Submittal Date: May 4, 2010

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Petitioner Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00171	83.14	05-03-10	Mound Plant

NIOSH-Proposed Class Definition

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who were monitored for tritium exposure while working at the Mound Plant in Miamisburg, Ohio, from March 1, 1959 through March 5, 1980, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00090	83.13	Mound Plant	Class included in the SEC for October 1, 1949 through February 28, 1959
SEC-00091	83.13	Mound Plant	Merged into SEC-00090

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
SEC Petition Evaluation Report for Petition SEC-00090	Mound Plant

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Evaluation Report Summary: SEC-00171, Mound Plant

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA) and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*.

NIOSH-Proposed Class Definition

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who were monitored for tritium exposure while working at the Mound Plant in Miamisburg, Ohio, from March 1, 1959 through March 5, 1980, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Feasibility of Dose Reconstruction Findings

NIOSH lacks sufficient information, which includes biological monitoring data, sufficient air monitoring information, or sufficient process and radiological source term information, to allow it to estimate with sufficient accuracy the potential internal exposures to radon isotopes associated with radium, actinium, and thorium to which the proposed class may have been subjected. NIOSH finds that it is likely feasible to reconstruct external doses, including occupational medical doses, for Mound Plant workers with sufficient accuracy.

The NIOSH dose reconstruction feasibility findings are based on the following:

- Sources of internal radiation for members of the proposed class include residual radioactive material from the radium-actinium-thorium process conducted in the SW Building. The residual material led to technologically-enhanced emanation of radon-220, radon-222, and radon-219 into Room SW-19.
- NIOSH previously determined in its evaluation of petition SEC-00090, that Mound workers could have received unmonitored intakes of radium-226, actinium-227, and thorium-228 during the period from October 1, 1949 through February 28, 1959. In 2008, the Department of Health and Human Services (DHHS) designated the following class for inclusion in the SEC:

Employees of the Department of Energy (DOE), its predecessor agencies, and DOE contractors or subcontractors who worked in any areas at the Mound Plant site from October 1, 1949, through February 28, 1959, for a number of work days aggregating at least 250 work days or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

- Through the course of ongoing research associated with SEC-00090, NIOSH has determined that residual radioactive material from the radium-actinium-thorium process conducted in the SW

Building led to technologically-enhanced emanation of radon-220, radon-222, and radon-219 into Room SW-19.

- NIOSH has found no bioassay or workplace monitoring records relevant to these radon exposures prior to when air measurements were made in 1979 and 1980. NIOSH is unable to put an upper bound on the radon exposures in SW-19 until the point at which a ventilation system was installed in early 1980 (prior to March 5, 1980) to vent SW Building tunnel air. This ventilation system reduced radon-222 concentrations in Room SW-19 by a factor of 10 or more.
- It is not feasible to determine which of the workers in the R and SW buildings may have frequented Room SW-19, therefore NIOSH cannot reasonably limit the cohort of workers who could have been exposed to radon in SW-19 more narrowly than the cohort of all workers in the R and SW buildings. Due to the extensive tritium operations occurring in these buildings, it was documented policy that everybody who worked in R and SW buildings submit periodic urine samples analyzed for tritium. While it is possible that a worker could have occasionally visited the R and SW buildings without submitting a tritium urinalysis sample, it is not plausible that a worker could have spent 250 days in these buildings without leaving a single tritium urine sample. Therefore, tritium urinalysis results will be taken as evidence of potential employment in R and SW buildings. Conversely, absence of such urinalysis data will be taken as evidence that individuals did not have the potential to be employed in R and SW buildings for 250 days.
- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at the Mound Plant during the period from March 1, 1959 through March 5, 1980, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Health Endangerment Determination

The NIOSH evaluation did not identify any evidence supplied by the petitioners or from other resources that would establish that the class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures, such as nuclear criticality incidents or other events involving similarly high levels of exposures. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of radon isotopes originating from residual radioactive material associated with the radium-actinium-thorium source term in tunnel underlying Room SW-19. Therefore, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250

work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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SEC Petition Evaluation Report for SEC-00171

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Karin Jessen, Oak Ridge Associated Universities. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for employees who worked at a specific facility during a specified time. It provides information and analysis germane to considering a petition for adding a class of employees to the Congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH, with the exception of the employee whose dose reconstruction could not be completed, and whose claim consequently led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC. This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

This evaluation, in which NIOSH provides its findings both on the feasibility of estimating radiation doses of members of this class with sufficient accuracy and on health endangerment, was conducted in accordance with the requirements of EEOICPA and 42 C.F.R. § 83.14.

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate, with sufficient accuracy, the radiation doses of the proposed class of employees through NIOSH dose reconstructions.¹

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioners and the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, to make recommendations to the Secretary of HHS on whether or not to

¹ NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at <http://www.cdc.gov/niosh/ocas>.

add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.²

3.0 NIOSH-Proposed Class Definition and Petition Basis

The NIOSH-proposed class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who were monitored for tritium exposure while working at the Mound Plant in Miamisburg, Ohio, from March 1, 1959 through March 5, 1980, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort. During this period, employees at this facility were involved in research and development, manufacturing weapons, and evaluation and maintenance of explosive components for the nuclear defense stockpiles. Other work included tritium recovery, isotope separation methods, development and production of heat sources in support of space programs, support of the fossil fuels program, and nuclear-materials processing.

The evaluation responds to Petition SEC-00171, which was submitted by an EEOICPA claimant whose dose reconstruction could not be completed by NIOSH due to a lack of sufficient dosimetry-related information. NIOSH's determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

Two petitions associated with the Mound site requested that NIOSH consider classes for addition to the SEC:

- Petition SEC-00090 was received on June 4, 2007, and qualified on August 17, 2007. NIOSH considered the following class: *All employees who worked in all areas within the boundaries at the Mound Plant from February 1949 through present.*
- Petition SEC-00091 was received on June 14, 2007, and qualified on September 24, 2007. NIOSH considered the following class: *All employees who worked within the boundaries of the Mound Plant from February 1, 1949 through December 31, 1970.*

The information and statements provided by the petitioners qualified the petitions for further consideration by NIOSH, the Board, and HHS. Petition SEC-00091 was qualified based on its timeframe being completely encompassed by Petition SEC-00090. Consequently, NIOSH merged the Petition SEC-00091 into Petition SEC-00090.

² See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available at <http://www.cdc.gov/niosh/ocas>.

There is currently a class of Mound Plant workers associated with the previous NIOSH evaluation of SEC Petition SEC-00090, for which the Secretary of DHHS has designated inclusion in the Special Exposure Cohort:

Class added to the SEC effective April 2, 2008 (DHHS, 2008): Employees of the Department of Energy (DOE), its predecessor agencies, and DOE contractors or subcontractors who worked in any areas at the Mound Plant site from October 1, 1949, through February 28, 1959, for a number of work days aggregating at least 250 work days or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Detailed information associated with this worker class added to the SEC in 2008 can be found in the NIOSH evaluation report, *SEC Petition Evaluation Report for Petition SEC-00090, Mound Plant* (NIOSH, 2007). The recommendation to add an SEC class in the SEC-00090 evaluation report was based on NIOSH's inability to reconstruct internal doses from exposures to radium-226, actinium-227, and thorium-228 with sufficient accuracy for the SEC-00090 worker class for the period from October 1, 1949, through February 28, 1959. The associated SEC class designated by DHHS was based on people working at the Mound facility during the time period when employees worked on research and production activities related to nuclear weapons production, as well as a lack of adequate information to conduct accurate individual dose reconstructions for internal doses from exposure to radium-226, actinium-227, and thorium-228 during this period.

In the course of its ongoing investigations related to SEC-00090, NIOSH has determined that internal doses also cannot be reconstructed for individuals employed in the R and SW Buildings from March 1, 1959 through March 5, 1980, due to large uncertainties in the assignment of dose from radon isotopes originating from the residual radioactive material associated with the radium-actinium-thorium (Ra-Ac-Th) source term in tunnel underlying Room SW-19.

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at the Mound Plant from March 1, 1959 through March 5, 1980, and the information available to NIOSH to characterize particular processes and radioactive source materials. Using available sources, NIOSH has attempted to gather process and source descriptions, information regarding the identity and quantities of radionuclides of concern, and information describing processes through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

Unless otherwise indicated, information for Section 4.0 and its related subsections was obtained from *SEC Petition Evaluation Report for Petition SEC-00090, Mound Plant* (NIOSH, 2007).

4.1 Operations Description

Mound was the nation's first postwar U.S. Atomic Energy Commission (AEC) site to be constructed. It was established to consolidate and continue the polonium work conducted at the Dayton Project for the Manhattan Project. Construction began in 1946, with polonium processing becoming operational in February 1949. There were originally 14 buildings with 360,000 square feet of space.

Early Mound programs investigated the chemical and metallurgical properties of Po-210 and its applications. Research and development included the fabrication of neutron and alpha sources for weapons use. Po-210 production declined in the 1960s and was phased out in 1971. Mound's narrowly-focused polonium production work expanded to include the development and production of components using Pu-238. Mound's main focus was to support DOE weapons and non-weapons programs, especially chemical explosives and nuclear technology. One of its principal missions was to research, develop, and manufacture non-nuclear explosive components for nuclear weapons that were then assembled at other sites.

Much of Mound's Cold War work involved production of the polonium-beryllium (Po-Be) initiators used in early atomic weapons, and the research and manufacture of radionuclides. In the 1950s, the facility began to manufacture a variety of nuclear weapons parts, including cable assemblies, explosive detonators, and electronic firing sets. Mound work evolved to include stable isotope separation, fossil fuels research, development of radioisotope thermoelectric generators (RTGs) for providing electrical power for space exploration, and other non-nuclear research and development. The Mound Plant ceased non-weapons work in 1971 and stopped production of weapons components in 1995.

Polonium Operations

Polonium research and production activities conducted at the Dayton Laboratory benefited from improved facilities at Mound specifically designed for those processes. These included the encapsulation of the process with provisions for remote operation. A detailed description of this equipment is included in an unpublished chapter of the book *Polonium* by H. V. Moyer (Moyer, 1956). Po-Be neutron sources were manufactured in the R Building from 1956 to 1961. Po-Be sources were first manufactured at Mound as neutron source initiators to support various weapons programs. Polonium was later used to produce Po-210 heat source generators (Mound, 1995). The SW Building was used for counting Po-210 sources, neutron source measurement, source strength verification, and Po-209 and Po-210 retrieval. Radium-226, actinium-227, and thorium-228 were part of the research on Ac-227 as a substitute for polonium in neutron initiators.

Radon

Beginning in 1952, sources of radon (Rn-222), thoron (Rn-220), and actinon (Rn-219) were present at Mound due to radium and thorium processing and separation of Pa-231 and Ac-227. Room SW-19 had elevated radon concentrations emanating from radium and thorium processing wastes. On October 12, 1979, inert gas concentrations in an unoccupied tunnel under Room SW-19 were measured at 88,000 pCi/l Rn-222, 28,000 pCi/l Rn-220, and 640,000 pCi/l Rn-219. A Rn-222 concentration of 88,000 pCi/l would correspond to 352 WL, assuming an ICRP 50 indoor mean radon daughter equilibrium factor of 0.45 (ICRP, 1987). The tunnel was not an occupied work area;

however, elevated concentrations of radon were measured in SW-19 work areas. Measurements of Rn-222 near an employee's desk ranged from 67 to 160 pCi/l in 1979.

A ventilation system was installed in early 1980 to vent SW Building tunnel air (Meyer, 1992). This system reduced Rn-222 concentrations in Room SW-19 by a factor of 10 or more. This result was confirmed with continuous measurements from 7.7 pCi/l to 13.4 pCi/l. A working level (WL) measurement by the employee's desk following ventilation system installation was 0.03 WL or 0.03 (12 mo/yr) = 0.4 working level month (WLM) compared with an occupational limit of 4 WLM/yr (Mound, 1995).

4.2 Radiation Exposure Potential from Operations

The potential for external radiation dose, for the purposes of this evaluation, existed in the R and SW Buildings, depending on operations. Sources of external exposure included beta, gamma, and neutron radiation emitted from a variety of research, development, analytical, recovery, and surveillance activities.

The primary sources of internal radiation exposure at the site, for the purposes of this evaluation, would have been inhalation and ingestion of radiological contamination, which would have been dependent on the operational area and activities. The major sources of intakes include polonium, plutonium, and tritium.

Sources of internal radiation exposure specific to the class proposed in this report include radon (Rn-222), thoron (Rn-220), and actinon (Rn-219) due to the radium and thorium processing and separation of Pa-231 and Ac-227 generated during a variety of research, development, analytical, recovery, and surveillance activities.

Additional information regarding the radionuclides, work areas, and operations associated with radiation exposures at Mound can be found in the NIOSH evaluation report, *SEC Petition Evaluation Report for Petition SEC-00090, Mound* (NIOSH, 2007).

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security, the time period associated with DOE operations at the Mound Plant is from 1947 through the present. As presented in Section 3.0 of this report, DHHS designated a class of Mound workers during the period from October 1, 1949 through February 28, 1959. The start date for the currently proposed class of March 1, 1959 was selected based on the end date of the previously designated class as specified by DHHS (DHHS, 2008). Sources of radon, thoron, and actinon were present at the Mound Plant due to radium and thorium processing and separation of Pa-231 and Ac-227.

Although Mound health physics monthly and quarterly reports show that monitoring of "short-lived alpha-emitters" was ongoing during the "Old Cave" (shielding/containment structure within the SW Building) actinium-processing activity, monitoring was curtailed after the end of the operational period in 1955 (HP Monthly, 1952; HP Monthly, 1953; HP Monthly, 1954; HP Quarterly, 1955; HP Quarterly, 1957). From that point, measurements of alpha air concentrations that are clearly directed

toward short-lived species are not available. Research was conducted in 1979-1980 to evaluate radon concentrations in Room SW-19 and nearby locations. As a result of this monitoring, additional ventilation was installed to reduce radon levels. Based on notes taken during the sampling effort, this installation occurred prior to March 5, 1980. No data from which radon concentrations may be inferred are available from the end of the operational period in 1955 to March 5, 1980.

4.4 Site Locations Associated with Radiological Operations

The following information describes the R and SW Buildings of the Mound Plant. Additional information regarding the work areas associated with radiation exposures at Mound can be found in the NIOSH evaluation report, *SEC Petition Evaluation Report for Petition SEC-00090, Mound* (NIOSH, 2007). The information listed below pertains to the class currently under evaluation.

R Building (or the Research Building): The R Building was built in 1948, and handled numerous programs involving various radionuclides, including Po-210, H-3, U-238, Ac-227, Pu-238, and Pu-239. The major radionuclide was Pu-238, with research beginning in 1959 and continuing through the 1960s. In addition to the Pu-238 activities, tritium was used for research and development.

SW Building: The SW Building was similar to the R Building in that it consisted of many laboratories engaged in a variety of research, development, analytical, recovery, and surveillance activities. Pilot plant operations in the SW Building were designed to recover Th-230 and Pa-231. The “Old Cave” and “New Cave” areas consisted of several rooms set up for “hot” work, with several types of alpha and gamma radiation and project capabilities. Other major programs that took place in the SW Building included the thorium refinery project, rare isotope program, neutron source, U-234 separation program, and various tritium programs. Beginning in the early 1970s and ending later that decade, the SW Building was used for processing Cotter Concentrate (St. Louis airport cake).

There is strong evidence that airborne contamination was produced by the operations in SW-1 from 1949 through 1959, and that this contamination was spread to other areas in the R and SW Buildings. This situation created significant exposure potential in the R and SW Buildings. From 1959 through 1980, there is a reasonable likelihood that elevated levels of radon isotopes and daughter isotopes were present in Room SW-19.

Considering all sources of information currently available to NIOSH, there is no evidence suggesting that any other buildings at the Mound Plant were affected by uncontrolled and unmonitored emanations of radon from Ra-Ac-Th.

4.5 Job Descriptions Affected by Radiological Operations

NIOSH has determined that the site-specific and claimant-specific data available for the Mound Plant for the time period under evaluation are insufficient to allow NIOSH to determine that any specific work group assigned to the R and SW Buildings was not potentially exposed to radon emanations from residual Ra-Ac-Th materials. NIOSH has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions.

5.0 Summary of Available Monitoring Data for the Proposed Class

The primary data used for determining internal exposures are derived from personal monitoring data, such as urinalyses, fecal samples, and whole-body counting results. If these are unavailable, the air monitoring data from breathing zone and general area monitoring are used to estimate the potential internal exposure. If personal monitoring and breathing zone area monitoring are unavailable, internal exposures can sometimes be estimated using more general area monitoring, process information, and information characterizing and quantifying the source term.

This same hierarchy is used for determining the external exposures to the cancer site. Personal monitoring data from film badges or thermoluminescent dosimeters (TLDs) are the primary data used to determine such external exposures. If there are no personal monitoring data, exposure rate surveys, process knowledge, and source term modeling can sometimes be used to reconstruct the potential exposure.

A more detailed discussion of the information required for dose reconstruction can be found in OCAS-IG-001, *External Dose Reconstruction Implementation Guideline*, and OCAS-IG-002, *Internal Dose Reconstruction Implementation Guideline*. These documents are available at: <http://www.cdc.gov/niosh/ocas/ocasdose.html>.

5.1 Data Capture Efforts and Sources Reviewed

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding the Mound Plant. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, the Atomic Energy Technical Report database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search.

In addition to the database and Internet searches listed above, NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees under evaluation. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

5.2 Worker Interviews

To obtain additional information in support of its 2007 evaluation of Petition SEC-00090, NIOSH interviewed 21 former Mound employees. Details regarding these interviews may be found in the *SEC Petition Evaluation Report for Petition SEC-00090, Mound* (NIOSH, 2007). Additional interviews for the specific purpose of supporting this evaluation were not deemed necessary, and therefore were not conducted.

5.3 Internal Personnel Monitoring Data

Summaries of the available *in vitro* and *in vivo* data, as well as general overviews of sampling and analytical protocols, are provided in *SEC Petition Evaluation Report for Petition SEC-00090, Mound* (NIOSH, 2007). Additional details, including analytical methods, detectable activities, and reporting protocols can be found in *Technical Basis Document for the Mound Site-Occupational Internal Dosimetry* (ORAUT-TKBS-0016-5), *Technical Manual: MD-22153, Issue I Mound Site Radionuclides by Location* (Mound, 1995), and *History of Mound Bioassay Programs* (Meyer, 1992).

As noted in ORAUT-TKBS-0016-5, radionuclides were categorized by Mound staff as either primary or secondary based on the potential extent of use and the amount of bioassay data available. Primary radionuclides included Po-210, plutonium isotopes (Pu-238, Pu-239), and tritium. These radionuclides were identified as primary because they were present in larger quantities and were more widespread at the site, often in multiple buildings and facility processes. Correspondingly, more monitoring data and site documentation are available (than for secondary radionuclides) to evaluate internal doses associated with these radionuclides.

Secondary radionuclides included those that were of limited use at the site or involved limited worker exposures. Often referred to as “other” radionuclides in Mound documents, they were part of smaller programs involving relatively few people. Many of the programs were relatively short-term research projects and brief production runs, and source material was received intermittently (MJW, 2002b, Appendix C). Fewer internal dosimetry data are available for these radionuclides than for the primary radionuclides. Available data for secondary radionuclides were collected from several sources during the Pre-1989 Dose Assessment Project and combined into two Excel spreadsheets: *Database of Radium, Actinium, and Thorium Excretion Data* (Excretion Data, 1953-1959) and the *Database of Excretion Data for Other Radionuclides* (Excretion Data, 1955-1988). Data sources included logbooks, cards, and non-plutonium data extracted from the Mound Plutonium Reconstruction (PURECON) database. Unlike the plutonium (PURECON) database or the polonium (PORECON) and tritium databases, which were created from fairly well-organized individual dosimetry records, the information for other radionuclides was generally very poorly-documented and the interpretations of the bioassay results were often scientific approximations. It appears that because the activities involving the other radionuclides were not large-scale operations, the documentation of associated bioassay sample information was secondary to the larger plutonium, polonium, and tritium sampling and analysis programs.

Difficulties encountered in attempting to interpret available bioassay records are described within a position paper on dose assessments for other radionuclides, contained within *Pre-1989 Dose Assessment Project Phase II Final Report* (MJW, 2002b, Appendix C). Some of the results were not associated with a name, social security number, or health physics number. Often, there were no units associated with a result. In many cases, there were results for an element such as radium or thorium, but it was unclear which isotope was intended. There was no information on the age, solubility, or chemical form of the elements. In some cases, it appears bioassay results were repeatedly reported for two, or sometimes three, different radionuclides. For example, a person may have identical results for protactinium and Th-232. In other cases, urine samples may have been analyzed for radium, actinium, and thorium by differential decay analysis of the radium fraction. The same urine sample may have

also been analyzed for Th-232 by doing a Ra-Th separation. The results of the differential decay analysis appeared to conflict with the Th-232 analysis in that the dominant radium isotope is Ra-223, whereas Ra-224 would be expected. This would seem to indicate that the thorium results should have been interpreted as Th-227.

Descriptions of radiation protection activities in periodic health physics reports demonstrate that the health physics program was considering short-lived air activity to the extent that this activity was routinely reported through the era of radium and thorium processing, as well as protactinium and actinium separation. However, residual radioactive material from the Ra-Ac-Th process resulted in the technologically-enhanced emanation of three isotopes of radon, Rn-220, Rn-222, and Rn-219 into Room SW-19. As discussed, no bioassay monitoring records relevant to radon exposures are available from 1955 until the measurements made in 1979-1980.

5.4 External Personnel Monitoring Data

The Mound Plant had a continuous external dose monitoring program that developed policies and made programmatic corrections as necessary. Mound used a film badge external dosimetry monitoring system from 1946 to 1977. From 1977 to the time Mound closed, Mound used a thermoluminescent dosimeter (TLD) system. Records of radiation exposures from personnel dosimeters worn by workers and co-workers are available for all years. The Mound Environmental, Safety, and Health system (MESH) database serves as the primary electronic repository of these records. It contains all radiation doses measured for Mound employees from 1947 to 2005. Periodic health physics reports contain summaries of the number of dosimeters read for each period, as well as the number of results in each of several dose ranges. When individual doses cannot be reconstructed more precisely, maximum doses can be based on these reported results.

Details regarding the dosimeters used at the Mound Plant are presented in ORAUT-TKBS-0016-6. Additional information regarding the external dosimetry equipment, methodologies, and techniques in use during most of the proposed class time period is provided in the various volumes of the document, *History of Personnel External Dosimetry Program at the Dayton Project and Mound Laboratory 1946-1993* (Meyer, 1994).

5.5 Workplace Monitoring Data

To support dose reconstruction and its evaluation of SEC-00090, NIOSH obtained routine air monitoring data from the beginning of Mound operations. Room SW-19 was the only location at Mound identified as an area of potential occupational exposure to Rn-222 and Rn-220 (King, 1995). Rn-220 and Rn-219 measurement results were very limited despite the high concentrations observed in the unoccupied tunnel. The only Rn-219 measurements were made in Building 21 at 0.3 to 0.7 pCi/l, but the holding time before analysis was excessive compared to the four-second half-life of Rn-219. The only Rn-220 measurement in SW-19 was below detection. Rn-220 and Rn-219 exposures would not be detectable in excreta by bioassay due to very short half-lives (ORIAUT-TKBS-0016-5).

As presented in Section 4.1 above, Room SW-19 had elevated radon concentrations emanating from radium and thorium processing wastes. A ventilation system was installed in early 1980 (prior to

March 5, 1980) to vent SW Building tunnel air (Meyer, 1992). This system reduced Rn-222 concentrations in Room SW-19 by a factor of 10 or more. This result was confirmed with continuous measurements from 7.7 pCi/l to 13.4 pCi/l. A WL measurement by the employee's desk following ventilation system installation was 0.03 WL or 0.03 (12 month/year) = 0.4 working level month (WLM), compared with an occupational limit of 4 WLM/year (King, 1995).

The use of facility ambient air monitoring data for purposes of assessing internal radiation doses was evaluated. With the exception of some data for airborne radon and tritium, the data were not considered a viable approach due to unknown factors impacting the representativeness of actual breathing zone air concentrations.

NIOSH has found no workplace monitoring records relevant to these radon exposures in the R and SW Buildings until air measurements were made in 1979 and 1980. Additional information regarding the quantity and condition of the Mound Plant workplace monitoring data available to NIOSH, as well as the NIOSH evaluation of such data, can be found in the related Mound evaluation report for SEC-00090 (NIOSH, 2007).

5.6 Radiological Source Term Data

Descriptions of radiation protection activities in periodic health physics reports demonstrate that the health physics program was considering short-lived air activity to the extent that this activity was routinely reported through the era of radium and thorium processing, as well as protactinium and actinium separation. However, residual radioactive material from the Ra-Ac-Th process resulted in the technologically-enhanced emanation of three isotopes of radon, Rn-220, Rn-222, and Rn-219. These radon isotopes represent an occupational radon exposure. As previously described, no monitoring records are available from 1955 until the measurements made in 1979-1980.

The operations would have generated Rn-219 from the decay of Ac-227; Rn-222 from the decay of Ra-226; and Rn-220 from the decay of Th-232. The mix of these radionuclides is difficult to measure in the field, and only one datum is currently known to exist, as reported in ORAUT-TKBS-0016. This single estimate of the proportion of inert gases gives the relative concentrations of the three isotopes of radon of interest in the SW Building. The measurement was taken in a tunnel under SW-2 (HP Monthly, 1953; HP Monthly, 1954) in an area that was not routinely occupied (having a depth of 2'3" according at a drawing dated January 8, 1952) (HP Quarterly, 1955), and is thus related to the proportions present in the workplace to an unknown degree. As of the date of this evaluation report, NIOSH has not discovered any other source term information other than this data point.

NIOSH lacks activity data for the residual Ra-Ac-Th source term affecting Room SW-19. Consequently, in the absence of workplace monitoring data, NIOSH is unable to calculate upper-bound radon concentrations for the R and SW Buildings. Additional information regarding the Mound Plant source term data available to NIOSH can be found in the related Mound evaluation report for SEC-00090 (NIOSH, 2007), and the Mound site profile documents.

6.0 Feasibility of Dose Reconstruction for the Proposed Class

42 C.F.R. § 83.14(b) states that DHHS will consider a NIOSH determination that there was insufficient information to complete a dose reconstruction, as indicated in this present case, to be sufficient, without further consideration, to conclude that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy.

In the case of a petition submitted to NIOSH under 42 C.F.R. § 83.9(b), NIOSH has already determined that a dose reconstruction cannot be completed for an employee at the DOE or AWE facility. This determination by NIOSH provides the basis for the petition by the affected claimant. Per § 83.14(a), the NIOSH-proposed class defines those employees who, based on completed research, are similarly affected and for whom, as a class, dose reconstruction is similarly not feasible.

In accordance with § 83.14(a), NIOSH may establish a second class of co-workers at the facility for whom NIOSH believes that dose reconstruction is similarly infeasible, but for whom additional research and analysis is required. If so identified, NIOSH would address this second class in a separate SEC evaluation rather than delay consideration of the claim currently under evaluation (see Section 10). This would allow NIOSH, the Board, and HHS to complete, without delay, their consideration of the class that includes a claimant for whom NIOSH has already determined a dose reconstruction cannot be completed, and whose only possible remedy under EEOICPA is the addition of a class of employees to the SEC.

This section of the report summarizes research findings by which NIOSH determined that it lacked sufficient information to complete the relevant dose reconstruction and on which basis it has defined the class of employees for which dose reconstruction is not feasible. NIOSH's determination relies on the same statutory and regulatory criteria that govern consideration of all SEC petitions.

6.1 Feasibility of Estimating Internal Exposures

NIOSH has evaluated the available personnel and workplace monitoring data and source term information and has determined that there are insufficient data for estimating internal exposures, as described below.

As discussed in Section 5.3 above, no bioassay monitoring records relevant to radon exposures in the R and SW Buildings are available from 1955 until the air measurements made in 1979-1980. NIOSH has determined that, for the period from March 1, 1959 through March 5, 1980, radon dose resulting from radioactive material associated with the separation activity in the R and SW Buildings cannot be reconstructed with sufficient accuracy prior to the measurements taken in 1979 and 1980, and prior to the completion of the installation of a ventilation system to vent the SW Building.

As discussed in Sections 5.5 and 5.6 above, NIOSH has found no workplace monitoring records after February 1955 relevant to the radon exposures in the R and SW Buildings until air measurements were made in 1979 and 1980. NIOSH also lacks activity data for the residual Ra-Ac-Th source term affecting the R and SW Buildings, and is consequently unable to calculate upper-bound radon concentrations for the R and SW Buildings during the period.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to radon isotopes originating from residual radioactive material associated with the Ra-Ac-Th source term in the tunnel underlying Room SW-19 during the period from March 1, 1955 through March 5, 1980. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to isotopes of radon and resulting doses for the class of employees covered by this evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from March 1, 1959 through March 5, 1980, for workers who worked in the R and SW Buildings, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at the Mound Plant during the period from March 1, 1959 through March 5, 1980, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.2 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures to radon isotopes originating from residual radioactive material associated with the Ra-Ac-Th source term in soil underlying Room SW-19 could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor (DOL). As noted above, DHHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Consequently, it is not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of workers covered by this report.

In its previous evaluation of petition SEC-00090, NIOSH concluded that for the period from February 1949 to present, it has access to sufficient information to either: (1) estimate the maximum external radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the external radiation doses to members of the class more precisely than a maximum dose estimate. This current evaluation has found no evidence to the contrary.

Adequate reconstruction of medical dose is likely to be feasible by using bounding assumptions in the technical information bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006), and Mound technical basis documents, collectively referred to as ORAUT-TKBS-0016.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the period from March 1, 1959 through March 5, 1980, NIOSH intends to use any external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at Mound during the period from March 1, 1959 through March 5, 1980, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.3 Class Parameters Associated with Infeasibility

Through the course of ongoing research, NIOSH has determined that no radon monitoring records are available from 1955 until measurements were made in 1979-1980, and that no approved method exists to support bounding radon dose during the period of March 1, 1959 through March 5, 1980. Because DHHS previously designated a class from October 1, 1949 through February 28, 1959 for inclusion in the SEC, NIOSH recommends that the class include the period from March 1, 1959 (based on the end-date of the previously designated class as specified by DHSS) through March 5, 1980.

As discussed in Section 4.4, the Mound workers in Room SW-19 could have received potential intakes of radon isotopes originating from residual radioactive material associated with the Ra-Ac-Th source term in the tunnel underlying Room SW-19. NIOSH has no evidence suggesting that any other buildings at the Mound Plant were affected by uncontrolled and unmonitored emanations of radon from residual Ra-Ac-Th materials. It is not feasible to determine which of the workers in the R and SW buildings may have frequented Room SW-19, therefore NIOSH cannot reasonably limit the cohort of workers who could have been exposed to radon in SW-19 more narrowly than the cohort of all workers in the R and SW buildings. Due to the extensive tritium operations occurring in these buildings, it was documented policy that everybody who worked in R and SW buildings submit periodic urine samples analyzed for tritium. While it is possible that a worker could have occasionally visited the R and SW buildings without submitting a tritium urinalysis sample, it is not plausible that a worker could have spent 250 days in these buildings without leaving a single tritium urine sample. Therefore, tritium urinalysis results will be taken as evidence of potential employment in R and SW buildings. Conversely, absence of such urinalysis data will be taken as evidence that individuals did not have the potential to be employed in R and SW buildings for 250 days. NIOSH recommends that the class definition include all workers who worked in the R and SW Buildings at the Mound Plant during the specified time period.

NIOSH has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions within the R and SW Buildings. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions. NIOSH therefore recommends that the class include all workers who worked in the R and SW Buildings during the specified time period, as evidenced by the the presence of tritium urinalysis data.

7.0 Summary of Feasibility Findings for Petition SEC-00171

This report evaluates the feasibility for completing dose reconstructions for employees at the Mound Plant from March 1, 1959 through March 5, 1980. NIOSH determined that members of this class may have received radiation exposures from radon isotopes originating from residual radioactive material associated with the Ra-Ac-Th source term in soil underlying Room SW-19. NIOSH lacks sufficient information, which includes bioassay, source term data, and workplace monitoring data that would allow it to estimate the potential radon exposures to which the proposed class may have been exposed.

NIOSH has documented herein that it cannot complete the dose reconstructions related to this petition. The basis of this finding demonstrates that NIOSH does not have access to sufficient information to

estimate either the maximum radiation dose incurred by any member of the class or to estimate such radiation doses more precisely than a maximum dose estimate.

Consistent with its findings associated with SEC-00090, NIOSH has established that it has access to sufficient information to: (1) estimate the maximum external radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the external radiation doses to members of the class more precisely than a maximum dose estimate.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at the Mound Plant during the period from March 1, 1959 through March 5, 1980, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00171

The health endangerment determination for the class of employees covered by this evaluation report is governed by EEOICPA and 42 C.F.R. § 83.14(b) and § 83.13(c)(3). Pursuant to these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulations require NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has determined that members of the class were not exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of radon isotopes originating from residual radioactive material associated with the Ra-Ac-Th source term in the tunnel underlying Room SW-19. Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 NIOSH-Proposed Class for Petition SEC-00171

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who were monitored for tritium exposure while working at the Mound Plant in Miamisburg, Ohio, from March 1, 1959 through March 5, 1980, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

10.0 Evaluation of Second Similar Class

In accordance with § 83.14(a), NIOSH may establish a second class of co-workers at the facility, similar to the class defined in Section 9.0, for whom NIOSH believes that dose reconstruction may not be feasible, and for whom additional research and analyses is required. If a second class is identified, it would require additional research and analyses. Such a class would be addressed in a separate SEC evaluation rather than delay consideration of the current claim. At this time, NIOSH has not identified a second similar class of employees at the Mound Plant for whom dose reconstruction may not be feasible.

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