

## SEC Petition Evaluation Report Petition SEC-00148

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Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00148	83.14	May 28, 2009	Norton Company

NIOSH-Proposed Class Definition
All AWE employees who worked at Norton Company in Worcester, Massachusetts, from January 1, 1945 through December 31, 1957, 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 included in the Special Exposure Cohort.

Related Petition Summary Information			
SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
None			

Related Evaluation Report Information	
Report Title	DOE/AWE Facility Name
None	

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## Evaluation Report Summary: SEC-00148, Norton Company

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 AWE employees who worked at Norton Company in Worcester, Massachusetts, from January 1, 1945 through December 31, 1957, 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 included in the Special Exposure Cohort.

### Feasibility of Dose Reconstruction Findings

NIOSH lacks sufficient information, which includes biological monitoring data, air monitoring information, and process and radiological source information that would allow it to estimate with sufficient accuracy the potential internal exposures to uranium, thorium, and their respective progeny to which the proposed class may have been subjected. NIOSH finds that reconstruction of external dose for individuals for whom personal monitoring records are not available is also not feasible.

NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Norton Company workers with sufficient accuracy.

- Principal sources of internal and external radiation exposure for members of the proposed class included exposures to uranium and thorium and their respective progeny. During their production of refractory crucibles and cylinders, Norton Company processed uranium and thorium ores, concentrates, scrap, and residues. This processing involved direct contact with radioactive materials and generated airborne dust and surface contamination.
- NIOSH has obtained thirteen bioassay urinalysis results recorded for 1955 and 1956. These samples were analyzed for uranium by fluorimetry, which yielded the total amount of uranium (by mass) in urine. The limited data available to NIOSH are not sufficient to quantify intakes of uranium or uranium progeny during the AWE operations period. NIOSH has obtained no thorium specific internal monitoring data, and has insufficient information to quantify intakes of thorium or thorium progeny during the AWE operations period at Norton Company.
- NIOSH has obtained a limited amount of area radiation survey data for 1954 and 1955 as well as limited gross alpha air monitoring results for 1957. These limited workplace monitoring data are insufficient for NIOSH to quantify the internal or external exposures during the AWE operations period at Norton Company.

- NIOSH has obtained no external dosimeter results for Norton Company workers for the period 1945 through 1957. NIOSH has determined that reconstruction of external dose during the AWE operations period is not feasible with the available information. NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Norton Company workers with sufficient accuracy.
- 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 Norton Company employees, NIOSH intends to use any available internal and external monitoring data that may be available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions may be performed using these data, as appropriate, for individuals with non-presumptive cancers or fewer than 250 days employment during the class period.

#### 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 uranium, thorium, and their respective progeny and from direct exposure to radioactive materials. 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-00148

*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: James Mahathy, Oak Ridge Associated Universities. These conclusions were peer-reviewed by the individuals listed on the cover page. 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.<sup>1</sup>

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 add one or more classes of employees to the SEC. Once NIOSH has received and considered the

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<sup>1</sup> 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>.

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.<sup>2</sup>

### **3.0 NIOSH-Proposed Class Definition and Petition Basis**

The NIOSH-proposed class includes all AWE employees who worked at Norton Company in Worcester, Massachusetts, from January 1, 1945 through December 31, 1957, 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 included in the Special Exposure Cohort. During this period, employees at this facility were involved in the fabrication and manufacturing of refractory crucibles and cylinders. Initially,  $UO_2$  and  $U_3O_8$  were used in stages of the Norton processes. By 1949, thorium ores and metals were also being used.

The evaluation responds to Petition SEC-00148 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. This claimant was employed as a Billing and Payroll Clerk at Norton Company between 1943 and 1949. 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).

### **4.0 Radiological Operations Relevant to the Proposed Class**

The following subsections summarize the radiological operations at Norton Company from January 1, 1945 through December 31, 1957 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.

#### **4.1 Operations Description**

The covered facility designated as Norton Company was located in Worcester, Massachusetts and began EEOICPA-covered operations in 1945. Under a Manhattan Engineer District (MED) contract, Norton started fabricating hexagons containing beryllium oxide-uranium oxide in 1945 at both the Worcester site and at Norton's Chippewa site in Ontario, Canada. Prior to May 1947, the work at Worcester was performed on a laboratory scale, with full production of the beryllium oxide-uranium oxide hexagons beginning soon after May 1947 (Beryllium, 1947) NIOSH has no information on the amount of uranium that was used in the hexagon process.

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<sup>2</sup> 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>.

In May 1947, the Atomic Energy Commission (AEC) asked Norton to fabricate ten beryllium oxide cubes that contained ten percent  $U_3O_8$  by weight (Cubes, 1947). Additional orders were placed in 1947 for small quantities of beryllium cylinders (30 or less) containing uranium from either  $UO_2$  or  $U_3O_8$  (Cylinders, 1947). NIOSH has obtained data on a portion of the uranium inventory at Worcester (Inventory, various dates). Norton Co. provided  $UO_2$  to the AEC in 1949 from stored materials (Profile, unknown date). In 1953, Norton shipped scrap to Fernald for recovery of about 160 kilograms of uranium (Scrap, 1953; Fernald, 1953).

Norton continued making crucibles and cylinders containing some amount of uranium through at least 1954 (Controls, 1954; Uranium, 1954; Crucibles, 1954). NIOSH has obtained survey results and urinalysis data that demonstrate that uranium was on site through at least 1956 (Sample Results, 1956; Inspection, 1956). Norton was producing materials using thorium ores and other forms by 1949 (Thorium, 1949). Norton made crucibles containing varying percentages of thorium, and also produced an oxide compound known as "Norton fused oxide" (Thoria Cylinders, 1954). Norton used thorium for commercial operations from 1958 through the early 1960s (Thoria, 1962; Thoria, 1963).

## 4.2 Radiation Exposure Potential from Operations

NIOSH has obtained documentation that describes and quantifies only some of the Norton Company source term. Records show that Norton processed uranium ores, concentrates, and scrap as well as thorium ores and metals during the production of refractory crucibles and cylinders. These processes involved direct contact with radioactive materials and generated respirable airborne dust and surface contamination. The potential for internal doses from intakes of uranium, thorium, and their respective progeny, and for external (photon and electron) doses from those radionuclides existed at all locations where radioactive materials were handled or stored.

NIOSH has found some information detailing the quantities of uranium and thorium maintained on site at Worcester and attributable to AEC weapons work. Available information includes annual inventories compiled by the AEC for one-time reports. These records indicate that Norton worked with a variety of forms of materials, including pitchblende ores, uranium concentrates and oxides, and uranium scrap materials (Beryllium, 1947; Oxide, 1947; Special Products, 1954). NIOSH has found little information on the forms of thorium used. Uranium operations involved processing materials to separate and concentrate the uranium and fuse it with other chemicals, including boron and beryllium. These processes involved chemically-separating uranium and its decay chain radionuclides and then re-concentrating them; as a result, they were frequently no longer in equilibrium; the degree of disequilibrium is not identifiable from site records. Similarly, thorium-processing activities resulted in thorium progeny but the degree of any disequilibrium is unknown.

While it is apparent that the Norton Company, worked with natural uranium, natural thorium, and their respective progeny, without additional documentation, NIOSH can make no assumption about the relative amounts of these materials that would have been encountered on site.

### **4.3 Time Period Associated with Radiological Operations**

Per the DOE Office of Health, Safety and Security, the time period associated with AWE operations at Norton Company is from 1945 through 1957 (DOE, 2009). NIOSH has discovered no additional data to support more specific dates for the beginning and end of AWE operations. Therefore, AWE operations at Norton Company are assumed to have started on January 1, 1945, and ended on December 31, 1957.

### **4.4 Site Locations Associated with Radiological Operations**

NIOSH has found no documentation to describe buildings and areas where radiological materials were used, or to limit such use to particular locations at the Worcester site. NIOSH has insufficient information to completely describe the source term, operational processes, worker movements, or potential for contamination spread at Norton Company; therefore, NIOSH must assume that the potential for exposure to radioactive materials existed in all areas of the Norton Company site in Worcester, Massachusetts during the period under evaluation.

### **4.5 Job Descriptions Affected by Radiological Operations**

NIOSH has found no documentation 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**

In addition to examining its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class, NIOSH identified and reviewed data sources to locate information relevant to determining the feasibility of dose reconstruction for the class of employees proposed for this petition. This included determining the availability of information on personnel monitoring, workplace monitoring, and radiological source term data.

NIOSH data capture efforts for Norton Company focused on successor companies, the Nuclear Regulatory Commission (including the ADAMS electronic records repository), the DOE (including OpenNet repository; and Office of Scientific and Technical Information [OSTI]), the State of Massachusetts, and the National Archives record centers. Attachment 1 contains a summary of Norton Company documents. The summary identifies specific data capture details for each document retrieved.

## **5.2 Worker Interviews**

NIOSH has reviewed the computer-assisted telephone interviews conducted for claims filed by Norton Company employees who worked on the site during the period 1945 through 1957. Based on the sparse data available for the Norton facility, NIOSH determined that additional worker interviews would neither change the feasibility determination nor allow NIOSH to limit the class to specific locations. Therefore, no additional interviews were pursued.

## **5.3 Internal Personnel Monitoring Data**

NIOSH reviewed its NIOSH OCAS Claims Tracking System (NOCTS) to determine whether internal and/or external personal monitoring records have been obtained for EEOICPA claimants. No internal data has been supplied for any Norton claimants.

NIOSH has obtained only thirteen bioassay results recorded in 1955 and 1956 (Sample Results, 1956). These samples were analyzed for uranium by fluorimetry, which yielded the total amount of uranium (by mass) in urine. Some of these results could not be correlated to individuals or specific time periods due to illegibility.

## **5.4 External Personnel Monitoring Data**

NIOSH reviewed its NIOSH OCAS Claims Tracking System (NOCTS) to determine whether internal and/or external personal monitoring records have been obtained for EEOICPA claimants. No external data has been supplied for any Norton claimants.

NIOSH has found no external monitoring results for the AWE operations period 1945 through 1957. NIOSH has obtained twelve dosimeter results for the weeks beginning February 3, 1958 and March 3, 1958, after the cessation of AWE operations (Tracerlab, 1958). It is not clear if these post-AWE-operations data represent personnel or area monitoring data.

## 5.5 Workplace Monitoring Data

NIOSH has identified 14 gross alpha air monitoring results for 1957 for the Worcester site (Air Dust, 1957). NIOSH has also obtained air monitoring data for Norton's Chippewa site taken in 1954; however, it is unclear if these data are representative of conditions at the Worcester site. A limited amount of area radiation survey data (Survey, 1955; Special Products, 1954; Survey, 1954) have been found for the Worcester site for 1954 and 1955.

## 5.6 Radiological Source Term Data

NIOSH has found some information partially detailing the quantities of uranium and thorium maintained on site at Worcester in the years 1947 and 1954 that were attributable to AEC weapons work (Inventory, various dates). Available information includes annual inventories compiled by the AEC for one-time reports. These records indicate that Norton worked with a variety of forms of materials, including pitchblende ores, uranium concentrates and oxides, and uranium scrap materials (Beryllium, 1947; Oxide, 1947; Special Products, 1954). Uranium operations involved processing materials to separate and concentrate the uranium and fuse it with other chemicals, including boron and beryllium. These processes involved chemically-separating uranium and its decay chain radionuclides and then re-concentrating them; as a result, they were frequently no longer in equilibrium; the degree of disequilibrium is not identifiable from site records. Similarly, thorium-processing activities resulted in thorium progeny but the degree of any disequilibrium is unknown.

## 6.0 Feasibility of Dose Reconstruction for the Proposed Class

42 C.F.R. § 83.14(b) states that HHS 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.

NIOSH has obtained only thirteen fluorimetric urinalysis results for the years 1955 and 1956, and no thorium bioassay data. NIOSH has insufficient uranium and thorium source term and process information to quantify potential intakes of uranium, thorium, and their respective progeny during the AWE operations period at Norton Company.

Although NIOSH has obtained area contamination survey data for 1954 and 1955, and area air sampling results for 1957 analyzed for gross alpha, these results are inadequate to bound internal intakes from uranium, thorium, and their respective progeny for the entire period from 1945 through 1957. The data are highly variable and there is insufficient information to allow NIOSH to apply general area air concentrations to individual breathing zones.

NIOSH has not identified sufficient documentation to define and quantify the total source term for Norton Company during the AWE operations period. Available documentation indicates that Norton worked with natural uranium, natural thorium and their respective decay chain radionuclides throughout the entire AWE operations period. Without additional documentation, NIOSH can make no assumptions about the relative amounts of these materials that would have been encountered during this period. Therefore, there is insufficient source term information available to NIOSH to bound internal exposures to uranium, thorium, and their respective progeny for the period from January 1, 1945 through December 31, 1957.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to uranium, thorium, and their respective progeny during the period of AWE operations from January 1, 1945, through December 31, 1957. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, total internal exposures and resulting doses for the class under evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from January 1, 1945 through December 31, 1957, NIOSH intends to use any available 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 Norton Company during the period from January 1, 1945 through December 31, 1957, 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 uranium, thorium, and their respective progeny could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor (DOL). As noted above, HHS 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.

NIOSH has obtained no external dosimeter results for the period January 1, 1945 through December 31, 1957. NIOSH has determined that reconstruction of the external dose received during the AWE operations period at Norton Company is not feasible. Adequate reconstruction of medical dose for Norton Company workers is likely to be feasible by using claimant-favorable assumptions in the complex-wide Technical Information Bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006).

Although NIOSH found that it may not be possible to completely reconstruct external radiation doses for all workers for the period from January 1, 1945 through December 31, 1957, NIOSH intends to use any available 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 Norton Company during the period from January 1, 1945 through December 31, 1957, 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

This report evaluates the feasibility for completing dose reconstructions for employees at Norton Company from January 1, 1945 through December 31, 1957. NIOSH found that the available monitoring records, process descriptions, and source term data are not sufficient to complete dose reconstructions for the proposed class of employees. NIOSH therefore recommends that the proposed class include the entire AWE-covered period of January 1, 1945 through December 31, 1957.

NIOSH has no documentation to demonstrate that radioactive materials were restricted to specific areas or that contamination was adequately controlled. NIOSH therefore has insufficient data to limit the SEC class by site location, and assumes that the potential for exposure to radioactive materials existed in all Norton Company buildings and areas during the AWE operations period. NIOSH recommends that the proposed class definition include all Norton Company buildings and areas during the specified time period.

NIOSH has found insufficient documentation associating job titles and/or job assignments with specific radiological operations or conditions. Without such information, NIOSH is unable to define the proposed SEC class based on worker job descriptions. NIOSH therefore recommends that the proposed class definition include all AWE period employees who worked at Norton Company during the specified time period.

## **7.0 Summary of Feasibility Findings for Petition SEC-00148**

This report evaluates the feasibility for completing dose reconstructions for employees at Norton Company from January 1, 1945 through December 31, 1957. NIOSH determined that members of this class may have received radiation exposures from uranium, thorium, and their respective progeny. NIOSH lacks sufficient information, which includes biological monitoring data, air monitoring information, and process and radiological source information that would allow it to estimate the potential internal exposure to which the proposed class may have been exposed. Reconstruction of external dose for individuals for whom personal monitoring records are not available is also not feasible. NIOSH considers the adequate reconstruction of medical dose for Norton Company workers to be likely feasible.

NIOSH has documented herein that it cannot complete the dose reconstruction 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.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any available 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 Norton Company during the period from January 1, 1945 through December 31, 1957, 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-00148**

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 uranium, thorium, and their respective progeny, and from direct exposure to radioactive materials. 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 included in the SEC.

## **9.0 NIOSH-Proposed Class for Petition SEC-00148**

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all AWE employees who worked at Norton Company in Worcester, Massachusetts, from January 1, 1945 through December 31, 1957, 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 included in the SEC.

## **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 Norton Company for whom dose reconstruction may not be feasible.

## 11.0 References

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p 22,296; May 2, 2002; SRDB Ref ID: 19391

42 C.F.R. pt. 82, *Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 2, 2002; SRDB Ref ID: 19392

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*; Final Rule; May 28, 2004; SRDB Ref ID: 22001

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Controls, 1954, Letter regarding operational health controls for beryllium, thorium, and uranium operations, from W. B. Harris (AEC Health and Safety Laboratory) to K. T. Benedict (Norton Company); April 17, 1954; SRDB Ref ID: 10397, pdf p. 13

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Cubes, 1947, Memo concerning Requisition 12297, from Purchasing Agent to W. P. Laber (U.S. Atomic Energy Commission); May 12, 1947; SRDB 11348, pdf p. 8

Cylinders, 1947, Various internal AEC memos concerning beryllium cylinder orders; various AEC personnel; various dates in 1947; SRDB Ref ID: 31645, pdf pp. 6, 12, 27, 32

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<http://www.hss.energy.gov/healthsafety/fwsp/advocacy/faclist/findfacility.cfm>

Fernald, 1953, *Fabrication of Urania Crucibles by Norton Company for Argonne*, letter from G. A. Bate (AEC New York Operations Office) to letter from D. P. Rudolph (AEC Chicago Operations Office); U.S. Atomic Energy Commission; December 1953; SRDB Ref ID: 29778

Inspection, 1956, *Industrial Building Inspection of Worcester's Hands Prior to Coffee Period, November 19, 1956*, memorandum from K. T. Benedict (Norton Company Medical Director); November 20, 1956; SRDB Ref ID: 32684

Inventory, various dates, Various AEC memos regarding inventories of uranium at the Norton Company, Worcester, MA, site, various AEC personnel, various dates; SRDB Ref ID 10397, pdf pp. 38-39, 50, 64

Oxide, 1947, Brown and Black Oxide Located at the Norton Company, letter to W. B. Daume (Monsanto Chemical Company) from C. E. Winters (AEC - Clinton Laboratories Division); July 23, 1947; SRDB Ref ID: 12749

Profile, unknown date, Facility profile for Norton Company, U.S. Department of Energy, Environmental Management; unknown date; SRDB Ref ID: 10397, pdf p. 52

Sample Results, 1956, "*Monday Morning*" Urine (sample results for Norton Company, Worcester, Mass.), AEC New York Operations Office, Health and Safety Division; December 17, 1956; SRDB Ref ID: 9677 (pdf p. 41) and SRDB Ref ID: 10412 (pdf pp. 3-4)

Scrap, 1953, *Fabrication of Urania Crucibles by Norton Company for Argonne*, letter from D. P. Rudolph (AEC Chicago Operations Office) to G. A. Bate (AEC New York Operations Office); U.S. Atomic Energy Commission; November 17, 1953; SRDB Ref ID: 10397, pdf p. 57

Special Products, 1954, *Memorandum – Special Products Division, Radiation Count in Special Products Area, February 18, 1954*, from C. H. Gustafson, Jr. (Norton Company); February 18, 1954; SRDB Ref ID: 32680

Survey, 1954, Radiation survey results from surveys conducted from November 1953 to January 1954; various plant locations; various dates in 1953 and 1954; SRDB Ref ID: 32678

Survey, 1955, *Radiation Survey – February 2, 1955*, conducted by K. T. Benedict, M.D., and Area Supervisors; February 2, 1955; SRDB Ref ID: 32664

Thoria, 1962, *Industrial Hygiene and Safety – Norton, Special Radiation Survey (Thoria-Urania Section)*, conducted by Liberty Mutual Insurance Company on February 2, 1962; report received by Norton: March 8, 1962; SRDB Ref ID: 32669

Thoria, 1963, *Industrial Hygiene and Safety – Norton, Radiation Survey (Thoria in Air Survey)*, conducted by Liberty Mutual Insurance Company on February 20, 1963; report received by Norton: March 12, 1963; SRDB Ref ID: 32687

Thoria Cylinders, 1954, *Thoria Cylinders*, letter to D. Masket (AEC New York Operations Office) from W. H. Hensen (Norton Company, Refractories Division); April 29, 1954; SRDB Ref ID: 10397, pdf pp. 9-11

Thorium, 1949, *Minerals Yearbook, 1949*, listing of sites currently using compounds of thorium (including Norton Company); *Minerals Yearbook* source: <http://digital.library.wisc.edu/1711.dl/Copyright>; SRDB Ref ID: 42461

Tracerlab, 1958, *Film Badge Service Radiation Dosage Report*, Tracerlab, Inc., Waltham, Mass.; results for weeks of February 3 and March 3, 1958; reported March 8, 1958; SRDB Ref ID: 32673

Uranium, 1954, *SF Material Located at the Norton Company*, letter to V. Vespe (AEC Chicago Operations Office) from S. J. Braiden (AEC New York Operations Office); June 4, 1954; SRDB Ref ID: 10397, pdf p. 50

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## Attachment 1: Data Capture Synopses

<b>Table A1-1: Data Capture Synopsis for Norton Company</b>			
<b>Data Capture Information</b>	<b>Data Captured Description</b>	<b>Date Completed</b>	<b>Uploaded</b>
Primary Site/Company Name: Norton Co.; BE 1944-1956; AWE 1945-1957; Residual Radiation 1958-July 2006  St. Gobain (Successor): Kevin Fogarty (IH Manager) (508) 795-5860	Pre-work spot urine samples of four employees, air sample data Tracer Lab Inc., film badge radiation dosage report, and various survey results.	04/16/2007	13
State Contacted: Robert Walker, Director Radiation Control Program Department of Public Health (617) 242-3035	No relevant data identified.	01/23/2007	0
Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	02/14/2009	0
DOE Germantown	Elimination and security information, thoria, heavy oxide, uranium and thorium inventory, radiation survey after thorium oxide fusion, procedures and policies, exposure data, and hazards and safety information.	03/12/2008	6
DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	02/21/2009	0
DOE Legacy Management Considered Sites	Tonawanda area report.	10/25/2007	1
DOE Legacy Management - Grand Junction Office	Uranium oxide crucibles and a FUSRAP investigation report.	02/12/2009	2
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Thorium production, engineering and development through 1954, trip report for Los Alamos Scientific Laboratory, ORNL purchase of fused thoria and crude material, fabrications of urania crucibles by Norton Company for Argonne, handling of uranium oxide, established maximum allowable concentration for airborne uranium, reduction of Ra-226 and Ra-228 in plant effluents, and NLO/Norton AEC contract information.	05/21/2008	26
DOE OpenNet	Historical report and monthly status and progress reports.	02/13/2009	7
DOE OSTI Energy Citations	No relevant data identified.	02/13/2009	0
DOE OSTI Information Bridge	Pacific Northwest laboratory activities report.	02/13/2009	1
Environmental Measurements Laboratory (EML) / Health and Safety Laboratory (HASL)	Site visit reports, 1953 annual report, and thorium sampling and storage information.	03/08/2005	1

<b>Table A1-1: Data Capture Synopsis for Norton Company</b>			
<b>Data Capture Information</b>	<b>Data Captured Description</b>	<b>Date Completed</b>	<b>Uploaded</b>
Google	Fusion process for production of stoichiometric UO <sub>2</sub> , improvements in or relating to a process for the preparation of uranium dioxide, information regarding license number STB-00770, process for the extraction of relatively pure thorium, process of making nuclear fuel element, and weekly information reports.	02/16/2009	8
NARA - Atlanta	Trip report and Norton Company information.	02/21/2007	5
NARA - College Park	Beryllium issues at Norton Company.	Unknown	1
National Academies Press (NAP)	No relevant data identified.	02/14/2009	0
National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	02/14/2009	0
NRC Agencywide Document Access and Management (ADAMS)	No relevant data identified.	02/13/2009	0
Oak Ridge National Laboratory	Health hazards information and brown and black oxide at Norton.	07/08/2004	1
ORAU Team	Confirmation of the Radiation Control Program of the Massachusetts Department of Public Health.	01/23/2007	1
Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	02/14/2009	0
Unknown	Air dust, breath, and water samples, urine sample results, multiple site historical information and thorium procurement and investigations.	Unknown	17
<b>TOTAL</b>			<b>90</b>

<b>Table A1-2: Database Searches for Norton Company</b>			
<b>Database/Source</b>	<b>Keywords</b>	<b>Hits</b>	<b>Uploaded</b>
DOE OpenNet <a href="http://www.osti.gov/opennet/advancedsearch.jsp">http://www.osti.gov/opennet/advancedsearch.jsp</a> COMPLETED 02/13/2009	"Norton Company"	20	7
DOE OSTI Energy Citations <a href="http://www.osti.gov/energycitations/">http://www.osti.gov/energycitations/</a> COMPLETED 02/13/2009	"Norton Company"	374	0
DOE OSTI Information Bridge <a href="http://www.osti.gov/bridge/advancedsearch.jsp">http://www.osti.gov/bridge/advancedsearch.jsp</a> COMPLETED 02/13/2009	"Norton Company"	316	1
NRC ADAMS Reading Room <a href="http://www.nrc.gov/reading-rm/adams/web-based.html">http://www.nrc.gov/reading-rm/adams/web-based.html</a> COMPLETED 02/13/2009	"Norton Company"	40	0
DOE CEDR <a href="http://cedr.lbl.gov/">http://cedr.lbl.gov/</a> COMPLETED 02/14/2009	"Norton Company"	0	0
	"Norton"		
National Academies Press <a href="http://www.nap.edu/">http://www.nap.edu/</a> COMPLETED 02/14/2009	"Norton Company"	86	0
	"Norton"		
NNSA - Nevada Site Office <a href="http://www.nv.doe.gov/main/search.htm">www.nv.doe.gov/main/search.htm</a> COMPLETED 02/14/2009	"Norton Company"	0	0
	"Norton"		
U.S. Transuranium & Uranium Registries <a href="http://www.ustur.wsu.edu/">http://www.ustur.wsu.edu/</a> COMPLETED 02/14/2009	"Norton Company"	1	0
Google <a href="http://www.google.com">http://www.google.com</a> COMPLETED 02/16/2009	Norton Company Worcester americium, OR Am241, OR Am-241, OR "AM 241", OR 241Am, OR 241-Am, OR "241 Am" -EEOICPA, -ORAU, -NIOSH	32,634	8
	Norton Company Worcester ionium, OR Th230, OR Th-230, OR "Th 230", OR 230Th, OR 230-Th, OR "230 Th" -EEOICPA, -ORAU, -NIOSH		

Table A1-2: Database Searches for Norton Company			
Database/Source	Keywords	Hits	Uploaded
	Norton Company Worcester neptunium, OR Np237, OR Np-237, OR "Np 237", OR 237Np, OR 237-Np, OR "237 Np" -EEOICPA, -ORAU, - NIOSH		
	Norton Company Worcester polonium, OR Po210, OR Po-210, OR "Po 210", OR 210Po, OR 210-Po, OR "210 Po" -EEOICPA, -ORAU, - NIOSH		
	thorium, OR Th232, OR Th-232, OR "Th 232", OR 232Th, OR 232-Th, OR "232 Th", OR "Z metal", OR myrnalloy, OR "chemical 10-66", OR "chemical 10-12"		
	ionium, OR UX1, OR UX2, OR Th-230, OR Th230, OR "Th 230", OR 230-Th, OR "230 Th", OR 230Th, OR Th-234, OR Th234, OR "Th 234", OR 234-Th, OR 234Th, OR "234 Th"		
	tritium, H3, H-3, mint, HTO		
	uranium, OR U233, OR U-233, OR "U 233", OR 233U, OR 233-U, OR "233 U", OR U234, OR "U 234", OR U-234, OR 234U, OR 234-U, OR "234 U"		
	U235, OR "U 235", OR U-235, OR 235-U, OR 235U, OR "235 U", OR U238, OR "U 238", OR U-238, OR 238-U, OR 238U, OR "238 U"		
	U308, OR "U 308", OR U-308, OR 308-U, OR 308U, OR "308 U", OR "uranium extraction", OR "black oxide", OR "brown oxide"		
	green salt, OR "orange oxide", OR "yellow cake", OR UO2, OR UO3, OR UF4, OR UF6, OR C-216, OR C-616, OR C-65, OR C-211, OR U3O8		
	plutonium, OR Pu-238, OR Pu238, OR "Pu 238", OR 238Pu, OR 238-Pu, OR "238 Pu", OR Pu-239, OR Pu239, OR "Pu 239", OR 239Pu, OR 239-Pu, OR "239 Pu"		
	Pu-240, OR Pu240, OR "Pu 240", OR 240Pu, OR 240-Pu, OR "240 Pu", OR Pu-241, OR Pu241, OR "Pu 241", OR 241Pu, OR 241-Pu, OR "241 Pu"		

Table A1-2: Database Searches for Norton Company			
Database/Source	Keywords	Hits	Uploaded
	radium, OR Ra-226, OR Ra226, OR "Ra 226", OR 226-Ra, OR 226Ra, OR 226-Ra, OR Ra-228, OR Ra228, OR "Ra 228", OR 228Ra, OR 228-Ra, OR "228 Ra"		
	radon, OR Rn-222, OR Rn222, OR "Rn 222", OR 222Rn, OR 222-Rn, OR "222 Rn"		
	thoron, OR Rn-220, OR Rn220, OR "Rn 220", OR 220Rn, OR 220-Rn, OR "220 Rn"		
	protactinium, OR Pa-234m, OR Pa234m, OR "Pa 234m", OR 234mPa, OR 234m-Pa, OR "234m Pa"		
	strontium, OR Sr-90, OR Sr90, OR "Sr 90", OR 90-Sr, OR 90Sr, OR "90 Sr"		
	oralloy, OR postum, OR tuballoy, OR "uranyl nitrate hexahydrate", OR UNH, OR K-65, OR "sump cake"		
	uranium dioxide, OR "uranium tetrafluoride", OR "uranium trioxide"		
	uranium hexafluoride, OR accident, OR "air count"		
	air dust, OR "air filter", OR "airborne test"		
	alpha, OR "belgian congo ore", OR bioassay, OR bio-assay		
	breath, OR "breathing zone", OR BZ, OR calibration, OR columnation		
	contamination, OR curie, OR denitration, OR "denitration pot"		
	derby, OR regulus, OR dose, OR dosimeter		
	dosimetric, OR dosimetry, OR electron, OR environment		
	Ether-Water Project, OR exposure, OR "exposure investigation", OR "radiation exposure"		
	external, OR "F machine", OR fecal, OR "feed material", OR femptocurie, OR film, OR fission, OR fluoroscopy		
	Formerly Utilized Sites Remedial Action Program, OR FUSRAP, OR gamma-ray, OR "gas proportional", OR "gaseous diffusion"		
	health, OR "health instrument", OR "health physics", OR "H.I.", OR HI, OR HP, OR "highly enriched uranium", OR HEU		

<b>Table A1-2: Database Searches for Norton Company</b>			
<b>Database/Source</b>	<b>Keywords</b>	<b>Hits</b>	<b>Uploaded</b>
	hydrofluorination, OR "in vitro", OR "in vivo", OR incident, OR ingestion, OR inhalation, OR internal		
	investigation, OR isotope, OR isotopic, OR "isotopic enrichment", OR "JS Project", OR Landauer, OR "liquid scintillation"		
	log, OR "log sheet", OR "log book", OR "low enriched uranium", OR LEU		
	maximum permissible concentration, OR MPC, OR metallurgy, OR microcurie, OR millicurie		
	mixed fission product, OR MFP, OR monitor, OR "air monitoring", OR nanocurie, OR "nasal wipe", OR neutron, OR "nose wipe"		
	nuclear, OR Chicago-Nuclear, OR "nuclear fuels", OR "nuclear track emulsion", OR "type A"		
	NTA, OR "occupational radiation exposure", OR occurrence, OR "ore concentrate", OR "PC Project"		
	permit, OR "radiation work permit", OR "safe work permit", OR "special work permit", OR RWP, OR SWP		
	phosphate research, OR photon, OR picocurie, OR pitchblende, OR "pocket ion chamber", OR PIC, OR problem, OR procedure		
	radeco, OR radiation, OR radioactive, OR radioactivity, OR radiograph, OR radiological		
	Radiological Survey Data Sheet, OR RSDS, OR radionuclide, OR raffinate, OR reactor		
	respiratory, OR "retention schedules", OR roentgen		
	sample, OR "air sample", OR "dust sample", OR "general area air sample"		
	solvent extraction, OR source, OR "sealed source", OR spectra, OR spectrograph, OR spectroscopy, OR spectrum, OR standard, OR "operating standard", OR "processing standard"		
	survey, OR "building survey", OR "routine survey", OR "special survey", OR "technical basis"		

<b>Table A1-2: Database Searches for Norton Company</b>			
<b>Database/Source</b>	<b>Keywords</b>	<b>Hits</b>	<b>Uploaded</b>
	thermal diffusion, OR "thermoluminescent dosimeter", OR TLD, OR "Tiger Team"		
	tolerance dose, OR urinalysis, OR urine, OR "whole body count", OR WBC, OR "working level", OR WL, OR X-ray, OR "X ray", OR Xray		
DOE Hanford DDRS <a href="http://www2.hanford.gov/declass/">http://www2.hanford.gov/declass/</a> COMPLETED 02/21/2009	"Norton Company"	81	0
	"Norton Co."		

<b>Table A1-3: OSTI Documents Ordered</b>			
<b>Document Number</b>	<b>Document Title</b>	<b>Requested</b>	<b>Received</b>
ORNL-P-123 OSTI ID: 4037808	Experience in the Fabrication of Uranium-233 Bearing Tho-Uo Rods in a Lightly Shielded Facility at ORNL	02/18/2009	N/A
ORNL-P-2 OSTI ID: 4003884	Pilot Plant Preparation of U 233-Tho Shards by the Sol-Gel Method, Preparatory to Producing Powders for Vibratory Packing into Fuel Tubes	02/18/2009	N/A