PETITION SEC-00256, Pinellas Plant

SPECIAL EXPOSURE COHORT (SEC) PETITION EVALUATION REPORT (ER)

Aerial photo of the Pinellas Plant [Gueretta 2015]

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

SPECIAL EXPOSURE COHORT PETITION EVALUATION REPORT

Petition SEC-00256

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EVALUATION REPORT SUMMARY

Petition under Evaluation

Petition Number:	SEC-00256
Petition Type:	83.13
Petition Receipt Date(s):	December 16, 2019; May 20, 2020; August 17, 2020
Qualification Date:	October 20, 2020
DOE Facility Name:	Pinellas Plant

Petition Class

Petitioner-Requested Class Definition:	All employees who worked in any area of the Pinellas Plant in Largo, Florida from January 1957 through December 1997 (August 17, 2020 version).
Class Defined by NIOSH for Further Evaluation:	All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990.
NIOSH-Proposed Class to be Added to the SEC:	None

Related Petition Summary Information

SEC Petition Tracking Number(s) and Type(s):	SEC-00111 (83.13), SEC-00130 (83.13), SEC-00176 (83.13), SEC-00184 (83.13), SEC-00231 (83.13), SEC-00233 (83.13), and SEC-00242 (83.13)
DOE/AWE Facility Name(s):	Pinellas Plant
Petition Status(s):	SEC-00111, SEC-00130, SEC-00176, SEC-00184, SEC-00231, SEC-00233, and SEC-00242 - Petitions did not qualify for evaluation

Related Evaluation Report Information

Report Title(s) and DOE/AWE Facility Name(s):	N/A

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EVALUATION REPORT SUMMARY: SEC-00256, PINELLAS PLANT

The National Institute for Occupational Safety and Health (NIOSH) prepared this evaluation report in response to a petition to add a class of workers at the Pinellas Plant to the Special Exposure Cohort (SEC). The *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 United States Code (U.S.C.) Section 7384 *et seq.* (EEOICPA) and 42 Code of Federal Regulations (C.F.R.) Part 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* [42 C.F.R. 83, 2018], describe the process for adding classes of workers to the SEC.

Petitioner-Requested Class Definition

NIOSH received the original SEC-00256 petition on December 16, 2019. The petitioners revised the petitioner-requested SEC class definition twice, following discussions during consultation calls. The original petition (December 16, 2019 version) requested that NIOSH consider the following class: Employees of the Department of Energy (DOE), DOE contractors and/or subcontractors who were employed by General Electric Neutron Devices including all names of this company listed in Part C, Martin Marietta Specialty Components, and/or Lockheed-Martin Specialty Components, Inc. (also known as the Pinellas Plant) during the period from August 1957 through December 1997. In addition, the petition submission included employment dates relevant to the petition as September 4, 1956 to May 19, 1957 at the Temporary Plant and May 19, 1957 to December 1997 at Pinellas Plant [[redacted] 2019].

The revised petition (May 20, 2020 version) included a narrative providing justification for including the "Temporary Plant," a transitional facility in St. Petersburg, Florida, and extending the covered period. This petition requested the following class: Employees of the Department of Energy (DOE), DOE contractors and/or subcontractors who were employed by General Electric Neutron Devices including all names of this company listed in Part C, Martin Marietta Specialty Components, and/or Lockheed-Martin Specialty Components, Inc. (also known as the Pinellas Plant) during the period from June 1956 through December 1997 [[redacted] 2020a].

NIOSH received a final revised petition (August 17, 2020 version) and qualified it for further evaluation on October 20, 2020. The petitioner requested that NIOSH consider the following class: Employees of the Department of Energy (DOE), DOE contractors and/or subcontractors who were employed by General Electric Neutron Devices including all names of this company listed in Part C, Martin Marietta Specialty Components, and/or Lockheed-Martin Specialty Components, Inc. (also known as the Pinellas Plant) during the period from January 1957 through December 1997 [[redacted] 2020b].

Class Defined by NIOSH for Further Evaluation

Based on its preliminary research, NIOSH modified the petitioner-requested class to include: All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990.

Following a comprehensive review of the documentation associated with the petition for support of all accepted bases, E.5 and F.1 through F.4, NIOSH qualified the petition (August 17, 2020 version) for evaluation under the F.4 basis. The 1990 *Tiger Team Assessment of the Pinellas Plant* found that during 1989, workers did not submit bioassay samples in accordance with General Electric Neutron Devices Department procedures [DOE 1990a, PDF p. 224]. The Tiger Team report focused on the 1988–1989 period and is not directly applicable to the time period that followed it because documentation shows that the Pinellas Plant responded to the finding. After the Tiger Team assessment, the Pinellas Plant began tracking individual compliance with bioassay sampling and had success in improving bioassay compliance. The Pinellas Plant documented this success in improving compliance in site As Low As Reasonably Achievable (ALARA) reports. Prior to these tracking efforts, it was unclear how widespread the non-compliance might have been.

Based on a professional review of the supporting documents provided, NIOSH determined there was adequate support for further evaluation of non-compliance with bioassay sampling procedures from 1957 through 1990, when the Pinellas Plant began reporting bioassay compliance. NIOSH evaluated the following class: All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990.

NIOSH Determination about Adding a Proposed Class to the SEC

NIOSH has access to internal and external exposure data for individual workers in the form of personal dosimetry data, summary information in the form of routine ALARA reports, and tritium dose summary data for most years. General area exposure conditions are available in routine health physics reports, incident and occurrence reports, routine ALARA reports, and air sampling data. However, the air sampling data are not comprehensive of the entire Pinellas Plant history. NIOSH also has access to safety work permit (SWP) summary log information, administrative program information, radiation protection procedures, and radiation protection survey protocols used at the Pinellas Plant. Finally, NIOSH has obtained a significant amount of environmental monitoring data, including emissions and environmental sampling. Based on its analysis of these available resources, NIOSH finds that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could be incurred in plausible circumstances by any member of the class under evaluation [42 C.F.R. 83, 2018, PDF p. 10]. Consequently, NIOSH concludes that it is feasible to estimate the radiation dose that the evaluated class of workers received.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. 83.13(c)(1), NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could be incurred in plausible circumstances by any member of the class under evaluation. Information available from the site profile and additional resources is sufficient to estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period [42 C.F.R. 83, 2018, PDF p. 10].

NIOSH bases the dose reconstruction feasibility findings on the following:

- The principal source of internal radiation for members of the NIOSH-evaluated class was tritium used in various production and development processes associated with the production of neutron generators. Internal exposure would have occurred through intake of tritium gas, tritium oxide, or metal tritides. The predominant internal radiation hazards were from tritium oxide and tritium gas.

- NIOSH reviewed the internal radiation exposure potential from other radionuclides used at the Pinellas site including plutonium, uranium, carbon-14, nickel-63, and krypton-85. NIOSH confirmed previous discussions by the Advisory Board on Radiation and Worker Health (ABRWH) Pinellas Plant Work Group that these radionuclides were not internal exposure concerns for the Pinellas Plant workers.

- NIOSH has access to the in vitro urinalysis monitoring records for Pinellas Plant workers with the potential for internal exposures including tritium urinalysis results, termination bioassay sample results, bioassay tabulation forms, exposure record cards, dose adjustment forms, bioassay dose summary reports, dosimetry cards for individuals, and individual plutonium in vitro bioassay results. NIOSH reviewed the NIOSH DCAS Claims Tracking System (referred to as NOCTS) claimant files and found over 20,000 tritium bioassay results for 230 individuals.

- NIOSH reviewed the DOE Tiger Team reported non-compliance with Pinellas Plant urine sampling procedures for tritium and determined there are approaches for assigning tritium dose to workers who have gaps in dosimetry, as would be the case for workers on routine-monitoring schedules that may have not been compliant with bioassay sampling schedules. NIOSH will update the site profile document, *Pinellas Plant – Occupational Internal Dose*, ORAUT-TKBS-0029-5 to further explain unmonitored, internal tritium dose approaches.

- The principal sources of external radiation for members of the NIOSH-evaluated class include exposures to beta and photon radiation emitted from radiation-generating devices used onsite and the use of krypton gas. Testing neutron generators built at the Pinellas Plant could have exposed workers to neutrons. Photon and neutron radiation exposures were possible near the plutonium-oxide sources used for the radioisotope-powered thermoelectric generators' heat sources. Leak testing of neutron-generator components could have exposed workers to beta radiation from krypton-85.

- NIOSH has access to whole body and extremity dosimetry records, as well as neutron dosimetry results for potentially-exposed workers. NIOSH uses established protocols to reconstruct beta, photon, and neutron doses for Pinellas Plant workers.

- NIOSH finds that it has access to sufficient information to estimate the occupational medical dose for Pinellas Plant workers.

- Pursuant to 42 C.F.R. 83.13(c)(1), NIOSH determined that there is sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could be incurred in plausible circumstances by any member of the class under evaluation [42 C.F.R. 83, 2018, PDF p. 10].

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. 83.13(c)(3), a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate the radiation dose received by the members of the evaluated class [42 C.F.R. 83, 2018, PDF p. 11].

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ACRONYMS AND ABBREVIATIONS

$^{238}PuO_2$	plutonium oxide
Abd/KUB	abdominal/kidneys ureters bladder
ABRWH	Advisory Board on Radiation and Worker Health
ADAMS	Agency-wide Documents Access and Management (NRC)
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ATL	Advanced Technologies and Laboratories International
AWE	Atomic Weapons Employer
Bq	becquerel
C-14	carbon-14
CAP 88	Clean Air Act assessment package–1988
CATI	computer assisted telephone interview
CDC	Centers for Disease Control and Prevention
C.F.R.	*Code of Federal Regulations*
Ci	curie
cm^2	square centimeter
cm^3	cubic centimeter
Co-60	cobalt-60
Cs-137	cesium-137
D-D	$D(d,n)^3He$: type of fusion reaction that generates neutrons (see also D-T)
D-T	$T(d,n)^4He$: type of fusion reaction that generates neutrons (see also D-D)
D&D	decontamination and decommissioning
DCAS	Division (formerly Office) of Compensation Analysis and Support
DDRS	Declassified Document Retrieval System (DOE Hanford)
DEEOIC	Division of Energy Employees Occupational Illness Compensation (DOL)
DOE	Department of Energy
DOELAP	DOE Laboratory Accreditation Program
DOL	Department of Labor
dpm	disintegrations per minute
DR	dose reconstruction
DTIC	Defense Technical Information Center
DU	depleted uranium
EECAP	Energy Employees Claimant Assistance Project
EEOICPA	*Energy Employees Occupational Illness Compensation Program Act of 2000*
EPA	Environmental Protection Agency
ER	Evaluation Report (NIOSH-owned document)
FAB	Final Adjudication Branch (DOL)
FBI	Federal Bureau of Investigation

FC-600	Bioassay Exposure Record form (Pinellas Plant)
FRC	Federal Records Center
ft^2	square feet
ft^3	cubic feet
GE	General Electric Company
GEND	General Electric Neutron Devices
GENDD	General Electric Neutron Devices Department
H-3	tritium
HHS	(Department of) Health and Human Services
HP	health physics
HSS	Health Safety and Security (DOE)
HTO	tritium oxide
HVAC	heating, ventilation, and air conditioning system
ICRP	International Commission on Radiological Protection
IMBA	Integrated Modules for Bioassay Analysis software program
keV	kiloelectron-volt, 1000 electron-volts
Kr-85	krypton-85
LAMB	lithium ambient
LAT	lateral
m^2	square meters
m^3	cubic meters
mCi	millicurie
MeV	megaelectron-volt, 1 million electron-volts
MMSC	Martin Marietta Specialty Components, Inc.
mrad	millirad
mrem	millirem
MUL-101	Bioassay Tabulation form (Pinellas Plant)
MUL-334	Exposure Record form (Pinellas Plant)
N-14	nitrogen-14
N/A	not applicable
NAP	National Academies Press
NARA	National Archives and Records Administration
NEPIS	National Environmental Publications Information System (EPA)
NFC 1163	Personnel Monitoring Record form (Pinellas Plant)
Ni-63	nickel-63
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration (DOE)
NOCTS	NIOSH OCAS (now DCAS) Claims Tracking System
NRC	Nuclear Regulatory Commission
NSCEP	National Service Center for Environmental Publication
NTA	nuclear track emulsion, type A (dosimetry film)

NTS	Noncompliance Tracking System (DOE)
NV5/DMA	NV5 | Dade Moeller
ORAU	Oak Ridge Associated Universities
ORAUT	Oak Ridge Associated Universities Team
ORPS	Occurrence Reporting Processing System (DOE)
OSHA	Occupational Safety and Health Administration
OSTI	Office of Scientific and Technical Information (DOE)
OTIB	ORAU Technical Information Bulletin
PA	posterior-anterior
PAD	Post Approval Dosimetry Evaluation Tracker System (NIOSH)
PDF	Portable Document Format
POTW	publicly-owned treatment works
Pu	plutonium
Pu-238	plutonium-238
Pu-239	plutonium-239
Pu-240	plutonium-240
Rb-85	rubidium-85
RBE	relative biological effectiveness (neutron weighting factor)
RMMA	Radioactive Materials Management Area
RTG	radioisotope-powered thermoelectric generator
S&H	safety and health (department)
SAIC	Science Applications International Corp.
SC&A	S. Cohen & Associates
SEC	Special Exposure Cohort
SEM	Site Exposure Matrix (DOL)
Sr-90	strontium-90
SRDB	Site Research Database (NIOSH)
SWP	safety work permit
TBD	technical basis document
Tl-204	thallium-204
TLD	thermoluminescent dosimeter
TRS	Tritium Recovery System
TRU	transuranic
U	uranium
UNC	University of North Carolina
U_3O_8	triuranium oxide, also known as yellowcake (used in borosilicate glass)
USACE	United States Army Corps of Engineers
U.S.C.	*United States Code*
WG	Work Group – ABRWH
µCi/cc	microcuries per cubic centimeter

µCi/l	microcuries per liter
µCi/mL	microcuries per milliliter

SEC PETITION EVALUATION REPORT FOR SEC-00256

1 SEC Petition Class under Review

This report contains NIOSH's evaluation of the feasibility of reconstructing radiation doses for all employees of the Department of Energy (DOE), its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990. It provides information and analyses pertinent to considering a petition for adding a class of employees to the congressionally-created Special Exposure Cohort (SEC). This report does not contain the final determination as to whether the proposed class will be added to the SEC (see Section 2.0).

As the petition evaluation is concerned with the feasibility of reconstructing radiation dose for a group of employees, this report does not make any determinations concerning dose reconstruction for any individual energy employee. However, the fact-finding and analysis completed for the evaluation of an SEC petition is informative to the dose reconstruction efforts for individual energy employees under 42 Code of Federal Regulations (C.F.R.) Part 82 [2019]. Likewise, 42 C.F.R. Part 82 [2019] provides the methods by which NIOSH is conducting dose reconstructions to estimate the radiation doses incurred by covered employees; therefore, the dose reconstruction methods in 42 C.F.R. Part 82 [2019] will be directly considered by NIOSH in determining whether it is feasible to estimate with sufficiency accuracy the radiation dose that the class received.

This evaluation was conducted in accordance with the requirements of *Energy Employees Occupational Illness Compensation Program Act of 2000,* as amended, 42 United States Code (U.S.C.) Section 7384 *et seq.* (EEOICPA), 42 C.F.R. Part 83 [2018], and the guidance contained in the Division of Compensation Analysis and Support's (DCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, DCAS-PR-004 [NIOSH 2011a].

2 Introduction

Both EEOICPA and 42 C.F.R. Part 83 [2018] require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. According to 42 U.S.C. 7384q(b)(1), the evaluation is intended to provide a science-based determination of whether it is "feasible to estimate with sufficient accuracy" the radiation dose that the class of employees received.

42 C.F.R. 83.13(c)(1) states: *Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class, or if NIOSH has established that it has access to sufficient information to estimate the radiation doses of members of the class more precisely than an estimate of the maximum radiation dose* [42 C.F.R. 83, 2018, PDF p. 10].

Under 42 U.S.C. 7384q (b)(2) and 42 C.F.R. 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy the radiation dose that the class members received, then NIOSH must determine whether "there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class." Under 42 C.F.R. 83.13(c)(3), if NIOSH has 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, then NIOSH will assume that any duration of unprotected exposure may have endangered the health of members of a class. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH will specify a minimum duration of employment to satisfy the health endangerment criteria as having been employed for at least 250 aggregated work days within the parameters established for the class or in combination with work days within the parameters established for one or more other SEC classes [42 C.F.R. 83, 2018, PDF p. 11].

NIOSH relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU), to analyze information relevant to the petition evaluation and document its findings and analyses in a report. Once completed, NIOSH provides the evaluation report to both the petitioner(s) and the Advisory Board on Radiation and Worker Health (Advisory Board). The Advisory Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Advisory Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. The NIOSH Director will then consider NIOSH's evaluation, the Advisory Board's deliberations, report, and recommendations, and any information presented or submitted to the Advisory Board. The Director of NIOSH will then propose a decision to add or deny adding any class or classes of employees to the SEC. The Secretary of HHS will make the final decision after considering information and recommendations provided by the Advisory Board and the Director of NIOSH. Petitioners may request an administrative review of a final decision to deny adding a class to the SEC or a health endangerment determination. See 42 C.F.R. 83 [2018] for a full description of the procedures summarized here. Additional internal procedures are available on the NIOSH Radiation Dose Reconstruction Program webpage.

3 SEC-00256, Pinellas Plant Class Definitions

The following subsections address the evolution of the class definition for SEC-00256, Pinellas Plant. When NIOSH receives a petition, NIOSH reviews the class definition as requested by the petitioner. Based on its review of the available site information and data, NIOSH will determine whether to qualify the petition for a full evaluation of all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify the revised class definition along with a justification for the modification. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

NIOSH received petition SEC-00256 (December 16, 2019 version) on December 16, 2019 [[redacted] 2019]. The petitioners revised the petitioner-requested SEC petition class twice [[redacted] 2020a,b], following discussions during consultation calls. Section 4.6 presents a more detailed discussion of the history of the petition submissions for SEC-00256. NIOSH received a revised petition (August 17, 2020 version) on August 17, 2020. The petitioners requested that NIOSH consider the following class: Employees of the Department of Energy (DOE), DOE contractors and/or subcontractors who were employed by General Electric Neutron Devices including all names of this company listed in Part C, Martin Marietta Specialty Components, and/or Lockheed-Martin Specialty Components, Inc. (also known as the Pinellas Plant) during the period from January 1957 through December 1997. A modified version of this class qualified for further evaluation on October 20, 2020.

The petitioners provided information, employment records, dosimetry documents, 24-hour heavy metal urine test reports, a bibliography of published reports, excerpts from the Pinellas Plant site profile, correspondence, an internal newsletter (i.e., Headliner) article, lists of many areas and job titles applicable to the Plant, and information on General Electric Neutron Devices (GEND)/General Electric Neutron Devices Department (GENDD) products in support of the petitioners' belief that dose reconstruction is not feasible for the Pinellas Plant employees in question. The petition (August 17, 2020 version) is comprised of ten sections, many with multiple subsections, exhibits, and two appendices. For additional specifics on the petitioner-supplied documentation in support of petition SEC-00256, see Section 4.6 and Attachment Two: Review of Petitioner-Provided Documentation.

When NIOSH received the third (and final) petition submission (August 17, 2020 version), the petitioners did not specifically identify any of the possible Form B petition bases. The petitioners clarified during consultation that the basis was to be an F.1 basis [[redacted] 2020b, PDF pp. 31–36] that radiation exposures and doses potentially incurred by the members of the class were not monitored. NIOSH reviewed the petition and information for qualifying support towards all bases and determined that the petition (August 17, 2020 version) qualified for evaluation under the F.4 basis. The F.4 basis relates to a scientific or technical report, issued by a government agency of the Executive Branch of Government or the General Accounting Office, the Nuclear Regulatory Commission, or the Defense Nuclear Facilities Safety Board, or published in a peer-reviewed journal, that identifies dosimetry and related information that are unavailable (due to either a lack of monitoring or the

destruction or loss of records) for estimating the radiation doses of energy employees covered by the petition. The petitioners provided the report *Tiger Team Assessment of the Pinellas Plant* [DOE 1990a] under the heading "F.4 Bibliographic of Scientific or Technical Reports." NIOSH reviewed all of the excerpts submitted from the DOE *Tiger Team Assessment of the Pinellas Plant* for applicability to an F.4 basis [DOE 1990a]. NIOSH then reviewed the Tiger Team report in its entirety and determined that the following information is sufficient to qualify SEC-00256 for evaluation:

- The report states "… compliance with the rules on providing bioassay samples at specified frequencies has not been satisfactory" [DOE 1990a, PDF p. 216] and "… In 1989, bioassay samples were not submitted in accordance with GEND procedures. Seventy percent of the required monthly samples and 35 percent of the required weekly samples were not submitted" [DOE 1990a, PDF p. 224].

The finding identified by the DOE *Tiger Team Assessment of the Pinellas Plant* provides sufficient documentation that some dosimetry information (i.e., uncollected bioassay samples) may not be available for the period prior to 1990.

3.2 Class Defined by NIOSH for Further Evaluation

Based on its preliminary research, NIOSH modified the petitioner-requested class. NIOSH qualified the petition for evaluation under the F.4 basis because the 1990 *Tiger Team Assessment of the Pinellas Plant* finding that 1989 bioassay samples were not submitted in accordance with GEND procedures [DOE 1990a, PDF p. 224] satisfies the criteria for the basis. The Tiger Team report focused on assessing the 1988–1989 period; therefore, this assessment does not directly apply to the time period that followed it. During the qualification assessment, NIOSH reviewed available documentation and information related to the site follow-up to determine if the issue identified in the report continued. In response to the Tiger Team assessment, the Pinellas Plant Health Physics Department began tracking individual compliance with bioassay sampling and had success in improving the compliance. The Pinellas Plant ALARA reports document the Plant's success in improving compliance. The *1990 Annual ALARA Program Report for Ionizing Radiation* [Weaver 1991, PDF p. 38] shows the bioassay program average participation was 78%, which is 2% short of the 80% target. NIOSH concluded, based on the bioassay compliance published in the 1990–1995 ALARA reports, that it is reasonable and prudent to consider 1990 a transition year to a more rigorous program. Therefore, NIOSH defined the following class for further evaluation: All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990.

3.3 NIOSH Determination about Adding a Proposed Class to the SEC

NIOSH has obtained internal and external exposure data for individual workers in the form of personal dosimetry data, including routine and termination tritium bioassay results, a limited amount of plutonium bioassay results collected by the Pinellas Plant, Landauer dosimetry reports, external film work sheets, personnel exposure records, and termination exposure reports (both internal and external). NIOSH has summary information in the form of routine

ALARA reports, routine health physics reports, radiation exposure reports, and tritium dose summary data for the NIOSH-evaluated period (i.e., 1957 through 1990). Radiation work permit summary log information is also available. General area exposure conditions are available in routine health physics reports, incident and occurrence reports, routine ALARA reports, and air sampling data. However, the air sampling data are not comprehensive of the entire Plant history. NIOSH also has access to SWP summary log information, administrative program information, radiation protection procedures, and radiation protection survey protocols used at the Pinellas Plant. Finally, NIOSH has obtained a significant amount of environmental monitoring data, including emissions and environmental sampling.

Based on the analysis of these available resources, presented in the later sections of this document, NIOSH concludes that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could be incurred in plausible circumstances by any member of the class under evaluation. Therefore, NIOSH does not recommend adding the NIOSH-evaluated class to the SEC.

4 Data Sources Reviewed by NIOSH to Evaluate the Class

NIOSH completed an extensive database and Internet search for information regarding the Pinellas Plant. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) SciTech Connect database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, the Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One includes a summary of Pinellas Plant documents. The summary specifically includes 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.

4.1 Site Profile and Technical Basis Documents (TBDs)

A site profile or Technical Basis Document (TBD) provides specific information on the documented historical practices for a specified site. Dose reconstructors can use TBDs to evaluate internal and external dosimetry data for monitored and unmonitored employees, and to supplement, or substitute for, individual monitoring data. For a large site, there can be a full site profile consisting of six TBDs that cover process history, personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations.

As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Pinellas Plant operations or related topics/operations at other sites:

- *TBD for the Pinellas Plant – Introduction*, ORAUT-TKBS-0029-1; Rev. 01; April 18, 2011; SRDB Ref ID: 99872 [ORAUT 2011a]
- *TBD for the Pinellas Plant – Site Description*, ORAUT-TKBS-0029-2; Rev. 02; April 1, 2011; SRDB Ref ID: 99874 [ORAUT 2011b]
- *TBD for the Pinellas Plant – Occupational Medical Dose*, ORAUT-TKBS-0029-3; Rev. 01; October 13, 2011; SRDB Ref ID: 102290 [ORAUT 2011c]
- *TBD for the Pinellas Plant – Occupational Environmental Dose*, ORAUT-TKBS-0029-4; Rev. 01; July 15, 2011; SRDB Ref ID: 99867 [ORAUT 2011d]
- *TBD for the Pinellas Plant – Occupational Internal Dose*, ORAUT-TKBS-0029-5; Rev. 03; July 18, 2016; SRDB Ref ID: 158070 [ORAUT 2016a]

- *TBD for the Pinellas Plant – Occupational External Dose*, ORAUT-TKBS-0029-6; Rev. 02; December 11, 2017; SRDB Ref ID: 168436 [ORAUT 2017a]

- *TBD for the Mound Site – Occupational External Dosimetry*, ORAU-TKBS-0016-6; Rev. 00; August 11, 2004; SRDB Ref ID: 19791 [ORAUT 2004a]

4.2 ORAU Technical Information Bulletins (OTIBs) and Procedures

An ORAU Technical Information Bulletin (OTIB) is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. An ORAU Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIBs as part of its evaluation:

- OTIB: *Tritium Calculated and Missed Dose Estimates*, ORAUT-OTIB-0011, Rev. 00; effective June 29, 2004; SRDB Ref ID: 19430 [ORAUT 2004b]

- OTIB: *Dose Reconstruction from Occupational Medical X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 06; effective September 27, 2019; SRDB Ref ID: 178310 [ORAUT 2019]

- OTIB: *Guidance on Assigning Occupational X-Ray Dose Under EEOICPA for X-Rays Administered Off Site*, ORAUT-OTIB-0079, Rev. 02; effective June 15, 2017; SRDB Ref ID: 166967 [ORAUT 2017b]

- Procedure: *Special Exposure Cohort*, ORAUT-PROC-0044, Rev. 01; effective October 19, 2017; SRDB Ref ID: 181580 [ORAUT 2017c]

4.3 Facility Employees and Experts

To obtain additional information, NIOSH reviewed four previous sets of interview notes [ORAUT 2007a,b; ORAUT 2013a,b] and interviewed and/or re-interviewed 16 former Pinellas Plant employees or DOE oversight staff. The ORAU Team and Advanced Technologies and Laboratories International (ATL) identified potential interview candidates by reviewing Pinellas Plant outreach meeting minutes [NIOSH 2012a], through communications with a petitioner representative [[redacted] 2020], and from reviewing documentation that listed former workers. NIOSH also reached out to anyone identified by an interviewee as someone likely to have additional information. By March 5, 2021, all interview notes had completed the classification review and NIOSH had returned the notes to the interviewees for their review and concurrence. Of the 16 individuals interviewed in 2020 and 2021, 15 concurred with the accuracy of the notes and with NIOSH citing them in the evaluation report. A single interviewee did not respond to requests for their final approval of the interview notes; therefore, NIOSH did not cite that set of interview notes. The following interviews contributed to this report:

- *Documented Communication with* [redacted] *on technical basis document Pinellas Plant – occupational medical dose*; telephone interview by ORAU Team; November 13, 2007; SRDB Ref ID: 37343 [ORAUT 2007a]

- *Documented Communication with* [redacted] *on Technical Basis Document Pinellas Plant - Occupational External Dose: Inquiring About Potential Radiation Exposures from the Kr-85 Gas that is Used in the Radiflo Leak Detection Systems*; Telephone interview by ORAU Team and NIOSH; November 20, 2007; SRDB Ref ID: 37342 [ORAUT 2007b]

- *Documented Communication with* [redacted] *on Past Radiological Control Practices at the Pinellas Plant with an Emphasis on the Controls for Metal Tritides*; Telephone interview by ORAU Team; June 18, 2013; SRDB Ref ID: 127111 [ORAUT 2013a]

- *Documented Communication with* [redacted] *and* [redacted] *on Analyzing Tritium Contamination Smears at Pinellas Plant*; Telephone interview by ORAU Team; November 12, 2013; SRDB Ref ID: 129125 [ORAUT 2013b]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990*; Telephone interview by ORAU Team and NIOSH; October 23, 2020; SRDB Ref ID: 185745 [ORAUT 2020a]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; November 30, 2020; SRDB Ref ID: 185748 [ORAUT 2020b]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 2, 2020; SRDB Ref ID: 185752 [ORAUT 2020c]

- *Documented Communication with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 7, 2020; SRDB Ref ID: 185809 [ORAUT 2020d]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 7, 2020; SRDB Ref ID: 185753 [ORAUT 2020e]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 9, 2020; SRDB Ref ID: 185749 [ORAUT 2020f]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 9, 2020; SRDB Ref ID: 185754 [ORAUT 2020g]

- *Documented Communication with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 16, 2020; SRDB Ref ID: 185929 [ORAUT 2020h]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 22, 2020; SRDB Ref ID: 185747 [ORAUT 2020i]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; December 22, 2020; SRDB Ref ID: 185813 [ORAUT 2020j]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; January 14, 2021; SRDB Ref ID: 185751 [ORAUT 2021a]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; January 27, 2021; SRDB Ref ID: 185810 [ORAUT 2021b]

- *Documented Communication SEC-00256 with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; January 28, 2021; SRDB Ref ID: 185812 [ORAUT 2021c]

- *Documented Communication with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; February 1, 2021; SRDB Ref ID: 185811 [ORAUT 2021d]

- *Documented Communication with* [redacted] *on Ability to Perform Radiation Dose Reconstructions for Pinellas Workers Between 1957 and 1990, Particularly Those Not Returning Bioassay Samples*; Telephone interview by ORAU Team and NIOSH; February 2, 2021; SRDB Ref ID: 185814 [ORAUT 2021e]

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of May 3, 2021)

Table 4-1: Number of Pinellas Plant Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	503
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1957 through December 31, 1990)	496
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval)	456
Number of claims for which NIOSH obtained internal dosimetry records for the time period in the evaluated class definition	279
Number of claims for which NIOSH obtained external dosimetry records for the time period in the evaluated class definition	277

Claimants submitted 496 claims for energy employees who worked during the period under evaluation; these include 456 completed dose reconstructions, 29 claims that DOL pulled or administratively closed, four that are eligible for SEC inclusion, and seven that are currently active.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. NIOSH identified 2,163 documents in this database that pertain to the Pinellas Plant. The documents include historical background on the radiological work plans and procedures, occupational dosimetry information (i.e., bioassay data, exposure investigations, radiological incidents, environmental and work area radiation surveys), air monitoring data, and radiation work permits (also known as safety work permits or special work permits) associated with specific tasks. NIOSH evaluated these documents for their relevance to this petition.

4.6 Documentation Provided by Petitioners

NIOSH received an 83.13 (Form B) petition application on December 16, 2019 from two petitioners and one representative [[redacted] 2019]. The petitioner-requested class included employment dates relevant to the petition as September 4, 1956 to May 19, 1957 at the Temporary Plant and May 19, 1957 to December 1997 at Pinellas Plant. NIOSH responded to petition SEC-00256 (December 16, 2019 version) by conducting a consultation call with one of the two petitioners and the petitioner representative on January 21, 2020

[NIOSH 2020a]. During the consultation call, NIOSH and the petitioner discussed the employment dates relevant to the petition. NIOSH informed the petitioner that this program does not cover employment at the interim manufacturing facility in St. Petersburg, Florida. The petitioner and representative confirmed that the worker class definition should include all employees who worked in any areas of the Pinellas Plant, in Largo, Florida from May 19, 1957 through December 31, 1997. They also confirmed during the consultation call that they filed the petition under the F.1 and F.2 bases, and that they were still in the process of obtaining supporting scientific reports.

On May 20, 2020, NIOSH received a revised petition requesting a petition period of June 1956 through December 1997 [[redacted] 2020a, PDF p. 5]. This revision included operations that occurred at the temporary plant in St. Petersburg, Florida. The temporary plant operated while the Pinellas Plant was under construction; however, it is not a covered facility.

NIOSH responded to this revised petition (May 20, 2020 version) by scheduling and conducting another consultation call with the petition representative on June 17, 2020. During this second consultation call, NIOSH again clarified that requested site facilities and time frames are limited to those as defined in the DOE Covered-Facility Database [NIOSH 2020b, PDF p. 3; NIOSH 2020c, PDF p. 3; NIOSH 2020d, PDF p. 3]. Also during the second consultation call, the petition representative indicated that heavy-metals testing results were intended to have been included and would be, that an F.1 basis is desired, and that additional information would be provided to indicate how the (previously-provided) "F.4 Bibliographic of Scientific or Technical Reports" documents indicate the limitations of existing DOE records regarding radiation exposures at the Pinellas Plant. On June 23, 2020, NIOSH sent a consultation call letter to the petitioners' representative and both petitioners summarizing the June 17, 2020 consultation call (i.e., second consultation call) [NIOSH 2020b,c,d].

On August 17, 2020, NIOSH received a second revised petition (August 17, 2020 version) containing a title page with the note "Replaces Document Submitted on January 21, 2020 and May 20, 2020" [[redacted] 2020b]. This second revised petition (August 17, 2020 version) had 10 parts, including lists of many areas and job titles applicable to the Pinellas Plant, and requested a petition period of January 1957 through December 1997; the petitioners removed previous references to the interim facility. Other additions included information for items identified in section F.4, an appendix (*Historical Report of Radiation Protection at GEND*), and urine results (heavy metals analysis) that were inadvertently excluded previously.

In qualifying and evaluating the petition (August 17, 2020 version), NIOSH reviewed the following documents submitted by the petitioners:

- Exhibit 1: Lists 28 radioactive materials used in the Plant [[redacted] 2020b, PDF p. 37]
- Exhibit 2: Presents the activity and dates of four strontium-90 check sources [[redacted] 2020b, PDF p. 38]

- Exhibit 3: Presents various sampling results from five Pinellas County environmental sampling locations collected between April 1976 and July 1993 [[redacted] 2020b, PDF pp. 39–40]

- Exhibit 4: Summarizes the designation, use, power output, weight, size, isotopic fuel, design life, and operational dates (ranging from 1959–1966) of isotopic-power systems for use in space [[redacted] 2020b, PDF p. 41]

- Exhibit 5: A single-page excerpted table that lists emissions, half-lives, specific power, and melting points for 28 isotopes useful for power generation [[redacted] 2020b, PDF p. 42]

- Appendix 1: "24-Hour Urine Heavy Metals Tests" includes urine test results (with patient information redacted) for eight EEOICPA claimants [[redacted] 2020b, PDF pp. 43–59]. Commercial laboratories performed the testing.

- Appendix 2 Health Physics Report: "Historical Report of Radiation Protection at GEND" describes GEND operations, significant HP activities, unusual events, and environmental releases of radioactivity over the 30-plus year period since the Pinellas Plant start-up in 1957 [[redacted] 2020b, PDF pp. 60–76].

- "Bibliographic of Scientific or Technical Reports" includes a list of five documents provided under Section F.4 [[redacted] 2020b, PDF pp. 31–36]. NIOSH reviewed the five documents in the bibliographic listing along with explanatory text describing each document's perceived applicability. Two of the five documents, as noted below, are specific to the Pinellas Plant: the *Review of the Department of Labor's Site Exposure Matrix Database* [Institute of Medicine 2013] and the *Tiger Team Assessment of the Pinellas Plant* [DOE 1990a]. The DOL publishes the Site Exposure Matrix Database in support of Subpart E of EEOICPA; it is not directly applicable to Subpart B, which governs this petition. The five documents listed includes:

  - *Review of the Department of Labor's Site Exposure Matrix Database* [Institute of Medicine 2013] **Note: This document is specific to the Pinellas Plant.**

  - *Tiger Team Assessment of the Pinellas Plant* [DOE 1990a] **Note: This document is specific to the Pinellas Plant.**

  - *Dosimetry is Key to Good Epidemiology: Workers at Mallinckrodt Chemical Works had Seven Different Source Exposures* [Ellis et al. 2018]

  - *The NIOSH Radiation Dose Reconstruction Program: Managing Technical Challenges* [Moeller et al. 2008]

  - *Scientific Issues in Radiation Dose Reconstruction* [Toohey 2008]

Following qualification on October 20, 2020, NIOSH received additional documents from the petitioners in support of SEC-00256.

- On November 11, 2020, NIOSH received copies of three memos: (1) correspondence between DOE Oak Ridge Operations and ORAU [Jelinek 1990], (2) correspondence from ORAU [Fry 1990], and (3) correspondence between DOE Headquarters and Pinellas Area Office [Goldsmith 1990], all regarding the implementation of an epidemiological study of Pinellas Plant employees conducted by ORAU.

- On November 17, 2020, NIOSH received two tables listing Neutron Devices Department (NDD) products [NDD product 1980; NDD product 1990], a flow-chart for neutron generator production [NDD generator 1986], and a table of electronic units specifying work units [Gurley 1968].

- On November 17, 2020, NIOSH also received a copy of a page from the *Headliner*, Martin Marietta's internal newspaper, with an article discussing the Pinellas Plant 908 operation as an early name for the neutron generator project [Martin Marietta 1994a]. The article states the project began in 1956 with 285 employees in a temporary site in St. Petersburg [Martin Marietta 1994a]. Also, NIOSH received a copy of a notice from the DOL Final Adjudication Branch (FAB). Under Findings of Fact, the FAB lists work at the Pinellas Plant, a covered DOE facility, from October 1, 1956 to April 30, 1962 [Newton, no date].

- On December 9, 2020, NIOSH received a copy of the technical report *Case Control Study of Multiple Myeloma Among Workers Exposed to Ionizing Radiation and Other Physical and Chemical Agents* [University of North Carolina 1997].

- On January 25, 2021, NIOSH received a copy of a 1967 memo from AEC Headquarters providing examples of types of cases identifying accidents or occupationally-related disease that could result in a workman's compensation claim or civil suit [Doran 1967].

The petitioners provided all of the documents listed above after NIOSH qualified Pinellas Plant SEC-00256 for further evaluation. NIOSH reviewed the documents for information that would support adding a class of workers to the SEC.

In December 2020, NIOSH forwarded the *Headliner* internal newspaper article and the letter from the FAB to DOL requesting a site clarification review. The petitioner provided these documents as support for changing the SEC petition period to include 1956, which is prior to the covered period for the Pinellas Plant. DOL confirmed the Pinellas Plant covered period of January 1, 1957 through December 31, 1997 [DOL 2020].

In addition to the documents listed above, the petitioners made NIOSH aware of several documents they had requested from DOE. NIOSH attempted to locate these requested documents to review as part of the evaluation. NIOSH reviewed the documents received from the petitioner and those retrieved by NIOSH for information relevant to the evaluation (See Attachment Two).

5 Radiological Operations Relevant to the Class Evaluated by NIOSH

While the NIOSH-evaluated class spans Pinellas Plant operations from January 1, 1957 through December 31, 1990, for the sake of context, Section 5 includes site history information through 1997. The following subsections summarize both radiological operations at the Pinellas Plant from January 1, 1957 through December 31, 1997 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources, NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. NIOSH intends for the information included within this evaluation report only to be a summary of the available information.

5.1 Pinellas Plant and Process Descriptions

The Pinellas Plant, located near the geographic center of Pinellas County, Florida was originally built to manufacture neutron generators (containing small amounts of tritium), a principal component in nuclear weapons. In addition to the manufacturing facility, the Plant maintained uniquely specialized areas of competence to develop equipment and processes used in weapons-component production. General Electric (GE) constructed the Pinellas Plant in 1956 and operated the Plant until May 31, 1992. In June 1992, Martin Marietta Specialty Components, Inc. (MMSC) assumed operation of the Plant. In September 1994, the facility stopped producing weapons-related components, and its mission changed to environmental restoration of the facility [DOE, no date-a]. DOE relocated the work to the Kansas City plant in Missouri and the Sandia National Laboratory in New Mexico. Decontamination and decommissioning (D&D) work, including disconnecting the equipment and transferring some employees to New Mexico occurred between 1994 and 1997 when DOE D&D operations were complete. The Pinellas County Industrial Council purchased the Plant in March 1995 [Patenaude 1997, PDF p. 2].

The Plant has been known by several names throughout its history including the 908 Plant, Pinellas Peninsula Plant, GE X-Ray Division-Florida, GENDD, GEND GE Pinellas Plant, and the Pinellas Plant [ORAUT 2011b, PDF p. 9; [redacted] 2019, PDF p. 3]. The Plant is located midway between the cities of Largo and Pinellas Park, Florida, on a 99.9-acre site, with one large building (Building 100) surrounded by 17 smaller buildings and structures, including two small school buildings equipped with a specialized heating, ventilation, and air condition (HVAC) system to allow the schools to be isolated from the environment. Though NIOSH has not located dates of school operation, the *Environmental Assessment Operation of the Pinellas Plant Child Development Center/Partnership School* [GE 1990, PDF p. 6] discusses the proposed joint venture to operate a Partnership School and Child Development Center and indicates that facilities were not in place or occupied before July 1990. The school buildings are located approximately 150 feet east of Building 100, surrounded by a 4-foot high chain-link fence and a 10-foot wide landscaped buffer zone, which separated them from the Pinellas Plant operations buildings.

The main Neutron Generator Production Area was Building 100. Building 100 (with its annex, Building 300) was over 625,000 square feet and included offices, production space, and laboratory space [ORAUT 2011b, PDF p. 29; DOE 1995a, PDF p. 29]. The building had separate "Areas" for manufacturing, engineering, and administrative support services. By 1991 the Plant had grown to 728,729 square feet total, including 68,106 square feet of mezzanines [Martin Marietta 1993a, PDF p. 20]. At its peak, the Plant employed approximately 2,000 people [GE 1987, PDF p. 269]. Figure 5-1 shows a map of the Pinellas Plant.

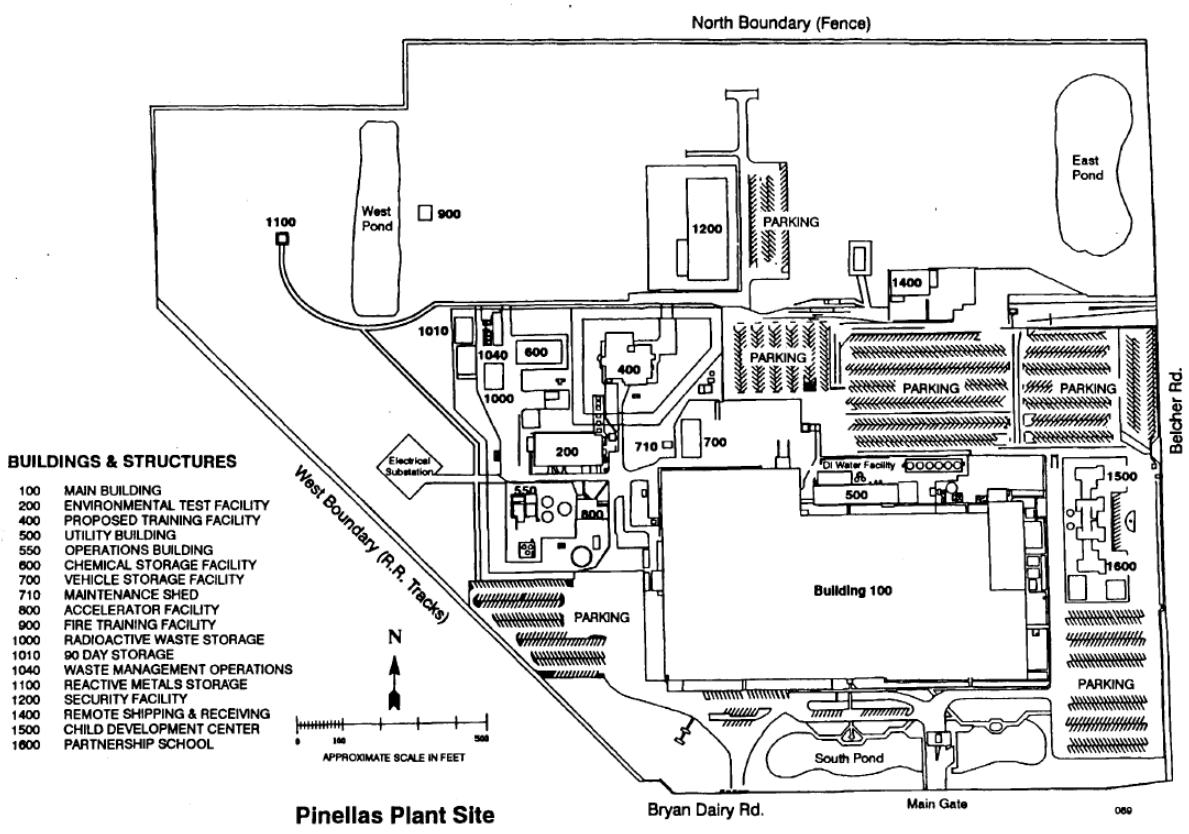

Figure 5-1: Pinellas Plant Site Map[a,b]

a. Source: [Martin Marietta 1993a, PDF p. 33]
b. Although not shown in the Pinellas site map, Building 100 contains Building 300.

Pinellas manufactured only neutron generators for its first ten years of operation [GE 1986, PDF p. 13], then DOE expanded the original mission to include the production of multiple electronic and support components for other DOE programs. These components included: neutron detectors, specialty capacitors, thermal batteries, electromagnetic devices, vacuum switch tubes (containing small amounts of plated nickel-63), lithium ambient (LAMB) batteries, frequency control devices, resonant accelerometers, lightning arrestor connectors, foam support pads, product testers, alumina ceramics, alumina ceramic feedthroughs, ferroelectric ceramics, glass ceramics, optoelectronics, shock transducers, and radioisotope-powered thermoelectric generators (RTGs).

In December 1991, DOE Secretary Watkins identified Pinellas as one of the plants slated for closure as part of Complex 21 [Pope 2007]. Documents indicate that the work continued using on-hand inventory to produce neutron generators and tubes; however, Pinellas did not acquire new radiological material [Inventory of radionuclides, no date]. In September 1994, DOE initiated the phase-out of production and began transitioning operations under Defense Programs to Environmental Management [DOE, no date-b, PDF p. 8].

The final mission for the Pinellas Plant was to clean up from the past radiological uses and transition to commercial uses [Martin Marietta 1996, PDF p. 12]. As workers came across the last war-reserve products (i.e., an asset amassed in peacetime to meet military requirements if war were to start), they calibrated the equipment (when required), disconnected, packaged, and shipped the equipment to Sandia National Laboratories in New Mexico [Pope 2007, PDF p. 36]. The employees finished disconnecting the fabrication equipment in September 1995 [Pope 2007, PDF p. 28].

5.2 Internal Radiological Exposure Sources from Pinellas Plant Operations

The Pinellas Plant's mission was small-volume production of selected high-technology nuclear weapon components, which required strict control of materials and processes in an ultra-clean environment [Martin Marietta 1993a, PDF p. 19]. NIOSH's review of the nuclides handled over the history of the Pinellas Plant indicates that tritium was the only radionuclide handled in sufficient quantity and form to present a significant internal exposure for the Pinellas Plant workers. While the Pinellas Plant used krypton-85 (Kr-85) in substantial quantities, it is not a significant internal radiation dose concern. Kr-85 is a noble gas; it does not have a reaction within the body. It decays via beta decay to stable rubidium-85, which means there are no daughter products to decay and contribute internal dose. For a person surrounded by Kr-85, the effective (i.e., whole body) dose is primarily from the external exposure [ICRP 1994a, PDF p. 38]. Therefore, this report only addresses Kr-85 as an external exposure concern. Radionuclides other than the tritium and Kr-85 were mostly limited to sealed and plated check sources, static meter sources, sources used in instruments to detect combustible gasses, heat sources, calibration sources (Cs-137 was the most common sealed source) [Weaver 1995, PDF p. 2], thickness gauges, gas chromatograph sources, dew point measurement sources, and static eliminator sources. NIOSH considered plutonium because the Pinellas Plant implemented a bioassay program to ensure there was no internal exposure resulting from RTG work with the triply-encapsulated plutonium sources. The program confirmed there was no internal exposure resulting from plutonium at the Pinellas Plant. NIOSH also does not consider uranium, nickel-63, and carbon-14 significant internal dose concerns because of their physical containment and quantity at the Pinellas Plant. The Advisory Board on Radiation and Worker Health (ABRWH) Pinellas Plant Work Group considered these other radionuclides during their site profile discussions and agreed that none were internal dose contributors [NIOSH 2012b; NIOSH 2016].

5.2.1 Tritium

Tritium is a radioactive isotope of hydrogen. Chemically it behaves very similarly to non-radioactive hydrogen. The tritium half-life is 12.3 years, and decay results in the production

of a stable helium-3 atom. The emitted beta particles have an average energy of 5.7 keV [ICRP 2008, PDF p. 33]. Because electrons below 15 keV do not have sufficient energy to penetrate the epidermal layer of the skin [NIOSH 2007, PDF p. 7], NIOSH does not consider tritium an external radiation hazard.

The Pinellas Plant had tritium present in the forms of tritiated water (also known as tritium oxide or HTO), tritium gas, organically bound tritium, and certain metal tritides. Based on available records, the predominant tritium exposure hazard to Pinellas workers was from tritiated water and tritium gas. Between 1957 and 1993, annual tritium inventories at the Pinellas Plant ranged from 5.44 g (5.24×10^4 Ci) to 53.27 g (5.14×10^5 Ci) [Biedermann 1994, PDF p. 3].

The Pinellas Plant used tritium gas in various production and development processes associated with neutron generators. These processes involved transferring controlled amounts of tritium between a reservoir and a receiver material such as a plated metal surface. Pinellas controlled the exposure to tritium gas mainly through containment, process design, and ventilation. The Plant placed room air monitors in all areas where there was a potential to release tritium gas into the work area. The monitoring systems included a 22-liter Kanne ionization chamber connected to a Beckman linear picoammeter. Each monitoring system had an alarm with a visual indicator set to alert at 80 $\mu Ci/m^3$ [Ward 1973, PDF p. 2]. A worker exposed to tritiated water at a rate of 80 $\mu Ci/m^3$ for an hour would receive a dose of approximately 9.6 mrem. This dose rate includes the International Commission on Radiological Protection (ICRP) recommended factor of 1.5 to account for potential skin absorption [ICRP 1994a, PDF p. 90; ICRP 1994b, PDF p. 20; DOE 2007, PDF p. 117].

During the production process at the Pinellas Plant, workers only handled tritium as a gas or solid. However, tritiated water forms whenever quantities of gaseous tritium come into contact with air containing water vapor because the tritium exchanges with non-radioactive hydrogen in airborne water vapor. This soluble form of tritium was the form measured in urine bioassay for internal doses reported by the Pinellas Plant. Based on NIOSH's research into the records, the predominant exposure hazard to workers was from tritiated water and tritium gas. The primary means of protection against exposure to tritiated water are the same as for tritium gas: containment, process design, and ventilation.

In some circumstances within the tritium areas, there was an exposure potential from organically-bound tritium compounds to those working with materials such as pump oils and organic solvents. Turbo and vacuum pumps used in systems at the Pinellas Plant periodically required maintenance, including changing the oil. For pumps located in tritium areas, the tritium could contaminate the pump oil. After workers drained the oil from a pump, they collected a sample of the oil for tritium analysis. Oils and solvents in tritium areas were handled, accumulated, and stored for disposal as if contaminated [Burkhart 1990, PDF pp. 19, 29, 30, 32, 33, 35, 37, 39; Pinellas Plant 1993].

At the Pinellas Plant, both soluble forms of tritium and insoluble tritium compounds (i.e., certain metal tritides) were present as a source of potential exposure in the same areas. During the production process, the tritium reacts with metal surfaces, coatings, and powders

for various purposes [Burkhart 1995, PDF p. 2]. Metal tritides, formed during production processes, could have escaped into the work environment as particulate aerosols.

The Pinellas Plant used titanium tritide in the original tritium storage beds, sealed inside a glass cylinder [Burkhart 1990, PDF p. 10]. The glass cylinders broke on occasion, resulting in release of tritium. In 1968, Pinellas replaced the original glass tritium storage beds with uranium hydride in stainless-steel cylinder tritium storage beds [Historical report of radiation, no date, PDF p. 7; Phillips 1975, PDF p. 2]. The stainless-steel tritium storage beds utilized depleted uranium tritide [Burkhart 1990, PDF p. 10; Eichman 1979, PDF p. 3].

5.2.2 Plutonium

The Pinellas Plant used triply-encapsulated plutonium when producing RTGs. Plutonium is a reactive, metallic, transuranic element. The Pu-238 radioisotope decays by alpha particle emission with a half-life of 87.8 years. Pu-238 emits alpha particles with an energy of 5.50 MeV in approximately 72% of decays, while the remainder have an energy of approximately 5.46 MeV [ICRP 2008, PDF p. 90]. Pu-238 has a relatively high specific activity and an energetic decay alpha (5.50 MeV), making it the choice for a compact, inherent heat source [IT/Radiological Sciences Laboratory 1986, PDF p. 17]. The radioisotope Pu-239 also decays by alpha particle emission with a half-life of 24,131 years and three possible energies: 5.10 MeV, 5.14 MeV, and 5.16 MeV with a relative abundance of 11.5%, 15.1%, and 73.1% respectively.

The first known receipt of plutonium at the Pinellas Plant was in January 1957. It was a 7g Pu-239 calibration source used for health physics monitoring equipment [First plutonium delivered, no date, PDF p. 2]. Triply-encapsulated plutonium oxide ($^{238}PuO_2$) heat sources for the RTGs began arriving in November 1975, when Pinellas received seven heat sources totaling 54.4 grams of Pu-238 from Sandia Laboratories [First plutonium delivered, no date, PDF p. 2]. There were two different sizes of the $^{238}PuO_2$ heat sources: 8.75 g and 10 g sources. The typical composition was 11.8% oxygen and 88.2% plutonium (80.2% of which is Pu-238) by weight [GE 1982a, PDF p. 39]. The small, sealed plutonium capsules were always produced at another DOE site [Internal dosimetry practices 1983] and were not altered by operations or destructively tested at the Pinellas Plant [HRS 1995; NIOSH 2012b, PDF p. 28]. The triple-encapsulations ensured complete containment of the plutonium under the most extreme potential accident conditions. Design criteria for the units included the ability to withstand exposure to a 1,000-degree Centigrade fire for one hour and withstand impact on an unyielding steel surface at a velocity of 150 meters/second without losing structural integrity [GE 1989a, PDF p. 76].

The Pinellas Plant received the triply-encapsulated plutonium sources at Building 400, which housed the RTG facility [GE 1982a, PDF p. 34]. Pinellas Plant staff conducted work area monitoring for plutonium in Building 400 using continuous air monitors with alpha spectrometers and a strip-chart recorder. The Plant also utilized discrete air sampling using filters to determine the airborne levels of plutonium in the workplace; the filters were changed monthly and analyzed [IT/Radiological Sciences Laboratory 1986, PDF p. 19].

The Pinellas Plant conducted RTG assembly and test operations in the eastern portion of Building 400. NIOSH has not located information regarding the annual inventories of the RTG heat sources beyond the initial shipment in 1975. Except for the unpacking procedure, the source-cleaning operation, and the actual assembly operation, the Pinellas Plant kept the triply-encapsulated sources in stainless-steel source storage containers. In 1990, the RTG product line was discontinued [Martin Marietta 1992, PDF p. 20], and DOE removed the plutonium from the site. The *Pinellas Plant Annual Site Environmental Report for Calendar Year 1992* specifically states "All plutonium, with the exception of calorimeter sources and small instrument calibration check sources, was removed from the plant in February 1991" [Martin Marietta 1993a, PDF p. 54]. A 1993 survey documented the removal of all radioactive materials from Building 400 and that there was no plutonium contamination present [Pharo 1993, PDF p. 2].

Even though the encapsulations ensured complete containment and the plutonium was in shard form to minimize the potential for respirable-size particles, Pinellas began an Environmental Monitoring Program because of the presence of the encapsulated material on the plant site [Internal dosimetry practices 1983, PDF p. 2]. Out of an abundance of caution, workers assigned to the RTG project submitted a pre-operational 24-hour urine sample [Internal dosimetry practices 1983, PDF p. 2]. Those working with RTG sources submitted annual samples while assigned to the work [Internal dosimetry practices 1983, PDF p. 2]. The plutonium urine sampling program concluded in 1992. During meeting discussions [NIOSH 2011b; NIOSH 2012b; NIOSH 2016], the ABRWH Pinellas Plant Work Group determined there was no credible potential for personnel internal dose from activities involving plutonium [ORAUT 2016a, PDF p. 12; NIOSH 2016]. The weight of evidence, including the process knowledge, the confirmatory measurements, and the modeling calculations demonstrate a low exposure potential [NIOSH 2011b, PDF p. 72–84].

5.2.3 Uranium

Both depleted and natural uranium were present at the Pinellas Plant. Uranium isotopes emit alpha particles and X-rays; however, some of the radioactive progeny emit beta particles and gamma rays. Beginning in 1968, the Pinellas Plant used depleted uranium in the tritium storage beds. The U-238 radioisotope, the predominant isotope in both depleted and natural uranium, decays by alpha particle emission with a half-life of about 4.5 billion years. The U-238 radioisotope decays with the emission of 4.3 MeV alpha particles in approximately 77% of decays, while the remainder have an energy of approximately 4.1 MeV [ICRP 2008, PDF p. 88].

The Pinellas Plant used uranium-hydride flasks as a “hydrogen-isotope reservoir to hold gas at essentially zero pressure in a solid state, release the gas to a processing vacuum system by application of heat, and resorb the gas to a pressure in the microns-of-mercury range” [Ward 1973, PDF pp. 30–31]. The flasks were stainless-steel cylinders, sealed with a stainless-steel gold sealed valve. The occluding material was 50 grams of depleted uranium powder [Ward 1973, PDF p. 31]. Since the uranium is sealed in the stainless-steel cylinders, it did not pose a significant internal dose hazard. The Pinellas Plant reported that the surveys conducted at the time showed no uranium contamination [ORAUT 2013a, PDF p. 5]. There were no reported incidents for the Pinellas Plant relating to a uranium release or uranium

fire incidents, which would be an indicator of uranium release from the cylinders. The uranium at Pinellas was contained when used for tritium storage.

NIOSH is aware of accidental tritium release incidents from the smaller uranium-tritide storage beds requiring Pinellas to take the beds out of service; one example resulted in a tritium contamination incident [Phillips 1975, PDF pp. 2–4]. A May 1975 memo states "the contamination incident which occurred on January 31, 1975 to our knowledge is the first such incident in the seven year usage of uranium beds…" [Phillips 1975, PDF p. 2], indicating the Pinellas Plant began using uranium in the storage beds in 1968. None of the reported incidents at the Pinellas Plant were uranium-release or uranium-fire incidents, supporting NIOSH's understanding that the Pinellas Plant stored uranium in containers. Based on the available information, NIOSH has determined that the depleted uranium in the uranium-tritide storage beds was not an internal exposure concern at the Pinellas Plant.

The Pinellas Plant used borosilicate glass doped with natural uranium (1.5% by weight) in the form of U_3O_8 [Pinellas Plant 1992–1994, PDF p. 2]. The uranium would have been encapsulated in the glass at the manufacturer before it arrived at the Pinellas Plant; therefore, the glass is considered a sealed source on arrival and would have posed little to no internal radiation dose hazard.

Neither the depleted nor the natural uranium used at Pinellas Plant was available as a routine, occupational internal exposure source and presented little to no internal dose hazard.

5.2.4 Carbon-14

Pinellas Plant's Radioactive Waste Implementation Plan stated that "Small quantities of carbon-14 labeled solvents are used in a laboratory operation which evaporates the solvent to the Plant's east exhaust stack" [GE 1984a, PDF p. 9]. The *Pinellas Plant Environmental Monitoring Report 1983* also describes the Pinellas Plant using carbon-14 as a solvent label in laboratory operations [GE 1980, PDF p. 13; GE 1984b, PDF p. 15]. Carbon-14, a naturally occurring radioisotope, decays by beta particle emission into stable nitrogen-14 and has a half-life of 5,730 years. The beta particles have an average energy of 49.5 keV [ICRP 2008, PDF p. 33].

The only indications of carbon-14 use at the Pinellas Plant come from the gaseous effluent monitoring. The Pinellas Plant reported carbon-14 airborne effluent from the Building 100 laboratory stack between 1979 and 1984 [HRS 1994, PDF p. 37]. There were no other indications of carbon-14 in use at the Pinellas Plant, nor any other occupational exposure pathways identified for plant workers.

The ABRWH Work Group discussed carbon-14 handing at the Pinellas Plant during their review of the site profile, saying the quantity of material was considered "negligible" and contributed less than a mrem per year dose when modeled by the Integrated Modules for Bioassay Analysis (IMBA) software program [NIOSH 2009, PDF pp. 57–58].

5.3 External Radiological Exposure Sources from Pinellas Plant Operations

The activities with a potential for external radiation exposure at the Pinellas Plant included testing the neutron tubes and neutron generators, working near the plutonium oxide heat sources, using other radiation-generating devices, and in rare instances, external exposure to Kr-85 gas leaks. The radiological materials with potential for external exposure included Kr-85, carbon-14, and plutonium. The depleted uranium used in the tritium storage beds presented no significant external radiation hazard due to the low specific-activity and the non-penetrating radiation emitted. Processing uranium-doped borosilicate glass at the Pinellas Plant involved both cutting and chemically etching the glass. Pinellas assessed worker exposures during these processes and estimated worst-case whole body exposures were well below the U.S. DOE annual limits (i.e., 5,000 mrem/year whole body). The calculated highest dose would have been 15 mrem/year whole body [Pinellas Plant 1992–1994, PDF p. 27]. The Pinellas Plant used other radionuclides; however, they were mostly limited to sealed and plated check sources such as static meter sources, sources used in the instruments to detect combustible gasses, heat sources, calibration sources, thickness gauges, gas chromatograph sources, dew point measurement sources, and static eliminator sources [Pinellas Plant radioactive, no date].

While radioactive materials and radiation-generating devices were necessary to the product manufacturing, the majority of the work performed at the Pinellas Plant did not involve exposures to external sources of radiation. This lack of external radiation exposure potential is why the Pinellas Plant did not monitor many workers for external doses.

5.3.1 Photon

The majority of the photon radiation exposures in the Neutron Generator Production Areas would have been from testing neutron tubes and neutron generators. The neutron generators also produce some X-rays by interactions within the accelerator [NCRP 1983, PDF p. 8].

In the RTG Production Areas (Building 400), the majority of the photon radiation exposures were from $^{238}PuO_2$ heat sources. The $^{238}PuO_2$ heat sources emitted gamma radiation, with a typical neutron to gamma ratio of about 2.5 (at approximately 2 feet) [Weaver 1989, PDF p. 7]. These plutonium heat sources accounted for the majority (approximately 67%) of the Plant's photon dose in 1990 [Harder 1991, PDF p. 4].

Before its relocation to Building 800, the Chemistry laboratory in Building 100 used a Model 200 HP Ion Implanter accelerator.

Specific photon-energy distribution information is available for only the Component Testing Area of Building 100 (Area 109), where Pinellas used Kr-85. Kr-85 is a radioactive (beta/gamma emitting) noble gas with a maximum beta energy of 687 keV and a low yield 500 keV gamma. The Plant used Kr-85 in two leak-detection systems, as described more completely in Section 5.3.2. For all other areas, NIOSH assumes 100% of the photons are 30 to 250 keV photons.

5.3.2 Beta

The potentially significant sources of electron radiation with sufficient energy to penetrate the skin were Kr-85 and radiation-producing devices such as X-ray diffraction and electron beam devices.

Krypton-85 is a noble gas with a radioactive half-life of 10.7 years that emits beta particles with an average energy of 251.4 keV [ICRP 2008, PDF p. 42]. Kr-85 decays into stable rubidium-85 through beta particle emission 99.57% of the time. The maximum energy of the beta particle is 687 keV with an average energy of 251 keV. The alternative Kr-85 decay mode is 0.43% of the time by beta emission with a maximum energy of 173 keV, followed by 514 keV gamma emission [IT/Radiological Sciences Laboratory 1986, PDF p. 14].

External radiation exposure to Kr-85 gas occurs only while a person is exposed to a cloud of the gas, causing the possibility of a skin dose [Weaver, no date, PDF p. 2]. It was used in relatively small quantities in two leak-detection systems (Radiflo and TRACER-flo) at the Pinellas Plant, operating from September 1963 until 1996 [Burkhart 1990, PDF pp. 14–15; Forest 1959–1962, PDF p. 253]. Pinellas used the systems to pressurize hermetically-sealed components under known time, pressure, and gas concentration conditions to detect leaks in the components [Detlefs 1993, PDF p. 4]. An April 1963 Health Physics Report states, “The radionuclide, krypton 85, was introduced into the Radiflo unit on September 24. Leaks in the unit resulted in a loss of 2.0 curies” [Forest 1963a, PDF p. 4]. The Pinellas Plant recovered most of the Kr-85 gas after each use but lost small amounts through the tested components. Pinellas received the Radiflo leak-detection system preloaded with 10 to 40 Ci of krypton gas. A service technician from the manufacturer typically added 5 to 10 Ci once each year after the initial delivery [ORAUT 2007b, PDF p. 3]. Pinellas placed the Radiflo and TRACER-flo leak-detection systems in separate rooms in Building 100, Area 109 (the Component Testing Area) [IT/Radiological Sciences Laboratory 1986, PDF p. 4; DOE 1987, PDF p. 216] and surrounded them with ventilation shrouds [DOE 1983, PDF p. 35; DOE 1987, PDF p. 216]. Each shroud connected to ductwork exhausting 3,300 ft^3/minute to the east main exhaust stack. Kr-85 submersion exposures would only have occurred during incidents involving gas leaks from either the Radiflo or the TRACER-flo systems, rather than from small amounts leaking from the components tested during normal operation. During such incidents, beta radiation fields would have been temporarily present in the rooms housing the systems, and non-routine external exposures may have occurred. Pinellas removed all Kr-85 gas from the site by the end of 1996 [Martin Marietta 1997a, PDF p. 12].

The Pinellas Plant used X-ray diffraction and electron-beam devices to analyze samples and to produce heat to either evaporate or weld material in the beam. It was possible for workers to receive electron radiation exposures from such devices if the beam containment was compromised. The Pinellas Plant located these radiation-generating devices in Building 100, Building 300, Building 800, and in the 1200 Area [Martin Marietta 1994–1995; Pinellas Plant 1976–1987]. However, it was more probable that any exposures from these devices would have been from scattered X-rays or bremsstrahlung production and not from a free-electron beam.

The Pinellas Plant did not normally assess electron exposures in Building 800, where they calibrated portable radiation dose-rate instruments, unless there was an accident with the

sealed 120 Ci Cs-137 calibration source. The sealed source was in a shielded cabinet in the concrete Building 800 [ORAUT 2017a, PDF p. 11; GE 1971–1984, PDF pp. 81–86].

Carbon-14 is a beta-emitting radionuclide with a half-life of 5,730 years. The average and maximum beta particle energies are 49.5 keV and 156.5 keV, respectively [ICRP 2008, PDF p. 33; Kocher 1981, PDF p. 79]; therefore, they are above the 15 keV threshold and are an external dose concern. A 1979 and a 1983 environmental assessment indicate that small quantities of carbon-14 labeled solvents were used in a laboratory testing operation [GE 1980, PDF p. 13; DOE 1983, PDF p. 26]. A 1980 reference describes the quantities used as exempt [Pinellas Plant 1980, PDF p. 3]. NIOSH has not found any documentation to indicate any other uses of carbon-14. The Gaseous Effluent Release Reports and an Environmental Assessment between 1979 and 1983 are the only indicators that carbon-14 was used and monitored in the effluent releases at the Pinellas Plant [DOE 1983, PDF p. 27; GE 1980, PDF p. 16; GE 1981, PDF p. 17; GE 1982b, PDF p. 17; GE 1983a, PDF p. 17; GE 1984b, PDF p. 17]. The Pinellas Plant reported the average maximum ground-level concentration to be significantly less than 0.1 percent of the recommended guidelines for continuous non-occupational exposure [GE 1980, PDF p. 16; GE 1981, PDF p. 17; GE 1984b, PDF p. 17]. Based on the reported gaseous effluent releases for the years 1979 through 1983, the Pinellas Plant used carbon-14 in much smaller quantities than tritium. During their review of the Pinellas Plant site profile, the ABRWH discussed carbon-14 handing at the Pinellas Plant and asked that carbon-14 be addressed in the site profile documents though the quantities of carbon-14 handled were considered “negligible” (less than a mrem per year dose contribution) [NIOSH 2009, PDF pp. 57–58].

The predominant, though not significant external exposure concern, source of electron radiation at the Pinellas Plant was tritium [ORAUT 2017a, PDF p. 10; DOE 1983, PDF p. 25]. The average beta particle energy from tritium is 5.7 keV and the maximum is 18.5 keV. The maximum range of the beta particle is less than 5 millimeters in air. The range of this beta radiation is about 0.6mg/cm^2 [Weaver 1989, PDF p. 7], which is less than the thickness of the epidermal layer of the skin [NIOSH 2007]; therefore, NIOSH does not consider tritium to be an external radiation hazard.

5.3.3 Neutron

There were two distinct sources of neutrons at the Pinellas Plant: (1) the neutrons produced by radiation-generating devices, and (2) those produced by the sealed $^{238}PuO_2$ heat sources used for the RTGs.

The neutron generator was the Pinellas Plant’s primary product and the most common type of radiation-generating device at the site. Such devices generate neutrons with either the T(d,n)^{4}He fusion reaction or the D(d,n)^{3}He fusion reaction (also notated as D-T and D-D reactions, respectively) and only produce neutrons when electrically activated. Most units produced at the Pinellas Plant were the D-T type that produced 14 MeV neutrons. There were reportedly a few 2.5 MeV neutron (D-D reaction) units [Weaver 1989, PDF p. 7]. These sources produce a distribution of neutrons at various energies versus neutrons at a single discrete energy. Neutron generators are miniaturized linear ion accelerators with a pulsed electric power supply. They do not produce neutrons unless they are energized (similar to

other accelerators) such as when the neutron tubes or the completed neutron generators are being tested. These tests were conducted as benchtop operations and were controlled from a short distance (i.e., 5-feet) away. Test stations were set up in multiple areas within Building 100 and operated according to the workloads that changed each year. These locations sometimes changed over the years. Plexiglas shielding was used along with distance to reduce worker exposure. The neutron generators at the Pinellas Plant produced radiation exposure for less than 60 seconds [Weaver 1996a] when the Plant conducted test shots and workers were not allowed within three feet of the device. These test shots do not produce large amounts of neutrons for extended periods of time and there was neutron monitoring at each station [SC&A/Salient 2006, PDF p. 51].

The Pinellas Plant also used an ion accelerator, a Model 200 HP Ion Implanter [Malbrough 1983, PDF p. 5]. It was a Cockroft-Walton-type linear ion accelerator, first installed in 1975 in Area 161 of Building 100 for use by the Chemistry Laboratory [GE 1977, PDF p. 6; Malbrough 1983, PDF p. 5]. In 1979, Pinellas relocated the accelerator to Building 800, where they used it for a larger variety of activities that included target assessment and material analysis work [Malbrough 1983, PDF p. 5].

From 1975 through 1990, Building 400 produced RTGs that contained small, sealed $^{238}PuO_2$ heat sources [First plutonium delivered, no date; Martin Marietta 1992, PDF p. 20]. The plutonium oxide generated neutron radiation from the alpha-n reaction and spontaneous fission. These plutonium heat sources were the only sources of measurable neutron exposures at the Pinellas Plant in 1990 [Harder 1991, PDF p. 4]. The neutrons from the heat sources fell into two energy groups: (1) 0.1-2 MeV and (2) 2-20 MeV with equal frequency. NIOSH assumes the typical workload to have been 50 generators per month for perhaps three personnel [ORAUT 2017a, PDF p. 28; Holliday 1983, PDF p. 3; Proposed increase 1988, PDF p. 6].

6 Summary of Available Monitoring Data and Data Sufficiency for the NIOSH-Evaluated Class

The subsections below provide the following information for the Pinellas Plant class under evaluation:

- Overviews of the state of the available internal and external monitoring data, environmental monitoring data, and occupational medical X-ray data.
- Evaluations of the sufficiency of the specified data. Data sufficiency addresses the background, history, and origin of the data. This includes looking at site methodologies that may have changed over time; primary versus secondary data sources and whether they match; and whether data are internally consistent.

6.1 Available Pinellas Plant Internal Monitoring Data and Data Sufficiency

Potential internal exposures at the Pinellas Plant between 1957 and 1990 were primarily associated with the inhalation of radionuclides. NIOSH's review of the Pinellas Plant internal monitoring program procedures shows that managers were required to direct employees whose work assignments had a potential for intakes to tritium to submit urine samples. The Pinellas Plant Internal Dosimetry Program included using tritium bioassay daily, weekly, or monthly, depending on the workers' recent tasks [GE 1984c, PDF p. 3; Burkhart 1995, PDF p. 10]. The Pinellas Plant determined the routine sampling frequency based on the likelihood of exposure. NIOSH reviewed monitoring data from 1957–1972 and determined that the urine-sampling frequency was usually weekly.

Beginning about 1986, the Pinellas Plant based their bioassay program on ANSI standard N13.14-1983 [Burkhart 1995, PDF p. 9; ANSI 1981]. Participation was determined based on the recommendations in the standard and included:

- Anyone with the potential to receive 100 mrem/year from tritium
- Declared pregnant workers likely to receive more than 50 mrem/gestation period
- All personnel who worked with or handled tritium contaminated systems or equipment

In later years, the frequency generally followed the criteria as described in the Pinellas Plant site profile documentation as follows [Burkhart 1995, PDF p. 10]:

Daily or on each performance:

- Work on open neutron generator tubes or tube processing equipment
- Maintenance on vacuum pumps, glove boxes, or exhaust systems including the Tritium Recovery System (TRS)
- Instances of area contamination

- Packaging and disposal of radioactive waste

Weekly:

- Operation of contaminated processing or analysis equipment
- Decontamination of materials and facilities
- Packaging and disposal of radioactive wastes

Monthly:

- Handling processed tubes (slight potential of measurable exposure)

The following subsections summarize the in vitro bioassay data, air data, and alternative data available to help evaluate internal doses. There was no in vivo monitoring performed at the Pinellas Plant. The subsections also present evaluations of the sufficiency of the specified data. The Technical Basis Document, *Pinellas Plant – Occupational Internal Dose* [ORAUT 2016a], presents the various analyses used and the associated minimum detectable activities.

6.1.1 In Vitro Analysis Data and Data Sufficiency

The Pinellas Plant's general operating procedures clearly defined the required frequencies and participation criteria for tritium monitoring through urine bioassay [GE 1969–1983, PDF pp. 64, 83]. Depending on the location and probability of tritium uptake, Pinellas assigned workers to different bioassay frequencies. For example, in 1984 GE Operating Procedure G.1.12, *Assignment of Personnel to Work in Radioactive Material, Contamination or Radiation Areas* stated that workers handling contaminated equipment were to provide samples daily; workers operating contaminated equipment were to provide samples weekly; and workers with a slight potential for uptake such as those handling processed tubes were to provide samples monthly [GE 1984c].

NIOSH has primary radiation exposure reports including tritium urinalysis results, termination bioassay sample results, bioassay tabulation forms (1957–1958), exposure record cards (1959–1965), dose adjustment forms (1957–1982), bioassay dose summary reports, dosimetry cards for individuals, and individual plutonium in vitro bioassay results for the years 1976 through 1986 [Pinellas Plant 1975–1986; Pinellas Plant 1976–1986]. Annual dose summary reports are also available as electronic records from 1967 through 1975. Early in the Pinellas Plant's operational history (i.e., from 1959–1963), monthly health physics reports presented only the total number of personnel monitored, either for external dose, for internal dose, or both for the month, with a maximum exposure and average exposure in mrem [Forest 1959–1962]. These reports generally characterized the personnel as manufacturing, engineering, employee and community relations, quality control, or laboratory workers. The reports also generally documented the number of bioassay samples collected, but there is no way to directly correlate the number of samples to the number of individuals monitored until the ALARA reports began reporting the number of individuals. NIOSH's review of ALARA reports indicates that the Pinellas Plant monitored approximately 12% of workers for tritium intakes from 1986 through 1995. (In November 1993, DOE

initiated the phase-out of production and transition to Environmental Management began. The number and percentage of workers internally monitored increased for 1994 and 1995.) See Section 7.4.9 of this report for additional discussion of the percentage of monitored workers. Because Pinellas Plant workers often changed jobs at the site throughout their employment (which could have changed their potential to receive a dose), when looking at general monitoring trends, NIOSH must rely on the Pinellas Plant's reported numbers of individuals monitored. Fortunately, many Pinellas Plant dosimetry records for individuals include cards or notations regarding the start and stop dates for internal dose monitoring.

For this evaluation, NIOSH looked at the number of monitored workers and the potential for unmonitored workers. Table 6-1 below provides the number of NOCTS claimants as of May 3, 2021, employed at the Pinellas Plant each year, and the number of those who had at least one tritium urine sample result in that year. In their report, *Review of the NIOSH Site Profile for the Pinellas Plant Site*, SC&A included a finding regarding "Missing Internal Dose Estimation Methods for Unmonitored Workers, such as Maintenance and Support Personnel, Not Provided" [SC&A/Salient 2006, PDF p. 14]. Table 6-1 also indicates the number of maintenance workers within the claimant pool. NIOSH counted a worker as a maintenance worker if the job title included the word "maintenance," as reported by them or their survivors during Computer Assisted Telephone Interview (CATI) calls with NIOSH. The final column of the table indicates the number of those maintenance workers with tritium results that year.

Table 6-1: Pinellas Claimants with Tritium Results[a]

Year	Number of Pinellas Claimants (all job titles) in NOCTS[b]	Number of Pinellas Claimants with Tritium Results	Number of "Maintenance" Claimants (by job title)	Number of "Maintenance" Claimants with Tritium Results
1957	110	12	10	1
1958	162	21	14	5
1959	178	42	19	9
1960	199	52	19	15
1961	212	56	20	12
1962	218	54	20	11
1963	218	45	21	10
1964	224	52	22	15
1965	219	47	21	12
1966	241	60	22	16
1967	248	57	22	16
1968	260	56	24	14
1969	259	56	24	11
1970	263	47	26	9

Year	Number of Pinellas Claimants (all job titles) in NOCTS[b]	Number of Pinellas Claimants with Tritium Results	Number of "Maintenance" Claimants (by job title)	Number of "Maintenance" Claimants with Tritium Results
1971	264	41	26	12
1972	268	38	26	9
1973	271	32	25	8
1974	267	44	25	11
1975	264	37	24	7
1976	274	40	26	10
1977	282	29	29	8
1978	297	33	31	11
1979	314	29	32	9
1980	320	35	31	11
1981	329	34	35	10
1982	343	31	34	10
1983	345	38	36	8
1984	349	35	37	8
1985	354	25	37	6
1986	343	26	36	7
1987	330	21	36	6
1988	310	8	34	1
1989	299	3	0	0
1990	288	10	32	1
1991	280	14	32	2
1992	268	37	34	4
1993	190	9	0	0
1994	162	19	17	4
1995	127	1	0	0
1996	89	12	6	1

a. Source: [ORAUT 2021f]
b. Based on NOCTS start and end dates (i.e., number employed within that year)

Table 6-2 below shows the reported total assigned internal dose, the number of monitored individuals, and the average individual internal dose reported by the Pinellas Plant in the ALARA reports. The Pinellas Plant ALARA reports from 1988 through 1995 are available. The 1988 ALARA report includes data from 1986 and 1987. Both the total internal dose and the average individual internal dose generally followed a downward trajectory from 1986

through 1990 (reported years within the evaluated period) and continued in the same direction until the employees finished disconnecting the fabrication equipment in 1995.

1995 Annual ALARA Program Report for Ionizing Radiation reports information on site-wide exposure to tritium for the period from 1988 through 1995, during which time the average exposure was between 0.08 and 4.38 mrem with an annual maximum value of between 6 and 130 mrem [Weaver 1996b, PDF p. 15]. The maximum value is the highest individual dose for the year. This indicates tritium exposures were low throughout the facility during this period. These averages and maximums each year include incident precipitated bioassay sampling. Examples of such incident-precipitated bioassay sampling are available throughout the facility's history in the health physics summary reports.

Table 6-2: Summary of Pinellas Internal Monitoring Data for Tritium 1986–1995[a]

Year	Number Monitored	Total Dose (person-mrem)	Average Dose (mrem)	Highest Individual Dose (mrem)
1986	194	699	3.60	86
1987	139	358	2.58	105
1988	129	565	4.38	130
1989	201	557	2.77	97
1990	177	184	1.04	31
1991	202	390	1.93	101
1992	164	150	0.91	35
1993	134	103	0.77	21
1994	217	17	0.08	6.3
1995	215	224[b]	1.04	93[b]

a. Sources: [Weaver 1993a, PDF pp. 20, 23; Weaver 1996b, PDF p. 15]
b. Includes dose from a single incident in which one individual received an exposure of 93 mrem. The total site dose and highest individual dose (excluding this one individual) were 131 and 23 mrem, respectively.

The NOCTS claimant files and the SRDB include a significant quantity of in vitro bioassay data for monitored Pinellas Plant employees, including 50 self-identified maintenance workers (as of May 3, 2021). Individual urine sample results for tritium are available for all years, 1957–1996, in primary data form. These are sometimes in dose adjustment forms, radiation exposure reports, urinalysis cards, etc. (see Table 6-3 below). NIOSH also has access to personal exposure summary (secondary) data, including tritium dose summary data (available in SRDB documents) for all years except 1959–1962, 1967–1974, 1980, 1982–1983, and termination occupational exposure reports with internal and external total occupational assigned doses [Pinellas Plant 1960–1978; Pinellas Plant 1978]. Table 6-3 below lists the forms used to document internal dose at different times during operations at the Pinellas Plant. The forms include individual bioassay results as concentrations of tritium in urine in µCi/l, doses calculated from these results in mrem, photon and neutron exposures

measured in mrem, or rem in the case of the Annual Occupational Radiation Exposure form, and summary data.

The Bioassay Tabulation (MUL-101), Exposure Record (MUL-334), and Bioassay Exposure Record (FC-600) forms were very similar and contained handwritten tritium bioassay results and doses. These forms were individual to each worker and included their name and badge number with an entry for each bioassay sample, including the date, concentration in µCi/l, and dose in mrem, although the Bioassay Tabulation labeled these as millirad. The Personnel Monitoring Record (FC-600) and Personnel Monitoring Record (NFC 1163) recorded external dosimetry data on the front of the form and tritium bioassay date, concentration in µCi/l, and the dose in mrem on the back of the form. The back of the form also repeated the badge number. These forms include detailed bioassay results and NIOSH considers them primary data.

The Annual Occupational Radiation Exposure form was a computer printout that summarized the worker's external and internal exposure. This form listed tritium dose in rem. The Dose Report form was a summary printout for all workers and listed external and internal dose with tritium dose reported in mrem. Both of these forms include summary data and NIOSH considers them secondary data.

Table 6-3: Pinellas Plant Internal Dose Record Series (Personnel Files)

Form Name or Description	Applicable Years	Summary Data[a] (Yes or No)	Detailed Data[b] (Yes or No)
Bioassay Tabulation (MUL-101)	1957–1958	Yes	Yes
Exposure Record (MUL-334)	1959–1965	Yes	Yes
Annual Occupational Radiation Exposure for Calendar Year	1964–1970	Yes	No
Bioassay Exposure Record (FC-600)	1964–1970	Yes	Yes
Personnel Monitoring Record (FC-600)	1970–1979	No	No
Urinalysis Data (backside of Personnel Monitoring Record FC-600)	1970–1979	Yes	Yes
Personnel Monitoring Record (NFC 1163)	1980–1987	Yes	No
Urinalysis Data (backside of Personnel Monitoring Record NFC-1163)	1980–1987	Yes	Yes
Dose Report	1988–1995	Yes	Yes

a. NIOSH considers internal summary data (e.g., compiled spreadsheets) as secondary data.
b. NIOSH considers internal detailed data (e.g., individual monitoring results) as primary data.

NIOSH reviewed all Pinellas Plant claims to determine whether internal and/or external personal monitoring records were available for each year evaluated (i.e., to ensure there were no outstanding temporal gaps in the records). NIOSH's review showed that internal and external monitoring results for the evaluated period, 1957 through 1990, are available in the NOCTS claimant files. NIOSH reviewed the data that it has recovered from different

record holdings (contained in the SRDB) and then compared the results to data provided by DOE in response to NIOSH requests for claim data. There was very good agreement between the two sources of dosimetry results, meaning that data received from DOE mirrored the NIOSH records in the SRDB. Section 7.4.9 of this report describes this review in more detail.

6.1.2 Air Monitoring Data Sufficiency

NIOSH has not found any indications of the Pinellas Plant conducting personal air monitoring or breathing-zone sampling during the evaluated period. From as early as April 1957, Pinellas performed routine area monitoring for airborne tritium radioactivity [Pinellas Plant 1957–1973, PDF p. 2]. The Pinellas Plant located fixed-room monitors in all areas where there was a potential for the release of tritium. As described previously in Section 5.2.1, the airborne tritium monitoring systems consisted of 22 L Kanne ionization chambers connected to a picoammeter and an alarm panel. In 1973, there were 40 sampling ports and 20 monitors. A Kanne ionization chamber monitor was capable of detecting tritium below the U.S. Atomic Energy Commission (AEC) 40-hour level of 2×10^{-5} µCi/mL (i.e., the derived air concentration agreed to by DOE and the NRC) [ORAUT 2016a, PDF p. 16; Ward 1971a; Weaver 1990a, PDF p. 2].

A May 3, 1957 Health Physics Summary Report describes a mobile monitor designed and fabricated for use as an operational air monitor [Pinellas Plant 1957–1973, PDF p. 3]. The Pinellas Plant used portable tritium gas monitors/ion chambers as temporary monitors in areas where fixed-room monitor probes were not located [DOE 1991, PDF pp. 125–126]. The Pinellas Plant also set up portable samplers using silica-gel collection media or silica-gel stations in some areas.

Various “check sheets” capture routine survey data at the Pinellas Plant. Pinellas specifically captured air monitoring results on the “Air Monitor Check Sheet” and “General Atmosphere Monitor” forms found in the Pinellas Plant records. These forms accompany dose records, incident investigations, and routine in-plant survey reports and are available to NIOSH for use as needed. These secondary air monitoring results exist in documents collected from the site, but NIOSH has not compiled and analyzed them because primary tritium and bioassay results are sufficient. NIOSH has found examples of these worksheets for the early years of operation, 1958–1960. These Air Monitor Check Sheets provide the location, date, and result, often notated as “OK” or with a concentration. The Pinellas Plant generally reported instances of airborne radioactivity levels exceeding the maximum permissible concentration in the health physics monthly reports up to 1962, including an air monitoring summary of the concentrations measured in µCi/cc (µCi/mL) [Pinellas Plant 1957–1973]. Beginning in 1962, reports often simply reported airborne radioactivity as “effectively controlled throughout the report period.” In 1970, the reporting period changed from monthly to quarterly. These reports are available in the SRDB.

6.1.3 Alternative Data Source and Sufficiency

The Pinellas Plant had a radioactive contamination monitoring and control program, as described in GEND Standard #5.2. The procedure defined types of contamination, the contamination limits of the different classifications of contamination areas, and

contamination controls including the general area monitoring of areas for loose surface contamination [GE 1989b, PDF p. 11]. Areas were monitored (smear surveyed) on a schedule determined by the work in the area on a daily, weekly, monthly, or semi-annual basis [Pinellas Plant 1995]. A smear survey procedure, circa 1960s, indicates the tritium contamination limit for uncontrolled areas was 220 dpm/100 cm^2 [Tritium smear surveys, no date; Burkhart 1989, PDF p. 2; ORAUT 2016a, PDF p. 22]. NIOSH has routine surface contamination monitoring results and special survey results for the various areas of the Pinellas Plant over the span of operations. NIOSH also has obtained Environmental, Safety and Health summary reports from 1957 through 1973, which provide information on the maximum tritium surface contamination levels. NIOSH documented additional information regarding available tritium-contamination survey data in *Pinellas Plant — Occupational Internal Dose* [ORAUT 2016a, PDF pp. 22–23].

6.2 Available Pinellas Plant External Monitoring Data and Data Sufficiency

The Pinellas Plant started an External Dosimetry Program in 1957 to monitor individual employees working in Neutron Generator Production Areas. Pinellas used photographic (beta-gamma) film dosimeters from the start of operations through June 1974. From July 1974 through March 1990, the Pinellas Plant primarily used the Type G film emulsion package dosimeter. Then in April 1990, Pinellas used Landauer Type Z/F dosimeter [ORAUT 2017a, PDF p. 20; Ward 1974; Hall 1989, PDF p. 2]. From 1974 through 1997, Landauer also supplied extremity dosimeters, including finger rings or wrist badges to monitor beta, X-ray, and gamma exposure as required [Weaver 1995; ORAUT 2017a, PDF p. 22]. Throughout the Pinellas Plant's operational history, Pinellas used Nuclear Track A (NTA) film, Landauer, and Mound dosimeters for neutron dosimetry.

The following subsections summarize the employee dosimetry, area monitoring, and alternative data sources available to help evaluate external doses in Section 7.2. The subsections also present evaluations of the sufficiency of the specified data. The Technical Basis Document, *Pinellas Plant – Occupational External Dose* [ORAUT 2017a] presents details regarding the various analyses NIOSH used and the associated minimum detectable activities.

6.2.1 Employee Dosimetry Data Sufficiency

Primary records, including quarterly personnel exposure reports (individual dosimetry data) and individual dose files for the entire history of Pinellas Plant operations, are available to NIOSH in the SRDB. Secondary records such as annual summary reports (external whole body data for shallow doses, photons, neutrons, and some extremity dose reports) are also in the SRDB. Based on the available claim records, the Pinellas Plant routinely recorded an individual's cumulative career dose. Pinellas reported monthly, annual, cumulative, and lifetime dose totals for the Pinellas Plant as whole body doses, which would include any internal tritium doses that the worker received. ALARA reports are available for 1988–1995. The Pinellas Plant data files include dose information for 1,694 workers.

The Pinellas Plant did not monitor all employees for external doses because most of the work performed at the Pinellas Plant did not involve radiological exposure to external sources of radiation and because most personnel did not have routine access to Radiation Areas. Personnel working with radiation-generating devices, such as the Model 200 HP Ion Implanter accelerator, were required to wear dosimeters capable of measuring photon and neutron dose [ORAUT 2017a, PDF p. 13; Barclay 1995, PDF p. 5]. NIOSH's review of the 1960 to 1973 AEC annual exposure summary reports indicates that 27.5% of the Pinellas Plant workers wore dosimetry badges. Based on a comparison of Pinellas Plant operating procedures to historical guidelines and regulations, the Plant monitored significantly more workers for external dose than was necessary [ORAUT 2017a, PDF p. 26; Weaver 1990b, PDF p. 14]. Section 6.2.5.1 of *Pinellas Plant – Occupational External Dose* [ORAUT 2017a, PDF p. 25] provides more information on historical guidelines and regulations for radiation protection and worker dose monitoring requirements that were effective throughout the Plant's operational history. For example, 10 C.F.R. 835 requires workers, who have the potential to receive 100 mrem/year of external dose, to be monitored [DOE 1994a, PDF p. 13]. Nearly 80% of the monitored workers at the Plant received an annual whole body dose of less than or equal to 20 mrem on average [ORAUT 2017a, PDF p. 25; ORAUT 2017d]. Personnel exposures were routinely very low. In 1991, Pinellas assessed worker exposures related to the uranium-doped borosilicate glass cutting and etching processes and calculated the worst-case exposure to extremities from the operations as 75 mrem/year [Pinellas Plant 1992–1994, PDF p. 27-30], which is well below the U.S. DOE annual limits (i.e., 50,000 mrem/year extremities).

Pinellas Plant workers often changed jobs throughout their employment, which then changed their potential to receive radiation dose. Fortunately, many Pinellas Plant dosimetry records include cards or notations regarding the start and stop dates for external and internal dose monitoring. For the majority of the operational period, the Pinellas Plant exchanged and analyzed external dosimetry on a monthly basis. Beginning in January 1990, external dosimetry was exchanged and analyzed quarterly [ORAUT 2017a, PDF p. 25; Weaver 1989, PDF p. 3; Weaver 1990c, PDF p. 3].

Table 6-1 of the site profile document *Pinellas Plant – Occupational External Dose* [ORAUT 2017a, PDF p. 14] lists only Pinellas Plant's Building 100, Area 109 as having electrons greater than 15 keV energy and consequently, an external beta-exposure concern. From 1957 through June 1974, the Health Physics Department processed the film dosimeters at the Pinellas Plant site [Burkhart 1987, PDF p. 2]. The available film worksheets indicate the use of only the open-window film for the dosimeters; thus, Pinellas did not separately report non-penetrating beta doses during this period. The Plant reported any beta doses received by workers as photon doses. In 1974, the Pinellas Plant began using dosimetry provided by R.S. Landauer Jr. & Co. (Landauer) [Ward 1974, PDF p. 2] who processed the dosimetry and reported both deep and shallow exposures for the reporting period (i.e., beta dose for the month). Landauer also reported the cumulative totals for the calendar quarter, year-to-date, and lifetime exposure history at the Pinellas Plant for workers. In April 1990, the Pinellas Plant changed from using Landauer film to using TLDs [Hall 1989, PDF pp. 2, 4]. Pinellas used the TLDs through the end of nuclear development and testing operations. More detail regarding the specific dosimeter configurations used over time at the Pinellas Plant can be found in Tables 6-4 through 6-7 of *Pinellas Plant – Occupational External Dose* [ORAUT

2017a, PDF pp. 20–23]. In 1990, Table 1 of the annual ALARA report [Harder 1991, PDF p. 8] shows the total dose and average dose in mrem as skin dose monitoring for photon and beta combined.

The Pinellas Plant used Mound TLDs to measure photon exposures in Building 400 from October 1979 through September 1987. Starting in the third quarter of 1981, the Pinellas Plant processed Mound TLDs to avoid signal fading, a loss of information that caused an underestimate of up to 30% of the dose recorded [Meyer 1993, PDF pp. 309–310, 344]. To compensate for this potential underestimate, NIOSH applies a correction factor of 1.43 for Mound TLD photon results from October 1979 through June 1981.

With the exception of the Mound TLDs, NIOSH applies no adjustments or bias corrections to photon doses. NIOSH described signal fading dose reconstruction adjustments for the Mound TLD dosimeters in *Pinellas Plant — Occupational External Dose* [ORAUT 2017a, PDF p. 28].

The Health Physics Department processed neutron-sensitive photographic films at the Pinellas Plant from 1957 through 1978. In mid-1978, Pinellas began using R.S. Landauer for monitoring exposures to 14 MeV neutrons produced during neutron-generator testing. Information on the whole body neutron and beta-gamma-neutron dosimeters used over time at the Pinellas Plant is in Table 6-5 of *Pinellas Plant – Occupational External Dose* [ORAUT 2017a, PDF pp. 21–22].

In October 1979, Pinellas started using Mound Laboratory dosimeters to evaluate exposures to neutrons during RTG handling at Building 400 [Burkhart 1987, PDF p. 2]. The RTG heat-source neutron spectrum was most likely adopted from Mound Laboratory and used by the Pinellas Health Physics Department to analyze the effectiveness of various Landauer Neutrak CR-39 film [Burkhart 1987]. Pinellas determined that the Landauer dosimeters responded to only about 67% of the dose equivalent for the RTG heat-source spectrum. The Plant monitored RTG workers using these separate dosimeters for neutron dosimetry. The workers were required to leave their badges in the RTG areas [ORAUT 2013a, PDF p. 6]. The Pinellas Plant used individual dosimetry data for RTG worker neutron doses and would only estimate neutron dose if an individual lost their dosimeter. The Pinellas Plant stopped using Mound Laboratory neutron dosimeters in October 1987 [Burkhart 1987].

Using information available from the Pinellas Plant ALARA reports, Table 6-4 below shows the reported total assigned external dose, the number of monitored individuals, and the average individual external dose for the period from 1985 through 1995. Pinellas did not report the average individual external dose for 1985 through 1987, and no trend is evident for 1988 through 1990. Both the total and average individual dose generally dropped each year through 1995. RTG operations, which moved offsite in early 1991, caused most external exposures [Weaver 1993b, PDF p. 16]. In 1990, the Pinellas Plant switched from a monthly dosimeter period to a quarterly dosimeter period [Weaver 1993b, PDF p. 16].

Table 6-4: Summary of Pinellas External Monitoring Data for 1985–1995[a]

Year	Number Monitored	Total Dose (person-mrem)	Average Dose (mrem)	Highest Individual Dose (mrem)
1985	Not Reported	5,525	Not Reported	411
1986	Not Reported	2,837	Not Reported	550
1987	Not Reported	2,102	Not Reported	321
1988	171	1,712	6.7	170
1989	187	1,847	4.9	180
1990	185	2,104	8.3	280
1991	107	830[b]	3.9	40
1992	117	350	1.7	30
1993	88	270	2.3	50
1994	80	60	0.5	20
1995	72	243	0.28	10

a. Sources: [Weaver 1992, PDF pp. 9, 15, 50; HRS 1995; Pinellas Plant 1996; Weaver 1996b, PDF pp. 12–13]

b. Most external exposures were from RTG operations which moved offsite in early CY1991.

NIOSH compiled exposure monitoring data between 1960 and 1985 for the site profile. The data indicate that the Pinellas Plant monitored between 225 and 588 individuals each year. Individual radiation exposure was generally between 0 and 1,000 mrem/year for the period 1960–1973 (the lowest reported category for that period) and between 0 and 100 mrem/year for the period 1974–1985 [ORAUT 2017d]. The maximum annual radiation exposure was less than 2,000 mrem for 1960–1973, and less than 1,000 mrem for 1974–1985 [ORAUT 2017d]. For the period 1988–1995, the Pinellas Plant monitored between 72 and 171 individuals for external exposure, with individual external radiation doses averaging between 0.28 and 8.3 mrem (maximum values ranged from 10 to 280 mrem) [Weaver 1996b, PDF p. 13].

Table 6-5 lists the types of external exposure monitoring records found in personnel files and indicates the years the Pinellas Plant used those forms. The forms include photon and neutron exposures measured in mrem except for the Annual Occupational Radiation Exposure form, which reports the summary data and detailed data results.

Table 6-5: Pinellas Plant External Dose Record Series (Personnel Files)

Form Name or Description	Applicable Years	Summary Data (Yes or No)	Detailed Data (Yes or No)
Personnel Exposure Record	1957–1958	Yes	Yes
Exposure Record	1959–1965	Yes	Yes
Annual Occupational Exposure for Calendar Year	1964–1970	Yes	Yes
Personnel Monitoring Record (FC-600)	1970–1979	Yes	Yes
Personnel Monitoring Record (NEC 1163)	1980–1987	No	No
Dose Report	1988–1995	Yes	Yes

6.2.2 Area Monitoring Data and Data Sufficiency

The Pinellas Plant had a Health Physics Program, including general operating procedures and routine surveillance activities that included conducting area monitoring and surveys to assure worker safety by monitoring contamination and radiation fields. The Health Physics Program included routine radiation and contamination surveys, work support surveys (i.e., pre-work surveys, waste-box loading surveys, item-release surveys, sample analysis results for contaminated pump oil, and area surveys), SWPs, and surveys of radioactive materials for transit. Pinellas conducted contamination surveys to detect any spread of radiological materials in use at the site. In the Neutron Generator Production Areas, Pinellas conducted tritium contamination surveys on a routine basis, checking both work areas and personnel; Pinellas documented the results in the health physics monthly reports when a result exceeded the contamination control limits. In Building 400, where the RTGs program involving triply-encapsulated plutonium sources occurred, Pinellas conducted surveys to detect potential plutonium contamination. NIOSH has not found the survey reports associated with plutonium contamination surveys but has summary reports indicating that the Plant did not detect plutonium contamination. The Plant documented routine, direct-radiation surveys (either with portable instruments or fixed-area badges) within the Pinellas Plant every six months and on request to measure radiation levels. Pinellas installed area badges in a fixed position and used them to monitor radiation fields around test equipment and "large" radioactive sources [DOE 1991, PDF p. 22]. Additional information on the specifics of contamination surveys is in the *Pinellas Plant – Site Description* [ORAUT 2011b] and *Pinellas Plant – Occupational Internal Dose* [ORAUT 2016a, PDF pp. 14–16].

NIOSH has access to area film monitoring work sheets, radiation survey sheets, radiation-producing equipment survey reports, material-transport survey reports, weekly routine smear surveys, area film-monitoring worksheets, contamination surveys, and health physics data summary reports that provide monthly summaries of contamination status and data in the form of primary records.

The available area monitoring data for Pinellas Plant span the site history and adequately represent the exposure scenarios to support dose reconstruction. Area monitoring data are secondary in the hierarchy of dose reconstruction information; that is, the information priority in the order of precedence is individual monitoring data, group or workplace (area)

monitoring data, and then process and source term description information [ORAUT 2017c, PDF p. 9]. Considering the available monitoring data and exposure-scenario information, NIOSH has sufficient Pinellas Plant area monitoring data to represent the NIOSH-evaluated class adequately.

6.2.3 Alternative Data Sources and Data Sufficiency

The Pinellas Plant used a safety work permit program for some jobs (e.g., maintenance on the recovery system or the transport line). Safety work permits (SWPs) identified bioassay and air-monitoring requirements, as well as any additional requirements. Pinellas tracked SWPs using pressure copy sheets. The tracking method assured that one copy was with the worker, one copy was on file, and one copy went to the Health Physics Department. Pinellas posted a copy in the work area. The Pinellas Plant often assigned groups of workers to a single SWP [ORAUT 2020a, PDF p. 5].

6.3 Available Pinellas Plant Ambient Environmental Monitoring Data and Data Sufficiency

The following subsections summarize the environmental monitoring data available to help evaluate bounding doses. The subsections also present evaluations of the sufficiency of the specified data.

6.3.1 Internal Environmental Data and Data Sufficiency

NIOSH has access to documentation including environmental assessments, environmental monitoring reports, health physics reports, annual stack emissions data reports, and internal correspondence regarding radiological emissions.

Radioactive Airborne Effluents

NIOSH can assess potential onsite environmental internal exposures and subsequent doses to workers at the Pinellas Plant using airborne effluent data, liquid effluent data, and onsite air monitoring data. NIOSH has located documentation and records describing both the radiological conditions in the onsite environment and the Environmental Monitoring Program at the Pinellas Plant. This documentation includes environmental monitoring data.

From the beginning of plant operations, Pinellas performed environmental air monitoring for tritium gas and oxide. NIOSH has access to a compiled summary of annual stack releases, with total release activity for tritium gas, tritiated water, and carbon-14 for the Pinellas Plant [ORAUT 2011e] for the years 1957 through 1997.

The earliest background monitoring for radioactivity was performed in April 1957, when four samples from areas around the Pinellas Plant were taken to establish background counts before operations began [HRS 1994, PDF p. 44]. The monitoring program was informal until the mid-1970s. There were no permanent air monitoring stations, and the Plant performed some monitoring activities on an irregular basis. During the mid-1970s, the Pinellas Plant installed six permanent onsite air monitoring stations for monitoring tritium [HRS 1994, PDF

p. 56]. From 1975 through 1992, the Pinellas Plant performed regular environmental monitoring for radioactive tritium releases [HRS 1994, PDF p.12].

Pinellas monitored for radioactive airborne effluent primarily at the exhaust stacks. Approximately 82% of the total airborne effluent releases at the Pinellas Plant occurred during the first four years of operation, 1957 through 1960, primarily tritium gas and tritiated water [ORAUT 2011d, PDF p. 12; HRS 1994, PDF p. 12]. Information regarding the location, stack dimensions, and potential nuclides within the effluent is available. Buildings 100, 200, 400, and 800 had stacks and areas that used radiological materials. The Pinellas Plant monitored radioactive emissions from all of these stacks. Pinellas never detected radioactive emissions from the Building 400 stack. Until 1974, Pinellas determined airborne tritium gas and tritiated water effluent discharges using a combination of continuous stack-sampling systems and "real-time" stack monitoring systems. Starting in 1974, Pinellas determined airborne effluent discharges of both tritium gas and tritiated water using continuous stack-sampling systems. NIOSH documented the technical details of the continuous stack monitoring system used to monitor tritium gas concentrations in *Pinellas Plant – Occupational Environmental Dose* [ORAUT 2011d, PDF pp. 9–13].

Starting in 1975, the Pinellas Plant monitored for plutonium because of the encapsulated plutonium related to the RTG operations conducted in Building 400 [HRS 1994, PDF p. 60]. Pinellas performed stack sampling for airborne effluents from Building 400 using a continuous stack-sampling system. However, after reviewing the incident reports and the environmental monitoring reports for 1975–1990, NIOSH could not find any evidence of plutonium releases reported at the Pinellas Plant.

The Pinellas Plant determined airborne effluent discharges of carbon-14, discharged from the Building 100 laboratory stack from 1979 to 1984 [HRS 1994, PDF p. 37] from the volumes of carbon-14 labeled solvent used during each year [GE 1980, PDF p. 13; GE 1984b, PDF p. 15].

Radioactive Liquid Effluents

The Pinellas Plant directed effluents into a county drainage system from the East pond until December 1982, when Pinellas directed effluents to the Publicly Owned Treatment Works (POTW). Tritiated water was the only radioisotope in the Plant's liquid effluents. Pinellas Plant personnel analyzed composite samples of releases to the POTW using liquid scintillation techniques. Discharges were generally several orders of magnitude less than the DOE 5480.1 standards [GE 1984b, PDF pp. 18–21].

The *Pinellas Plant – Occupational Environmental Dose* contains supporting technical data to evaluate the total Pinellas occupational environmental radiation dose that can reasonably be associated with a worker's radiation exposure [ORAUT 2011d].

6.3.2 External Environmental Data and Data Sufficiency

NIOSH has not located evidence of environmental external dose monitoring at the Pinellas Plant. It is likely that the Pinellas Plant did not perform environmental external monitoring due to the low potential for workers to encounter significant sources of external radiation outdoors at the Plant.

Beginning in 1963 when the Pinellas Plant first used Kr-85 on site, Pinellas performed stack sampling for discharges of Kr-85. Pinellas housed commercially-available models of two leak-detection systems containing Kr-85 gas in separate rooms of Area 109 in Building 100. Kr-85 was released from the Radiflo or TRACER-Flo leak-detection units during purge cycles into shrouds connecting the two units to an exhaust system from the enclosed testing area [IT/Radiological Sciences Laboratory 1986, PDF p. 15]. The Pinellas Plant monitored the concentration of Kr-85 in the exhaust duct using partial bypass of the stream into a Kanne ionization chamber connected to a picoammeter and a strip chart recorder. Pinellas read the Kanne ionization chambers daily [DOE 1987, PDF p. 216]. The Pinellas Plant only expected Kr-85 emission to occur from the Building 100 main stack [Martin Marietta 1994b, PDF p. 17]. NIOSH has access to a compiled summary of annual stack releases showing total release activity for Kr-85 for the Pinellas Plant [ORAUT 2011e] for the years Kr-85 was in use, 1963 through 1996.

6.4 Available Pinellas Plant Occupational Medical X-ray Data and Data Sufficiency

This section summarizes the occupational medical X-ray data available to help evaluate bounding external doses in Section 7.4. This section also presents an evaluation of the sufficiency of these data. NIOSH has not found any indication that the Pinellas Plant monitored the medical X-ray dose for individuals receiving occupational X-rays. There is a report discussing a radiation protection survey of the diagnostic X-ray installation at Pinellas Plant performed by the Pinellas County Health Department in December 1972 [McCall 1973, PDF pp. 3–12]. This report does not give information related to the dose received by workers from the medical X-ray diagnostic procedure, but it indicates that the Pinellas Plant made efforts to ensure the equipment was functioning as expected by asking for an outside, objective survey.

The Pinellas Plant operations contractors (i.e., GE and Martin Marietta/Lockheed Martin Specialty Components) required pre-employment and routine medical examinations as part of their Occupational Health and Safety Programs. The pre-employment examinations and some of the periodic medical examinations required X-ray screening.

At the Pinellas Plant, the X-ray screening procedures typically included posterior-anterior (PA) and infrequent lateral (LAT) chest X-rays [ORAUT 2007a, PDF p. 3; ORAUT 2011c, PDF p. 8]. NIOSH does not have site documents reporting the examination frequency protocols; however, Pinellas Plant workers' medical X-ray files contain information about the X-rays taken, including the numbers and types of projections and the frequencies at which they occurred. Pinellas Plant workers' NOCTS claim file records indicate that Pinellas administered PA chest X-rays on a semi-regular basis with infrequent LAT or oblique chest X-rays

throughout the Pinellas Plant's history. The Pinellas Plant medical records show that it was relatively common for a worker to have received a lumbar spine X-ray, an abdominal/kidneys ureters bladder (Abd/KUB) X-ray, or both, along with the chest X-rays, especially between 1969 and 1974. Specifically, one of the most common combinations of X-ray examinations during the years from 1969 through 1974 included an anteroposterior (AP) Abd/KUB, lateral (LAT) lumbar spine, and PA chest X-rays.

7 Feasibility of Dose Reconstruction

The feasibility determination for the class of employees under evaluation in this report is governed by both EEOICPA and 42 C.F.R. 83.13(c)(1). Under the SEC regulation, NIOSH must establish whether or not it has access to sufficient information either to 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 to estimate the radiation doses to members of the class more precisely than a maximum dose. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions [42 C.F.R. 83, 2018, PDF p. 10].

In determining feasibility in the light of new information identified in this petition (August 17, 2020 version), NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating the potential radiation dose received by individual workers who are members of the class. NIOSH also evaluates whether any new information supplied in this petition (August 17, 2020 version) calls into question either the NIOSH dose reconstruction methods or their underlying assumptions. NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. NIOSH's SEC Petition Evaluation Internal Procedures, which are available on the NIOSH Radiation Dose Reconstruction Program webpage, discuss this approach.

7.1 Internal Radiation Doses at the Pinellas Plant

The principal source of internal radiation exposures to members of the class under evaluation was from inhalation of dispersible radiological materials used at the Pinellas Plant. As discussed in Section 5.2, tritium and Kr-85 were the dispersible radionuclides most widely used at the Pinellas Plant and only tritium could contribute significantly to internal dose [ORAUT 2011b, PDF p. 14]. The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.1.1 Evaluation of Bounding Operational Internal Radiation Doses

The following subsections summarize the extent and limitations of information available for bounding operational internal doses of the members of the class under evaluation.

7.1.1.1 Tritium

The Pinellas Plant used tritium in multiple forms for the development and production associated with neutron generators. Potential exposures to both soluble (i.e., tritium gas, tritium oxide, and organically-bound tritium compounds) and insoluble forms of tritium (i.e., metal tritides) were possible during the transfer of tritium between the reservoirs and receiver materials, during routine cleaning and maintenance of equipment, as a result of

contamination, and during any tritium-related incidents. The Pinellas Plant performed in vitro sampling for tritium internal exposure, routine area air monitoring for airborne tritium, environmental emissions monitoring, and tritium surface contamination surveys, as described in Sections 6.1 and 6.3 of this report.

From January 15 to February 2, 1990, DOE performed an audit of the Pinellas Plant site. In the resulting report, *Tiger Team Assessment of the Pinellas Plant*, DOE stated that 20 percent of the workers who terminated in 1989 did not provide termination samples [DOE 1990a, PDF p. 224]; this was taken to mean tritium urine samples. This indicates that the Pinellas Plant did collect termination samples for 80 percent of workers who terminated in 1989. The Pinellas Plant responded that the only bioassay requirement upon employment termination was limited to those who had worked with radioactive materials and that all personnel leaving a tritium area for any reason were required to submit bioassay samples and also implemented a new termination checklist [DOE 1990b, PDF pp. 281–282].

In 2004, NIOSH captured a sampling of employee termination records for employees with last names beginning with "E-G" [Pinellas Plant 1948–1985] and employees with last names beginning with "S" [Pinellas Plant 1942–1985] from the Atlanta Federal Records Center. That same year, NIOSH initiated a process (called SPEDELite) to link any energy employee data collected in the NIOSH SRDB to the dose reconstruction claim for the employee. During this evaluation, NIOSH searched the Pinellas claimant files for monitored employees and identified the 10 with the most data within the SRDB to determine if claim records routinely included tritium termination samples. Of the 10 claims reviewed, seven of the DOE records responses contained the termination tritium sample information. This gives NIOSH a degree of confidence that the termination samples are available to NIOSH within the claimant files. As stated earlier, NIOSH has termination records available in the SRDB for use in performing dose reconstructions. However, due to the short half-life of tritium, termination samples collected at the end of employment rather than after an indication of exposure, are not able to detect tritium exposures as effectively as samples collected immediately after the potential exposure. The termination samples provide an indication of any tritium exposure that occurred just preceding the sample collection, and so are of limited value. NIOSH believes that any missing termination bioassay samples would have a minimal impact on dose reconstruction.

The Tiger Team report also stated as part of the same finding, "In 1989 bioassay samples were not submitted in accordance with GEND procedures. Seventy percent of the required monthly samples and 35 percent of the required weekly samples were not submitted" [DOE 1990a, PDF p. 224]. The level of worker participation in the bioassay program had been an ongoing concern for the site [ORAUT 2021e, PDF pp. 7–8]. A memo dated March 1, 1971, describes procedure changes the Pinellas Plant initiated to ensure bioassay samples were submitted on time [Ward 1971b, PDF p. 2]. In response to the Tiger Team assessment, the Plant noted the weekly and daily sampling requirements and listed several steps to improve worker participation [DOE 1990b, PDF pp. 281–282]. In 1990, the Pinellas Plant set a goal of an overall participation rate of 80% [Harder 1991, PDF p. 2]. Pinellas began tracking individual compliance with bioassay sampling requirements. The actions taken by the Pinellas Plant, in response to the Tiger Team finding, increased the average participation rate of workers in the tritium monitoring program to 78% in 1990 [Harder 1991, PDF p. 4]; in

1991 it was above 85% [Weaver 1992, PDF p. 4]; and in 1992 it was above 90% [Weaver 1993a, PDF p. 11]. The *1990 Annual ALARA Program Report for Ionizing Radiation* describes updating the ALARA goal to have all employees in the tritium monitoring program "maintain at least 80% participation during the year, not just an average" [Harder 1991, PDF p. 6]; NIOSH assumes this means the 1991 participation rate (reported as above 85%) was for all employees in the urine-sampling program.

As discussed in Section 6.1.1, both the total internal dose and the average individual tritium dose generally followed a downward trajectory from 1986 through 1990 and continued in the same direction through the end of reporting in 1995 when the Pinellas Plant was undergoing D&D work. Therefore, the increase in bioassay compliance achieved in response to the DOE Tiger Team findings did not lead to an increase in the Pinellas Plant's total measured internal dose or the average individual internal dose, as might be expected if the bioassay program had missed identifying significant exposures.

In addition to the idea that the Pinellas Plant had not missed identifying significant exposures due to the bioassay compliance issue, NIOSH finds that because of this issue the overall tritium dataset available from the Pinellas Plant would likely be biased high. The Pinellas Plant monitored those workers with the highest internal-exposure potential for tritium the most often, i.e., on a daily or weekly frequency. According to the findings of the 1990 Tiger Team report, this group of workers was more compliant with the sampling program than the workers with lower exposure potential, who were sampled on a monthly frequency. This indicates that the monitoring data that is available would likely be biased high due to the larger fraction of missing data from the workers with lower exposure potential. In turn, any unmonitored dose approach based on the monitored workers would also be biased high.

To further assess the potential impact of the bioassay compliance for the period before 1990, NIOSH looked at the data in the NOCTS claimant files to represent the monitoring conducted at the Pinellas Plant. While there are significantly more dose records available to NIOSH than the claim records, only the claim records are consistently associated with the worker's job description, as self-reported in the CATI reports. NIOSH searched for and found broad titles like operator, maintenance, manager, engineer, secretary, and draftsman in the claimant files. NIOSH found that the claimant files included workers with one or more of the construction trade titles for all years of Pinellas Plant operation. During its review, NIOSH confirmed that the workers it expected to have had a potential for internal tritium exposure (e.g., those with hands-on tritium work or tritium-equipment or systems-maintenance responsibilities) were in fact monitored, as these are the categories of workers seen in the claims. Job categories included: engineers (101), operators (93), maintenance (60), technician (41), chemist (15) manager (33), secretary (13), stock clerk (11), janitor (22), nurse (1), and quality control (17). This list is not exhaustive and will contain duplication as the job titles are self-reported and an individual may have held numerous positions.

The Pinellas Plant determined worker urine-sample requirements based on their assigned work/tasks. While Pinellas was aware of the tasks of each employee, the tasks are not clearly indicated anywhere in the records available to NIOSH, making it necessary for NIOSH to use contextual clues such as job description, job change notations, history of urine samples, or

other indications in the records to determine the worker's exposure potential for any longer-than-expected period (generally between 30 and 60 days) between samples. NIOSH found that this lack of any clear indication of when a urine sample had to be submitted made it impossible to quantify the degree of compliance with bioassay schedules for each former worker. However, NIOSH analyzed the number of urinalysis results each year for each claimant to identify indications of volatility in the numbers of samples submitted across years. This analysis of the data from 1957 through 1989, identified only four claims that seemed to be more variable than the others, having significant changes in the numbers of samples given from one year to the next, and worth further review in detail. The four claim records were for a lab technician, a maintenance craftsman, a development physicist, and a neutron tube technician. All of these were jobs that NIOSH would expect to be on a weekly to monthly urine sample schedule. NIOSH reviewed these claims and determined that the worker monitoring appeared consistent with the job responsibilities and exposure potential for these workers.

The Tiger Team audit document does not include references, specific data, or documentation to support the finding related to bioassay procedure compliance; therefore, NIOSH must assess it at face value. During interviews with former workers and DOE oversight staff, NIOSH asked participants to identify the cause of bioassay non-compliance. Of the 15 former Pinellas workers and DOE oversight staff who were interviewed specifically on the topic of participation in the bioassay program, all stated that they did not know of workers not submitting samples as requested [ORAUT 2020a,b,c,d,e,f,g,h,I,j; ORAUT 2021a,b,c,d,e]. Although they did not know of workers who were not submitting samples, the responses on possible causes ranged widely. A former worker who had participated in the Tiger Team audit said the Plant set the 80% participation goal in response to the audit, and that non-participation was sometimes a result of workers being on leave during their scheduled sample period [ORAUT 2020a, PDF p. 7]. This same former worker informed NIOSH that there were support personnel who entered a production area on a non-routine basis, who the site assigned to the bioassay sample program for routine sampling instead of only requiring the worker to provide a sample upon leaving the tritium area. Providing a sample when exiting a radiological area was the Plant's protocol for non-routine entries involving exposure potential. Thus, according to the interviewee, there were a large number of people placed on the routine sampling program though it was unnecessary [ORAUT 2020a, PDF p. 6]. A Radiation Control Compliance document from 1993 reports that the system used to document participation did not accurately track the reason samples were not submitted (i.e., vacation, sick leave, reassignment, or "just forgot") [Martin Marietta 1993b, PDF p. 6]. Therefore, NIOSH doesn't have any evidence or indication of a single root cause of non-compliance with the requirement to submit a bioassay sample. It is unlikely that the non-compliance issue was a systemic problem and there is no indication it was widespread among the workers. Therefore, the bioassay compliance issue does not impact NIOSH's ability to develop a dose reconstruction approach based on the available monitored worker data.

In addition to reviewing Pinellas Plant documentation and interviewing former employees regarding the bioassay compliance finding, NIOSH also reviewed past ABRWH Pinellas Plant Work Group discussions and reviews regarding dose reconstruction methods for unmonitored workers. On September 15, 2006, SC&A issued their report, *Review of the*

NIOSH Site Profile for the Pinellas Plant Site. The report had 11 findings including "Finding 7: Missing Internal Dose Estimation Methods for Unmonitored Workers, such as Maintenance and Support Personnel, Not Provided" [SC&A/Salient 2006, PDF p. 14]. In Finding 7, SC&A indicated the ORAUT-TKBS-0029-5, Rev 0 statement, "All HTO and Plutonium potentially exposed workers have likely been monitored" needed justification [SC&A/Salient 2006, PDF p. 14]. When the ABRWH Pinellas Plant Work Group met on June 11, 2008, this became Issue #7 in the *Issues Resolution Matrix for the Pinellas Plant* [SC&A 2016a, PDF pp. 8–9].

NIOSH assesses unmonitored workers, those who were not monitored because their job assignment did not involve significant potential for internal exposure, as only being exposed to on-site levels of environmental tritium effluent and follows the guidance in *Pinellas Plant – Occupational Internal Dose*, ORAUT-TKBS-0029-5 [ORAUT 2016a, PDF p. 23]. To address the unmonitored worker issue, NIOSH developed a whole body dose for the unmonitored worker based on monitored, whole body doses calculated by Pinellas that were available in documents in the SRDB. The Pinellas Plant reported total whole body dose, which included the measured, external whole body dose and the calculated whole body dose based on tritium bioassay. NIOSH analyzed the results and determined that on average, 95% of the monitored workers at the Plant received annual doses equal to or less than 100 mrem between 1957 and 1995 [ORAUT 2017a, PDF PP. 56–62]. ORAUT-TKBS-0029-6 Attachment B, *Basis for Unmonitored External Dose Assignment* describes the derivation of the dose.

During the February 11, 2016 ABRWH Pinellas Plant Work Group meeting, the Pinellas Plant Work Group discussed the need for an unmonitored dose approach specific to internal dose. However, the Work Group found that the approach for determining the unmonitored dose assigned in *Pinellas Plant – Occupational External Dose*, ORAUT-TKBS-0029-6, included internal dose and therefore met their concern about unmonitored internal dose [NIOSH 2016, PDF pp. 25–26]. In the PowerPoint presentation dated March 23, 2016, SC&A discussed each issue from the Issues Matrix. On the slide for Issue 7 was the statement "NIOSH 'whole body dose' coworker model includes a tritium component in addition to neutron and external gamma dose assigned at the 95th percentile" [SC&A 2016b, PDF p. 13]. During this SEC evaluation, NIOSH reviewed this approach to determine if a methodology for assigning internal dose for individuals with monitoring gaps (e.g., when a worker did not submit a required urine bioassay sample) is needed. Currently, NIOSH applies the 95^{th} percentile whole body dose to all Pinellas claimants who were potentially exposed to photons or neutrons and were unmonitored for external exposure. NIOSH determined that the use of an unmonitored approach, based on the 'whole body' dose, as a surrogate for the internal dose component is appropriate and claimant favorable when alternative approaches are not viable. NIOSH will update *Pinellas Plant – Occupational Internal Dose*, ORAUT-TKBS-0029-5, following the SEC-00256 evaluation to include a discussion of how to determine exposure potential for unmonitored workers or workers with large gaps in dosimetry and a discussion of available approaches to bound internal dose.

As described in Section 6.1.1, NIOSH has access to a considerable number of dosimetry records and tritium in vitro bioassay results for personnel who worked with or handled tritium equipment or tritium-contaminated systems because these were the former workers monitored for potential intakes. Pinellas Plant procedures required that supervisors assign anyone with the potential to receive 100 mrem/year or more from tritium to the monitoring

program, as discussed in Section 6.1. NIOSH assumes these supervisors would be in the best position to be aware of workers' assignments and the potential of those tasks for tritium exposure, necessitating tritium exposure monitoring. NIOSH reconstructs operational internal doses for soluble tritium (i.e., tritium gas, tritium oxide, and organically-bound tritium) from these bioassay monitoring results. The method outlined in *Pinellas Plant – Occupational Internal Dose*, ORAUT-TKBS-0029-5, Section 5.8.1.1 details the methodology NIOSH uses [ORAUT 2016a]. NIOSH assesses exposure to both 100% tritium gas and tritium oxide and 100% organically-bound tritium and then assigns only the most claimant-favorable value. Tritium urine data are assessed as organically-bound tritium even though, as indicated in Section 5.2.1, organically-bound tritium exposure was only associated with work on vacuum-pump systems and their associated contaminated oils. Such activities involved a small subset of the Pinellas work force and individuals performing these activities were subject to a job-specific bioassay requirement (i.e., daily or upon job performance).

NIOSH assumes that workers exposed to insoluble tritium compounds (i.e., certain metal tritides) would have worked with soluble tritium and that the Pinellas Plant would have monitored them for tritium [ORAUT 2016a, PDF pp. 22–23]. Therefore, NIOSH assigns insoluble tritium exposures only for the period of a worker's history when they provided a urine sample. Although the Pinellas Plant limited the amount of the insoluble forms compared to the soluble forms, NIOSH assesses all former workers monitored for soluble tritium as though they received exposures to insoluble tritium at the same time. Although urine bioassay sampling has the capability to detect a large intake of insoluble forms of tritium, because of the nature of these compounds (i.e., solubility), it can be very difficult to accurately separate a large insoluble intake from a small soluble intake when exposed to both simultaneously. Instead, NIOSH assigns dose from insoluble tritium compounds based on a bounding, hypothetical intake derived using available tritium surface contamination data. The method used to bound operational internal doses for insoluble tritium is outlined in *Pinellas Plant – Occupational Internal* Dose, ORAUT-TKBS-0029-5 Section 5.7.1.2 [ORAUT 2016a]. This bounding methodology was discussed with the ABRWH Pinellas Plant Work Group, as documented in meeting transcripts [NIOSH 2016, PDF pp. 43–114] and applied in *Pinellas Plant – Occupational Internal Dose* [ORAUT 2016a, PDF pp. 21–23].

In summary, the Pinellas Plant improved worker compliance with urine-sample submission frequency following the 1990 Tiger Team report and NIOSH found that measured doses did not increase as a result of improved compliance. This indicates there was no significant dose that went unmonitored when workers sometimes did not turn in the urine samples according to procedure. NIOSH's claimant-records review indicates that tritium bioassay data are available for the workers most likely to have been exposed during the period under evaluation. Bioassay data are available for the time period, for the personnel who worked in the areas, doing the jobs that NIOSH considers to have the potential for radiation exposure. NIOSH will update the site profile document, *Pinellas Plant – Occupational Internal Dose*, ORAUT-TKBS-0029-5 to further explain unmonitored, internal tritium dose approaches and how NIOSH will use them to bound internal dose based on claim information, job title, and monitoring history.

7.1.1.2 Plutonium

The plutonium used at the Pinellas Plant in RTG production from 1975 through 1990 was not a potential source of internal exposure. The RTG heat-source containment rendered the plutonium non-dispersible and there was no plutonium contamination within the facility [GE 1982a, PDF p. 6; Pinellas Plant 1988, PDF p. 3; Pharo 1993, PDF p. 2]. However, out of an abundance of caution, the Pinellas Plant performed plutonium bioassay. An internal dosimetry practices document from 1983 states that "No leakage [of the $^{238}PuO_2$ heat sources] has occurred during the eight years that those sources have been used at the site…" [Internal dosimetry practices 1983, PDF p. 2]. Workers assigned to the RTG project, working with the RTG sources, submitted annual samples while assigned to the work [Internal dosimetry practices 1983, PDF p. 2], and NIOSH has access to the bioassay results as discussed in Section 5.2.2. NIOSH concludes plutonium was not available in the work area for inhalation or ingestion by workers. The ABRWH Pinellas Plant Work Group concluded that they do not consider the potential for personnel internal dose from activities involving plutonium as credible [NIOSH 2011b; NIOSH 2012b; NIOSH 2016]. Therefore, an internal dose reconstruction methodology for plutonium is not necessary.

7.1.1.3 Uranium

NIOSH and the ABRWH examined the potential for exposure to the uranium that was part of the tritium storage beds and the borosilicate glass at the Pinellas Plant and did not consider it a potential source of internal exposure [NIOSH 2009, PDF pp. 60–64]. The Pinellas Plant reported that the surveys conducted at the time showed no uranium contamination [ORAUT 2013a, PDF p. 5]. There were no reported incidents for the Pinellas Plant relating to a uranium release or a uranium fire incident. Neither form of uranium the Pinellas Plant used was available as a routine occupational internal exposure source and posed little to no internal dose hazard. NIOSH concludes that uranium was not available in the work area for inhalation or ingestion by workers; therefore, an internal dose reconstruction methodology for uranium is not necessary.

7.1.1.4 Carbon-14

The Pinellas Plant used carbon-14 from 1979 through 1983. *Pinellas Plant's Radioactive Waste Implementation Plan* stated that "Small quantities of carbon-14 labeled solvents are used in a laboratory operation which evaporates the solvent to the plant's east exhaust stack" [GE 1984a, PDF p. 9]. There were no other indications of carbon-14 in use at the Pinellas Plant, nor any other occupational exposure pathways identified for plant workers. The ABRWH Pinellas Plant Work Group discussed carbon-14 as part of the TBD review under "Finding #7: Missing Internal Dose Estimation Methods for Unmonitored Workers, such as Maintenance and Support Personnel, Not Provided". The work group agreed in 2009 that the amount of carbon-14 in use at the Plant contributed less than a mrem/year dose and declared that part of the issue resolved [NIOSH 2009, PDF p. 57–58]. NIOSH concludes that carbon-14 was not available in the work area for inhalation or ingestion by workers; therefore, an internal dose reconstruction methodology for carbon-14 is not necessary.

7.1.2 Evaluation of Bounding Ambient Environmental Internal Radiation Doses

The following subsections summarize the extent and limitations of information available for bounding ambient environmental internal radiation doses of the members of the class under evaluation.

NIOSH assessed potential onsite intakes attributable to the Pinellas Plant's onsite measured air concentrations [ORAUT 2011f]. NIOSH also assessed bounding potential onsite environmental internal doses for a hypothetical worker employed at the Pinellas Plant from 1957–1997, using the intake information and exposure scenarios described in *Pinellas Plant – Occupational Environmental Dose* [ORAUT 2011d, PDF pp. 19–21]. For each exposure scenario, the assessment indicates the total internal dose to all internal organs was <1 mrem [ORAUT 2011g,h].

7.1.2.1 Tritium

Onsite ambient environmental exposure to tritium was possible because airborne effluent, released primarily at the exhaust stacks, would have included tritium gas and tritiated water. Greater than 95% of the radioactivity released from the Pinellas Plant stacks was from tritium [ORAUT 2011d, PDF p. 19; ORAUT 2011i]. NIOSH adjusted tritiated water intakes by a factor of 1.5 in accordance with NIOSH procedures. NIOSH summarized the resulting annual intakes in *Pinellas Plant – Occupational Environmental Dose* [ORAUT 2011d, PDF p. 20]. As discussed in Section 6.3.1, NIOSH has access to sufficient amounts of environmental monitoring documentation to assess the onsite environmental internal exposures and subsequent doses to workers at the Pinellas Plant. The Pinellas Plant performed onsite tritium air monitoring from the beginning of operations, and the annual results are summarized for the years 1975 through 1992 [ORAUT 2011d, PDF p. 18; ORAUT 2021g, PDF p. 23]. NIOSH calculates potential intakes and applies them to unmonitored workers using over-estimating approaches with stack emissions data, liquid effluent data, and onsite air monitoring data.

7.1.2.2 Plutonium

The Pinellas Plant conducted onsite environmental air monitoring for plutonium beginning in 1975, when RTG production began, and DOE first brought plutonium onsite. Pinellas sampled airborne effluents from the Building 400 stack for plutonium using a continuous stack-sampling system. The Pinellas Plant collected particulate air samples on filters they exchanged monthly and later analyzed for plutonium radioisotopes [IT/Radiological Sciences Laboratory 1986, PDF pp. 18–19]. *Pinellas Plant – Occupational Environmental Dose* describes the analysis method [ORAUT 2011d, PDF p. 12]. The minimum detection levels reported for this type of plutonium sampling ranged from 5.9×10^{-19} to 3.7×10^{-18} µCi/mL for Pu-238 and Pu-239/240 [IT/Radiological Sciences Laboratory 1986, PDF p. 20]. NIOSH reviewed environmental monitoring reports for the Pinellas Plant and no plutonium was ever reported to have been released to the environment; therefore, an ambient environmental internal dose reconstruction methodology for plutonium is not necessary [Martin Marietta 1994c, PDF p. 58; Martin Marietta 1995, PDF pp. 29–30].

7.1.2.3 Carbon-14

The only indication of carbon-14 use at Pinellas Plant is in the annual environmental monitoring reports, which report carbon-14 releases to air from 1979 through 1983. According to Pinellas Plant environmental assessments, Pinellas used the carbon-14 as a solvent label in laboratory operations [GE 1980, PDF p. 13; GE 1984b, PDF p. 15]. Pinellas determined airborne effluent discharges of carbon-14 from the volumes of carbon-14 containing solvent used each year [GE 1981, PDF p. 16]. The Pinellas Plant only discharged carbon-14 from the Building 100 laboratory stack [GE 1982b, PDF p. 16]. NIOSH found no other documentation indicating any other uses of carbon-14 at Pinellas Plant and found no information regarding the chemical forms of carbon-14. NIOSH documented stack releases in Table 4-5 in ORAUT-TKBS-0029-4, *Pinellas Plant – Occupational Environmental Dose* [ORAUT 2011d, PDF p. 20] with the activity amounts at a very small fraction (10^{-5} or less) of the tritium releases. The environmental reports indicate the maximum ground-level concentration of carbon-14 (i.e., 4.0×10^{-23} µCi/ml) [GE 1982b, PDF p. 17] was significantly less than 1/10 of 1 percent of the standard for continuous non-occupational exposure which was 1.0×10^{-7} µCi/ml [GE 1982b, PDF p. 17].

The quantity of carbon-14 measured in the effluent involved was small (less than 2×10^{-4} Ci/year for 5 years as shown in Table 4-2 of *Pinellas Plant – Occupational Environmental Dose*) [ORAUT 2011d, PDF p. 13]. NIOSH documented the maximum annual onsite average air concentrations of carbon-14 and the resulting annual intakes in the *Pinellas Plant – Occupational Environmental Dose* site profile document [ORAUT 2011d, PDF p. 13]. The highest calculated carbon-14 annual intake by inhalation is 3.5×10^{-14} Ci (1.30×10^{-3} Bq), which results in effective organ doses much less than 1 mrem. Therefore, it is unlikely that carbon-14 was a significant environmental internal dose concern at the Pinellas Plant and an ambient dose reconstruction methodology for carbon-14 is not necessary.

7.1.3 Internal Dose Reconstruction Feasibility Conclusion

NIOSH evaluated whether the reported non-compliance with Pinellas Plant bioassay sampling procedures for tritium had a significant impact on dose reconstruction feasibility and found it does not because:

- After the Tiger Team assessment, the Pinellas Plant initiated efforts to improve participation in the Bioassay Sampling Program. The Pinellas Plant ALARA reports document success in increasing the participation rates. As discussed in Section 7.1.1.1, the increase in bioassay sample compliance achieved by the Pinellas Plant in response to the DOE Tiger Team findings did not lead to an increase in either the Pinellas Plant's total measured internal dose or the average individual internal dose, as would be expected had the bioassay program missed identifying significant exposures.

- The Plant monitored those with the highest internal-exposure potential the most often, i.e., on a daily or weekly frequency. This group of workers was more compliant with the sampling program, according to the 1990 Tiger Team report. Therefore, the dataset available to NIOSH for determining an unmonitored dose approach would likely be biased high.

- Doses for monitored workers are low. Attachment B of the *Pinellas Plant – Occupational External Dose* document demonstrates that eighty percent (80%) of monitored workers received an annual whole body dose less than or equal to 20 mrem on average, and 95% received an annual whole body dose less than or equal to 100 mrem for any given year [ORAUT 2017a, PDF p. 58]. These whole body doses include external dose and tritium internal dose. Therefore, NIOSH finds it can bound tritium internal dose.

NIOSH reviewed each claim file in NOCTS to determine whether internal personal monitoring records were available for the employee and found internal monitoring results for the years 1957 through 1990, the period under evaluation. These records include individual urine sample results for tritium in primary data form. The claimant files included job titles ranging from "accountant" to "worker in the X-ray department." NIOSH reviewed the claim files specifically for maintenance positions, looking for any evidence that those workers were missing internal monitoring results and found the Plant monitored maintenance workers and their records are available.

NIOSH reviewed NOCTS claimant files in early 2020 and found over 20,000 tritium bioassay results for 230 individuals. NIOSH found that the dosimetry records in the claimant files often, but not consistently include indications of job changes and/or the intentional removal of an individual from the bioassay program in the form of notations regarding the start and stop dates for internal dose monitoring. NIOSH performed an in-depth review of claims with unusual result patterns (i.e., the number of results were higher than would be associated with simple routine monitoring) and found indications of samples being taken following non-routine tasks that had potential for exposure (i.e., SWP covered work).

Former workers, Environmental Safety and Health staff, and DOE oversight personnel confirmed during interviews that Pinellas workers were generally very compliant with requirements. This supports the statement of one former worker who said the non-compliance may have been an artifact of the written bioassay lists not being well maintained (i.e., not promptly removing workers who no longer needed to submit a sample). NIOSH has the tritium bioassay results for hundreds of former Pinellas workers who have become claimants. In addition, NIOSH added scans of the entire radiological history files for most, if not all, formerly monitored workers to the SRDB in October 2020.

For routinely monitored workers, NIOSH uses the dosimetry results for the individual worker to assess internal dose reconstruction. For workers monitored in response to performing specific tasks with tritium exposure potential or those routinely monitored workers with significant gaps in dosimetry, NIOSH uses the individual's available dosimetry in conjunction with claim information, default methods, and values prescribed in the site profile documents and applies the most conservative and reasonable assumptions.

The uranium used as part of the tritium-storage system only had dispersal potential during a non-routine incident. Pinellas Plant site records have no such incident documented. NIOSH does not consider uranium entrained in the borosilicate glass, as discussed in Section 5.2.3, a potential source of internal exposure at Pinellas Plant. Pinellas used carbon-14 in exempt quantities in the laboratory to label solvents [Pinellas Plant 1980, PDF p. 3] and NIOSH considers it an unlikely source of internal exposure. NIOSH does not consider plutonium to

be an internal exposure concern at the Pinellas Plant both because monitoring for it indicates it was contained by the triple encapsulations and because bioassay monitoring (i.e., plutonium urinalysis) confirmed plutonium was not a source of internal radiation dose.

NIOSH has access to information to support bounding operational internal radiation doses including information on operations, programmatic reports, area contamination survey reports, air monitoring results, area characterization reports, internal dosimetry results, radiation dosimetry program information, radionuclide and source inventory, historical Radiation Protection Program information, employment records, information on hazardous waste operations, safe work permits, environmental management reports, unusual occurrence/incident reports, and related data for Pinellas Plant employees. With this information, which is representative of the workers with potential for exposure, and because NIOSH did not find an indication of a negative impact of the bioassay non-compliance issue on dose reconstruction, NIOSH is able to complete internal dose reconstruction.

NIOSH has enough information to assign internal doses to monitored and unmonitored Pinellas Plant workers.

7.2 External Radiation Doses at the Pinellas Plant

The principal source of external radiation doses for members of the class under evaluation was radioactive material and radiation-generating devices required during product manufacturing at the Pinellas Plant. The predominant radioactive materials used at the Plant included tritium, Kr-85, DU, and plutonium [ORAUT 2017a, PDF p. 10; Pinellas Plant radioactive, no date]. Various other radionuclides in the form of sealed and plated sources were also in use at Pinellas [Jech 1963, PDF p. 8]. The only open-area radiation fields that workers could routinely encounter were from the testing of neutron tubes and neutron generators, during the use of machine-generated X-rays, and during RTG heat source operations in Building 400. Kr-85 gas leaks may have created non-routine, open-area radiation fields in the rooms housing the two leak-detection systems. The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external dose reconstruction.

7.2.1 Evaluation of Bounding Operational External Radiation Doses

The following subsections summarize the extent and limitations of information available for bounding the operational external doses of the members of the class under evaluation.

7.2.1.1 Photon

Exposure to photons at the Pinellas Plant would result primarily from testing neutron tubes and generators in the Neutron Generator Production Areas, from exposure to Kr-85 gas, and from proximity to the heat sources in the RTG Production Areas. The photon energy distribution information is not available for most locations of the Pinellas Plant, so NIOSH generally assumes 100% of the photons are 30 to 250 keV photons unless specific information otherwise is known [ORAUT 2017a, PDF p. 14]. Specific photon-energy distribution information is available for Area 109, the Component Testing Area of Building

100 where workers used the Kr-85. NIOSH attributes the specific photon energy distribution only for exposures to Kr-85 gas, based on the X-rays and gamma-rays emitted from the krypton gas [ORAUT 2017a, PDF p. 14].

The Pinellas Plant started using external dosimetry in 1957 to monitor workers in the Neutron Generator Production Areas [ORAUT 2017a, PDF p. 25]. Records of radiation dose to individual workers from personnel dosimeters are generally available for 1957 to 1994 for the workers' time of employment. NIOSH's review of the available dosimetry data indicates that Pinellas routinely monitored employees with any significant potential for external dose exposure.

While only 27.5% of the Pinellas Plant workers wore dosimeters, this was more than was required by the regulations for the radiation exposure potentials, as described in Section 6.2.1. NIOSH has employee dosimetry records (primary data) and area monitoring data to support dose reconstruction.

NIOSH looked at NOCTS claim records and compared them against their self-reported job title. NIOSH sorted these records by how many external dose results they had per year of employment. The job titles NIOSH expected to have the most potential for exposure opportunities included assembler or engineer. As expected, NIOSH found these job titles to have the most external monitoring data per year employed. In Attachment B of the *Pinellas Plant – Occupational External Dose* document, there is an analysis of all external dose results available from claimants in NOCTS at that time. Eighty percent (80%) of monitored workers received an annual whole body dose less than or equal to 20 mrem on average, and 95% received an annual whole body dose less than or equal to 100 mrem for any given year [ORAUT 2017a, PDF p. 58]. For years with detailed dose information, a significant number of the annual whole body doses are either entirely or mostly attributable to internal tritium dose [ORAUT 2017a, PDF p. 57]. The large percentage of monitored individuals that routinely had doses below the reporting levels demonstrates that the photon exposure potential at the Pinellas Plant was generally low, as discussed in Section 6.2.1.

For periods in which the Pinellas Plant did not monitor a worker for external dose, NIOSH assigns an annual unmonitored external dose of 100 mrem [ORAUT 2017a, PDF p. 56]. The 100 mrem external dose for unmonitored workers was first presented to and discussed by the ABRWH Pinellas Plant Work Group in their meeting on June 11, 2008 [NIOSH 2008a, PDF pp. 63–81], and revisited in subsequent meetings. NIOSH derived the 100 mrem value from Pinellas whole body exposure totals and calculated it to represent the 95th percentile of all whole body exposure assigned by the Pinellas Plant. The ABRWH Pinellas Plant Work Group has discussed and agreed this 100 mrem value [NIOSH 2008a, PDF pp. 79–81; NIOSH 2009, PDF pp. 39, 55–57] is a reasonable overestimate of external exposure for those workers without external monitoring data. For unmonitored periods of less than a full year, NIOSH prorates the unmonitored dose assignment. The technical basis for the NIOSH established unmonitored external dose assignment can be summarized as:

- Pinellas Plant monitored workers based on exposure potential, so those workers that were not monitored are expected to have less exposure than the monitored workers.

- The majority of the annual whole body doses reported for monitored Pinellas Plant workers were ≤20 mrem, or the limit of detection for some of the dosimeters used at the site.

- Therefore, external dose data from monitored workers provides a bounding approach for the unmonitored workers.

NIOSH provided a detailed discussion of the basis for unmonitored worker external dose assignment in Attachment B of the *Pinellas Plant — Occupational External Dose* [ORAUT 2017a, PDF pp. 57–62], and it applies to the SEC-00256 evaluated class.

Missed photon doses apply to the neutron generator operations and RTG operations workers who had one or more reported dosimeter readings less than half the limit of detection. NIOSH will estimate missed dose for the NIOSH-evaluated class based on dosimeter results and dosimeter limits of detection, as is explained in greater detail in the *Pinellas Plant-Occupational External Dose* [ORAUT 2017a, PDF pp. 31–32].

As described in Section 6.2.1, there are no adjustments or bias corrections to photon doses necessary except when assessing the Mound TLD results for X-ray exposures in Building 400 from October 1979 through September 1987 [ORAUT 2017a, PDF p. 28]. NIOSH describes signal fading dose reconstruction adjustments for the Mound TLD dosimeters in *Pinellas Plant — Occupational External Dose* [ORAUT 2017a, PDF p. 28].

The ABRWH Pinellas Plant Work Group reviewed the *Pinellas Plant — Occupational External Dose* site profile document and agreed that the protocols in the document are appropriate and sufficient to assign monitored and unmonitored photon dose [NIOSH 2011b, PDF pp. 50–62; NIOSH 2016, PDF p. 22].

7.2.1.2 Beta

Though the predominant source of electron radiation at the Pinellas Plant was tritium, only beta exposures above 15 keV apply to external dose. Open-area radiation fields applicable to external dose may have been temporarily present during leaks of Kr-85 gas into Building 100, Area 109. Only the workers in the rooms housing the leak-detection systems during the event incurred these external exposures. Any leak-incident exposure is assessed as 100% >15 keV electrons. Beta dose monitoring for Kr-85 at the Pinellas Plant may have underestimated the dose because of the correction factor used until 1986. NIOSH compensates for the energy spectrum differences by applying a correction factor of 3.5 for the applicable years [ORAUT 2017a, PDF p. 31].

NIOSH reviewed data for 172 claimants, those with external monitoring data in NOCTS, against each claimant's job title. The data represented the span of Pinellas Plant operations from 1957 through 1997, with 21 workers only having data for a single year. NIOSH reviewed the available dosimetry data in light of job classification and found Pinellas routinely monitored employees with operational positions involving proximity to the Kr-85 leak-detection equipment and significant potential for external dose exposure. Either the worker or their survivor provided the claimant's job title during the claim process and in a few cases included more than one job title. NIOSH observed broad patterns in the data when searching

for certain key words. For example, NIOSH found that workers with descriptors indicating operational work, potentially in proximity to the Kr-85 leak-detection systems, like "assembler" or "engineer" in the job title had the most external monitoring data. Titles including "manager" and "guard" that NIOSH expected to routinely operate in proximity to the Kr-85 leak-detection system less frequently than "assemblers" and "engineers" had some external monitoring data. Titles like "secretary" and "draftsman" that NIOSH expected would not perform their work around the Kr-85 leak-detection system had very little external monitoring data.

Additionally, NIOSH found that workers with one or more of the construction trade titles, such as electrician, mason, pipe fitter, iron worker, etc., were represented in the data for all years that the Pinellas Plant was in operation. NIOSH reviewed the *Tiger Team Assessment of the Pinellas Plant* [DOE 1990a, PDF p. 216] and found the assessment reported no significant findings related to the External Dosimetry Program, other than the dosimetry system had not completed accreditation. The Tiger Team noted that the Pinellas Plant generally kept external exposures, both individual and integrated plant personnel, very low.

NIOSH has access to beta dosimetry results, as well as other supporting data as described in this report for the entire period under evaluation to reconstruct dose. The dose measured by dosimeters, recorded at the time of measurement, represents the highest quality record for dose reconstruction.

The ABRWH Pinellas Plant Work Group has reviewed the *Pinellas Plant — Occupational External Dose* site profile document and has agreed that the protocols in the document are appropriate and sufficient to assign monitored and unmonitored electron dose [NIOSH 2011b, PDF pp. 50–62; NIOSH 2016, PDF p. 22].

7.2.1.3 Neutron

The Pinellas Plant generated neutrons by neutron-generator sources and by RTG sealed heat sources. These produced neutrons in two distinct energy ranges. In the Neutron Generator Production Areas, located in Building 100, the neutrons were in the 2 to 20 MeV range. The plutonium in the RTG heat sources emitted neutrons with an average energy of 2 MeV and an energy range of thermal to 12 MeV [Burkhart 1987]. The RTG heat sources were all located in Building 400.

As described in Section 6.2.1, the Pinellas Plant used neutron-sensitive photographic films from 1957 through 1978, and beginning in mid-1978, R.S. Landauer provided neutron dosimetry for the Plant. Pinellas used Mound Laboratory dosimeters for the RTG handling work at Building 400, beginning in October 1979. NIOSH applies a correction factor to adjust for the poor response of NTA film to low-energy neutrons. This limitation does not affect dosimetry for neutron generator workers because neutron generators produce higher-energy neutrons. A 1969 study documented film badge fading experienced over a monitoring period of one month for neutron exposures to determine a correction factor from the data [Dosimeter fade study, no date]. The study recommended that the Pinellas Plant incorporate a correction factor of 3 to account for fading in NTA track film, starting in January 1970 [Dosimeter fade study, no date, PDF p. 12]. NIOSH also applies the correction factor of 3 for NTA film results between 1957 and 1969 for neutron generator workers

because there is no indication that the Pinellas Plant used this factor prior to 1970. The NTA film Pinellas used from 1957 through June 1978, does not detect neutrons with an energy below 0.5 MeV [ORAUT 2006, PDF pp. 10–11]. Because 6.4% of the neutrons from the RTG heat sources have an energy of less than 1 MeV [Neutron spectra RTG, no date, PDF p. 5], NIOSH applies a 1.07 correction factor for NTA neutron results for RTG workers.

Starting in the third quarter of 1981, the Pinellas Plant processed Mound TLDs to avoid signal fading, a loss of information that caused an underestimate of up to 30% of the dose recorded [Meyer 1993, PDF pp. 309–310, 344]. To compensate for this potential underestimate, NIOSH applies a correction factor of 1.43 for Mound TLD results from October 1979 through June 1981.

When Pinellas used the Mound dosimeters to monitor exposures from RTG operations (i.e., October 1979–September 1987), they applied a relative biological effectiveness (RBE) value of 7 to the Pinellas Plant doses reported by the Mound Laboratory [ORAUT 2004a, PDF p. 25]. Because lower-energy neutrons have a relatively greater biological impact, the current ICRP Publication 60 uses a neutron-weighting factor of 20 for neutron energies at or below 2 MeV, and a weighting factor of 10 for energies above 2 MeV and below 20 MeV [ICRP 1990]. NIOSH applies two RBE correction factors for neutron results from 1957 through 1997 for RTG workers. Half of the result is multiplied by 2.85 (20/7) for the range below 2 MeV and half of each result is multiplied by 1.42 (10/7) for the energy range above 2 MeV.

The Pinellas Plant used an RBE weighting factor of 10.0 when calculating the effective dose for 14-MeV neutrons [Holliday, no date]. Since this is equivalent to the ICRP Publication 60 neutron-weighting factor for neutron energies from 2 MeV [ICRP 1990], NIOSH does not apply a correction factor to the RBE weighting factor for neutron generator workers.

Available documentation does not describe any separate dosimetry processing when the Pinellas Plant used Landauer dosimeters to monitor exposures from RTG operations. Therefore, NIOSH assumes that the Pinellas Plant applied an RBE of 10 to the neutron doses from RTG operations when workers used Landauer dosimeters for the RTG operations from January 1, 1975 through September 1979, and from September 1987 through February 1991. From October 1979 through September 1987, NIOSH applies a single RBE value of 7 to the Pinellas Plant doses reported by the Mound Laboratory [ORAUT 2004a, PDF p. 17]. Because the RBE used for the Mound dosimeters is more favorable to claimants than the RBE believed to have been used for Landauer dosimeters, and because it compensates for the signal fading, NIOSH assumes an RBE of 7 and multiplies the Mound TLD results reported during the period from October 1979 through June 1981 by a signal-fading correction factor of 1.43 (1/0.70). After June 1981, Mound dosimeters used TLD chips that responded well to the neutron energies encountered by RTG workers. There was no significant signal fading for those dosimeters and no corrections for signal fading are necessary. Therefore, NIOSH applies no adjustment for the neutron-energy response of the Mound dosimeters after June 1981 [ORAUT 2004a]. For the Mound TLDs, NIOSH applies an uncertainty of ±30% based on the site-specific information for the Mound Site [ORAUT 2004a].

The ABRWH Pinellas Plant Work Group reviewed the history of the RBE weighting factor [NIOSH 2011b, PDF pp. 51–55] and has reviewed the minimum detection levels of the neutron dosimetry and the expected neutron energy distribution [NIOSH 2016, PDF p. 17].

7.2.2 Evaluation of Bounding Ambient Environmental External Radiation Doses

Kr-85 is the only external ambient environmental exposure concern at the Pinellas Plant. Tritium emits beta particles of less than 15 keV and are not energetic enough to penetrate the skin. Based on the information available to NIOSH, workers could have received small external doses from the Kr-85 stack emissions. Emissions from the area sources (i.e., the ponds and aeration area) would not have contributed to the environmental external doses at the Pinellas Plant because tritium was the only emission from the area sources. NIOSH uses the annual airborne effluent data to calculate the maximum air concentrations from the annual Kr-85 releases, using the atmospheric dispersion factors documented in Table A-8 of *Pinellas Plant – Occupational Environmental Dose* [ORAUT 2011d, PDF p. 43]. NIOSH then calculates dose rates using the maximum dose coefficient for air submersion found in the Federal Guidance Report No. 12, *External Exposure to Radionuclides in Air, Water, and Soil* [Eckerman and Ryman 1993, PDF p. 75]. NIOSH calculated onsite ambient Kr-85 doses assuming continuous release over a calendar year, even though most of the releases were instantaneous acute releases [ORAUT 2011j]. NIOSH multiplies the calculated dose rates by the number of seconds in a 2,600-hour working year to estimate the bounding annual onsite ambient doses. NIOSH included the onsite ambient external doses from stack releases of Kr-85 in *Pinellas Plant – Occupational Environmental Dose* [ORAUT 2011d, PDF p. 23] for the years that the Pinellas Plant reported Kr-85 releases.

Unmonitored Pinellas Plant workers had the potential to receive external doses that were <20 mrem/year but were more than the highest onsite ambient doses for the site [ORAUT 2011d, PDF p. 23]. Because the potential external doses at the Pinellas Plant were likely larger than the calculated onsite ambient doses, NIOSH assigns unmonitored external doses, based on the 95th percentile of monitored workers, for all workers in lieu of onsite ambient doses.

7.2.3 External Dose Reconstruction Feasibility Conclusion

Pinellas staff knew the areas of potential radiation exposure and routinely monitored them. Photon radiation exposure at Pinellas only occurred in the areas described in Section 5.3.1 of this report, including the Neutron Generator Production Areas, Building 400, accelerator areas, and the Component Testing Area. The Pinellas Plant routinely surveyed these areas and the results were below the operational standards. Based on NIOSH's review of the available dosimetry data, the Pinellas Plant routinely monitored employees with a potential for external dose exposure. The large number of monitored individuals that routinely had doses below the reporting levels (approximately 95% of the monitored workers at the Pinellas Plant had a whole body dose of less than or equal to 100 mrem for any given year, and nearly 80% received annual doses less than or equal to 20 mrem per year) [ORAUT 2017a, PDF p. 27] is evidence that exposures to large radiation fields were very unlikely. NIOSH has found that it is feasible to reconstruct external dose for Pinellas Plant workers for the period under evaluation, using the available personnel monitoring data, area monitoring

data, and ambient environmental data. NIOSH will continue to use the existing external dose assessment methods for the Pinellas Plant to assign external dose for the class under evaluation.

7.3 Occupational Medical X-ray Doses at the Pinellas Plant

As stated in Section 6.4, Pinellas Plant workers were administered chest X-rays throughout the Pinellas Plant history [ORAUT 2007a; ORAUT 2011c, PDF pp. 10–14]. NIOSH did not find site-specific information for radiographic equipment before 1972; organ doses for this period are from ORAUT-OTIB-0006 [ORAUT 2019]. NIOSH calculates organ doses for 1972 and later based on actual Pinellas Plant X-ray machine measurements and included these doses in the *Pinellas Plant – Occupational Medical Dose* site profile document [ORAUT 2011c, PDF pp. 20–32].

NIOSH has access to sufficient information to estimate the radiation dose resulting from occupational medical X-rays using OTIB-0006 [ORAUT 2019]. Therefore, NIOSH concludes that it is feasible to estimate the occupational medical dose for Pinellas Plant employees.

7.4 Evaluation of Petition Basis for SEC-00256

The following subsections evaluate the assertions made in petition SEC-00256 (August 17, 2020 version) for the Pinellas Plant. From this point forward, all references to the petition include only the August 17, 2020 version unless otherwise specified. The petition requests a Special Exposure Cohort for the Pinellas Plant based on reported incomplete radiological characterizations that did not include strontium-90, cobalt-60, thallium-204, beryllium, and uranium [[redacted] 2020b, PDF pp. 24–31]. The petition claims dosimetry and exposure records are absent beyond 1981 for workers who the Pinellas Plant monitored, and that workers who the Pinellas Plant did not monitor would have been unaware of their exposures [[redacted] 2020b, PDF pp. 24–25, 30]. It generally contends that there is uncertainty about the ability of NIOSH to adequately and accurately perform dose reconstructions for former workers of the Pinellas Plant given an incompleteness of data sources, questionable technical accuracy, and overall inadequacy of data related to the four previously mentioned radionuclides (beryllium is not a radionuclide and does not represent a source of radiological exposure).

Note: Throughout Section 7.4 and its subsections, NIOSH has summarized all petitioner-identified issues unless they appear in italics, which indicates a direct quote.

7.4.1 Unmonitored Exposures to Sr-90, Co-60, Tl-204, and Uranium

Petition Issue: ORAU identifies seven radionuclides deemed pertinent to estimating the doses of the former workers of the Pinellas Plant and does not address other miscellaneous radionuclides for Pinellas Plant workers. The petitioners indicate that unmonitored exposures to strontium-90, cobalt-60, thallium-204, and uranium occurred [[redacted] 2020b, PDF pp. 20–31].

NIOSH Response: The petition included five "Exhibits," including: Exhibit 1 titled "Radioactive Material Inventory at the Pinellas Plant," Exhibit 2 titled "Pinellas Plant Radioactive Source Historical Inventory Status," Exhibit 3 titled "Radioactive Measurements of Pinellas County," Exhibit 4 titled "Space Isotopic Power Systems," and Exhibit 5 titled "Properties of Isotopes Useful for Isotopic Power Generation." Exhibits 1 through 3 are excerpts from documents that note the presence of radioactive materials in and around the Plant, including strontium check sources, and sampling results from five Pinellas County sampling locations for radium, tritium, strontium. The presence of radioactive materials at Pinellas is not an indication of an unmonitored exposure condition. Exhibits 4 and 5 are general references not specific to the Pinellas Plant that provide information about space isotopic-power systems and other isotopes useful for power generation. NIOSH found no indication of an unmonitored exposure condition at the Pinellas Plant related to strontium-90, cobalt-60, thallium-204, or uranium in these excerpts.

NIOSH reviewed the information available regarding post-employment urine sampling and analysis of former workers of the Pinellas Plant that the petitioners provided. NIOSH has concluded that there is no information supporting exposures to the radionuclides mentioned. The provided data (i.e., laboratory results) do not support the assertion that any individuals incurred exposures to these "other" radionuclides used at the facility. The metals urine analysis, purported to represent exposures to strontium-90, cobalt-60, and thallium-204, was not specific to these radionuclides; rather, the results were for elemental strontium, cobalt, and thallium, all of which occur in nature in a non-radioactive form. The presence of these elements, as indicated by chemical analysis, is not indicative of occupational exposure to the radioactive isotopes. The results of the uranium analysis were reported as either 'none detected' or <1.0 ng/ml. A notation in the laboratory report associated with the < 1 ng/ml result is "Normal (unexposed population)" [[redacted] 2020b, PDF p. 47].

Uranium was used at the Pinellas Plant as described in Section 5.2.3 of this report, but there are no indications of internal exposures and uranium is considered to have posed little to no internal dose hazard. Although the Pinellas Plant used other radionuclides, as discussed in Section 5.3, they were mostly limited to sealed and plated check sources [Pinellas Plant radioactive, no date] and would not have presented a significant internal exposure hazard. The site used strontium and cobalt sealed sources that were kept under control and some level of radiological surveillance to ensure that the materials were well fixed, as indicated by the identification of the leaking Co-60 source and indicated in routine health physics reports [Jech 1963, PDF p. 8]. NIOSH's review of Pinellas Plant records suggests Pinellas addressed such incidents of contaminated sources immediately when found, including assessing involved personnel. Consequently, contaminated sources are not evidence of unmonitored exposures.

7.4.2 Radiological Incidents

Petition Issue: *Although the Department of Energy (DOE) and National Institute of Occupational Safety and Health (NIOSH) have documented a series of radiological incidents that occurred at the Pinellas Facility, nowhere in this documentation is there any discussion*

of whether these exposures were actually used to determine the extent of exposure for ANY worker at the Pinellas Plant at the time of the incident [[redacted] 2020b, PDF p. 21].

NIOSH Response: Based on its review of radiological incidents that occurred during the petition time period, NIOSH found that worker dose assessment was an important part of each incident response. The Pinellas Plant included such dose assessments in the workers' dosimetry file. A review of the scope of incidents shows them to primarily be contamination, loss of containment, or other isolated situations. The incidents are of a routine industrial variety that had the potential to result in localized radiation exposures, which according to NIOSH's review, Pinellas likely assessed as part of the incident response. NIOSH initially reviews all incidents against the SEC Petition E.5 basis criteria.

Based on NIOSH's review of available documentation, indications are that the Pinellas Plant was diligent about following-up on contamination-related incidents and personnel exposures, as documented in incident reports [GE 1972, PDF pp. 2–10; Holliday 1970–1979; Pinellas Plant 1976–1979; Pinellas Plant 1971–1975] and Health Physics Investigation Reports [Jech 1963; GE 1963; GE 1983b,c; Holliday 1982a,b]. Manufacturing Engineering and Health Physics conducted a three-week investigation of the contamination incident, as described in the subsequent correspondence [Phillips 1975]. Incidents meeting the reporting threshold as an unusual occurrence had the immediate response actions documented in Occurrence reports [Burkhart 1988, PDF pp. 4–7; DOE 1992a,b; DOE 1995b] along with any assessment of exposures. The Pinellas Plant would have included any incident-related exposures in the employee dose files.

The petition specifically cited three resources related to incidents:

- *Tiger Team Assessment of the Pinellas Plant* by the U.S. Department of Energy, Environment, Safety and Health [DOE 1990a]
- *Health Physics Report: Historical Report of Radiation Protection* [Historical report of radiation, no date]
- Department of Labor's Site Exposure Matrices: Incident Search by Related Item – Pinellas Plant by the U.S. Department of Labor [DOL, no date]

None of the three resources identified by the petitioners provided documentation of incidents that were unmonitored, unrecorded, or inadequately monitored or recorded.

The Tiger Team Assessment noted that there was no formal documentation of investigations into personnel exposure anomalies [DOE 1990a, PDF p. 222], but described investigations of personnel exposure anomalies that were completed by the health physicist who assigned the final dose. The finding pertained to the lack of formality, and not informing personnel or their supervisors of the incident information used to develop the exposure assignment.

The *Historical Report of Radiation Protection at GEND* [Historical report of radiation, no date] discusses glass breakage as a frequent occurrence during early operations and breakage of a titanium-hydride bed causing high levels of floor contamination, both of which had the potential to cause personnel exposure. The report gives no indications that Pinellas

did not monitor or inadequately monitored personnel during these events, or that Pinellas did not document the monitoring.

The DOL Site Exposure Matrices website [DOL, no date] incident search for Pinellas Plant lists 42 incidents, including radiological contamination, radiological releases, hazardous conditions, and potential exposures to toxic materials from 1963 to 1993. The Exposure Matrices website provides no information on personnel exposure or monitoring.

None of the three cited resources contain any specific information to support the assertion that Pinellas did not monitor employees for radiological exposure caused by radiological incidents. NIOSH has not found information indicating the Plant did not monitor individuals associated with the incidents discussed in the documents. NIOSH previously reached this same conclusion when it evaluated the incidents identified in the *Historical Report of Radiation Protection at GEND* as well as during a review of available SRDB documents during the qualification efforts for SEC-00130 [ORAUT 2009], SEC-00184 [ORAUT 2011k], and SEC-00231 [ORAUT 2016b].

The petitioners cited an event listed in Appendix A of the report *Historical Report of Radiation Protection at GEND* [Historical report of radiation, no date, PDF pp. 9–12] related to a leaking Co-60 source in 1961 as an example of an incident involving potential unmonitored exposure. The full citation was: "100 mCi of Co-60 source found leaking was corrected" [Historical report of radiation, no date, PDF p. 10; Burkhart 1990]. A review of monthly health physics reports for 1961 identified the source of the summarized information as the July 1961 report, which contained the following entry: "A routine survey revealed leakage of Health Physics' 100 mc [sic] cobalt source. Corrective action was taken immediately" [Forest 1961, PDF p. 4]. The source documents do not provide any indication or evidence to indicate that the identified condition, which Pinellas immediately corrected, precipitated an unmonitored exposure condition to site personnel.

7.4.3 Plutonium

Petition Issue: *While the Department of Energy notes that plutonium present at the Pinellas Plant site was triply encapsulated in metal to contain potential releases, air monitoring and soil monitoring procedures were put in place to monitor for the release of plutonium 238/239. Despite encapsulation, levels of plutonium 238 and 239 were detected in both air and soil samples. While the Department of Energy noted that the levels of plutonium were at environmental background levels, it is important to note that the Tiger Team found sampling deficiencies where plutonium was concerned. (*Citation: A/CF-6 Plutonium Stack Sampling Deficiencies) *The majority of workers WERE NEVER monitored for plutonium 238/239 exposures* [[redacted] 2020b, PDF p. 22].

NIOSH Response: Finding A/CF-6 Plutonium Stack Sampling Deficiencies specifically relates to the environmental monitoring equipment associated with the heat-source production area (i.e., the Building 400 area involving the use of plutonium sources). The stack-sampling equipment monitors concentrations of radionuclides in effluent leaving the facility and is unrelated to the concentrations within the facility work areas. Accordingly, the finding has no bearing on the radiation exposure monitoring program associated with site employees.

In addition, the ABRWH contractor reviewed the issue of plutonium monitoring at the Pinellas Plant [SC&A/Salient 2006, PDF pp. 26, 33] and discussed it at subsequent Advisory Board Meetings [NIOSH 2009, PDF pp. 26–31; NIOSH 2011b, PDF pp. 70–89; NIOSH 2012b, PDF p. 28]. SC&A documented the final resolution in the March 15, 2016 update of the Issue Resolution Matrix [SC&A 2016a, PDF p. 5], which summarizes the plutonium issue as follows:

> *This was a concern early in the issues resolution process, when some potential exposure to plutonium (Pu) was not ruled out. Based on discussions at the October 2011 WG meeting, it was determined that the only source of potential intake was from handling of newly received triple encapsulated radio-thermal generators (RTGs). However, there was no surface contamination greater than 200 dpm (the rejection level), and NIOSH calculations show that to receive even 1 mrem annual dose would require handling thousands of RTGs in a year. Therefore there is no credible source of exposure. In Revision 2 of TBD 5, all Pu discussion was removed based on discussion at the October 2011 WG meeting. If evidence of a positive exposure is discovered, NIOSH will need to develop a dose reconstruction (DR) methodology.*

Accordingly, NIOSH determined that there was no significant source of exposure to Pu-238 at the facility and concluded that the issue does not impact its ability to perform individual dose reconstructions for members of the NIOSH-evaluated class.

7.4.4 Duplicate Samples

Petition Issue: *Health Physicist Holliday also reported that accurate monitoring was impacted by the fact that "Employees were found falsely identifying urine samples"* [[redacted] 2020b, PDF p. 22].

NIOSH Response: The source of the condition is a statement in the September 1963 monthly report by Health Physicist Holliday: "*During the past month it was discovered that some personnel were falsely identifying urine samples submitted for radioactivity analysis. This condition was brought to the attention of responsible supervision and efforts are being made to develop a technique to positively identify duplicate samples"* [Forest 1963a, PDF p. 4].

The October 1963 monthly report appears to follow-up on the issue when it states: "*A discussion was held with a Manufacturing work group regarding the purpose and value of the Bio-assay Program*" [Forest 1963b, PDF p. 4].

NIOSH has not located any further discussion definitively related to the issue. The response to the "condition" was to develop a technique to positively identify duplicate samples. This indicates the condition did not impact the actual individual sample results (i.e., the results derived from the samples were not falsified or otherwise impacted). The September Health Physics Report identifying the condition states "some personnel" were falsely identifying samples, which leads NIOSH to believe a simple misunderstanding by workers of the bioassay-sampling requirements is the most likely scenario. If the issue of "falsely identifying urine samples" was related to deliberately and incorrectly associating individual samples to a particular person and/or sample date, such a circumstance would not likely impact the overall population of sample results (which NIOSH has access to). NIOSH has found no

indication of widespread "falsely identifying urine samples" or that the condition impacted a majority of the results; NIOSH accepts the report statement that "some personnel" were involved.

NIOSH believes the most reasonable interpretation of the situation is one of misdating samples; for example, an employee who was required to provide more than one sample in a week could have split one sample by voiding in two sample containers or provided two samples on the same day. Two samples given at the same time or near to the same time would be considered duplicate samples for the purposes of determining tritium dose, unless they were specifically given before and after tritium work.

Based on the frequency of tritium bioassay sample collection, an issue with individual bioassay sample misidentifying would not impact the ability to reconstruct radiation dose for members of the evaluated class prior to 1963. NIOSH has access to Pinellas radiation protection program documentation confirming that Pinellas actively tracked individual radiation exposures via tritium urine bioassay samples. NIOSH understands that the Pinellas Plant expected that individuals continuing work in tritium areas, those included in the bioassay sampling program, would provide a sample during the next cycle. Those most likely to be exposed were on the shortest cycle (daily vs. weekly vs. monthly) and would have been expected to provide a sample in the very near term. This means if there are individuals that may not have turned in samples due to this issue, NIOSH can calculate their dose from the next sample that was turned in. For any workers with duplicate samples, NIOSH will assign the higher of the two results for the monitoring period. The Pinellas Plant bioassay program records show that results seldom reached or exceeded the site action levels for the radionuclides under assessment. Therefore, it is unlikely that the Pinellas Plant failed to monitor any significant worker exposures. Because individual duplicate results won't affect the population of results, NIOSH can use tritium bioassay data from this time period to determine an unmonitored dose approach, if needed. NIOSH concludes that the issue does not impact its ability to perform individual dose reconstructions for all members of the NIOSH-evaluated class.

7.4.5 Radioactive Materials in Building 100

Petition Issue: Documentation mentions a Radioactive Materials Management Area (RMMA) in Building 100, and rooms within Building 100 are not self-contained, so airborne radioactive materials could circulate throughout the Plant [[redacted] 2020b, PDF p. 23].

NIOSH Response: The reference to the RMMA designation in Building 100 comes from the 1995 report, *Moratorium Documentation Manual for the Pinellas Plant*. The purpose of this document is to identify areas where dispersible radioactive material is present in order to control the generation of mixed hazardous and radioactive waste [Ohlweiler 1995, PDF p. 16]. Designation as an RMMA in and of itself does not relate to the potential for unmonitored radiological exposure to site personnel. NIOSH is aware of the designation of areas within Building 100 as RMMAs and has documented this in Table 2-3 of *Pinellas Plant – Site Description* [ORAUT 2011b, PDF p. 31]. The document does not provide any information specific to a lack of containment of radiological materials or a lack of radiological monitoring within the area identified as an RMMA within Building 100.

Documentation describes Building 100 as a warehouse-style facility with partitions. An MMSC safety assessment describes Building 100 as the main production area, divided into distinct rooms. Some areas of Building 100 were access controlled to prevent the spread of contamination. Access to these areas required passage through two sets of locked doors [Martin Marietta 1994d, PDF pp. 39–44]. Pinellas designed and constructed buildings with ventilation systems, fume hoods, and gloveboxes to minimize inhalation uptakes by workers [SC&A/Salient 2006, PDF p. 28]. The Pinellas Plant conducted routine surface and air monitoring in work areas containing radioactive material [ORAUT 2016a, PDF pp. 14–16], as discussed in Sections 6.1.2 and 6.2.2. Design features (e.g., ventilation systems and fume hoods), in conjunction with the radiological monitoring program in place, would preclude unidentified and unmonitored exposure of general employees in areas that were "not self-contained."

7.4.6 Employer-required Chest X-rays

Petition Issue: The petitioners reviewed employee files and found that the majority of employees were not afforded chest X-rays [[redacted] 2020b, PDF p. 23].

NIOSH Response: DOE provides records of medical X-rays performed for individual claimants. NIOSH detailed the interpretation of, and assumptions related to medical X-rays in ORAUT-TKBS-0029-3, *Pinellas Plant – Occupational Medical Dose*. Current NIOSH dose reconstruction guidance assigns medical doses based on individual X-ray examinations recorded in the submitted medical records. When no X-ray examination records are available for an individual, the dose reconstructor assumes that an annual PA chest X-ray was administered, in accordance with the *Pinellas Plant – Occupational Internal Dose* site profile document [ORAUT 2011c, PDF p. 10]. NIOSH notes that if employees were not given chest X-rays, the approach described above would overestimate radiation doses to those employees.

7.4.7 Lack of Radiological Surveys

Petition Issue: A technical review of the Pinellas Plant in 1994 identified a lack of comprehensive radiological surveys [[redacted] 2020b, PDF p. 23].

NIOSH Response: The full citation, related to comprehensive surveys also includes the statement: "Process knowledge, experience, and surveys in hand describe the identification of the location, quantity, extent, and type of contamination within each buildings [sic]" [DOE 1994b, PDF p. 55]. The purpose of the cited *Independent Technical Review of the Pinellas Plant* document is to document the transition of the Pinellas Plant from operations to either community-developed reuse or safe deactivation leading to decontamination and decommissioning [DOE 1994b, PDF p. 6]. The cited Technical Review is unrelated to the potential for unmonitored worker exposure during Pinellas Plant activities.

7.4.8 Environmental Monitoring Record Keeping

Petition Issue: *According to the Pinellas Plant Feasibility Study Final Report (1990): "Typical of many DOE facilities, meticulous environmental monitoring and records keeping did not*

take place until the early to mid 1970's. Prior to that, monitoring and records keeping was not very thorough" [[redacted] 2020b, PDF p. 23].

NIOSH Response: The complete citation includes the following statement: "However, after reviewing plant publications, interviewing key personnel, and checking the existence, accessibility, and quality of documents important to dose reconstruction at the plant, we have concluded that a dose reconstruction is feasible" [HRS 1994, PDF p. 124]. The scope of the document relates to the reconstruction of exposure to members of the public, not site employees, and is unrelated to the potential for unmonitored worker exposure during site activities.

7.4.9 Missing Dosimetry Records

Petition Issue: *A small number of workers were monitored for radiologic exposures, although inconsistently, and some were never monitored for such exposures. For those that were monitored, their dosimetry records only included information until 1981. Dosimetry records beyond 1981 were missing from all of their DOL and DOE files that were examined* [[redacted] 2020b, PDF p. 24].

NIOSH Response: As discussed in Section 6 of this report, NIOSH has access to both internal dosimetry data for 1957–1996 and external dosimetry data for 1957–1995. NIOSH also has area monitoring results spanning the operations at the Pinellas Plant. As mentioned in Section 6.1.1, NIOSH reviewed ALARA reports, which are available from 1986 through 1995, and that review showed the site monitored 1,772 workers over those 10 years. NIOSH has estimated an average workforce size of 1,500 for all of those ten years, primarily from reviewing the annual site environmental reports and counting the number of employees listed on rosters. Dividing the number of employees monitored by the number of workers for 10 years indicates that the site monitored approximately 12% of employees for tritium intakes from 1986 through 1995. Therefore, in response to the claim the Pinellas Plant monitored a small number of workers for radiological exposures, NIOSH agrees that this could be considered a small number of workers but finds that the monitoring practices at the Pinellas Plant were based on exposure potential rather than plant population and that adequate dosimetry records are available for dose reconstruction.

NIOSH's review of the dosimetry files shows that the Pinellas Plant was consistent in assigning employees to the monitoring program. Although some Pinellas Plant files show that some workers have breaks in tritium bioassay monitoring, these are ordinary and explainable gaps in the dosimetry data that are consistent with the exposure potential of comparable tasks assigned to similar job descriptions across the DOE industrial complex. While lending to the impression of inconsistent monitoring, these breaks do not impede dose reconstruction. NIOSH expects there to be periods when monitoring was halted for legitimate reasons and has established methods to account for such gaps in internal monitoring, as described in Section 7.1.1.

Regarding dosimetry data availability post-1981, as stated above, NIOSH has dosimetry data available past 1981. The petitioners mentioned "DOE and DOL files that were examined" in the issue identified above. NIOSH assumes the review is of dosimetry records files provided

for Pinellas Plant claimants by DOE or DOL. NIOSH reviewed the files it received from DOE and found that DOE is, in a majority of cases, providing the same dosimetry data that are available to NIOSH from NIOSH's own independent data-capture efforts, including post-1981 data.

In 2006, NIOSH became aware it was not receiving all of the dosimetry records from DOE for some Pinellas Plant claimant files. Following this discovery, NIOSH worked with DOE to locate additional dosimetry records at archival locations across the DOE complex; NIOSH uploaded that additional data to the SRDB. NIOSH has completed linking this captured dosimetry data in the SRDB to individual NOCTS claimant files via the SPEDELite process. NIOSH's Post Approval Dosimetry (PAD) Evaluation Tracker System routinely identifies claims with new information. NIOSH reviews the information to determine if the SPEDELite-linked information has any impact on the previously-completed dose reconstruction. Completed dose reconstructions are re-evaluated regularly to include consideration of the updated dosimetry record for the individuals. If the new information has the potential to increase the previously reconstructed doses, NIOSH reworks the non-compensable dose reconstruction. If a previously non-compensable claim becomes compensable through the re-work process, NIOSH notifies the claimant. NIOSH has no mechanism to notify claimants that they are reviewing their claim in this PAD process unless the claim becomes compensable. Therefore, if the petitioners based their dosimetry data review on claims impacted by this issue, the original claimant files may not have included dosimetry data that NIOSH received and reviewed at a later time.

In 2020, NIOSH performed a data review to ensure that DOE was providing data for monitored Pinellas worker claims. NIOSH identified monitored workers by the presence of SPEDELite links to monitoring data in the SRDB. Using this information, NIOSH has been able to identify 332 claimants for whom NIOSH has significant dosimetry data within the SRDB (out of 496 Pinellas claimants). An additional 59 claimants were not included in this analysis because, for them, NIOSH only identified termination samples and no other routine monitoring data. Of these 332 claimants with significant dosimetry data, DOE provided all of the same dosimetry data for 293 (88%).

NIOSH then chose the 10 claims with the highest number of SPEDELite links to check that the data provided by DOE in response to claim-record requests were consistent with what NIOSH had independently captured and loaded in the SRDB. NIOSH's comparison showed that seven of the 10 files had no discrepancies between what DOE provided on request and what NIOSH has available for those workers. Of the three DOE responses that had some discrepancy, two were missing a termination tritium-sample result, and the final response was missing both a termination tritium-sample result and one other sample (which showed no detectable tritium internal exposure). Note that whether NIOSH receives the information in the DOE responses or via data capture and SPEDELite-linked to the claim, NIOSH considers all information in the dose reconstruction.

NIOSH also compared the contents of the termination folders in the SRDB [Pinellas Plant 1942–1985; Pinellas Plant 1948–1985] to the DOE record-request responses. NIOSH reviewed the termination folder records and identified records for 21 NOCTS claims. For the 21 claims, the DOE response had 100% agreement with the termination folder data.

7.5 Summary of Feasibility Findings for Petition SEC-00256

This report evaluates the feasibility for completing dose reconstructions for employees at the Pinellas Plant from January 1, 1957 through December 31, 1990. NIOSH found that the available monitoring records, process descriptions, and source term data are sufficient to complete dose reconstructions for the evaluated class of employees.

NIOSH has determined that the Pinellas Plant had policies in place to monitor internal and external radiation doses incurred by members of the NIOSH-evaluated class. The Internal Dose Monitoring Program in effect during the NIOSH-evaluated period is described in *Pinellas Plant – Occupational Internal Dose* [ORAUT 2016a, PDF pp. 14–18]. *Pinellas Plant – External Dosimetry* describes the external dose monitoring program [ORAUT 2017a, PDF pp. 16–27]. These documents indicate that Pinellas did not monitor some workers but did monitor the workers with the potential for radiation exposure using bioassay and external dosimetry. Both external and internal dosimetry results are available, and the available data extend beyond 1981. In addition, NIOSH has found that claimant records provided by DOE generally include both internal and external dosimetry results for potentially exposed workers. NIOSH finds that the Pinellas Plant did monitor potentially exposed personnel and did not find indications of lack of monitoring for the class under evaluation. NIOSH concludes that it has sufficient data to perform dose reconstructions.

Table 7-1 summarizes the results of the feasibility findings at the Pinellas Plant for each exposure source during the period from January 1, 1957 through December 31, 1990.

Table 7-1: Summary of Feasibility Findings for SEC-00256
January 1, 1957 through December 31, 1990

Source of Exposure	Reconstruction Feasible (Yes or No)
Internal (tritium)	Yes
Internal (plutonium, uranium, carbon-14)	N/A
External (Gamma, Beta, Neutron)	Yes
External (Occupational Medical X-ray)	Yes

As of May 3, 2021, NIOSH has received a total of 496 claims for individuals who worked at the Pinellas Plant during the period under evaluation in this report. NIOSH has completed dose reconstructions for 456 individuals (~92%).

8 Evaluation of Health Endangerment for Petition SEC-00256

The health endangerment determination for the class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy the radiation dose that the class members received, then NIOSH must also determine that there is a reasonable likelihood that such radiation dose may have endangered the health of members of the class. There are two ways to establish health endangerment. First, if NIOSH finds 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, then NIOSH will assume that any duration of unprotected exposure could cause a specified cancer, and hence may have endangered the health of members of a class. Second, if the occurrence of an exceptionally high-level exposure has not been established, then NIOSH will specify that health was endangered for those employees 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 [42 C.F.R. 83, 2018, PDF p. 11].

Based on the sum of information from available resources, NIOSH's evaluation determined that it is feasible to estimate the radiation dose received by members of the NIOSH-evaluated class. Therefore, a health endangerment determination is not required.

9 Class Conclusion for Petition SEC-00256

Based on its full research of the class under evaluation, NIOSH found that it can estimate radiation doses received by members of the class under evaluation and the entire period of employment under consideration. This class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990.

NIOSH has carefully reviewed all material sent in by the petitioners, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the SRDB, for information relevant to SEC-00256. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

NIOSH bases these actions on existing, approved NIOSH processes used in dose reconstruction for claims under EEOICPA. NIOSH's guiding principle in conducting these dose reconstructions is to ensure that the assumptions used are fair, consistent, and well-grounded in the best available science. Simultaneously, uncertainties in the science and data must be handled to the advantage, rather than to the detriment, of the petitioners. When adequate personal dose monitoring information is not available, or is very limited, NIOSH may use the highest reasonably possible radiation dose, based on reliable science, documented experience, and relevant data to determine the feasibility of reconstructing the dose of an SEC petition class. NIOSH contends that it has complied with these standards of performance in determining the feasibility or infeasibility of reconstructing radiation dose for the class under evaluation.

10 References

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ATTACHMENT ONE: DATA CAPTURE SYNOPSIS

Table A1-1: Summary of Holdings in the SRDB for Pinellas Plant

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Primary Site / Company Name: Pinellas Plant DOE 1957-1997; Remediation 1999, 2008-2009 Alternate Site Names: GE X-ray Division-Florida; GE Neutron Devices Department (GENDD); GE Neutron Devices (GEND) GE Pinellas Plan (GEPP) Physical Size of the Site: 99.9 acres; 755,584 ft2 interior building space; Site Population: 285 employees at the Neutron Generator temporary plant in 1957; 1252-1304 total plan employees from 1960-1973; 1974-1975 not available; 1976-1985 298-405 employees monitored for radiation exposure.	Annual report on waste generation and waste minimization progress, conduct of operations implementation plan, development of the Pinellas plant site profile presentation, medical X-ray survey, gas leak reported at nuclear facility, general electric (GE), "GEND medical X-ray surveys" health physics department, historical report of radiation protection at GEND, medical facility shielding document, NIOSH Dose Reconstruction Project meeting on Pinellas site profile, Pinellas community health concerns detail report, report of radiation protection survey at General Electric Co., X-ray projections, techniques and shielding data.	02/21/2013	8
State Contacted: [redacted], M.P.H., Chief, Florida Department of Health, Bureau of Radiation Control [redacted]	No relevant documents identified.	02/25/2013	0

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
DCAS SEC Viewer	Employment records, petition and request for a full evaluation for a Special Exposure Class (SEC) under the EEOICP Act and Government Fraud of Transparency, petition document reviews, Professional Judgment SEC Petition, radiation exposure and employment records, SEC petition-Form B, and summary of telephone conversations and agreements.	09/23/2020	32
Department of Labor / Paragon	Application for a hazardous waste facility permit, area 117P room diagram, asbestos-containing materials survey and bulk sampling report, banned hazardous substances, catholyte mixture, chemical and hazardous material inventories, conduct of operations area operating envelope for different areas tube assembly, de-encapsulation process specification, DOE tritium focus group meeting notes 1993, radiation dosimetry of metal tritides, effects of vacuum processing erbium dideuteride/ditritide films, final safety analysis reports, Industrial Hygiene audits, irradiation of units at low temperature test, job titles and responsibilities, neutron device department non-exempt job descriptions and position analysis forms, notes of areas and operations, occupational medical appraisal, Pinellas Plant inventory list, process waste assessment plan, review of neutron generator disposal, radio isotopically-powered thermoelectric generators (RTG) fixture cleaning process, safe work permits, air monitoring results, systematic risk assessment for General Electric neutron devices department, waste, trip report, tritium control technology at the Pinellas Plant, uranium bed oxidation vacuum process system, and X-ray emission spectroscopic determination.	01/23/2012	337

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
DOE Germantown	DOE Legacy Management process used to respond to Energy Employee Occupational Illness Compensation Act (EEOICPA) claims, search procedures for records request to records holding area 1916T-2 Oak Ridge, Tennessee, and toxic hazards of beryllium as related to the reactor development program.	08/08/2012	4
DOE Legacy Management - Grand Junction Office	Baseline environmental management report 1996.	11/18/2010	1
DOE Legacy Management - Morgantown Office	Area radiation and contamination surveys, daily gel columns/monthly totals, air surveys, area closeout surveys, area characterization and final closeout reports, area film monitors, badge distribution lists by department, bioassay results, area tritium results, comprehensive Quality Assurance Plan, counter efficiency worksheets, daily tritium oxide discharge sheets, gamma and neutron film personnel data, health physics reports, items to be released surveys, National Emission Standards For Hazardous Air Pollutants Proposed Standards (NESHAPS) for radionuclides, Nuclear Chicago film badge exposure reports, personnel bioassay results, radon screening results, radioisotopically-powered thermoelectric generator (RTG) air sample station report, tritium bioassay results, waste summary, and exhaust stack summary.	06/18/2014	239

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
DOE Legacy Management - MoundView Office (Fernald Holdings, includes Fernald Legal Database)	DOE's annual radionuclide air emission report 1985, incineration of radioactive solid wastes a report, individual dosimetry data 1979-1987, manufacturing statement for weapons production schedule of transfers 1962, and Mound reports of neutron/photon dosimeter results from Pinellas neutron devices department 1985.	02/01/2012	15
DOE Legacy Management - Westminster Office	NIOSH worker study protocol comments and Federal Bureau of Investigation (FBI) files of site raid in 1989.	07/03/2014	2
DOE National Nuclear Security Administration (NNSA) - Albuquerque Office	Active employee listing 1995, area characterization and final closeout report, bioassay results 1993-1996, dose data summary 1994-95, final radiological status reports, Landauer external exposure reports 1993-96, personnel dosimetry –thermal luminescent dosimetry (TLD) system questionnaire, Pinellas Plant personnel external dosimetry program, and life dose sorted by badge number 1996.	09/04/2008	69
DOE Office of Scientific and Technical Information (OSTI)	History of the production complex, DOE environmental restoration, and waste management site maps and facilities listings.	05/17/2007	2

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Federal Records Center (FRC) - Atlanta	Active employees by badge unit and shift, air flow studies, air sample results, analysis of stack heights, annual ALARA report, annual radionuclide air emission report, annual stack emissions reports (tritium), annual summary of whole body exposures, area badge results, area film badge results, area surveys, bed oxidation capability, bioassay trends, building decommissioning and descriptions, calibration facility (Cs-137), calibration sources, clean air act assessment package-1988 (CAP 88-pc), characterization report Area 195, radiological incidents, contamination assessment reports for groundwater investigation, criticality safety for Pu-238 systems, decontamination and decommissioning summary site plan, environmental monitoring, EPA compliance certification, estimated doses to personnel handling unmarked neutron generation units, evaluation of energy conservation and tritium containment options, exhaust stack H3 and Kr-85 emission summary, final radiological status report, first plutonium delivered onsite, gamma and neutron film data worksheet, health physics data summary, health physics operating procedures, historical tritium inventory, industrial X-ray surveys, internal dosimetry technical basis document Lockheed Martin, Kr-85 release survey, lab procedures for tritium analysis, medical and health physics services report, neutron shielding charts, environmental monitoring report, plutonium bioassay results, quality program plan health physics program, quality program plan for mixed waste management, radiological control manual, radon results, RTG safety information, safety analysis reports, semi-annual leak test master list, special work permits, state of Florida tritium smear data, technical evaluation of the air monitoring systems, termination urines, unusual occurrence reports, visitor dose information, and X-ray producing equipment at General Electric Neutron Device facility (GEND).	09/302020	586

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Federal Records Center (FRC) - Denver	Data inventories by facility, beryllium incidents, and onsite discharge data compilations 1973.	06/15/2010	3
Federal Records Center (FRC) - Kansas City	Tiger Team findings, onsite radioactive waste inventories 1989, cleaning of equipment contaminated with beryllium or radioactive material, and nuclear safety appraisal of the Albuquerque Operations Office 1985.	10/09/2013	4
Federal Records Center (FRC) - Lee's Summit	Analysis of findings DOE Tiger Team assessments, draft materials in inventory depleted uranium project, noteworthy practices as identified by the Tiger Team assessment 1990, proposed site treatment plan national summary report, radiological related occurrence reports, replacement of General Electric neutron devices, review of draft programmatic environmental impact statement for environmental restoration and waste management, and an annual report on waste generation and waste minimization progress.	06/06/2016	13
Federal Records Center (FRC) - San Bruno	Corrective action plan to the report of the task group on operation of DOE tritium facilities.	11/30/2005	1
Hanford	Defense programs monthly occurrence report summary 1995, DOE comments on the Hazardous Waste Management system, and air quality area designations and classifications for DOE facilities.	04/15/2011	4

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Idaho National Laboratory	Tritium storage development progress report 1978, DOELAP accreditation decision for Pinellas Plant, DOE Laboratory Accreditation Program (DOELAP) applications for Albuquerque Operations Office 1988, and Idaho National Laboratory visitor cards 1971-1972.	08/25/2018	6
Interlibrary Loan	Environmental levels of radioactivity at Brookhaven National Laboratory and Pinellas Plant 1965-1972.	04/01/2010	13
Internet - Centers for Disease Control and Prevention (CDC)	Issue resolution matrix for Pinellas Plant (draft), NIOSH Advisory Board on Radiation and Worker Health work group on Pinellas 2009, 2011-2012.	09/17/2020	4
Internet - Defense Technical Information Center (DTIC)	Los Alamos National Laboratory institutional plan 1998-2003 and estimating the cold war mortgage volume 1 the 1995 baseline environmental management report.	07/20/2012	2
Internet - DOE	Facility l for General Electric X-ray Division.	02/16/2007	1
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Comments and request to postpone proposed rule changes to Washington Administrative Code, radiation protection - air emission program.	09/01/2010	1
Internet - DOE Health Safety and Security (HSS)	Twenty-fourth annual report radiation exposures for DOE and DOE contractor employees 1991.	03/07/2011	1

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - DOE Legacy Management	Area plume control report, site assessment reports, environmental restoration project closure monitoring plan, environmental restoration project quarterly progress report, Pinellas environmental restoration project sitewide environmental monitoring quarterly progress reports, sampling and analysis plan for U.S. DOE Office of Legacy Management sites, and a DOE interim mixed waste inventory report.	03/30/2020	50
Internet - DOE Legacy Management Considered Sites	No relevant documents identified.	06/08/2020	0
Internet - DOE Noncompliance Tracking System (NTS)	Radiological worker training closed report and a radiological incident of contaminated material not properly transferred.	06/09/2020	2
Internet - DOE Occurrence Reporting Processing System (ORPS)	Occurrence reports of radiological incidents that include: contaminated material, improper shipment of explosive neutron generators, air monitor alarms, tritium control limits exceeded, improper shipment labeling, radiation readings exceeding site standards, stack alarm failure, inoperative Kanne chamber alarm, radiological exposure to an operator, and violation of a radiological safety procedure.	10/21/2020	57
Internet - DOE OpenNet	AEC financial report, division progress report, index to the twenty-third semiannual report to Congress, manufacturing statement for weapons production schedule of transfers 1962-64, shipping request to General Electric Company, and a United States nuclear weapons program summary.	08/01/2012	12

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - DOE Office of Scientific and Technical Information (OSTI)	Pulsed neutron generator for logging, analyses and hydrogen-isotope-transport calculations of current and future designs of the rotating-target neutron source, applications of nuclear reaction analysis to metal hydride film characterizations, assay of heavy water in drums, conceptual site treatment plan for Pinellas Plant, contamination control training, evaluation of a laboratory neutron generator, electron focusing by an ion beam, environmental assessment for decontamination and dismantlement, install active/passive neutron examination and assay, ion sources for sealed neutron tubes, main radiological exhaust stack monitoring system evaluation project plan, milliwatt generator heat source progress reports, mobile site safety review for the transuranic (TRU) waste characterization program, neutron tube disassembly glovebox operational readiness check, operating characteristics of a developmental model portable neutron generator, portable tritium recovery system (TRS) - operational readiness check, quality program plan for environmental monitoring, radiological dose assessment of DOE Pinellas waste, radiological emergency actions manual, safety assessment/building 800 low-level waste repacking, semi-annual report of the DOE Office of Environmental Restoration, thick target D-T neutron yield measurements using metal occludes, and a DOE Legacy Management site fact sheet.	12/01/2020	88

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - DOE OSTI Energy Citations	Annual report of waste generation and pollution prevention progress, application to ship defense low-level radioactive waste to the Nevada Test Site, chemical processing of Pu-238, internal-dosimetry practices at DOE facilities, environmental restoration activities at the Pinellas Plant, impact statement and the baseline environmental management report, environmental monitoring plan, radiological stack flow report, radiological control manual, radionuclide air emissions annual report 1993, safety assessment for waste management environmental, safety and health, site dose assessment plan, and waste characterization summary form.	03/28/2013	47
Internet - DOE OSTI Information Bridge	Annual waste reduction activities report, environmental management progress, integrated database for spent fuel and radioactive waste inventories, neutron generator production mission in a national laboratory, report of the task group on operation of DOE tritium facilities, Savannah River Laboratory monthly reports, Pinellas Plant ion accelerator facility, DOE Legacy Management program update 2009, and workforce estimates for environmental restoration.	12/30/2012	50
Internet - DOE OSTI SciTech Connect	Report to Congress on long-term stewardship, annual report on waste generation and waste minimization progress 1991-1992, 1995, planning process for mixed low-level waste disposal, summary of treatment, storage, and disposal facility usage data collected from DOE sites.	01/21/2016	16

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - Energy Employees Claimant Assistance Project (EECAP)	Environmental restoration program wastewater neutralization area corrective measures, Pinellas environmental restoration project interim remedial action plan, and a site environmental report for 2004.	03/30/2020	20
Internet - Environmental Protection Agency (NEPIS EPA)	USEPA's center for exposure assessment modeling-meteorological data -Florida, remediation case studies Volume 13.	11/11/2013	2
Internet - Google	Report to Congress detailing DOE's existing and anticipated long-term stewardship obligations, review of the health and mortality experience of DOE workers, effectiveness of personnel protective equipment against tritium, ALARA analysis of alternatives for disposal of hazardous wastes, acronym master list, annual report of waste generation and pollution prevention progress 1994, report on contractor work force restructuring, Building 100 area remediation technology screening report, controlling particulates, temperature, and tritium in an inert glovebox, DOE environmental management Pinellas Plant, human radiation experiments, Sternglass papers, nuclear weapons data book, operational accidents and radiation exposures 1975-1977, radiological impact caused by emissions of radionuclides into air, sitewide environmental monitoring quarterly progress reports 2004- 2009, summary site environmental report radiological doses and releases 1990-1994, and a Legacy Management program update 2006.	11/03/2020	184
Internet - Health Physics Journal	No relevant documents identified.	06/08/2020	0

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	06/08/2020	0
Internet - National Academies Press (NAP)	Nuclear weapons complex management for health, safety, and the environment best practices, improving management of persistent contaminants, and research opportunities for deactivating and decommissioning DOE facilities.	09/01/2010	4
Internet - National Institute for Occupational Safety and Health (NIOSH)	Building 200 information, report on residual radioactive and beryllium contamination at atomic weapons employer facilities, Special Exposure Cohort (SEC) petition evaluation report, and notes on a Pinellas technical call with Landauer dosimetry expert.	11/06/2018	13
Internet - NRC Agencywide Document Access and Management (ADAMS)	Environmental restoration wastes, evaluation of the potential for recycling of scrap metals from nuclear facilities, integrated database for 1991-92 spent fuel and radioactive waste inventories, and long-term surveillance and maintenance program reports 1998-2000.	09/28/2017	15
Internet - ORAU	Medical testing for beryllium sensitivity or exposures available to former Pinellas Plant workers.	09/01/2010	1
Internet - Sandia National Laboratory - New Mexico	Transfer of the neutron generator production mission to Sandia lessons learned.	04/01/2013	1

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - US Army Corps of Engineers (USACE)	No relevant documents identified.	06/08/2020	0
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	06/08/2020	0
Kansas City Plant	Annual environmental summary reports 1973-1981, DOE follow-up review of 10CFR835 Radiation Protection Program, DOE Laboratory Accreditation Program (DOELAP) onsite assessment report, facilities radioisotopes data 1990, occupational radiation exposure 1958-1969, packing and transportation safety appraisal of the Pinellas Plant site, radioactive source surveys 1976-1977, radioactive waste documentation, and personnel neutron monitoring badges for the neutron generator tester area.	01/14/2016	18
Landauer Client (site) List	No relevant documents identified.	01/27/2021	0
Lawrence Livermore National Laboratory	Building 331 tritium facility upgrade relative to vacuum effluent recovery system.	02/26/2015	1
Los Alamos National Laboratory	Nonnuclear consolidation environmental assessment volume II, spent fuel and radioactive waste inventories, and projections and characteristics.	12/13/2007	2
Mel Chew & Associates	Recycled uranium project Fernald historical data shipments of depleted and normal uranium 1952-1999 spreadsheets.	12/14/2014	2

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Missouri Department of Natural Resources	Plutonium working group report on environmental, safety and health vulnerabilities associated with the department's plutonium storage.	10/01/2008	3
Mound Museum	Manufacturing statement for weapons production schedule of transfers 1964, quarterly health physics report through 1959, and Mound Laboratory classification guides 1966, 1969.	07/14/2008	5
National Archives and Records Administration (NARA) - Atlanta	Environmental monitoring, in-plant surveys (1958-1967), personnel dose report, bioassay reports, area film monitor worksheets, CAP - 88 run 1997, directory of consultants to AEC contractors, dosimeter badge distribution, environmental monitoring procedures, monitored employees list, health physics guidelines for Kr-85 operations, health physics report, incident investigations, historical radionuclides and sources inventory, information on tritides, internal dose information, Landauer radiation dosimetry report, Pinellas plant radioactive waste management implementation plan, Pu heat source standards, Pu-238Be neutron source information, radiation work permits, radioisotope thermoelectric generator (RTG) assemblies at Pinellas, special work permits and contamination survey reports, termination occupational exposure reports, tritium particulate air and smear sampling, urine sample submittal procedure for tritium analysis, and a waste management site plan.	08/12/2004	71
National Archives and Records Administration (NARA) - Kansas City	Facilities used by Atomic Energy Commission (AEC) between 1942-1957.	11/10/2004	1

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
National Institute for Occupational Safety and Health (NIOSH)	Annual report to Congress of the Atomic Energy Commission 1965, 1970-71, Advisory Board meeting on issues of concern with Pinellas Plant data, Pinellas 1980 directory, environmental baseline report 1997, tritide study at the Responsive Neutron Generator Product Deployment Center, unusual occurrence report on 03 failure of an X-ray shield on E-beam welding, and worker outreach meeting notes.	08/25/2020	44
NIOSH OCAS Claims Tracking System (NOCTS)	Operation and Maintenance instructions electron beam welder and Pinellas Plant newsletter articles 1981-1987.	10/05/2010	2
Nevada Test Site	Final environmental impact statement for the Nevada Test Site and offsite locations in the state of Nevada volume 1.	10/01/2003	1
Nuclear Regulatory Commission Public Document Room	Registry of radioactive sealed sources.	09/01/2011	1
NV5/DMA Richland Office	Personnel dosimetry performance criteria for testing.	09/22/2017	1
ORAU Team	Annual environmental intakes attributable to Pinellas Plant's onsite air concentrations, application of photofluorography, documented communications, eighth annual report of radiation exposures 1975, Landauer dosimetry information from the 1970s, plant stack data spreadsheet, and unmonitored insoluble H-3 intakes spreadsheet.	11/04/2020	51

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Pantex	Equipment analysis automation of pit staging vaults.	06/23/2011	1
Personal files - [redacted]	Biokinetics and dosimetry of titanium tritide particles in the lung, dissolution rates, and radiation dosimetry of metal tritides.	01/02/2008	3
Personal files - [redacted]	Seventeenth – twenty-first annual report radiation exposures for DOE and DOE contractor employees 1984-1988.	10/11/2006	5
Personal files - [redacted]	Department of Labor (DOL) response to a proposal to extend the covered employment for the Pinellas Plant to include 1956.	01/07/2021	1
S. Cohen & Associates (SC&A)	Documented communication on history of operations at SNL-Livermore from 1956 to present, total inventory of all microfilmed records 1992, Pinellas Plant's waste management site plan, radioisotopic thermoelectric generator (RTG) shipping container, environmental survey preliminary summary report of the defense production facilities, and packing of low-level radioactive wastes.	05/24/2017	16
Sandia National Laboratory - Albuquerque, New Mexico	Revised radiological control manual implementation plans with comments, final radiological status reports for areas and buildings, health protection survey reports, Ross Aviation shipment surveys and shipping documents 1982, and incident of unsuspected contamination.	09/09/2014	31

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Savannah River Site	Californium packaging facility general information and a compliance assessment of the Savannah River Site 1990.	02/07/2012	3
Science Applications International Corp (SAIC)	Radiation exposure information 1963-1973 and summaries of whole body radiation exposures to external penetrating radiation accumulated during the year 1962 and 1964.	09/02/2004	9
Southern Illinois University	Department of Health and Human Services Centers for Disease Control National Institute for Occupational Safety and Health Advisory Board on Radiation and Worker Health 48th Meeting 2007.	11/01/2008	1
University of Colorado Norlin Library	Study of cost and benefits of a formal safety program.	04/10/2006	1
University of Rochester	Nuclear materials management station code list.	08/20/2008	1
Unknown	Annual site environmental report Sandia National Laboratories Albuquerque, New Mexico 1999, environmental legacy of nuclear weapons production, decommissioning information, description of the exposure monitoring at Pinellas, DOE occupational radiation exposure report 1992-1995, epidemiologic use of non-detectable values in radiation exposure measurements, framework for DOE mixed low-level waste disposal, history of personnel external dosimetry program at the Dayton Project and Mound Laboratory 1946-1993, site history, fact sheet, and environmental data and surveys.	11/12/2004	25

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Unknown / SC&A	Environmental assessment Pinellas Plant site, personnel security report monthly alpha listing and terminated list 1992, radiation hazards questionnaire, radiological monitoring personnel, environmental and workplace 1957-1971, and a Pinellas Plant overview.	06/16/2004	8
TOTAL	**N/A**	**N/A**	**2,218**

Table A1-2: Database Searches for Pinellas Plant

Database/Source Database search terms and Internet URL are available in the Microsoft Excel file called "Pinellas Plant Rev 00, (SEC-00256) 02-03-2021."	**No. of Hits**	**No. Uploaded into SRDB**
Defense Technical Information Center (DTIC) COMPLETED 06/08/2020	797	0
DOE Hanford Declassified Document Retrieval System (DDRS) and Public Reading Room COMPLETED 06/08/2020	0	0
DOE Legacy Management Considered Sites COMPLETED 06/08/2020	1,785	0
DOE National Nuclear Security Administration (NNSA) - Nevada Site Office COMPLETED 06/08/2020	76,937	0
DOE Noncompliance Tracking System COMPLETED 10/21/2020	2	2
DOE Occurrence Reporting Processing System COMPLETED 10/21/2020	250	50
DOE OpenNet COMPLETED 06/08/2020	46	0
DOE OSTI.Gov COMPLETED 06/08/2020	51,932	39
Energy Employees Claimant Assistance Project (EECAP) COMPLETED 03/30/2020	105	22

Database/Source Database search terms and Internet URL are available in the Microsoft Excel file called "Pinellas Plant Rev 00, (SEC-00256) 02-03-2021."	**No. of Hits**	**No. Uploaded into SRDB**
Google COMPLETED 11/17/2020	20,455,117	32
Health Physics Journal COMPLETED 06/08/2020	212	0
Journal of Occupational and Environmental Hygiene COMPLETED 06/08/2020	0	0
National Academies Press COMPLETED 06/08/2020	61,631	1
National Service Center for Environmental Publication (NSCEP) COMPLETED 06/08/2020	2,713	0
NRC ADAMS Reading Room COMPLETED 06/08/2020	67	0
United States Army Corps of Engineers (USACE) COMPLETED 06/08/2020	0	0
U.S. Transuranium & Uranium Registries COMPLETED 06/08/2020	0	0

ATTACHMENT TWO: REVIEW OF PETITIONER-PROVIDED DOCUMENTATION

This attachment itemizes the various parts of the petition submission for SEC-00256 Pinellas Plant. It provides a concise summary of the NIOSH review of the submission and the supporting documentation that followed.

Table A2-1 below itemizes the content of the qualified, Form B petition (August 17, 2020 version). The 83.13 petition submission initially followed the same naming convention as the SEC Form B until Section F relating to the bases for proposing an addition to the Special Exposure Cohort (SEC). "Part F: Basis for Proposing that Records and Information are Inadequate for Individual Dose Reconstruction" makes up the major part of the petition, excluding Appendix 1 (pp. 43–59) which includes 24-hour urine heavy metals test information and results. Appendix 2 (pp. 60–76) includes a copy of the report *Historical Report of Radiation Protection at GEND*.

Table A2-1: Petition SEC-00256 (August 17, 2020 version)

Petition[a] Content	PDF Page Number
Parts A-D: Petition representative information and energy employee information for both petitioners, as applicable.	pp. 3–5
PART E: PROPOSED DEFINITION OF ENERGY EMPLOYEE CLASS COVERED BY PETITION – includes petitioner's requested definition of class.	pp. 5–6
PART E: Subsection E.1 includes 9 alternate names for the Pinellas Plant. One of the names cited is the General Electric Temporary Plant, which is not a covered facility.	p. 6
PART E: Subsection E.2 includes 191 named locations at the facility with the caveat "All locations and areas of the facility including but not limited to:"	pp. 6–11
Part E: Subsection E.3 includes a listing of job titles and/or duties of energy employees, including but not limited to 184 primary job titles with associated alternate titles.	pp. 11–20
Part E: Subsections E.4 and E.5 include employment dates relevant to the petition and the declaration that the petition is not based on one or more unmonitored, unrecorded or inadequately monitored or recorded exposure incidents. Note: PDF p. 20 starts the deviation from the 83.13 Form B labeling. Instead, the petition uses the following title: "PART F: BASIS FOR PROPOSING THAT RECORDS AND INFORMATION ARE INADEQUATE FOR INDIVIDUAL DOSE RECONSTRUCTION" which includes sub-parts F.1 through F.3, F.8, and F.4 in that order.	p. 20

Petition[a] Content	PDF Page Number
Part F: Subsection F.1 "Historic Approach to Monitoring of Radiological Exposures at the Pinellas Plant" introduces Exhibit 1: Radioactive Material Inventory at the Pinellas Plant [HRS 1994, PDF p. 34] and the *Pinellas Plant Feasibility Study: Final Report* [HRS 1994]. The subsection also lists radionuclides mentioned in ORAU Team documents relevant to worker doses. These include tritium, plutonium, depleted uranium, natural uranium, nickel-63, carbon-14, and krypton-85. Text in this subsection states that the Plant never monitored the majority of workers for any possible exposure to the listed radionuclides.	pp. 20–21
Part F: Subsection F.2: "Incomplete Radiological Characterization at the Pinellas Plant and Need for Special Exposure Cohort" includes three sub-headlines. Sub-headline "Exposures Not Monitored or Inadequately Monitored" lists sources of information believed to contain radiological incident information, a lack of monitoring for associated exposures, and sampling deficiencies. It includes 11 numbered points and discussion of the *DOE Tiger Team Assessment of the Pinellas Plant* [DOE 1990a], the report *Health Physics Report: Historical Report of Radiation Protection* [Historical report of radiation, no date], and the Department of Labor Site Exposure Matrices [DOL, no date]. Sub-headline "Characterization of Former Nuclear Weapons Workers at Pinellas Plant" summarizes a review of workers' files and notes that workers often worked in multiple locations and performed multiple roles for which monitoring was often inconsistent and erratic. It includes 5 numbered points and discussion of the *Pinellas Plant Environmental Baseline Report June 1997* [Martin Marietta 1997b], *Independent Technical Review of the Pinellas Plant* [DOE 1994b], and the *Pinellas Plant Feasibility Study: Final Report* [HRS 1994]. Sub-headline "24 Hour Heavy Metals Urine Tests" summarizes heavy-metal urine tests performed and includes 3 numbered points and mentions the previously discussed reports.	pp. 21–26
Part F: Subsection F.3: "Presence of Radioactive Materials at the Pinellas Plant" includes the sub-headlines "Strontium-90" (with 7 numbered points), "Cobalt-60" (with 4 numbered points), "Thallium" (with 2 numbered points), "Uranium" (with 3 numbered points), and "Beryllium" (with 3 numbered points). Each sub-headline focuses on presenting evidence of the specified source terms.	pp. 26–30
Part F. Subsection F.8: "Conclusion" summarizes the petitioners' bases for their position that U.S. Department of Labor, DOE, and ORAU have incomplete Pinellas Plant radiological characterizations and that previous worker exposures to strontium-90, cobalt-60, thallium-204, beryllium, and uranium are probable.	pp. 30–31

Petition[a] Content	PDF Page Number
Part F. Subsection F.4: "Bibliographic of Scientific or Technical Reports" includes a discussion of five reports and provides material (titled as exhibits) that reflects possible intent to support the standard EEOICPA F.3 basis goals and requirements, although the introductory text paraphrases the 83.13 Form B, F.4 basis goals and requirements. Summaries of the following five documents and their applicability to monitoring deficiencies are provided: 1. *Dosimetry is Key to Good Epidemiology: Workers at Mallinckrodt Chemical Works had Seven Different Source Exposures* [Ellis et al. 2018] 2. *Review of the Department of Labor's Site Exposure Matrix Database* [Institute of Medicine 2013] 3. *Tiger Team Assessment of the Pinellas Plant* [DOE 1990a] 4. *The NIOSH Radiation Dose Reconstruction Program: Managing Technical Challenges* [Moeller et al. 2008] 5. *Scientific Issues in Radiation Dose Reconstruction* [Toohey 2008]	pp. 31–36
5 exhibits: 1. Exhibit 1 (PDF p. 37): a one-page excerpt of the *Pinellas Plant Feasibility Study Final Report* [HRS 1994, PDF pp. 34–36] from section 3, Radioactive Material Inventory at the Pinellas Plant, listing 28 radioactive materials used in the plant 2. Exhibit 2 (PDF p. 38): a table labeled "Pinellas Plant Radioactive Source Historical Inventory/Status" from the *Pinellas Plant Feasibility Study Final Report* [HRS 1994, PDF p. 122] presenting the activity and dates of four strontium-90 check sources 3. Exhibit 3 (PDF pp. 39–40): tables labeled "Pinellas County Water Sources Radioactivity Measurements" from the *Pinellas Plant Feasibility Study Final Report* [HRS 1994, PDF pp. 173–174] presenting various sampling results from five Pinellas County sampling locations for total alpha, beta, radium, radon, tritium, and strontium collected between April 1976 and July 1993 4. Exhibit 4 (PDF p. 41): a table labeled "Space Isotopic Power Systems" from an article of the same name [Carpenter 1963, PDF p. 4] summarizing the designation, use, power output, weight, size, isotopic fuel, design life, and operational dates, ranging from 1959–1966, of SNAP, thermionic, and thermoelectric power systems 5. Exhibit 5 (PDF p. 42): a single-page excerpted table labeled "Properties of Isotopes Useful for Isotopic Power Generation" listing emissions, half-lives, specific power, and melting points for 28 isotopes useful for power generation from a document called *Radioisotopes Power Production* [Ragheb 2011, PDF pp. 7–8]	pp. 37–42

Petition[a] Content	PDF Page Number
Appendix 1: "24-Hour Urine Heavy Metals Tests" includes heavy-metals urine test results (beryllium, cobalt, thallium, and uranium) for eight EEOICPA claimants	pp. 43–59
Appendix 2 consists of a copy of the report "Historical Report of Radiation Protection at GEND" [Historical report of radiation, no date]	pp. 60–76

a. Source: [[redacted] 2020b]

Following the qualification of the petition, the petitioners provided NIOSH with the documents listed in Table A2-2 below as support of the petition. NIOSH reviewed and assessed all of the documents for information related to the evaluation of dose reconstruction feasibility for the class of workers included in the SEC-00256 petition.

In addition, the petitioners made NIOSH aware of additional documents by email correspondence, providing limited bibliographic information for each. NIOSH attempted to locate these documents as well and was able to access those listed in the table below. NIOSH reviewed each of the additional documents for information pertinent to dose reconstruction feasibility. None of the reviewed documents indicated difficulties that could hinder or impede dose reconstruction to the class of workers, and none of the documents pertained to radiological exposures, lack of dosimetry information, or any other condition that would negatively impact dose reconstruction for the class of workers under evaluation.

Table A2-2: Supporting Documents for SEC-00256 Provided Post-Qualification

Document Description	SRDB Ref ID
NDD Product Descriptions April 1980/NDD Products 198004xx.pdf. A one-page table of various neutron generators, assemblies, lightning arrester connectors, capacitors, thermal batteries, neutron detectors, and other products. A useful reference document. Dated April 1980.	187249
NDD Product Descriptions October 31, 1990/NDD Products 19901031.pdf. A single-page table including various neutron generators, assemblies, lightning arrester connectors, capacitors, power sources, neutron detectors, quartz devices, and other products. The table also lists units in later stages of pre-production development. A useful reference document.	187358
NDD Generator Production/NDD Units 19860902.pdf. A quality assurance flow chart for the neutron generator components involved in certain products. Dated 9/2/1986.	187359
MC Unit-Timer-TTA Matrix Electronic Units/NDD Units Electronic 19680801.pdf	187360

Document Description	SRDB Ref ID
Epidemiologic Study of Pinellas Plant Employees. A memo from Energy Programs Division of DOE to the president of ORAU announcing the request for an epidemiologic study among present and former Pinellas Plant workers, and asking for ORAU staff to participate in an introductory on-site meeting with representatives of the Plant to develop the action plan and initiate the study. The memo date is 10/5/1990.	187490
Epidemiologic Study of Pinellas Plant Employees: Implementation. A memo initiating interactions with the Pinellas Area Operations Office and Pinellas Plant personnel to begin outlining the scope of an epidemiologic study of Pinellas Plant employees, identify working contacts and develop an action plan. The memo date is 9/12/1990.	187536
DOE Notification of ORAU Epidemiologic Study of Pinellas Plant Employees. A letter from DOE headquarters in Washington DC to the DOE Pinellas Area Office announcing that ORAU will conduct an epidemiologic study of present and former Pinellas Plant workers. The letter specifies ORAU responsibilities and the cooperation required from Pinellas staff to accomplish the study. The letter date is 9/5/1990.	187537
DOL Notice of Final Decision on Employment Dates. This DOL document is the decision of the Final Adjudication Branch concerning a claim for benefits.	187688
GE Headliner Newsletter The Last of the Best…From Tubes & Generators to Heather & Capacitors…Employees Come Through. The first page of the Martin Marietta Specialty Components newsletter Vol. 3, No. 38 dated September 23, 1994. The article reports on neutron generator production ending, and provides some history of the temporary plant. The final Heather cap assemblies welding operation was also mentioned.	187361
GE memo re: specifics of classified associations between the Heather program and Building 300 production. A one-page memo announcing a meeting on October 30, 1968, to discuss classification concerns. The memo date is October 24, 1968.	187689
Case Control Study of Multiple Myeloma Among Workers Exposed to Ionizing Radiation and Other Physical and Chemical Agents – Final. The Final Technical report by the School of Public Health at UNC-Chapel Hill on a study of multiple myeloma among workers at DOE nuclear facilities to evaluate occupation exposures to ionizing radiation and other biological, physical, and chemical hazards as risk factors for multiple myeloma. The Pinellas Plant cohort of workers was not included in this study because there was no evidence of significant external radiation exposures at the plant. The populations included in the study had the potential for external radiation exposure.	187538

Document Description	SRDB Ref ID
Examples of Types of Accidents or Occupationally-Related Disease That Have Resulted or Could Result in a Workmen's Compensation Claim or Civil Suit. A memo from DOE headquarters regarding examples of types of cases to be listed in information storehouse, that would be maintained and followed by this office, identifying employees involved in accidents or occupationally-related disease while in the employment of a contractor, of such degree or with results of such experience that has or could sometime in the future result in a workmen's compensation claim or civil suit and includes examples of cases for input.	187539
"Resume of Radi-flo Leak Detection" A report discussing the parameters and procedures for use of the Radiflo system to detecting leaks in completed product tubes and to guarantee that tubes do not exceed a prescribed maximum leak rate. Also describes a two-week course delivered by the vendor on the theory, application, operation, and maintenance of the equipment. The report lists the names of personnel who completed the course.	108394
Health Protection Survey Reports/Memo to H A Nowak, Subject: Revision of Trip Report - Industrial Health Survey of Pinellas Area Plant (ATT: Trip Report Re Same). A report on an industrial health survey of industrial medicine, industrial hygiene, radiological safety, waste disposal, and food-handling sanitation at the Pinellas Plant conducted in 1963. The discussion of radioactive waste disposal includes a listing of tritium gas and oxide releases through the 100' stack from March 1962 through December 1962. The report discusses solid and liquid wastes, personnel exposures including the number of employees monitored during the month, and contamination control. The report mentions daily, composite urine-sample collection in addition to routine individual urine samples. It announces the installation of a new "Radiflo" unit, with a 500 Ci Kr-85 reservoir. The report provides a calculated estimate of 0.5 Ci for release to the stack per cycle.	86965 PDF pp. 17–24
Unusual Occurrence Report NDD-88-03 Failure of an X-ray Shield on E-Beam Welding Unit Area 331 – Final Report. An unusual occurrence report concerning a failure of an X-ray shield on an E-beam welding unit in Area 331. The Pinellas Plant did not support the lead glass shielding in the window-opening in the door of the welder in a fail-safe manner. Health Physics personnel performed surveys and calculations to define the scope of the X-ray field present during operation, and estimates of exposures received for personnel involved using interview responses to determine time and distance estimates.	105284
Memo to H A Nowak, Subject: Radiological Fallout Monitoring Station at the Pinellas Plant. A memo regarding adding a fallout station to the nationwide network of stations. The memo gives requirements for the proposed station and provides reporting conditions. "Information is desired on general atmospheric radiation fallout due to atomic weapons testing, etc., not on local plant operation."	In process

Document Description	SRDB Ref ID
Press Release, Subject: Pinellas Area Office to be Opened 2/3/58 (Press Queries)-indicates H. Nowak as Manager. A press release documenting the opening of a new Area Office at the Pinellas Plant, known as the Pinellas Area Office. The press release reports the appointment of Henry A. Nowak as Manager. The office was responsible to the Albuquerque Operations Office for the GE contract administration.	In process
Press Release, Subject: Bulcock and Scoville Transfer to ALO and Eagle Transfers from Rocky Flats to Pinellas. A press release documenting two AEC employees transferring to the Albuquerque Operations Office and one employee transferred to Pinellas Area Office as a Program engineer.	In process
Pinellas Quality Assurance Inspection Agency (Quality Report)-reporting acceptance numbers on materials per specifications by material and lot identifier. A report including a general summary, quality rating for contractor performance, compilation of verification inspection, description of audit and survey activity, and items of general interest.	In process
Memo to File, Subject: AEC 177/6 - Payments in Lieu of Taxes to Pinellas County, Florida-notes of a meeting on 3/22/61 related to burdens and benefits to the county resulting from the Plant.	In process
Memo to James Scammahorn, Acting Director, Subject: AEC 127/21 - Extension of Incentive Arrangement- GE-Pinellas. A memo relaying notes related to payments and contract negotiations.	In process
Memo to File, Subject: AEC 127/22 - Transfer of Work from GE X-ray Department at Milwaukee to Pinellas Plant. Notes of an AEC meeting approving the General Managers recommendation to transfer the neutron generator development support work from Milwaukee to Pinellas Plant.	In process
Memo to A N Kenly, Subject: Re Heather Program (AS100070). A memo announcing a meeting to discuss the classified association between programs.	In process
Heather Project Documentation (U) Supplement to the Heather Project Executive Summary (AS11133009) (Partial). Only the document cover pages were accessible.	In process
Helix Adjust History (AS68048). This file includes hand-written notes, charts, and work order profile reports compiled to evaluate the defect and yield history of the Helix Adjust Line to determine process stability.	In process
IP Schedule Transmittal/Approval GEND Shipment to ABA/BKCD (AS163332). The transmittal paperwork related to a transformer, CV toroid to be returned to GEND on a proposed alternative schedule. ABA/BKCD is Allied Bendix Aerospace Bendix Kansas City Division.	In process

Document Description	SRDB Ref ID
Memo to G W Torrance, et al, Subject: Request for Pump Needed for Helix Proof Test (AS20995). A memo from GE to Q.C. Equipment & Facilities Planning with justification and the request to obtain reliable pump equipment for use with the Helix Proof Test Station.	In process