SEC Petition Evaluation Report
Petition SEC-00169

Report Rev #: 0 Report Submittal Date: April 28, 2010

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Site Expert(s):	N/A

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00169	83.14	April 19, 2010	BWX Technologies, Inc. (Virginia)

NIOSH-Proposed Class Definition

All Atomic Weapons Employer employees who worked at BWX Technologies, Inc., in Lynchburg, Virginia, during the periods:

- from January 1, 1959 through December 31, 1959; or
- from January 1, 1968 through December 31, 1972

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-00169, BWX Technologies

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 BWX Technologies, Inc. in Lynchburg, Virginia, during the periods:

- from January 1, 1959 through December 31, 1959; or
- from January 1, 1968 through December 31, 1972

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 sufficient biological monitoring data, air monitoring information, and process and radiological source term information to allow it to estimate with sufficient accuracy the potential internal exposures to fission and activation products, uranium, and thorium to which the proposed class may have been subjected. NIOSH finds that it is likely feasible to reconstruct occupational medical dose for BWX Technologies, Inc., workers with sufficient accuracy.

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

- Principal sources of internal and external radiation for members of the proposed class included exposures to fission and activation products, uranium of varying degrees of enrichment, and thorium. Associated BWX Technologies, Inc., operations included fuel fabrication, uranium recovery, and commercial reactor and laboratory operations.

- Urine sampling at BWXT during the 1959 AWE period used fluorometric analysis for evaluating uranium exposures to workers; such analysis is insufficient for the evaluation of enriched uranium intakes unless enrichment values are known. Data available to NIOSH do not provide adequate enrichment values for 1959.

- BWXT did not directly monitor worker exposures to thorium using bioassay. Thorium intakes may be inferred from bioassay-derived uranium intakes if the relative activities of thorium and uranium can be established; however, the records available to NIOSH for 1959 do not definitively show that thorium was always used in conjunction with uranium at BWXT.

- For individuals who worked where high-activity commercial materials were handled and stored, personnel internal dose monitoring records were not found for the first AWE operational period (1959), and were found for less than half the workers for the second operational period (1968 through 1972).

- NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored internal exposures for BWXT workers during the periods of AWE operations from January 1, 1959 through December 31, 1959, or from January 1, 1968 through December 31, 1972, regardless of assigned work location.

- 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 BWX Technologies, Inc., during the periods from January 1, 1959 through December 31, 1959; or January 1, 1968 through December 31, 1972, 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 natural uranium, enriched uranium, and thorium 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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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: Vincent King; MJW Corporation. 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 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

[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.

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 AWE employees who worked at BWX Technologies, Inc. in Lynchburg, Virginia, during the periods:

- from January 1, 1959 through December 31, 1959; or
- from January 1, 1968 through December 31, 1972

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 with fuel fabrication, uranium recovery, and commercial reactor and laboratory operations.

The evaluation responds to Petition SEC-00169 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).

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at BWX Technologies, Inc., (BWXT) in Lynchburg, Virginia during its three AWE operations periods from January 1, 1959 through December 31, 2001 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.

[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.

4.1 Operations Description

The EEOICPA facility designation for BWX Technologies, Inc., includes two separately-licensed locations in Lynchburg, Virginia, that have performed work for a variety of Atomic Energy Commission (AEC) and DOE projects (Public Hearings, 1959). During various periods of the site's operating history, the Nuclear Navy Fuels Division (or NNFD) has been referred to as the 'main plant' at Mount Athos (DOE, 2010), the Nuclear Facilities Plant (NFP), the Nuclear Products Division (NPD), or the Nuclear Operations Group – Lynchburg (NOG-L) (Personal Communication, 2010a). The second location is the Lynchburg Technology Center (LTC), formerly called the Lynchburg Research Center (LRC) (Personal Communication, 2010a). These two separate BWXT locations are referred to as NNFD and LTC in this document.

NNFD Facility

The NNFD facility was built in 1956 and has continuously operated through the present (BWXT History, 1994). Operated by the Babcock and Wilcox Company, NNFD participated in the AEC's Oxide Pellet Fabrication Program, which was managed by the New York Operations Office in 1959 (HASL-70, 1959). Records indicate that shipments of enriched uranium were made to and from the Fernald facility during the years 1968-1972. The company also recovered highly-enriched uranium from weapons scrap received from the DOE's Oak Ridge facility between 1985 and 1996. In 1997, the Babcock & Wilcox Company facility in Lynchburg became the BWX Technologies facility. From 1998 to 2000, the company fulfilled a contract for the recovery of enriched uranium from scrap materials containing beryllium. Records available to NIOSH indicate that the Lynchburg plant also participated in the DOE-sponsored Project Sapphire from 1995 through March 2001, which entailed downblending enriched uranium from the government of Kazakhstan (DOE, 2010; Sapphire, undated).

NNFD activities for all operational periods primarily involved fuel fabrication using enriched uranium; activities also involved thorium or uranium-thorium mixtures in 1959. Throughout the site's history, uranium enrichment was stated to be typically >90% (BWXT History, 2008), although enrichments as low as approximately 4% were also used (HASL-70, 1959; Shipment Analysis, 1969; Shipment Request, 1959), and small amounts of depleted and natural uranium were also on site during downblending operations (BWXT History, 2008). Investigation reports in claimant DOE files provided to NIOSH also occasionally include a BWXT internal dose assessment form (Form RP-04-01), which included checkbox items for 20%, 93%, and 97% U-235, indicating that these were likely to be commonly-encountered enrichments. Enrichment for one process evaluated during the 1959 operational period is recorded as 4.2% (HASL-70, 1959), but NIOSH has no indication that this value adequately represents the range of NNFD's possible uranium work in 1959.

LTC Facility

Construction of the LTC facility began in 1956 (BWXT History, 1994). Work at the LTC location primarily involved reactor research, fuel testing, and hot cell work (BWXT History, 2008). The LTC is comprised of four main buildings (A, B, C, and D) and several support building and areas (e.g., Liquid Waste Disposal, Building J, silos). Building A was the reactor building. Reactors were in operation from 1957 through 1983 (Reactor CX-1 began operation in 1957; Reactors CX10, CX-19, CX-12, and R-47 began operations in 1958). All reactors were decommissioned by 1986. Building B was constructed in the 1960s and housed offices, the hot cells, and a laboratory that provided sample

analysis for all the radiological facilities. Building B is currently in operation. Building C served mainly as a fuel-processing test facility and was in service from 1962 until it was decommissioned in 1983. Building D mainly provided administrative support and an X-ray facility. In the information available to NIOSH, the only evidence of LTC directly performing weapons-related work are indications that the analytical laboratory provided sample analysis services for the BWXT NNFD facility (Personal Communication, 2010a). LTC laboratories included the Plutonium Development Lab (PDL), the Nuclear Development Center (NDC), and the Criticality Experiment Lab (CEL) (BWXT History, 2008).

4.2 Radiation Exposure Potential from Operations

The potential for internal and external radiation dose existed at both the NNFD and LTC facilities. A breakdown of facilities and activities with the potential for radiation exposure is shown in Table 4-1.

Table 4-1: Timeline for Facilities and Operations at BWXT

Building/Facilities	Operation Type	Start of Operations	End of Operations
LTC Facility			
Building A	Research and Development activities with radioactive materials, reactors	1956	1984 (Materials License, 1987), final decommissioning June 1986 (BWXT History, 1994)
Subassembly room 1	Unencapsulated fuel (uranium and thorium)	1957	Unrestricted release 1984 (Materials License, 1987)
CX-1	reactor	3/20/1957	6/6/1973 (License Termination, 1986)
CX-10	reactor	Constructed 1957 (operations began 1/22/1958)	September 1983 (License Termination, 1986)
Subassembly room 2	Unencapsulated fuel (uranium and thorium)	1958	Unrestricted release 1984 (Materials License, 1987)
R-47	reactor	1958	July 1982 (License Termination, 1986)
Lynchburg pool reactor (LPR)	reactor	1958	1981 (Materials License, 1987)
CX-19	reactor	1/22/1958	6/6/1973 (License Termination, 1986)
CX-12	reactor	9/24/1958	1971 (Materials License, 1987)
Babcock & Wilcox Test Reactor (BAWTR)	reactor	Construction began 1962; operations began 1/28/1964	12/22/1972 (Materials License, 1987)
Building B	Laboratory analysis for all BWXT facilities, hot cells, Cask Handling Area (CHA), Liquid Waste Disposal Facility (LWDF), storage of highly activated/contaminated materials, fuel rod examination	1960s (BWXT History, 1994)	present

Table 4-1: Timeline for Facilities and Operations at BWXT			
Building/Facilities	**Operation Type**	**Start of Operations**	**End of Operations**
Building C (License SNM-778)	Fuel research and development	1962	1983 (BWXT History, 1994)
	Thorium fuel research	1962	1966 (BWXT History, 1994; BWXT History, 2009)
	Thorium – U-233 fuel research	1964	1964 (BWXT History, 1994)
	Plutonium fuel research	1966	1971 (BWXT History, 1994)
	Uranium fuel research	1971	1983 (BWXT History, 1994)
NNFD Facility			
Main facility	Uranium and thorium fuel fabrication	1956	1963 (thorium) (BWXT History, 2009) Present (uranium)
	Project Sapphire, downblending of foreign HEU to fuel grade enrichments	Shipments received 1995 Downblending starts September 1996	March 2000 (NucNews, 2002; NucNews, 2003; Sapphire, undated)

NNFD Exposures

Based on the site operations outlined in Section 4.1, sources of exposure at NNFD included photon and electron radiation emitted from both AEC-related and commercial uranium at various degrees of enrichment and thorium. The primary source of internal radiation exposure at the NNFD facility was exposure to airborne enriched uranium and thorium generated during fuel fabrication operations (BWXT History, 2008).

LTC Exposures

Sources of external exposure at LTC included photon, electron, and neutron radiation associated with reactor operations and maintenance, and laboratory and hot-cell operations. External doses were higher during earlier years (late 1950s to early 1960s) when thorium-bearing fuels were processed; external doses at LTC were also higher than those for NNFD due to the presence of fission products (BWXT History, 2008). Examples of LTC activities that involved external exposures include (BWXT History, 1994):

- Construction of large quantities of plate-type enriched uranium and metallic thorium fuel assemblies
- Criticality experiments with large quantities of uranium or uranium-thorium fuels
- Laboratory analysis of fuel streams for various Lynchburg operations, including support of downblending contracts at the NNFD plant
- Storage, repackaging, and examination of DOE special nuclear material (SNM) waste, fuel remnants, and related fission products
- Fuel rod examination, including thoriated fuel

- Hot cell activities; examination of irradiated equipment and spent nuclear fuel
- Cask-handling activities involving receipt of highly-radioactive components such as fuel assemblies
- Storage of highly-contaminated and highly-activated materials
- Neutron radiation from reactor operations and/or Pu-Be neutron sources

The primary sources of internal radiation exposure at the LTC facility were fissile materials such as airborne enriched uranium, thorium, plutonium, and U-233 generated during fuel fabrication, testing, and analysis operations; transuranics during sample analysis and materials analysis; irradiated fuels and materials during destructive testing and analysis; fissile materials and/or fission and activation products during scrap recovery; and fission and activation products during sample analysis, hot cell operations, and waste processing (BWXT History, 1994)

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security, the time periods associated with AWE operations at the BWXT site are 1959; 1968 through 1972; and 1985 through 2001 (DOE, 2010). NIOSH has discovered no additional data to support more specific dates for the start and stop of these AWE operations periods. Therefore, AWE work at BWXT is assumed to have occurred during the periods from January 1, 1959 through December 31, 1959; from January 1, 1968 through December 31, 1972; and from January 1, 1985 through December 31, 2001.

4.4 Site Locations Associated with Radiological Operations

NIOSH has determined that both commercial operations and operations with AEC-related materials occurred at the NNFD and LTC facilities. NNFD operations involved enriched uranium for all operational periods, and thorium and thorium-uranium alloys in 1959. Documentation available to NIOSH for either facility does not indicate any definite boundaries between radiological and non-radiological areas for the periods under evaluation. Interviews conducted by NIOSH with BWXT energy employees indicate that workers sometimes travelled between the two BWXT sites (Personal Communication, 2010b). NIOSH has reviewed the available monitoring and employment records for the interviewed energy employees and has determined that worker movement between the sites often is not accurately represented in the individual records. Several workers interviewed indicated that they worked at both facilities over their work histories, but records made available to NIOSH did not identify work site locations or transfers between work sites that correlate with the information provided in the interview for those workers. No additional program documentation was found in the available records that allowed NIOSH to identify protocols or procedures for determining potential worker movements between the NNFD and LTC sites. NIOSH has determined that the site-specific and claimant-specific data available are insufficient to allow NIOSH to characterize worker movements throughout or between the two BWXT facilities. NIOSH is therefore unable to define individual worker exposure scenarios based on specific work locations within the BWXT facilities during the periods under evaluation.

4.5 Job Descriptions Affected by Radiological Operations

NIOSH has determined that the site-specific and claimant-specific data available for the LTC and NNFD facilities of BWXT for the time period under evaluation are insufficient to allow NIOSH to determine that any specific work group was not potentially exposed to radioactive material releases or possible subsequent contamination.

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 BWXT. 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. Attachment One contains a summary of BWXT documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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, NIOSH interviewed 36 former BWXT employees.

- Personal Communication, 2010a, *Personal Communication with BWXT Health Physicist*; Telephone Interview by ORAU Team; March 11, 2009; SRDB Ref ID: 61504

- Personal Communication, 2010b, *Personal Communication with various BWXT employees*; Telephone Interviews by ORAU Team with 34 former BWXT employees to verify employment information; March 23-25, 2010; SRDB Ref ID: 80148

- Personal Communication, 2010c, *Personal Communication with a BWXT employee*; Telephone Interview by ORAU Team; March 30, 2010; SRDB Ref ID: 80182

As stated in Section 4.4, these interviews verified that workers sometimes travelled between the NNFD and LTC sites even though such movements could not be identified from the individual or program records available to NIOSH.

5.3 Internal Personnel Monitoring Data

NNFD Facility

BWXT internal monitoring records evaluated by NIOSH typically included urinalysis for uranium (which was performed from the beginning of AWE operations).

Th-232 was in use at BWXT from the beginning of operations through February 1963 (BWXT History, undated). Although monitoring and urinalysis for Th-232 intakes was initially planned at the beginning of site operations (Frazier, 1956), the inability to correlate urinalysis results to body burdens of thorium led to the decision not to implement thorium urinalysis (Frazier, 1956; BWXT History, 2009). Consequently, for the 1959 operational period, worker exposures to thorium were not monitored directly by bioassay methods. Thorium intakes may be inferred from bioassay-derived uranium intakes if the relative activities of thorium and uranium can be established; however, the few records available to NIOSH for this period cannot definitively show that thorium was always used in conjunction with uranium. One feasibility study from 1959 (Feasibility Report, 1959) provides a uranium fraction of 5.93% in a uranium-thorium mixture, but this does not address other mixtures that may have been encountered.

Routine urine samples were evaluated for uranium content by fluorometric analysis from the beginning of operations through May 1965, with results reported in micrograms of uranium per day. Fluorometric analysis was also used to analyze baseline urine samples (called "background" samples) for all periods. (BWXT History, 2008). Because fluorometric analysis evaluates uranium content on a mass basis, it is ineffective at determining intakes of enriched uranium unless the enrichment value is also known.

Gross alpha counting for total uranium was performed from 1964 through 1991, with units initially reported in disintegrations per minute (dpm) per day, and later in picocuries per liter (pCi/L). Earlier records in dpm/day were often converted to pCi/L (BWXT used 1.4 liters per day excretion and 2.22 dpm/pCi for this conversion). Records show some samples were also analyzed for isotopic uranium during later periods. After November 1994, isotopic urinalysis for uranium was performed by Teledyne Brown (BWXT History, 2008).

Chest counting was performed for U-235 with results reported in micrograms of U-235 (BWXT History, 2008).

Evaluation of uranium intakes using personnel monitoring was supplemented by breathing zone air sampling as discussed below in Section 5.5.

Consistent with the source term information discussed below, internal personnel monitoring for NNFD workers was for uranium exposures only.

NIOSH has reviewed the records for a total of 64 BWXT claims with identifiable employment at NNFD. The number of energy employees monitored for internal exposures by bioassay or breathing zone air sampling for each operational period are shown in Table 5-1 below.

Table 5-1: NNFD Energy Employees Internal Monitoring Information

BWXT Operational Period	No. of Energy Employees Employed at NNFD	No. of Energy Employees with No Internal Monitoring	Percentage Unmonitored or No Dose Record Available
1959	7	4	57%
1968 through 1972	42	3	7%
1985 through 2001	58	15	26%

The only bioassay sampling results obtained by NIOSH for NNFD workers were retrieved from individual-claim-related records; the samples were analyzed for uranium only. The numbers of samples available for evaluation are: 14 results for 1959; 232 results for 1968 through 1972; and 1190 results for 1985 through 2001. For the latter period, 764 samples were analyzed for total uranium and 426 were analyzed for isotopic uranium.

LTC Facility

Evaluation of LTC claim records indicates that, in addition to monitoring for uranium (using the same methods described above for NNFD), analyses were also performed in response to specific exposure situations or incidents. These analyses included plutonium urinalysis, fecal analysis for plutonium and americium, chest counts, and whole body counts consistent with the range of source term materials discussed in Section 5.6.

NIOSH has received records for a total of nine BWXT claims with identifiable employment at LTC. The number of energy employees monitored for internal exposures by operational period are shown in Table 5-2.

Table 5-2: LTC Energy Employees Internal Monitoring Information

BWXT Operational Period	No. of Energy Employees Employed at LTC	No. of Energy Employees with Internal Monitoring Records (Bioassay or Breathing Zone Samples)
1959	2	0
1968 through 1972	5	4
1985 through 2001	7	4

The only internal dose monitoring results obtained by NIOSH for LTC workers were obtained from individual-claim-related records and typically included urinalysis for uranium, whole body counts, or breathing zone samples, although numerous bioassay samples of various types were found for one worker in response to an exposure incident involving plutonium. A summary of the sample types and reported radionuclides obtained from individual worker records is provided in Table 5-3.

Table 5-3: LTC Energy Employees Internal Exposure Monitoring by Radionuclide and Type

Internal Monitoring Method	Number of Analyses		
	1959	1968 – 1972	1985 - 2001
Urinalysis for total uranium	0	6	3
Urinalysis for isotopic uranium	0	5	3
Breathing zone	0	0	9
Whole body count for fission products	0	6	11
Lung count for uranium, plutonium, and americium	0	3[a]	10
Urinalysis for plutonium	0	34[a]	0
Fecal sample analysis for plutonium and americium	0	11[a]	0
Fecal sample analysis for uranium	0	7[a]	0

[a] Samples were for a single worker as part of an incident follow-up.

Information in site records and employee monitoring records does not contain information that clarifies whether the absence of monitoring records is due to missing records or due to the employee being removed from the monitoring program because of low exposure potential (although the latter is likely for claims during the last AWE operational period because there are external dose monitoring records available to NIOSH for the individuals).

5.4 External Personnel Monitoring Data

NIOSH has identified external dose monitoring results from film and TLD badges during the AWE operations periods. In recent years, BWXT reported that external dose monitoring was discontinued for individuals due to lack of potential for exposures above the regulatory threshold for monitoring, and that many routine dosimetry badges were eliminated in 1994 in response to a revision to 10 C.F.R. 20, *Standards for Protection Against Radiation* (BWXT History, 2008). Records indicate that monitoring for most workers was suspended from 1996 through 1999 and in 2001.

Dosimeters were provided by Landauer from the beginning of operations through 2001 (BWXT History, 2008). Film badges were used until late 1990s when Luxel OSL badges were put in use until 2001. Global Dosimetry provided TLDs from 2001 to the present (BWXT History, 2008). The available energy employee data indicate that early monitoring may have also deployed pocket dosimeters.

NNFD Facility

NIOSH identified the following dosimeter types and exchange frequencies for NNFD based on evaluation of worker records:

- 1959-1991: film badges, monthly exchange
- 1992: film badges, biannual exchange
- 1993-1999: film badges, annual exchange.
- 2000-Present: TLD badges, annual exchange

Monitoring was performed to assess exposures to photons and electrons for all years; neutron exposure was not significant for the materials involved in NNFD operations and did not require monitoring.

NIOSH has reviewed the records of 64 BWXT claims with identifiable employment at NNFD. The number of energy employees monitored for external exposures for each operational period is shown in Table 5-4. The years 1996 through 1999 and 2001 were not included in the evaluation in Table 5-4 because NNFD suspended dosimeters for most employees during those years, as discussed above. A breakdown of average and maximum worker annual doses is shown in Table 5-5.

Table 5-4: NNFD Energy Employees External Monitoring Information

BWXT Operational Period	No. of Energy Employees Employed at NNFD	No. of Energy Employees with No External Monitoring	Percentage Unmonitored or No Dose Record Available
1959	6	3	50%
1968 through 1972	43	3	6%
1985 through 2001	58	3	5%

Table 5-5: NNFD Energy Employees Annual External Dose Summary			
BWXT Operational Period	**No. of Annual External Dose Records**	**Average Annual Recorded Dose (rem)**	**Maximum Annual Recorded Dose (rem)**
1959	3	0.007	0.020
1968	23	0.033	0.160
1969	35	0.019	0.110
1970	37	0.051	0.610
1971	39	0.027	0.270
1972	39	0.022	0.190
1985	56	0.070	0.310
1986	54	0.035	0.370
1987	55	0.053	0.300
1988	55	0.024	0.150
1989	52	0.022	0.100
1990	49	0.019	0.150
1991	48	0.026	0.160
1992	45	0.042	0.340
1993	39	0.028	0.230
1994	39	0.040	0.430
1995	39	0.107	0.850
1996	8	0.070	0.140
1997	9	0.054	0.150
1998	6	0.072	0.180
1999	6	0.077	0.230
2000	26	0.121	0.661
2001	4	0.155	0.309

As discussed above, external dose monitoring was discontinued by BWXT during the last operational period for a number of individuals because of low exposure potential.

LTC Facility

At LTC, whole body badges were exchanged on a quarterly or monthly frequency based on the potential for higher doses due to fission products (BWXT History, 2008). Evaluation of records from personnel files and from Landauer verified that monitoring was performed to assess exposures to photons and electrons during all periods, and to assess exposures to neutrons for years during which the commercial reactors were operational. Available Landauer records include over 2200 pages of dosimetry data for the period from 1985 through 2001 (Dosimetry Reports, 1985 through 2001).

NIOSH has received records for a total of nine BWXT claims with identifiable employment at LTC. The number of energy employees monitored for external exposures for each operational period is shown in Table 5-6. A breakdown of average and maximum worker annual doses is shown in Table 5-7.

Table 5-6: LTC Energy Employees External Monitoring Information		
BWXT Operational Period	**No. of Energy Employees Employed at LTC**	**No. of Energy Employees With External Monitoring Records**
1959	2	1
1968 through 1972	5	4
1985 through 2001	6	6

Table 5-7: LTC Energy Employees Annual External Dose Summary			
BWXT Operational Period	**No. of Annual External Dose Records**	**Average Annual Recorded Dose (rem)**	**Maximum Annual Recorded Dose (rem)**
1959	1	N/A	3.285
1968	4	0.968	1.830
1969	4	0.423	0.790
1970	4	0.705	1.180
1971	4	0.603	1.140
1972	4	0.378	1.030
1985	3	0.058	0.110
1986	4	0.028	0.090
1987	5	0.040	0.100
1988	5	0.048	0.120
1989	5	0.032	0.090
1990	4	0.083	0.130
1991	4	0.075	0.160
1992	4	0.058	0.130
1993	2	0.015	0.020
1994	2	0.020	0.020
1995	1	N/A	0.090
1996	1	N/A	0.030
1997	0	N/A	N/A
1998	1	N/A	0.030
1999	0	N/A	N/A
2000	0	N/A	N/A
2001	0	N/A	N/A

Information in site records and employee monitoring records did not contain information that clarified whether the absence of monitoring records was due to missing records or due to the employee being removed from the monitoring program because of low exposure potential**.**

5.5 Workplace Monitoring Data

NIOSH has identified limited area dust sampling and breathing zone air sampling data, as discussed below.

5.5.1 Breathing zone air sampling

NIOSH has found nine breathing zone air sampling results beginning in 1989 (with the exception of one worker for whom results were recorded beginning in 1985). Prior to 1994, results were recorded in MPC-hours (Maximum Permissible Concentration). Following a 1994 revision to 10 C.F.R. 20, *Standards for Protection Against Radiation*, breathing zone sampling became a routine monitoring method, with results reported in DAC-hours (Derived Air Concentration) (BWXT History, 2008). Results were recorded for both alpha emitters and beta emitters.

5.5.2 Dust studies

A 1959 occupational air dust study conducted by the Health and Safety Laboratory (HASL-70, 1959) provides time-weighted airborne dust exposure data for two different commercial uranium-processing operations. The first study was performed on June 3-4, 1959 and included 153 workers involved in the Naval reactor uranium-zirconium fuel plate program. The second study included eight workers involved in the NYOO oxide pellet fabrication program (S.S. Savannah reactor fuel). No other information was found in the records outlining whether other operations were in progress or what air concentrations would have been outside of the limited scope of these evaluations (two days each).

5.6 Radiological Source Term Data

NNFD Source Term

The primary radionuclides that were sources of external and internal radiation exposure at the NNFD facility were uranium, typically enriched from 4% to over 90% U-235 (by mass), and Th-232 (BWXT History, 2008). Thorium was in use from the beginning of operations through February 1963 (BWXT History, undated); uranium has been processed at NNFD for all periods of operations.

LTC Source Term

The primary radionuclides that were sources of external and internal radiation exposure at the LTC facility were (BWXT History, 1994):

- fissile materials such as airborne enriched uranium, thorium, plutonium, and U-233
- transuranics
- irradiated fuels and materials
- fission and activation products

In the records available to NIOSH, NIOSH has found no radioactive material inventory data that would enable it to place an upper bound on potential exposures to the wide array of commercial and AEC radiological sources that could have been encountered at the BWXT facilities.

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.

NNFD Internal Exposures

Urine sampling for the first operational period used fluorometric analysis for evaluating uranium exposures to workers. As pointed out above, fluorometric analysis, which measures uranium by mass, is not capable of evaluating enriched uranium intakes unless a well-defined enrichment value is also known. Because enrichments at NNFD ranged from 4% percent to over 90% for all periods, and because available records do not provide adequately documented enrichment values for operations during this period, assessing worker doses due to enriched uranium intakes is infeasible for the period January 1, 1959 through December 31, 1959.

Additionally, with the exception of the 1959 feasibility study discussed in Section 5.3 (Feasibility Report, 1959), thorium exposures cannot be correlated to relative uranium amounts. Because no urinalysis or other evaluation of thorium exposure was performed, estimating worker doses due to thorium intakes is infeasible for the period January 1, 1959 through December 31, 1959.

Records available to NIOSH include the 1959 occupational air dust study conducted by the Health and Safety Laboratory (HASL-70, 1959). However, NIOSH has no indication that air concentrations due to later operations would be comparable to those in the 1959 study; consequently, NIOSH is unable to use the 1959 air data to bound unmonitored internal exposures during the 1968 through 1972 AWE period at BWXT.

LTC Internal Exposures

High-activity commercial radioactive materials were handled and stored at various LTC locations (e.g., hot cells, Liquid Waste Disposal facility, irradiated fuel storage areas) (BWXT History, 1994). NIOSH has personnel monitoring records for one LTC worker that include routine bioassay analyses for uranium and fission products, and also include bioassays for plutonium and americium related to a 1969 incident; these results indicate the potential for non-uranium exposures at LTC.

In the absence of personnel monitoring data, NIOSH has not found sufficient general area air sampling, breathing zone air sampling, or other site survey information to allow it to bound potential exposures to commercial radioactive materials at the LTC facility during the AWE operational periods from January 1, 1959 through December 31, 1959, and from January 1, 1968 through December 31, 1972.

LTC Infeasibility Applicability to NNFD Workers

Worker interviews (see Section 5.2) and other records indicate that some workers assigned to work at the NNFD site also worked a portion of their time at the LTC site; consequently, NIOSH is unable to adequately define individual exposure scenarios based on available records. As a result, potential intakes cannot be established for NNFD workers who may have also worked at LTC during the AWE operations periods from January 1, 1959 through December 31, 1959, and from January 1, 1968 through December 31, 1972.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored internal exposures for BWXT workers during the periods of AWE operations from January 1, 1959 through December 31, 1959, or from January 1, 1968 through December 31, 1972, regardless of assigned work location.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the two specified AWE operations periods at BWXT, 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 BWXT during the periods from January 1, 1959, through December 31, 1959, or January 1, 1968, through December 31, 1972, 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 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.

External dose monitoring records for NNFD and LTC appear to be more complete than BWXT internal dose monitoring records, but some external data appear to be missing, especially for the 1959 AWE operational period for which records could only be located for three of the six energy employees working at NNFD and one of the two workers at LTC during that year. Comprehensive Landauer dose reports are available for the 1985-2001 AWE operational period for LTC workers (Dosimetry Reports, 1985 through 2001). Consequently, NIOSH has found that external dose reconstruction is likely feasible for the latter AWE operational periods (1968 through 1972, and 1985 through 2001) for both NNFD and LTC workers.

Adequate reconstruction of medical dose is likely to be feasible by using claimant-favorable assumptions in the Technical Information Bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006).

Although NIOSH found that it is not possible to completely reconstruct radiation doses at BWXT, 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 BWXT during the period from January 1, 1959 through December 31, 1959, or January 1, 1968 through December 31, 1972, 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

Based on the information in Section 4.3, NIOSH assumes that AWE work at BWXT occurred during the periods from January 1, 1959 through December 31, 1959; from January 1, 1968 through December 31, 1972; and from January 1, 1985 through December 31, 2001. Based on the information in Section 6.0, NIOSH has determined that it has insufficient dose reconstruction information available for the two earlier AWE periods. Therefore, NIOSH recommends that the class include the time periods from January 1, 1959 through December 31, 1959, and from January 1, 1968 through December 31, 1972.

As presented in Sections 4.4 and 5.2, NIOSH has determined that workers sometimes travelled between the two BWXT sites, and NIOSH is not always able to determine an individual worker's exposure potential using the available individual monitoring or employment records. NIOSH is unable to define individual worker exposure scenarios based on specific work assignments within the two BWXT facilities. NIOSH therefore recommends that the class definition include all buildings and areas of BWXT's LTC and NNFD sites during the specified time periods.

NIOSH has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions at the LTC and NNFD facilities of BWXT. Therefore, NIOSH recommends that the class include all BWXT workers during the specified time periods.

7.0 Summary of Feasibility Findings for Petition SEC-00169

This report evaluates the feasibility for completing dose reconstructions for employees of BWXT from January 1, 1959 through December 31, 1959, and from January 1, 1968 through December 31, 1972. NIOSH determined that members of this class may have received internal and external radiation exposures from fission and activation products, uranium, and thorium. NIOSH lacks sufficient information, which includes insufficient biological monitoring data, air monitoring information, and process and radiological source information that would allow it to estimate the potential internal exposures to fission and activation products, uranium, and thorium to which the proposed class may have been exposed.

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 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 BWX Technologies, Inc., during the period from January 1, 1959 through December 31, 1959; January 1, 1968 through December 31, 1972, 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-00169

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 natural uranium, enriched uranium, and thorium 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 in the SEC.

9.0 NIOSH-Proposed Class for Petition SEC-00169

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 BWX Technologies, Inc. in Lynchburg, Virginia, during the periods:

- from January 1, 1959 through December 31, 1959; or
- from January 1, 1968 through December 31, 1972

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.

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 BWXT for whom dose reconstruction may not be feasible.

11.0 References

10 C.F.R. pt. 20, *Standards for Protection Against Radiation*; U.S. Nuclear Regulatory Commission; Revised as of January 1, 2009; http://www.nrc.gov/reading-rm/doc-collections/cfr/

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

42 U.S.C. §§ 7384-7385 [EEOICPA], *Energy Employees Occupational Illness Compensation Program Act of 2000*; as amended; DCAS website

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Dosimetry Reports, 1989, *Babcock and Wilcox Company Radiation Dosimetry Report Account 69864;* R.S. Landauer, Junior and Company; various dates between 1989 and 1990; SRDB Ref ID: 52585

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Dosimetry Reports, 1991, *Babcock and Wilcox Company Radiation Dosimetry Report Account 69864;* R.S. Landauer, Junior and Company; various dates between 1991 and 1992; SRDB Ref ID: 52595

Dosimetry Reports, 1992, *Babcock and Wilcox Company Radiation Dosimetry Report Account 69864;* R.S. Landauer, Junior and Company; various dates between 1992 and 1993; SRDB Ref ID: 52596

Dosimetry Reports, 1993, *Babcock and Wilcox Company Radiation Dosimetry Report Account 69864;* R.S. Landauer, Junior and Company; various dates in 1993; SRDB Ref ID: 52597

Dosimetry Reports, 1994, *Babcock and Wilcox Company Radiation Dosimetry Report Account 69864;* R.S. Landauer, Junior and Company; various dates in early 1995; SRDB Ref ID: 52598

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Sapphire, undated, *The SAPPHIRE and 50 MT Projects at BWXT, Lynchburg, VA*, symposium paper written by R. Thiele (IAEA), B. Horn, C. W. Coates, and J. R. Stainback; to be presented by R. Thiele; International Atomic Energy Agency (IAEA); IAEA-SM-367/8/01/P; undated; SRDB Ref ID: 40730

Shipment Analysis, 1969, *Analysis of Uranium Shipment #101*, Hobson; March 31, 1969; SRDB Ref ID: 43868

Shipment Request, 1959, *Requests to Ship Nuclear Material Made to U.S. Atomic Energy Commission and Responses;* May 8-15, 1959; SRDB Ref ID: 56321

Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for BWX Technologies, Inc.			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded into SRDB**
Primary Site/Company Name: BWX Technologies, Inc. AWE 1959; 1968-1972 & 1985-2001; Res. Rad. 1960-1967; 1973-1984; & 2002-July 2006; BE 1995-2001 Other Site Names: Tubular Products Div., Lone Star Tech Babcock & Wilcox Co. BWXT	Process knowledge write-up of Babcock and Wilcox Mount Athos Facility early operations with uranium and thorium.	02/19/2009	1
State Contacted: Les Foldesi and Mike Welling, Virginia Department of Health	Composite environmental air samples and radioisotopes, forms, and possession limits from radioactive materials license 45-00105-01.	10/23/2009	3
DOE Germantown	Contract AT(30-1)-4220 transmittal letters.	Unknown	1
DOE Legacy Management - Grand Junction Office	AEC licensing and contract documents, description of the Lynchburg Technology Center (LTC), survey and decommissioning reports for LTC Buildings A and C, thorium inventories and work descriptions at the Mt. Athos facility, health physics activities reports, and Landauer correspondence on anomalous film badge readings.	10/20/2009	44
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Shipment records for thorium and enriched uranium received at Fernald from BWXT, disposition order transferring enriched uranium standards to BWXT from Fernald, and a report of plutonium contamination in UO2 received at Fernald from various sites, including BWXT.	06/30/2008	5
Hanford	A 1971 Hanford monthly report including plutonium receipts from BWXT.	11/24/2008	1
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	11/06/2009	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford progress reports that mention that B&W was working on the aluminum corrosion problem and the development of fuel for the heavy water reactor.	11/06/2009	2
Internet - DOE OpenNet	No relevant data identified.	11/04/2009	0
Internet - DOE OSTI Energy Citations	No relevant data identified.	03/28/2008	0
Internet - DOE OSTI Information Bridge	Records of Sapphire material including U-232 content, downblending highly enriched UF6, low-level waste report including a brief history of BWXT plutonium operations, mention of BWXT as a vendor of pressurized water reactors in a mixed oxide fuel report, and an aerial radiological survey of the facility and its environs.	01/08/2008	8
Internet - DOE OSTI Science Accelerator	No relevant data identified.	11/05/2009	0

Table A1-1: Summary of Holdings in the SRDB for BWX Technologies, Inc.			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded into SRDB**
Internet - Google	A report on the Sapphire and 50-MT downblending projects, news reports on BWXT's business prospects and a criticality violation, site decommissioning plans, licensing correspondence, DOE occupational exposure reports, environmental reports, and a mixed oxide fuel report.	11/06/2009	42
Internet - National Academies Press (NAP)	No relevant data identified.	11/06/2009	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	11/04/2009	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	Environmental assessments, safety evaluation report on the container storage facility, final generic environmental statement on the use of recycled plutonium in mixed oxide fuel reactors, inspection report with a criticality safety notice of violation, license application and Oak Ridge National Laboratory license report regarding the rolling and machining of B&W thorium ingots at Jessop Steel, NRC license SNM-42 amendments, and a license application for the rolling and machining of B&W thorium ingots at Superior Steel Corporation.	11/06/2009	23
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	11/06/2009	0
NOCTS	Description of the dosimetry program and the availability of dosimetry records.	07/21/2008	1
NRC Records	Listing of fuel fabricators and processors including summary group dose information, 1982-2001.	07/13/2005	1
ORAU Team	Documented communications regarding a BWXT process knowledge interview and a request for BWXT documents held by the Grand Junction Operations Office.	10/19/2009	2
R.S. Landauer	External dosimetry reports from 1975-2001.	08/19/2008	28
SAIC	Summary of radiation exposures.	09/02/2004	1
Unknown	New York Operations Office (NYOO) reports mentioning the Babcock & Wilcox (B&W) proposal to alter the Brookhaven graphite pile structure, NYOO reports of B&W enriched uranium inventories, air dust analysis cards from 1959-1961, Health and Safety Laboratory air dust study at B&W, and project spreadsheets.	Unknown	7
Westinghouse Site, Hematite, MO	Records of fuel shipments from United Nuclear to B&W, an exposure history for a United Nuclear employee provided to B&W, and a report of a proposed enforcement action against B&W for criticality safety violations.	04/07/2009	3
TOTAL			**173**

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
DOE CEDR http://cedr.lbl.gov/ COMPLETED 11/06/2009	BWX "Tubular Products" SNM-42 OR License	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 11/06/2009	"BWXT" "Babcock & Wilcox" BWXT BWX	1	2 (Added during Hanford site association review)
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 11/04/2009	BWXT Tubular Products Lone Star Babcock & Wilcox BWX	54	0
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 03/28/2008	Tubular Products Div. Lone Star Tech BWXT "weapons scrap" BWXT "oxide pellet" BWXT "Project Sapphire" BWXT "Fernald" BWXT "Kazakhstan" BWXT "FMPC" Babcock & Wilcox "Project Sapphire" Babcock & Wilcox "weapons scrap" Babcock & Wilcox "oxide pellet" Babcock & Wilcox "Fernald" Babcock & Wilcox "Kazakhstan" Babcock & Wilcox "FMPC" SNM-42 BWX Docket 70-27 SNM-16 SNM-32 C-3465 C-3473 C-3555 45-105-4 (E60) 45-105-3	111	0

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
DOE OSTI Science Accelerator http://www.scienceaccelerator.gov/ COMPLETED 11/05/2009	SNM-42 BWX Docket 70-27 SNM-16 SNM-32 C-3465 C-3473 C-3555 45-105-4 (E60) 45-105-3	110	0
Google http://www.google.com COMPLETED 11/06/2009	BWXT "Lynchburg" Babcock & Wilcox "lynchburg" Babcock & Wilcox "lynchburg" "nuclear" babcock & wilcox "lynchburg" 1955 1956 1957 1958 1959 Kellex "Lynchburg" atomic energy commission "babcock" "lynchburg" BWXT "NRC" BWXT "lynchburg""Americium" BWXT "lynchburg""Americium" BWXT lynchburg "Am241" OR, "Am-241" OR "AM 241" OR "241Am" OR "241-Am" OR "241 Am" bwxt lynchburg "Th230", OR "Th-230", OR "Th OR 230", OR "230Th", OR "230-Th", OR "230 Th" "bwxt"lynchburg""th230" "bwxt"lynchburg""th-230" "bwxt"lynchburg""th 230" "bwxt"lynchburg""230th" "bwxt"lynchburg""230-th" "bwxt"lynchburg""230 th" "bwxt"lynchburg""Thorium" "bwxt"lynchburg""Neptunium" "bwxt"lynchburg""Polonium" "bwxt"lynchburg""Ionium" "BWXT""Lynchburg""AEC"	47,391	42

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	“BWX Technologies” AND americium OR Am241 OR Am-241 OR Am 241 OR 241Am OR 241-Am OR 241 Am -EEOICPA -ORAU –NIOSH "BWX Technologies" AND ionium OR Th230 OR Th-230 OR Th 230 OR 230Th OR 230-Th OR 230 Th -EEOICPA -ORAU –NIOSH "BWX Technologies" AND neptunium OR Np237 OR Np-237 OR Np 237 OR 237Np OR 237-Np OR 237 Np OR palm OR palmolive -EEOICPA -ORAU –NIOSH "BWX Technologies" AND polonium OR Po210 OR Po-210 OR Po 210 OR 210Po OR 210-Po OR 210 Po -EEOICPA -ORAU -NIOSH "BWX Technologies" AND thorium OR thoria OR Th232 OR Th-232 OR Th 232 OR 232Th OR 232-Th OR 232 Th OR Z metal OR Z-metal -EEOICPA -ORAU –NIOSH "BWX Technologies" AND myrnalloy OR chemical 10-66 OR chemical 1066 OR chemical 10 66 OR chemical 18-12 OR chemical 1812 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND OR chemical 18 12 OR chemical 10-12 OR chemical 1012 OR chemical 10 12 OR UX1 OR UX2 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND Th-234 OR Th234 OR Th 234 OR 234-Th OR 234Th OR 234 Thtritium OR H3 OR H-3 OR mint OR HTO -EEOICPA -ORAU –NIOSH "BWX Technologies" AND 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 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND 234U OR 234-U OR 234 U OR U235 OR U 235 OR U-235 OR 235-U OR 235U OR 235 U -EEOICPA -ORAU –NIOSH		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	"BWX Technologies" AND U238 OR U 238 OR U-238 OR 238-U OR 238U OR 238 U OR U308 OR U 308 OR U-308 OR 308-U -EEOICPA -ORAU –NIOSH "BWX Technologies" AND 308U OR 308 U OR black oxide OR brown oxide OR green salt OR orange oxide OR yellow cake OR UO2 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND UO3 OR UF4 OR UF6 OR C-216 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND C-616 OR C-65 OR C-211 OR U3O8 (uranium extraction OR uranium dioxide OR uranium hexafluoride OR uranium tetrafluoride OR uranium trioxide) -EEOICPA -ORAU –NIOSH "BWX Technologies" AND 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 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND 239 Pu OR Pu-240 OR Pu240 OR Pu 240 OR 240Pu OR 240-Pu OR 240 Pu OR Pu-241 OR Pu241 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND Pu 241 OR 241Pu OR 241-Pu OR 241 Pu -EEOICPA -ORAU –NIOSH "BWX Technologies" AND radium OR Ra-226 OR Ra226 OR Ra 226 OR 226-Ra OR 226Ra OR 226 Ra OR Ra-228 OR Ra228 -EEOICPA -ORAU –NIOSH "BWX Technologies" AND Ra 228 OR 228Ra OR 228-Ra OR 228 Ra -EEOICPA -ORAU –NIOSH "BWX Technologies" AND radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn -EEOICPA -ORAU –NIOSH		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	"BWX Technologies" AND thoron OR Rn-220 OR Rn220 OR Rn 220 OR 220Rn OR 220-Rn OR 220 Rn -EEOICPA -ORAU –NIOSH "BWX Technologies" AND protactinium OR Pa-234m OR Pa234m OR Pa 234m OR 234mPa OR 234m-Pa OR 234m Pa -EEOICPA -ORAU –NIOSH “BWX Technologies" AND strontium OR Sr-90 OR Sr90 OR Sr 90 OR 90-Sr OR 90Sr OR 90 Sr OR oralloy -EEOICPA -ORAU –NIOSH "BWX Technologies" AND postum OR tuballoy OR uranyl nitrate hexahydrate OR UNH OR K-65 OR sump cake OR accident OR air count OR air dust OR air filter -EEOICPA -ORAU –NIOSH "BWX Technologies" AND airborne test OR alpha OR belgian congo ore OR beta OR bioassay OR bio-assay OR breath OR breathing zone OR BZ OR body burden -EEOICPA -ORAU -NIOSH "BWX Technologies" AND contamination OR curie OR denitration OR denitration pot OR derby OR regulus OR derived air concentration OR DAC OR dose -EEOICPA -ORAU –NIOSH "BWX Technologies" AND calibration OR chest count OR columnation OR dosimeter OR dosimetric OR dosimetry OR electron -EEOICPA -ORAU –NIOSH "BWX Technologies" AND environment OR Ether-Water Project OR exposure (exposure investigation OR radiation exposure) OR external OR F machine OR fecal OR feed material OR femptocurie OR film OR fission -EEOICPA -ORAU –NIOSH "BWX Technologies" AND fluoroscopy OR Formerly Utilized Sites Remedial Action Program OR FUSRAP OR gamma-ray OR gamma ray OR gas proportional -EEOICPA -ORAU –NIOSH "BWX Technologies" AND gaseous diffusion OR health (health instrument OR health physics) OR H.I. OR HI OR HP OR highly enriched uranium -EEOICPA -ORAU –NIOSH		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	"BWX Technologies" AND HEU OR hydrofluorination OR in vitro OR in vivo -EEOICPA -ORAU –NIOSH "BWX Technologies" AND fluoroscopy OR Formerly Utilized Sites Remedial Action Program OR FUSRAP OR gamma-ray OR gamma ray OR gas proportional OR gaseous diffusion -EEOICPA -ORAU –NIOSH "BWX Technologies" AND health (health instrument OR health physics) OR H.I. OR HI OR HP OR highly enriched uranium OR HEU OR hydrofluorination OR in vitro OR in vivo -EEOICPA -ORAU –NIOSH "BWX Technologies" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR isotopic enrichment OR JS Project OR Landauer -EEOICPA -ORAU –NIOSH "BWX Technologies" AND contamination OR curie OR denitration OR denitration pot OR derby OR regulus OR derived air concentration OR DAC OR dose -EEOICPA -ORAU –NIOSH "BWX Technologies" AND calibration OR chest count OR columnation OR dosimeter OR dosimetric OR dosimetry OR electron -EEOICPA -ORAU –NIOSH "BWX Technologies" AND environment OR Ether-Water Project OR exposure (exposure investigation OR radiation exposure) OR external OR F machine OR fecal OR feed material OR femptocurie OR film OR fission -EEOICPA -ORAU –NIOSH "BWX Technologies" AND fluoroscopy OR Formerly Utilized Sites Remedial Action Program OR FUSRAP OR gamma-ray OR gamma ray OR gas proportional -EEOICPA -ORAU –NIOSH "BWX Technologies" AND gaseous diffusion OR health (health instrument OR health physics) OR H.I. OR HI OR HP OR highly enriched uranium -EEOICPA -ORAU –NIOSH		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	"BWX Technologies" AND HEU OR hydrofluorination OR in vitro OR in vivo -EEOICPA -ORAU –NIOSH "BWX Technologies" AND fluoroscopy OR Formerly Utilized Sites Remedial Action Program OR FUSRAP OR gamma-ray OR gamma ray OR gas proportional OR gaseous diffusion -EEOICPA -ORAU -NIOSH "BWX Technologies" AND health (health instrument OR health physics) OR H.I. OR HI OR HP OR highly enriched uranium OR HEU OR hydrofluorination OR in vitro OR in vivo -EEOICPA -ORAU –NIOSH "BWX Technologies" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR isotopic enrichment OR JS Project OR Landauer -EEOICPA -ORAU –NIOSH "BWX Technologies" AND liquid scintillation OR log (log sheet OR log book) OR low enriched uranium OR LEU OR lung count OR maximum permissible concentration OR MPC -EEOICPA -ORAU –NIOSH "BWX Technologies" AND metallurgy OR microcurie OR millicurie OR mixed fission product OR MFP OR monitor (air monitoring) -EEOICPA -ORAU –NIOSH "BWX Technologies" AND nanocurie OR nasal wipe OR neutron OR nose wipe OR nuclear (Chicago-Nuclear OR nuclear fuels) OR nuclear track emulsion type A -EEOICPA -ORAU –NIOSH "BWX Technologies" AND NTA OR occupational radiation exposure OR occurrence OR ore concentrate OR PC Project -EEOICPA -ORAU –NIOSH "BWX Technologies" AND permit (radiation work permit OR safe work permit OR special work permit) OR RWP OR SWP OR phosphate research OR photon -EEOICPA -ORAU –NIOSH		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	"BWX Technologies" AND picocurie OR pitchblende OR pocket ion chamber OR PIC OR problem OR procedure OR radeco OR radiation -EEOICPA -ORAU –NIOSH "BWX Technologies" AND radioactive OR radioactivity OR radiograph OR radiological OR Radiological Survey Data Sheet OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR retention schedules -EEOICPA -ORAU –NIOSH "BWX Technologies" AND roentgen OR sample (air sample OR dust sample OR general area air sample) OR sampling (air sampling OR dust sampling OR general area air sampling) -EEOICPA -ORAU –NIOSH "BWX Technologies" AND solvent extract+B31ion OR source (sealed source) OR spectra OR spectrograph OR spectroscopy OR spectrum OR standard (operating OR processing OR etc) -EEOICPA -ORAU –NIOSH "BWX Technologies" AND survey (building survey OR routine OR special) OR technical basis OR thermal diffusion OR thermoluminescent dosimeter OR TLD OR Tiger Team -EEOICPA -ORAU –NIOSH "BWX Technologies" AND 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 -EEOICPA -ORAU –NIOSH "Lone Star Tech" AND Virginia -EEOICPA -NIOSH -ORAU "Tubular Products"" AND Virginia AND Lynchburg -EEOICPA -NIOSH –ORAU SNM-42 Docket 70-27 SNM-16 AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	SNM-32 AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH C-3465 AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH C-3473 AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH C-3555 AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH 45-105-4 (E60) AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH 45-105-3 AND license AND Virginia AND Lynchburg -EEOICPA -ORAU –NIOSH "Ken Conway" AND Babcock		
National Academies Press http://www.nap.edu/ COMPLETED 11/06/2009	BWXT BWX	18	0
National Archives http://www.archives.gov/research/arc/ COMPLETED 03/28/2008	BWXT BWX Technologies, Inc BWX Technologies Babcock & Wilcox Co. Babcock & Wilcox Tubular Products Div. Tubular Products Lone Star Tech	33	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 11/04/2009	BWX Technologies, Inc BWX Technologies Babcock & Wilcox Co. Babcock & Wilcox Tubular Products Div. Tubular Products Lone Star Tech BWXT		

Table A1-2: Internet Database Searches for BWX Technologies, Inc.			
Database/Source	**Keywords/Phrases**	**Hits**	**Uploaded into SRDB**
	BWX Docket 70-27 SNM-42		
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 11/06/2009	Tubular Products; filter by Virginia Lone Star Tech BWX Technologies, Inc oxide pellet enriched uranium fernald weapons scrap project sapphire environmental monitoring environmental monitoring oxide pellet enriched uranium fernald weapons scrap project sapphire SNM-42 (Restricted by date: 01/01/1959-12/31/2006) SNM-42 (Restricted by Docket 70) SNM-16 SNM-32 C-3465 C-3473 C-3555 45-105-4 (E60) (Filtered with BWX) 45-105-3	2,186	23
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 11/06/2009	BWX Technologies, Inc BWX Technologies Babcock & Wilcox Co. Babcock & Wilcox Tubular Products Div. Tubular Products Lone Star Tech BWX SNM-42		

Table A1-3: OSTI Documents Requested for BWX Technologies, Inc.			
Document Number	**Document Title**	**Requested Date**	**Received Date**
BAW-4228-1	Research and Development Programs on Plutonium Fuels Technology, Feb 1, 1971	11/10/2009	
BAW-4228-2	Research and Development Programs on Plutonium Fuels Technology, Report No. 2, Aug 1, 1971	11/10/2009	
BAW-1322	Advanced Test Reactor Internals Vibration Summary, May 1968 dated Jun 1, 1968	11/10/2009	