SEC Petition Evaluation Report
Petition SEC-00218

Report Rev #:0 Report Submittal Date: July 17, 2014

Subject Expert(s):	Toshihide Ushino
Site Expert(s):	N/A

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00218	83.14	June 27, 2014	General Atomics

NIOSH-Proposed Class Definition
All Atomic Weapons Employees who worked for General Atomics at its facility in La Jolla, California, during the period from January 1, 1960 through December 31, 1969, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees included in the Special Exposure Cohort.

Related Petition Summary Information			
SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00064	83.14	General Atomics	Class added to the SEC for the period January 1, 1960 through December 31, 1969 (Building Specific)

Related Evaluation Report Information	
Report Title	DOE/AWE Facility Name
SEC Petition Evaluation Report for Petition SEC-00064	General Atomics

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Evaluation Report Summary: SEC-00218, General Atomics

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

NIOSH-Proposed Class Definition

The intent of this evaluation is to address consistency and implementation issues associated with NIOSH's 2006 Special Exposure Cohort Evaluation for General Atomics, specifically SEC-00064 (NIOSH, 2006). A NIOSH review of existing SEC class definitions evaluated criteria such as consistency, applicability, and whether any class definitions needed to be corrected by NIOSH (DCAS, 2010). In this review, NIOSH determined that the class definition as set forth in SEC-00064 needed revising because of the potential for difficulties in implementing the class definition. In addition, through the course of ongoing dose reconstruction and research, NIOSH has determined that, due to undocumented worker movements across the site, limited claimant-specific information pertaining to work locations, and observation that that employment records do not always indicate work locations, NIOSH is unable to eliminate any specific worker from potential exposure scenarios based on assigned work location. NIOSH has found that a determination cannot always be made as to the specific area an employee worked in, or whether an employee should have been monitored for radiological exposures.

Accordingly, NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class description associated with SEC-00064 for the period from January 1, 1960 through December 31, 1969. As such, NIOSH recommends expanding the SEC class definition to include all areas of the General Atomics facility, and to include all Atomic Weapons Employees who worked for General Atomics during the period from January 1, 1960 through December 31, 1969. This SEC-00218 evaluation recommends a class that is consistent with current NIOSH methods for defining a recommended SEC class.

The NIOSH-proposed class definition is all Atomic Weapons Employees who worked for General Atomics at its facility in La Jolla, California, during the period from January 1, 1960 through December 31, 1969, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees included in the Special Exposure Cohort.

Feasibility of Dose Reconstruction Findings

NIOSH lacks sufficient information, which includes biological monitoring data, sufficient air monitoring information, or sufficient process and radiological source information, that would allow it to estimate with sufficient accuracy the potential unmonitored internal exposures, including unmonitored uranium, thorium, plutonium, tritium, and fission and activation products, to which the proposed class may have been subjected during the period from January 1, 1960 through December

31, 1969. Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures).

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

- Principal sources of internal radiation for members of the proposed class included exposures to uranium isotopes (depleted, natural, enriched and recycled), plutonium, thorium, tritium, and other fission and activation products associated with radiological research and production activities, including reactor and accelerator operations.

- NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class description associated with NIOSH's 2006 evaluation of SEC-00064 exposures for the period from January 1, 1960 through December 31, 1969. Additionally, due to the issues identified during ongoing dose reconstruction and methodology reviews conducted by NIOSH and the Advisory Board on Radiation and Worker Health (the Board) after implementation of SEC-00064, NIOSH has determined that infeasibilities associated with sufficiently accurate reconstruction of internal exposures during that period extend beyond the assessment of thorium exposures as was presented in NIOSH's 2006 evaluation of General Atomics. NIOSH lacks sufficient information that would allow it to estimate with sufficient accuracy the potential unmonitored internal exposures, including unmonitored uranium, thorium, tritium, and fission and activation products, to which the proposed class may have been subjected during the period from January 1, 1060 through December 31, 1969.

- Principal sources of external radiation for members of the proposed class included exposures to radiation fields associated with reactor, accelerator, and fuel production operations and experiments.

- Through the course of ongoing dose reconstruction and methodology reviews conducted by NIOSH and the Board after implementation of SEC-00064, NIOSH has also determined that NIOSH is unable to define individual worker external exposure scenarios for those workers that were not monitored for external exposure. NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored external beta, gamma, or neutron exposures during the period from January 1, 1960 through December 31, 1969.

- NIOSH considers that sufficiently accurate reconstruction of medical dose for General Atomics workers is feasible by using claimant-favorable assumptions as well as applicable protocols specified in the complex-wide ORAUT-OTIB-0006, *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at General Atomics during the period from January 1, 1960 through December 31, 1969, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Health Endangerment Determination

The NIOSH evaluation did not identify any evidence supplied by the petitioners or from other resources that would establish that the class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures, such as nuclear criticality incidents or other events involving similarly high levels of exposures. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures from radionuclides of uranium, thorium, plutonium, tritium, and fission and activation products associated with radiological research and production activities, including reactor and accelerator operations. Therefore, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Toshihide Ushino, MJW Corporation. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

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

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

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

2.0 Introduction

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

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

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

of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 NIOSH-Proposed Class Definition and Petition Basis

The NIOSH-proposed class includes all Atomic Weapons Employees who worked for General Atomics at its facility in La Jolla, California, during the period from January 1, 1960 through December 31, 1969, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees included in the Special Exposure Cohort. During this period, employees at this facility performed an array of radiological research and production activities to support development of commercial applications for nuclear technology.

The evaluation responds to Petition SEC-00218 which was submitted by an EEOICPA claimant whose dose reconstruction could not be completed by NIOSH due to a lack of sufficient dosimetry-related information. NIOSH's determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

There is currently one class of General Atomics workers associated with the previous NIOSH evaluation of SEC petition SEC-00064 (NIOSH, 2006), for which the Secretary of HHS has designated inclusion in the Special Exposure Cohort:

> <u>Class added to the SEC effective March 18, 2007</u>: All AWE employees who were monitored or should have been monitored for exposure to ionizing radiation while working at the following General Atomics locations: Science Laboratories A, B, and C (Building 2); Experimental Building (Building 9); Maintenance (Building 10); Service Building (Building 11); Buildings 21 and 22; Hot Cell Facility (Building 23); Waste Yard (Buildings 25 and 26); Experimental Area (Buildings 27 and 27-1); LINAC Complex (Building 30); HTGR-TCF (Building 31); Fusion Building (Building 33); Fusion Doublet III (Building 34); SV-A (Building 37); SV-B (Building 39); and SV-D (no building number) for a number of work days aggregating at least 250 work days from January 1, 1960, through December 31, 1969, or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

A NIOSH review of existing SEC class definitions evaluated criteria such as consistency, applicability, and whether any class definitions needed to be corrected by NIOSH (DCAS, 2010). In this review, NIOSH determined that the class definition as set forth in SEC-00064 needed revising because of the potential for difficulties in implementing the class definition. In addition, through the course of ongoing dose reconstruction and research, NIOSH has determined that, due to undocumented worker movements across the site, limited claimant-specific information pertaining to work locations, and observation that that employment records do not always indicate work locations, NIOSH is unable to eliminate any specific worker from potential exposure scenarios based on assigned work location. NIOSH has found that a determination cannot always be made as to the

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

specific area an employee worked in, or whether an employee should have been monitored for radiological exposures.

Accordingly, NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class description associated with SEC-00064 for the period from January 1, 1960 through December 31, 1969. As such, NIOSH recommends expanding the SEC class definition to include all areas of the General Atomics facility, and to include all Atomic Weapons Employees who worked for General Atomics during the period from January 1, 1960 through December 31, 1969. This SEC-00218 evaluation recommends a class that is consistent with current NIOSH methods for defining a recommended SEC class.

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at General Atomics from January 1, 1960 through December 31, 1969, and the information available to NIOSH to characterize particular processes and radioactive source materials. Using available sources, NIOSH has attempted to gather process and source descriptions, information regarding the identity and quantities of radionuclides of concern, and information describing processes through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

4.1 Operations Description

General Atomics is located in La Jolla, California, on 60-acres on the Torrey Pines Mesa site. The main site is approximately 300-feet above sea level, 1-mile from the Pacific Ocean, and 13-miles northwest of downtown San Diego. The General Atomics site is in the center of the Torrey Mesa Science Center, a 304-acre industrial park. The majority of General Atomics buildings are on top of the mesa, but some work, such as work at the Fuel Fabrication Facility (Building 37) and the Fusion Energy Facility (also known as DIII-D National Fusion Facility), occurred (and some still occurs) at the base of the mesa to the east of the central set of site buildings. For the period evaluated by NIOSH, the General Atomics workforce consisted of approximately 1,900 workers. Of the approximately 1,900 workers (obtained by averaging data from 1960 through 1964), approximately 400 workers/year were monitored for external penetrating doses.

General Dynamics Corporation established the General Atomics Division in San Diego, California, to develop commercial applications for nuclear technology. General Atomics performed an array of radiological research and production activities at its Torrey Pines Mesa facility in La Jolla, California (General Atomics, 1998). General Atomics operated under licenses first issued by the Atomic Energy Commission (AEC) and later by the State of California. The General Atomics source term includes depleted, normal, and highly-enriched uranium [typically greater than 20% and up to 93.5% (SNM-696) U-235 by mass]. This uranium was in the form of scrap, fresh reactor fuel, and irradiated reactor fuel comprised of uranium, activation products, and fission products. Thorium was used in fuel fabrication work. Plutonium work was also done on site. Four linear accelerators (LINACs) and several nuclear reactors were employed. Sealed sources were used for instrument calibrations and other work. By-product materials (Atomic Numbers 3-83) and tritium were also used.

General Atomics performed irradiation and time-of-flight studies with four LINACs; developed and fabricated reactor fuels; operated three on-site TRIGA reactors (Training/Research/Isotopes General Atomics); performed fusion research (since the mid-1960s); ran experimental criticality test facilities; used an "experimental" facility that is understood to have conducted a diverse set of tests with radioactive materials; and worked with special nuclear material (SNM) and radioactive tracers in its laboratory facilities. Hot Cells were used for handling radioactive materials associated with high radiation fields or very large quantities of radioactive materials that might be subject to processes resulting in dispersion. Operations conducted in these hot cells included post-irradiation examinations of DOE fuels, structural materials, and reactor dosimetry materials; and mechanical inspection of irradiated fuel. Development and manufacture of Experimental Beryllium Oxide Reactor (EBOR) fuel, tritium extraction, and experiments to test plutonium transport using plutonium oxide were also performed in hot cells.

Fuel fabrication involved working with uranium (up to 93.5% U-235 by mass) and thorium. Radioactive materials were coated, blended, compounded, heated, rolled, extruded, machined, compacted, and eventually made into fuel elements. There were many tasks required for fuel fabrication whereby raw materials were converted to usable fuel assemblies.

General Atomics reclaimed highly-enriched uranium (HEU) from non-irradiated NERVA (Nuclear Engines for Rocket Vehicle Applications) scrap fuel. The scrap was identified as being in Scrap Groups III (uranium compounds such as oxides) and IV (combustibles such as paper, tissue wipes, filters, etc.). The scrap materials were to be shipped from the Westinghouse Electric Corporation's Astrofuel Facility in Cheswick, Pennsylvania, to General Atomics for processing into uranium oxides (Type III recovered uranium: UO2, UO3, and U3O8). SNM in the form of uranium-bearing impure scrap materials (e.g., oxides or carbides) was processed to recover and purify the contained uranium. The material was accumulated from several sources (both on-site and off-site), including out-of-specification SNM product, process equipment, scrap, waste, and solid residue from liquid evaporation. Some of the materials came from the facility recovery operations.

The steps used for uranium material extraction and purification are described in SNM License 696 (SNM-96). In addition to the production, research, and recovery activities conducted with uranium and SNM, General Atomics also worked with thorium materials. Thorium was one of the radionuclides used in the initial stages of operation; such use continued through the operational period. Thorium was used in Building 2 (Science Laboratories) for testing mixtures and components of fuel assemblies. The thorium operations conducted in Building 2 included grinding of thorium, high-temperature heating under vacuum, and fabrication of thorium-uranium gel. Undetermined amounts of thorium were used in Building 9 (Experimental Building); operations included extrusion, rolling, cutting, milling, lathing, and casting of metal. Research and development of reactor fuel pellets using uranium and thorium was one of the activities conducted in Building 23 (Hot Cell Facility). When work was performed in hot cells, there was the potential for exposure during the transport of radioactive materials to and from the Hot Cells and during maintenance of equipment.

Radioactive materials containing thorium and other radionuclides were volume-reduced at, stored at, and shipped from the Waste Yard (Buildings 25 and 26). Information regarding the total quantities and activities of individual radionuclides handled at the Waste Yard has not been identified. Coated thorium fuel pellets were irradiated in the linear accelerator building (LINAC Complex or Building 30). Other research activities involving thorium were also conducted at the LINAC Complex. Criticality testing of fuel elements containing thorium was routinely conducted at the

Critical Assembly Facility (Building 31); thorium compaction also occurred in this facility. Fabrication and testing of HTGR (High Temperature Gas Cooled Reactor) fuel was performed in Buildings 37 (SV-A) and 39 (SV-B). One of the primary uses of thorium at General Atomics was in the fabrication of Th-U fuel. Potential exposure to thorium in these Sorrento Valley areas resulted in part from the transport and handling of materials, maintenance of fabrication equipment, and airborne leaks from the thorium conversion furnace (SNM-696).

Records suggest that thorium was routinely used in the aforementioned buildings. However, based on available documentation (General Atomics, 1964; SNM-696), the transfer, storage, and use of thorium in other radiological buildings was also likely. NIOSH has not located documentation on the amount of thorium used and processes employed in these remaining buildings or on the level of thorium activity in any specific locations of the facility.

Table 4-1: General Atomics Facilities that Conducted Radiological Work

Building	Process
Building 2 Science Laboratories A, B, and C*	Radiological and chemical laboratories
Building 9 Experimental Building (E Building)*	Many radiological operations, including fuel element development and Pu storage
Building 10 Maintenance Building	Radioanalytical laboratory and Health Physics
Building 11 Service Building	Shipping and receiving of radioactive materials
Building 21 (TRIGA)	Housed three TRIGA reactors
Building 22	TRIGA Fuel Fabrication
Building 23 (Hot Cell Facility)*	Multiple radiological operations
Buildings 25* and 26 *	Waste handling, minimization, processing, and storage; SNM storage; and a gamma counting facility
Building 27 (Experimental Area Building #1)	Preparation of target samples for neutron irradiation; post-irradiation radiochemical separations
Building 27-1 (Experimental Area Building #1 – Bunker; also contained 'Strontium Facility')	Neutron activation; yttrium production from Sr-90; and research and development
Building 30 (LINAC Complex)*	High-energy electron accelerators
Building 31 (HTGR-TCF)* Also called the Critical Assembly Facility	Testing of fuel elements
Building 33 (Fusion Building)	Study of controlled thermonuclear reactions
Building 34 (Fusion Doublet III)	Research in magnetic fusion technologies (involving short-lived radiation sources)
Building 37 (SV-A)*	Fabrication of fuel elements; SNM
Building 39 (SV-B)*	Fabrication and testing of fuel assemblies for HTGR; SNM
SV-D (no building number)	Assembled thermionic and thermoelectric fuel elements; SNM

Note:
* Records suggest that thorium was routinely used in these buildings. However, based on available documentation (General Atomics, 1964; SNM-696) the transfer, storage, and use of thorium in other radiological buildings was also likely.

Some of the larger radiological operations involved the Fuel Fabrication Facility, the Hot Cell Facility (Building 23), the reactors, and the linear accelerator. In addition, there were a number of research and development and small-scale manufacturing projects on going in the General Atomics research and experimental buildings. Although many of the facilities were operational by 1960, some were moved or constructed during the 1960s. This evaluation report identifies the functional areas and facilities where thorium was handled, used, or processed. A list of these facilities is shown in Table 4-1; these thorium facilities are discussed in the successive report sub-sections.

LINAC Facility

The LINAC facility began operating in 1962 and was used for a variety of research activities. Early experiments investigated the intensity of delayed radiations from the fission of uranium-238, uranium-235, plutonium-239, and thorium-232 (General Atomics, 1964). Tritium was also used as a LINAC target. However, information on the design and construction of the targets was not found.

Administrative controls coupled with physical interlocks were used to ensure the safety and protection of LINAC personnel. Any material registering over twice background on an alpha, beta, or gamma detector was considered radioactive (SNM-69).

Experimental Building (E Building)

The Experimental Building was involved in much of the initial fuel development work conducted onsite. The first major operation conducted within the facility was the fabrication of TRIGA reactor fuel elements (UZrH, a uranium-zirconium hydride alloy). There were two radiologically-controlled areas within the structure, designated as Zones A (South Control Zone: A-1, A-2, and A-3) and B (Hot Suite: B-1, B-2, and B-3). All operations with the potential to generate particulate matter were conducted in hoods or glove boxes, or were serviced by portable ductwork attached to an exhaust system. Procedural and administrative controls were in place to minimize exposure; these controls typically helped the health physics group to protect personnel. There were two SNM storage vaults located adjacent to the east wall of the facility and a security storage area designed to store materials in Zone A for short periods of time.

Undetermined amounts of thorium were used in the Experimental Building in fuel fabrication experiments involving extrusion, rolling, cutting, milling, lathing, and casting of metal.

Critical Assembly Facility

This facility consisted of two buildings contained in a fenced area between the LINAC Complex and TRIGA / Experimental Area Building #1. The facility was used to conduct many critical and sub-critical assembly experiments. These buildings, also referred to as Building 31, were collectively referred to as the Critical Assembly Facility. The buildings were used to support the Marine Gas-Cooled Reactor (MGCR) and HTGR programs (General Atomics, 1961). In addition to these two buildings, a fuel assembly building was located in the area. Fuel assemblies were irradiated with accelerator-produced neutrons or with neutron triggers (e.g., PoBe or PuBe sources). The design of the fuel and assembly was such that if an undesired criticality were to occur, the fuel would either rapidly expand (Russell, 1967) or the sub-critical fuel beds would separate (Pound, 1974), inducing the neutron excursion to terminate. Criticality testing of fuel elements containing thorium was conducted at this facility.

Science Laboratories

The Science Laboratories were composed of three two-story, arc-shaped buildings forming an annular ring around the central library and cafeteria buildings. The Science Laboratories contained 150 individual laboratories and associated offices. Much of General Atomics' work in chemistry, experimental physics, electronics, metallurgical research, reactor physics, and thermoelectricity was performed in these buildings. Thorium was used in the Science Laboratories for testing mixtures and components of fuel assemblies. Operations included grinding of thorium, high-temperature heating under vacuum, and fabrication of thorium-uranium gel.

Hot Cell Facility

The Hot Cell Facility (HCF), Building 23, was constructed in 1959 and used primarily to facilitate remote inspection of irradiated, highly-radioactive HTGR and TRIGA fuel (General Atomics, 1960). Approximately 12% of the building footprint was taken up by the hot cell (SNM-69). A hot cell was made up of 3 sections: the high-level cell (HLC), low-level cell (LLC), and the metallurgy cell (MC). The HLC was used as a remotely operated “hot” machine shop to cut open and section irradiated fuel samples for inspection. The MC was used for analytical inspection and research activities, including the sample preparation that entailed grinding, polishing, and mounting. The LLC was used as an interface between the other “hot” cells and other areas of the building, and housed all shipping cask off-loading and packaging operations. Thick (up to 42-inch), high-density concrete walls were in place to minimize personnel exposure to penetrating radiation. In addition to uranium and other fuel constituents, thorium materials were handled in the hot cell facility.

Waste Yard/Incinerator

The waste processing facility includes several buildings, collectively referred to as Building 25. The facility was used for waste handling, minimization, processing, and storage; SNM and by-product material storage; and as a gamma-counting facility. Liquid wastes generated on the site were treated by placing them in evaporation pools. Only authorized personnel were allowed into the fenced-off incinerator area; they were required to wear a film badge and a self-reading dosimeter, and to submit bioassay samples for analysis (SNM-69). Several locations were used within the waste processing facility area to store radioactive materials, including TRIGA Hot Storage, a temporary storage yard, the Butler Building, and the By-Products Vault. Radioactive materials containing thorium were volume-reduced at, stored at, and shipped from the Waste Yard. Information regarding the total quantities and activities of individual radionuclides handled at the Waste Yard has not been identified.

Reactor Facilities

Three separate TRIGA reactors (Mark I, Mark F, and Mark III) were operated within Building 21; each reactor was individually licensed (R-38, R-67, and R-100, respectively). The original building, constructed in 1957, housed the Mark I reactor. The building was later expanded to the east and then to the north (1966) to house the Mark F and III reactors, respectively. The Mark I, F, and III reactors were all below-ground pool reactors (General Atomics, 1966-1969). They were designed to: provide university training; provide a source of neutrons and/or gamma radiation for research; aid investigations of the effects of radiation on materials; and produce radioisotopes.

The Mark I, which was graphite-reflected, was operated routinely at steady-state thermal levels up to 250 kW; it could also be operated in pulsed mode. The Mark F reactor (also known as the Advanced TRIGA Prototype and the FLAIR [Flash Irradiation Reactor]), which was water-reflected, operated routinely at steady-state thermal power levels up to 1500 kW and also could be operated in pulsed mode. The Mark III reactor, also water-reflected, operated routinely at steady-state thermal levels up to 1500 kW.

The core of the TRIGA reactor contained reactor fuel, dummy fuel assemblies, and one or more neutron source holders. Workers may have been exposed to external and internal radiation during fuel loading and maintenance. Thorium was a fuel mixture constituent during some of these operations.

Other Locations

Due to the diversity of General Atomics operations, there was a significant potential for thorium storage, handling, or use in any of the buildings or work areas associated with radiological activities. For instance, thorium was likely handled in a radiochemistry laboratory located in the Maintenance Building, and the Service Building was used for receiving and shipping radioactive materials and components. Based on available information, NIOSH cannot rule out the possible existence of thorium contamination in any General Atomics radiological work area. Consequently, all General Atomics radiological work areas are included in the proposed SEC class.

4.2 Radiation Exposure Potential from Operations

The General Atomics source term includes depleted, normal, and highly enriched uranium (typically greater than 20% and up to 93.5% U-235 by mass) in the form of scrap and reactor fuel both in a fresh form and in an irradiated form that includes uranium as well as activation and fission products. Thorium was used in fuel fabrication work. Plutonium work also occurred on the site. Four linear accelerators (LINACs) and several nuclear reactors were also available. Sealed sources were used for instrument calibrations and other work. Byproduct materials (atomic numbers 3 to 83) and tritium were also used.

The potential for external radiation dose existed at all the General Atomics facilities that conducted radiological work. The areas known to NIOSH as radiological work areas include: Science Laboratories A, B, and C (Building 2); Experimental Building (Building 9); Maintenance (Building 10); Service Building (Building 11); Buildings 21 and 22; Hot Cell Facility (Building 23); Waste Yard (Buildings 25 and 26); Experimental Area (Buildings 27 and 27-1); LINAC Complex (Building 30); HTGR-TCF (Building 31); Fusion Building (Building 33); Fusion Doublet III (Building 34); SV-A (Building 37); SV-B (Building 39); and SV-D (no building number). Based on the site operations outlined in Section 4.1, sources of exposure included photons and neutrons emitted from the reactors and the LINACs and neutron from sources such as Pu-Be and Am-Be.

The primary sources of internal radiation exposure at the site were uranium isotopes (depleted, natural, enriched, and recycled), plutonium, thorium, tritium, and other fission and activation products generated during various processes at General Atomics.

Determining the amount and variety of radionuclides comprising the source term for radiological exposures at General Atomics is a difficult process due to changes in radionuclides over time as well as fluctuations in SNM inventory on the site. The number of laboratories, and the variety of laboratory activities associated with work in chemistry, experimental physics, electronics, metallurgical research, reactor physics, and thermoelectricity, led to the potential for a large variety of radionuclides as well as varying quantities of these radionuclides on the site at any given time (ORAUT-TKBS-0045, PDF p. 40).

Building 23, HCF (which contained BeO, EBOR, tritium production, and a room where plutonium was handled) was also referred to as the Plutonium Laboratory. In late 1959, during the final phase of construction, General Atomics decided to expand the original building design to include an additional 1,200 ft^2 of laboratory space to accommodate the EBOR Fuel Fabrication Facility. Portions of the building have been used to conduct other radiological activities, including the development and manufacture of EBOR fuel (in Rooms 108/108A), a tritium extraction laboratory for preparation and testing of irradiated fuel samples in Room 109 from 1969 to 1987, and a plutonium transport experiment that used plutonium oxide (Room 116). General Atomics conducted the SNAP-15A Program for AEC, which utilized a small thermoelectric generator that was powered by Pu-238. General Atomics also documented the presence of plutonium on the site in October 1964 when the SNAP-15A Plutonium Handling Room was completed at the SV-B Building (Bold, 1964), but plutonium was probably handled elsewhere on the site earlier. The SNAP Plutonium Handling Room was later relocated to the Experimental Building concrete vault in October 1965 (ORAUT-TKBS-0045, PDF pp. 37-38).

Thorium in the form of oxides, carbides, and nitrates was documented at General Atomics. Thorium was used for fabrication of thorium-uranium fuel. Thorium appears to have been on the site before and throughout the AWE operational period. Some of the operations at the HCF and Experimental Critical Facility involved irradiated, experimental HTGR fuels for a thorium fuel cycle and irradiated fuel for the Reduced-Enrichment Research and Test Reactor (RERTR) program. The HTGR design employed two types of fuel, both in the physical form of microspheres. No *in vitro* bioassay results specifically for thorium have been found for General Atomics. There does not appear to be a defensible way to ratio thorium intakes to uranium intakes because some tasks included pure thorium handling. Thorium source terms that were associated with internal exposures would have most commonly been associated with the Fuel Fabrication Facility, the Scrap Handling Facility, the laboratory buildings, the Experimental Building High Bay and HTGR critical assembly, and the waste handling areas.

General Atomics conducted research and development on thermoelectric generators that were powered by radioisotopes for space power applications for AEC. By the end of September 1964, a 250-W 90Sr-powered thermoelectric generator had been investigated and test generators were being fabricated and tested (General Atomics, 1964). Radioactive strontium was associated with the irradiated fuels and the Y-90 Production Facility. Specific information on chemical form or forms of Sr-90 at General Atomics has not been found by NIOSH, but strontium that is associated with the irradiated fuels is likely to be in the form of an oxide and strontium used for the production of nuclear batteries (thermoelectric generators) may have been in the form of SrTiO3 (ORAUT-TKBS-0045). Other fission products were associated with irradiated fuel and reactor operations. General Atomics documentation mentions Cs-134, Cs-137, and Ta-182 and Eu-154 (ORAUT-TKBS-0045). Monthly reports in the mid-1960s discuss the use of titanium tritide associated with the TRIGA Reactor Building. It appears that targets were irradiated in the TRIGA reactor and then the Activation Analysis group worked with the targets in the Experimental Area Building #1 – Bunker (ORAUT-TKBS-0045, PDF p. 20).

The TRIGA reactors and the LINAC were used to activate a variety of materials including soils, steel, cladding materials, uranium, and plutonium. A detailed list of possible activation products at the LINAC is provided in Attachment F of ORAUT-TKBS-0045.

Little information has been found on the quantities and chemical forms of tritium that were used at General Atomics during the AWE period, but site documentation indicates that a Texas Nuclear Corporation Neutron Generator console at the LINAC was being used with a “new 3 to 5 curie tritium target" in January 1963 (Bold, 1963). The October 1965 monthly report for TRIGA and Activation Analysis Facilities (Cockle, 1965) noted that 25 used tritium targets that totaled 111 Ci were transferred from General Atomics for storage and ultimate disposal. Tritides (particulate) and tritiated water vapor and tritiated gas (the latter compounds would be released during off-gassing of the tritium targets) were likely chemical forms on the site.

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security (HSS), the time period associated with AWE operations at General Atomics is from January 1, 1960 through December 31, 1969, as specified by DOE HSS (https://hsspublic.energy.gov/search/facility/ViewByName.aspx). NIOSH has discovered no additional data to support more specific dates for the start and stop of AWE operations. Therefore, AWE work at General Atomics is assumed to have started on January 1, 1960, and to have continued through December 31, 1969.

4.4 Site Locations Associated with Radiological Operations

The General Atomics facility was comprised of many buildings where many different activities occurred. These activities required the use of test reactors, fusion reactors, LINACs, hot cells, and radiochemistry laboratories; many of these operations involved uranium, plutonium, and thorium.

- Building 2 held radiological and chemical laboratories.
- Building 9 was the site of radiological operations, including fuel element development and Pu storage.
- Building 10 had a radio-analytical laboratory.
- Building 11 was used for shipping and receiving radioactive materials.
- Building 21 housed three TRIGA reactors.
- Building 22 was for TRIGA Fuel Fabrication.
- Building 23 housed the Hot Cell Facility.
- Buildings 25 and 26 were for waste storage, SNM storage, and housed a gamma counting facility.
- Building 27 was for preparing target samples for neutron irradiation and post-irradiation radiochemical separations.
- Building 27-1, also known as the "Experimental Area Building #1 – Bunker" contained the Strontium Facility and was the location for neutron activation, yttrium production, and research and development.
- Building 30 was the LINAC Complex that housed the high-energy electron accelerators.
- Building 31 was the Critical Assembly Facility used for testing fuel elements.
- Building 33 was the Fusion Building for studying controlled thermonuclear reactions.
- Building 34 housed the Fusion Doublet III for research in magnetic fusion technologies.
- Building 37 was for fabricating fuel elements.
- Building 39 was for fabrication and testing fuel assemblies for HTGR.
- Building SV-D stored assembled thermionic and thermoelectric fuel elements.

Records suggest that thorium was routinely used in nine of the buildings specified above. However, based on available documentation (General Atomics, 1964; SNM-696) the transfer, storage, and use of thorium in other radiological buildings was also likely. Through the course of ongoing dose reconstruction and research associated with the SEC-00064 class period, NIOSH has determined that, due to undocumented worker movements across the site, limited claimant-specific information pertaining to work locations, and observation that employment records do not always indicate work locations, NIOSH is unable to eliminate any specific worker from potential exposure scenarios based on assigned work location. NIOSH is therefore unable to define individual worker exposure scenarios based on specific work locations within the General Atomics site during the period under evaluation.

4.5 Job Descriptions Affected by Radiological Operations

NIOSH has determined that the site-specific and claimant-specific data available for General Atomics for the time period under evaluation are insufficient to allow NIOSH to determine that any specific work group was not potentially exposed to external radiation fields, radioactive material releases, or possible subsequent contamination.

NIOSH has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions.

5.0 Summary of Available Monitoring Data for the Proposed Class

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

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

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

5.1 Data Capture Efforts and Sources Reviewed

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

Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One contains a summary of General Atomics documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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

5.2 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. NIOSH also reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. Table 5-1 summarizes the results of this review. (NOCTS data available as of June 11, 2014)

Table 5-1: No. of Site Name Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	145
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1960 through December 31, 1969)	107
Number of dose reconstructions completed for energy employees who worked during the period from January 1, 1960, through December 31, 1969 (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	59
Number of claims for which internal dosimetry records were obtained for the period from January 1, 1960, through December 31, 1969	78
Number of claims for which external dosimetry records were obtained for the identified for the period from January 1, 1960, through December 31, 1969	58

5.3 Worker Interviews

The specific purpose of this evaluation is to expand the existing class description associated with SEC-00064 by removing the area-specific and monitoring criteria from the class parameters. As such, NIOSH has determined that additional interviews supporting this evaluation were not necessary, and therefore were not performed.

5.4 Internal Personnel Monitoring Data

During the AWE operational period for General Atomics (1960 through 1969), some workers were monitored by bioassay; however, bioassays were not routine at General Atomics until October 1963. NIOSH has reviewed available data, which appear to be from random sampling, and identified 1,188 bioassay results through September 1963. NIOSH has identified 1,577 bioassay records for the period October through December 1963. These results are gross activity results. NIOSH has identified 17,188 results from October 1963 through December 1969. According to the data available to

NIOSH, most results were for *in vitro* sampling. A majority of the samples collected from 1960 through 1963 were analyzed for gross beta, gross alpha, and U-235. Most of the *in vitro* bioassay data available for the period October 1963 through December 1969 show that samples were analyzed for gross alpha or for uranium activity. The bioassay program incorporated gross counting methods to determine exposure to uranium, and the analytical methods used are generally unavailable to NIOSH.

Determination of the specific internal exposures to other radionuclides, including thorium-232, thorium-238, plutonium, and americium, did not occur within the AWE operational period (ending December 31, 1969). NIOSH has located no *in vitro* results specifically for exposure to thorium. Further, NIOSH has not found any evidence to suggest that routine or job-specific *in vitro* bioassay for thorium exposure was performed at General Atomics.

Strontium analyses involved chemically removing the strontium from the urine sample, counting the new sample, and counting again when the Y-90 has started to grow back in order to determine the activity of Sr-90. Strontium could have been associated with irradiated fuels or the Y-90 Production Facility (about which little is known), as well as other programs (ORAUT-TKBS-0045, PDF pp. 56-57).

General Atomics began monitoring for tritium exposure by bioassay in September 1965. NIOSH has identified 194 tritium bioassay records for the period November 1965 through December 1969. NIOSH's 2006 evaluation for SEC-00064 determined that it is not feasible to reconstruct internal radiation doses from exposure to tritium before October 1965 (ORAUT-TKBS-0045, PDF p. 58). The type of metal tritides potentially present at General Atomics is important for accurate assessment of internal dose since metal tritides exhibit different characteristics depending on their formulation. For example, compared to HTO which is classified as Type F, titanium tritide studies have reported it to be Type M or S materials in terms of dissolution classification. If the metal tritide is zirconium tritide, then it would be classified as Type S. If all tritium is in the form of insoluble Type S metal tritide, a urinalysis program could fail to detect rather large intakes. There is no information on whether any analyses were performed on the type of metal tritides that may have been present at General Atomics, and what the potential for intake might have been during the AWE period.

Urine samples that contained mixed fission and activation products were likely placed in a container and gamma-counted, or evaporated to dryness and beta-counted. The radionuclides were typically not identified, and the results were reported in terms of gross activity or gross beta and adjusted to a 24-hour time if a 24-hour sample was not provided or analyzed (ORAUT-TKBS-0045, PDF p. 58).

At some point, maybe in 1963, the urine samples were chemically processed and then beta-counted, but it is not known if the gamma-counted results were chemically processed or if results that were designated as MFPs or beta represent the same or different analysis types (ORAUT-TKBS-0045, PDF p. 58).

No explicit concentration measurements of thoron progeny have been found for 1960 through 1969. Given the fairly routine references to contamination on air samples from thoron progeny in the Fuel Fabrication area during the 1960-1969 period, and the lack of information about what activities took place at the Thorium Pilot Plant after AWE operations, NIOSH assumes that the later Pilot Plant measurements are not useful for estimating thoron concentrations during the operational period in areas where large quantities of thorium were stored and handled.

General Atomics implemented an *in vivo* analysis program in 1966. The Helgeson mobile counter was brought to the site a few times each year. The perceived potential for internal exposure was the early basis for including a worker in the *in vivo* bioassay program. Many individual measurement spectra are included with results identifying the radionuclide and quantity measured. Background and calibration measurements were also observed in the records provided by Helgeson (Helgeson, 1966). The first U-235 lung counting results (~1966 through 1967) were considered "experimental" by Helgeson, and were either associated with some large uncertainty or assumed to be invalid. Workers were chosen for lung counts based on their potential for U-235 exposure and the results of their uranium urinalyses (Helgeson, 1969). The early General Atomics U-235 *in vivo* measurements are indicators that a worker had the potential for U-235 exposure.

In addition to the Helgeson *in vivo* analysis, General Atomics conducted its own in-house *in vivo* measurements beginning in 1966. The subject sat in an office chair lined with 0.25-inch thick lead and a 4” x 4” NaI(Tl) detector operated in a lap geometry.

The *in vivo* bioassay program was not used in 1966 to routinely monitor for exposures to thorium, although twelve workers were analyzed for thorium in March of that year. These results were reported to be experimental and final results were not provided by Helgeson (Helgeson, 1966). Available records indicate that a thorium *in vivo* result was reported for only one worker in 1969, who was reported to have no thorium activity (Helgeson, 1969).

5.5 External Personnel Monitoring Data

External whole body dosimetry results are available for monitored General Atomics workers for the entire AWE operational period (January 1960 through December 1969). NIOSH has 27,661 external monitoring records available for that period. Initially, external dosimetry services using film badges were provided by R. S. Landauer, Jr. and Company. In July 1961, those services were transferred to Radiation Detection Company; however, in 1965 they were transferred back to R. S. Landauer, Jr. and Company. Personnel working in areas where potential neutron exposure could occur were issued film badges sensitive to beta, gamma, and neutron radiation. Otherwise, personnel were issued film badges sensitive to only beta and gamma radiation.

No details on the Radiation Detection Company dosimeter design or film type are currently available, but site documentation suggests that the film badge was comparable to the Landauer design. Film badge detection thresholds for R.S. Landauer, Jr. and Company badges were reported in January 1961 as 10 mrem from gamma, 40 mrem from beta, and 20 mrem from fast neutrons. Other documentation indicates that film badge detection thresholds in the early days were assumed to be as high as 50 mrem for gamma and 60-80 mrem for beta.

In addition to the badge dosimeters, personnel used direct- or indirect-reading dosimeters, such as personal ion chambers. It is unclear whether these additional dosimeters detected low-energy X-rays. (Currently available pocket dosimeters designed for low-energy X-ray detection report the lower end of the energy range as 20 to 40 keV. Dosimeters not specifically designed for low-energy X-ray detection have thresholds of about 80 keV.) Extremity dosimeters were used in some operations, such as during removal of irradiated samples from the TRIGA reactors (Gurren, 1966). Results from the pocket dosimeters were logged by staff on a routine basis. Some on-site readings are included in the available individual dosimetry records.

Site documentation indicates that during the 1960 to 1961 timeframe, film badges, fast and thermal neutron detection equipment, and direct- and indirect-reading pocket dosimeters were irradiated to evaluate the radiation recorded on each device. Beginning in early 1960, indium foils were incorporated into personnel security badges in case of a criticality event (Ray, 1960). By July 1961, all personnel film holders were equipped with a built-in threshold detector for neutron dose evaluations in the event of a criticality (Bold, 1961). Badges were exchanged on a bi-monthly frequency at General Atomics in 1960 and 1961 (Bold, 1962). In 1962, badges were exchanged monthly (Bold, 1968); this frequency was likely used until 1996 when quarterly exchanges were begun.

According to 1961 correspondence, “Special Tests for Employees Working Around BeO,” special radiation tests, X-rays, and spirograms were conducted for employees working in the vicinity of BeO (Bethard, May1961, Bethard, Jun1961, Bethard, Sep1961, and 1961d). No additional documentation detailing occupationally-required medical X-ray examinations has been identified. NIOSH’s review of data for EEOICPA claimants who worked at General Atomics suggests that X-rays were given annually. To date, no information regarding equipment and techniques specific to General Atomics has been located.

5.6 Workplace Monitoring Data

Engineering controls to reduce radiation/radioactivity exposure appear to have been present throughout the site. General Atomics conducted routine air monitoring, but noted inadequacies in the frequency and quality of its program in the early years. NIOSH has no documentation that suggests thorium was specifically monitored by air sampling.

Surface area wipe-testing was performed periodically at General Atomics, but it is unclear whether direct contamination surveys were routinely performed. Several incidents involving radioactivity releases and occurrences of contamination were documented (Hughes, 1964; Hughes, 1967; Hughes, 1969; Kesting, 1964; Kesting, 1969; Lepper, 1963). At least one incident, in 1968, involved the LINACs whereby both long- and short-lived radionuclides were potentially released. Because thorium was irradiated at the accelerators, it is plausible that thorium was released during one or more incidents.

5.7 Radiological Source Term Data

Much of the information specifying the radioactive isotopes and their quantities used, produced, and/or fabricated at General Atomics from January 1, 1960 through December 31, 1969 are not available to NIOSH. However, it is clear that various radionuclides, such as TRIGA fuel, were present at General Atomics during that period. It is possible to obtain a snapshot of allowable quantities of radioactive material at General Atomics from radioactive material licenses. Table 5-2 presents summary information available to NIOSH regarding licensed quantities during the period from 1960 through 1969 (ORAUT-TKBS-0045; SNM-69, PDF pp. 9-11). Radionuclides and allowable quantities might have changed over time, but based on site descriptions, health physics reports, and inventory reports, the materials listed in Table 5-2 are generally representative of the variety and the upper limits on source term during the AWE covered period.

Table 5-2: Allowable Quantities of Radioactive Material at General Atomics						
Date	**License**	**Material**	**Description**	**Form**	**Quantity**	**Total**
ca. 1960	AEC License No. 4-1611-11 (J-60)	Byproduct materials, atomic numbers from 3 through 83		Any	10 Ci each	500 Ci
		H-3			200 mCi	
		Sr-90		Sealed	1 Ci	
		Sr-90		Unsealed	100 mCi	
		Po-210		Sealed	50 Ci	
		Po-210		Unsealed	100 mCi	
		Tm-170/171			50,000 Ci	
Dec. 1960	AEC License No. 4-1611-11 (J-60), proposed increase	Byproduct materials, atomic numbers 3 through 83	Any		100,000 Ci each	500,000 Ci
	Proposed addition	Fission products	All		1,000,000 Ci	
May 1965	SNM-69	Uranium		As metal or metallic alloy	300 kg (up to 20% enriched U-235)	
		U-235		As metal, metallic alloy, or compounds	265 kg (up to 93.5% enriched in U-235)	
		U-233		As metal, metallic alloy, or compounds	100 gm (any enrichment)	
		U-235		In sealed containment	50 gm (up to 93.5% enriched in U-235)	
		U-233		In sealed containment	32 gm (any enrichment)	
		Plutonium		In sealed containment	1095 gm (any enrichment)	
		Plutonium		Unseparated, bred fissionable material	1 gm	

6.0 Feasibility of Dose Reconstruction for the Proposed Class

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

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

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

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

6.1 Feasibility of Estimating Internal Exposures

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

As stated in Section 3.0 of this report, HHS has designated an SEC class for General Atomics workers for the period from January 1, 1960 through December 31, 1969 (HHS, 2007). In the class designation letter,
HHS states:

(1) General Atomics AWE employees in the proposed class could have received internal and external radiation exposures from uranium, thorium, plutonium, and other radioactive materials.

(2) NIOSH lacks sufficient information, including biological monitoring data, air monitoring information and process and radiological source information, that would allow it to estimate the potential intakes(s) of thorium, and the resulting dose to which the proposed class may have been exposed for the period from January 1, 1960, through December 31, 1969.

(3) Pursuant to 42 C.F.R. § 83.13(c)(I), NIOSH determined that there is insufficient 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 of members of the class more precisely than a maximum dose estimate.

(4) Although NIOSH is unable to adequately estimate total internal exposures for members of the class, internal dose due to intake of uranium can be reconstructed for exposures starting in October 1963, and tritium internal dose can be estimated after September 1965. NIOSH considers the reconstruction of occupational external radiation doses, including medical dose to be feasible for members of the class

.

The associated SEC class designated by HHS included only those employees who worked in Science Laboratories A, B, and C (Building 2); Experimental Building (Building 9); Maintenance (Building 10); Service Building (Building 11); Buildings 21 and 22; Hot Cell Facility (Building 23); Waste Yard (Buildings 25 and 26); Experimental Area (Buildings 27 and 27-1); LINAC Complex (Building 30); HTGR-TCF (Building 31); Fusion Building (Building 33); Fusion Doublet III (Building 34); SV-A (Building 37); SV-B (Building 39); and SV-D (no building number).

The 2007 class description was based on the NIOSH determination that exposure potential was limited to workers in these buildings, that all workers with the potential for radiation exposures during the proposed SEC class time period were included in the external dose monitoring program, and that unmonitored workers had no potential for radiation exposures.

A NIOSH review of existing SEC class definitions evaluated criteria such as consistency, applicability, and whether any class definitions needed to be corrected by NIOSH (DCAS, 2010). In this review NIOSH determined that the class definition recommended in its 2006 evaluation of SEC-00064 needed revising because of the potential for difficulties in implementing the class definition. In addition, through the course of ongoing dose reconstruction and research, NIOSH has determined that, due to undocumented worker movements across the site, limited claimant-specific information pertaining to work locations, and observation that employment records do not always indicate work locations, NIOSH is unable to eliminate any specific worker from potential exposure scenarios based on assigned work location. NIOSH has found that a determination cannot always be made as to the specific area an employee worked in, or whether an employee should have been monitored for radiological exposures.

Accordingly, NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class description associated with SEC-00064 thorium exposures for the period from January 1, 1960 through December 31, 1969. As such, NIOSH recommends expanding the SEC class definition to include all areas of the General Atomics facility, and to include all employees of Atomic Weapons Employees who worked for General Atomics during the period from January 1, 1960 through December 31, 1969.

Also through the course of ongoing dose reconstruction and methodology reviews conducted by NIOSH and the Board after implementation of SEC-00064, the following issues have been identified that may pertain to assessing internal exposures during the General Atomics period from 1960 through 1969:

- Using non-contemporaneous data to estimate exposures during the AWE operational period

- Concerns were raised regarding the use of long-lived gross airborne alpha activity observed in the Fuel Fabrication Facility from 1965 through 1968 to estimate exposures during earlier time periods (i.e., 1960 through 1964). Concerns were also raised regarding the use of radionuclides observed in the high-level cell area in 1994 to estimate plutonium exposures throughout the facility during the earlier AWE operational period.

    - Applying air sample results from one period to other periods and locations relies on the assumption that the relative quantities of radionuclides used and the work practices remained the same throughout various time periods and locations.

    - NIOSH has little information regarding inventory of the materials used in the Fuel Fabrication Facility and whether the type of work conducted changed during the AWE period. The licenses include various quantities of isotopes of uranium, plutonium, natural thorium, fission products, and activation products. It is known that General Atomics employees worked with these radionuclides throughout the AWE period. The fuel fabrication work moved from the Experimental Building to the Fuel Fabrication Facility in 1962 (ORAUT-TKBS-0045, PDF p. 25).

    - Available site documentation indicates that supplied air hoods were required in the thorium process area of the Fuel Fabrication Facility by January 1966 (ORAUT-TKBS-0045, PDF p. 44), possibly indicating that work or work process at the facility may have changed around that period.

    - Because NIOSH does not have access to records indicating time periods, locations, and the quantities of uranium, plutonium, and thorium present, their isotopic ratios as well as their relative isotopic ratios of airborne activity cannot be established with any degree of confidence. Thus, there does not appear to be a defensible way to extrapolate airborne exposure for the 1960-1964 period from the long-lived gross airborne alpha activity observed during the 1965-1968 period.

- Gross alpha procedures used during the AWE period

    - Concerns were raised regarding the gross alpha procedures that were used during the AWE operational period. There are indications that little consideration was given to the presence of plutonium isotopes, as well as americium and other alpha emitters in the samples.

    - The explanation for bioassay codes in ORAUT-TKBS-0045, Table 3-1 states that uranium urinalysis (results written as U-235 in urine) can be assumed to be total uranium. These samples could either have been analyzed by fluorimetry or gross-alpha counting. Any alpha emitter that made it through the chemical processing of the urine would be detected by the gross-alpha counting methods, but the actual chemical recovery for non-uranium alpha emitters is unknown, so only uranium is assumed (ORAUT-TKBS-0045, PDF p. 49).

    - If the chemical recovery of non-uranium alpha emitter is unknown, then internal dose resulting from intake of other radionuclides cannot be correctly accounted for. Thus, accuracy of dose reconstruction using such partial data is doubtful.

- Strontium exposure/dose reconstruction
    - The need was identified for a method to reconstruct internal doses to workers who might have been exposed to strontium during the AWE operational period, but were not part of a bioassay program.
        - The earliest indication of presence of strontium at General Atomics is in AEC license No. 4-1611-11 from 1960, which includes Sr-90 in sealed and unsealed forms (ORAUT-TKBS-0045, PDF p. 124). The initial focus of the bioassay program appeared to be uranium. Bioassay before October 1963 occurred only in response to nose wipes and incidents and was not routine. Records of urinalysis for fission and activation products are available as early as 1963 (ORAUT-TKBS-0045, PDF p. 48).
        - Strontium could have been associated with irradiated fuels or the Y-90 production, as well as other programs.
        - ORAUT-TKBS-0045 states that specific information on the chemical form(s) of Sr-90 at General Atomics is unavailable; although strontium that was associated with the irradiated fuels is likely to be in the form of an oxide and not titanate. If strontium was being used for the production of thermoelectric generators it might have been in the form of $SrTiO_3$.
        - ORAUT-TKBS-0045 further suggests that in the absence of any information about the urine sample processing at General Atomics during the AWE period, it is favorable to the claimant to assume that the analysis is strontium; this results in the largest strontium values on which other radionuclides are based.
        - However, all of the current dose reconstruction methodologies for General Atomics assume that urinalysis was performed. In absence of any urinalysis because the workers were not part of any bioassay program, reasonable and accurate strontium dose reconstruction cannot be performed.
- Metal tritide exposure/dose reconstruction
    - A concern was raised regarding the possible need for expanded consideration of the potential for exposure to metal tritides and the methods used to identify workers that might have been exposed to metal tritides.
        - Monthly reports in the mid-1960s discuss the use of titanium tritide associated with the TRIGA reactor building. It appears that targets were irradiated in the TRIGA reactor and then the Activation Analysis group worked with the targets in the Experimental Area Building #1.
        - Little information has been found regarding the quantities and chemical forms of tritium that were used at General Atomics, but site documentation indicates that a Texas Nuclear Corporation Neutron Generator console at the LINAC was being used with a “new 3 to 5 curie tritium target” in January 1963 (ORAUT-TKBS-0045, PDF p. 39).

   - The October 1965 monthly report for TRIGA and Activation Analysis Facilities noted that 25 used tritium targets that totaled 111 Ci were transferred from General Atomics for storage and ultimate disposal. Tritides (particulate) and tritiated water vapor and tritiated gas (the latter compounds would be released during off-gassing of the tritium targets) were likely chemical forms on the site (ORAUT-TKBS-0045, PDF p. 39).

   - Various materials were used as LINAC targets, including fissile material. Documents mention the use of LINAC tritium targets. However, there is no information on the material used in the construction of the targets, the number of tritium targets, nor the tritium activity within the targets used in the LINAC.

   - If all tritium is in the form of insoluble (Type "S") metal tritide, a urinalysis program could fail to detect rather large intakes, which could result in correspondingly large missed doses, particularly to the lung.

   - There is no information on whether any analyses were performed on the type(s) of metal tritide that may have been present at General Atomics, nor on what the potential intake by workers might have been during the AWE period. Thus, without the knowledge of the type of metal tritide and the fraction of tritium intake that the metal tritide may represent, sufficiently accurate internal dose assessment cannot be made.

- Plutonium-241 exposure/dose reconstruction

  - A concern was raised regarding the possible need for an expanded consideration of plutonium-241 exposures. Pu-241 has a 14-year half-life and decays to Am-241 through beta emission.

    - Table E-1 in Attachment E of ORAUT-TKBS-0045, provides information on the types of work and radiological monitoring that were performed at the Plutonium Laboratory in the HCF. The work appears to have involved mostly unencapsulated fuel-grade plutonium in glove boxes (ORAUT-TKBS-0045, PDF p. 38).

    - ORAUT-TKBS-0045 states that at the HCF Plutonium Laboratory the beta-activity fraction was as high as or higher than the alpha-activity fraction, possibly due to the presence of Pu-241, which might have been significant (about 85%) in terms of activity in a Pu-239/Pu-240 source term. With the maximum energy beta emissions of 21 keV, Pu-241 would be difficult to detect unless a windowless counter was used. But it is possible that the photon emissions from the plutonium isotopes and Am-241, as well as the bremsstrahlung from the Pu-241 beta emissions, were detected and attributed to beta emissions (ORAUT-TKBS-0045, PDF p. 38).

    - Documentation available to NIOSH does not mention Am-241 in association with the plutonium source term. For fresh source terms the Am-241 activity would be insignificant, but after 5 years the Am-241 in-growth would account for approximately 8% of the total radioactivity in an unirradiated reactor fuel-grade source term.

    - Thus, it is possible that Pu-241 could have escaped detection or its presence could have been attributed to other isotopes. Moreover, without the knowledge of whether Pu-241 went undetected or was erroneously identified as other isotopes, and the lack of information on the magnitude of the missed activity, sufficiently accurate Pu-241 dose construction cannot be performed.

- Thoron exposure/dose reconstruction
  - Concerns were raised regarding the use of thoron measurements performed at the Pilot Plant during post-operations to characterize possible thoron exposures during AWE operations.
    - No explicit concentration measurements of thoron or its progeny have been found for 1960 through 1969. A later set of measurements from 1975 is not considered representative of the 1960-1969 period (ORAUT-TKBS-0045, PDF p. 47).
    - ORAUT-TKBS-0045 states that given the fairly routine references to contamination on air samples from thoron progeny in the fuel fabrication area and the lack of information about what activities took place at the Thorium Pilot Plant, it seems unreasonable to assume that these later Pilot Plant measurements are useful for estimating thoron concentrations during the operational period in areas where large quantities of thorium were stored and handled (ORAUT-TKBS-0045, PDF p. 61).

Due to the issues indicated above, NIOSH has determined that infeasibilities associated with sufficiently accurate reconstruction of internal exposures during the period from January 1, 1960 through December 31, 1969 extend beyond the assessment of thorium exposures, as was presented in NIOSH's 2006 evaluation of SEC-00064. NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to unmonitored radionuclides, including unmonitored uranium, thorium, plutonium, tritium, and fission and activation products, during the period of AWE operations. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to unmonitored radionuclides, including unmonitored uranium, thorium and progeny, plutonium, tritium, and fission and activation products, and resulting doses for the class of employees covered by this evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the proposed class, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at General Atomics during the period from January 1, 1960 through December 31, 1969, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.2 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures to unmonitored radionuclides could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor (DOL). As noted above, HHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Although it is consequently not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of workers covered by this report, this sections presents NIOSH's findings regarding issues identified through the course of ongoing dose reconstruction and methodology reviews conducted by NIOSH and the Board after implementation of SEC-00064.

As presented above, the existing SEC class description for SEC-00064 was based on NIOSH's 2006 determination that exposure potential was limited to workers in specific buildings, that all workers with the potential for radiation exposures during the SEC-00064 class time period were included in the external dose monitoring program, and that unmonitored workers had no potential for radiation exposures. Through the course of ongoing dose reconstruction and methodology reviews conducted by NIOSH and the Board after implementation of SEC-00064, the following issues have been identified that may pertain to assessing external exposures during the General Atomics period from 1960 through 1969:

- External photon and neutron angles of incidence associated with reconstructing beta doses for skin cancers
- The validation of neutron adjustment factors presented in the General Atomics Site Profile (ORAUT-TKBS-0045)
- The neutron energy distributions assumed

Due to thus far unresolved issues such as those indicated above, NIOSH has determined that infeasibilities associated with sufficiently accurate reconstruction of worker doses during the period from January 1, 1960 through December 31, 1969 extend beyond the assessment of internal exposures, as was presented in NIOSH's 2006 evaluation of SEC-00064. NIOSH has determined that it is unable to define individual worker exposure scenarios for those workers that were not monitored for external exposure at General Atomics during the period 1960 through 1969. NIOSH has been unable to verify that external monitoring results are available for all workers with potential for external beta, gamma, or neutron exposures during the period.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored external beta, gamma, or neutron exposures during the period of AWE operations from January 1, 1960 through December 31, 1969.

In addition, NIOSH considers the adequate reconstruction of medical dose for General Atomics workers feasible by using claimant-favorable assumptions as well as applicable protocols specified in the complex-wide TIB ORAUT-OTIB-0006, *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*.

Although NIOSH found that it is not possible to completely reconstruct external radiation doses for the proposed class, NIOSH intends to use any external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at General Atomics during the period from January 1, 1960 through December 31, 1969, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.3 Class Parameters Associated with Infeasibility

HHS has designated an SEC class associated with SEC-00064 for General Atomics workers for the period from January 1, 1960 through December 31, 1969 (HHS, 2007). The time period covered by this current report is unchanged from that previously designated by HHS in 2007. The area-specific and personnel monitoring requirements designated by HHS in 2007 are removed by this current report. NIOSH therefore recommends that the current class include all workers and all areas of the General Atomics site for the time period from January 1, 1960 through December 31, 1969.

7.0 Summary of Feasibility Findings for Petition SEC-00218

This report evaluates the feasibility for completing dose reconstructions for employees at General Atomics from January 1, 1960, through December 31, 1969. NIOSH determined that members of this class may have received radiation exposures from radionuclides of uranium, thorium, plutonium, tritium, and fission and activation products associated with radiological research and production activities, including reactor and accelerator operations. NIOSH lacks sufficient information, including biological monitoring data, sufficient air monitoring information, or sufficient process and radiological source information that would allow it to estimate with sufficient accuracy the potential unmonitored internal exposures, including unmonitored uranium, thorium, plutonium, tritium, and fission and activation products, to which the proposed class may have been subjected.

NIOSH has documented herein that it cannot complete the dose reconstruction(s) related to this petition. The basis of this finding demonstrates that NIOSH does not have access to sufficient information to estimate either the maximum radiation dose incurred by any member of the class or to estimate such radiation doses more precisely than a maximum dose estimate.

NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class description associated NIOSH’s 2006 evaluation of SEC-00064 exposures for the period from January 1, 1960 through December 31, 1969. Additionally, due to the issues identified during ongoing dose reconstruction and methodology reviews conducted by NIOSH and The board after implementation of SEC-00064, NIOSH has determined that infeasibilities associated with sufficiently accurate reconstruction of internal exposures during the period from January 1, 1960 through December 31, 1969 extend beyond the assessment of thorium exposures as was presented in NIOSH’s 2006 evaluation of SEC-00064. NIOSH lacks sufficient information that would allow it to estimate with sufficient accuracy the potential unmonitored internal exposures, including unmonitored uranium, thorium, plutonium, tritium, and fission and activation products, to which the proposed class may have been subjected.

Table 7-1: Summary of Feasibility Findings for General Atomics January 1, 1960 through December 31, 1969				
Source of Exposure	**SEC-00064 Previous Designation SEC class effective March 18, 2007**		**SEC-00218 NIOSH Determination**	
	Reconstruction Feasible	**Reconstruction Not Feasible**	**Reconstruction Feasible**	**Reconstruction Not Feasible**
Internal[1]		**X**		**X**
- Thorium		X		X (unmonitored)[1]
- Thorium Progeny	Not Specifically Addressed			X (unmonitored)[1]
- Uranium (Natural, Depleted and Enriched)	X (October 1963 onward)	X (before October 1963)		X (unmonitored)[1]
- Uranium Progeny	Not Specifically Addressed			X (unmonitored)[1]
- Plutonium	Not Specifically Addressed			X (unmonitored)[1]
- Tritium	X (October 1965 onward)	X (before October 1963)		X (unmonitored)[1]
- Fission and Activation Products	Not Specifically Addressed			X (unmonitored)[1]
External	**X**			**X**
- Gamma	X			X (unmonitored)[1]
- Beta	X			X (unmonitored)[1]
- Neutron	X			X (unmonitored)[1]
- Occupational Medical X-ray	X		X	

Notes:
1 - Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures).

Through the course of ongoing dose reconstruction and methodology reviews conducted by NIOSH and the Board after implementation of SEC-00064, NIOSH has also determined that NIOSH is unable to define individual worker external exposure scenarios for those worker that were not monitored for external exposure. NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored external beta, gamma, or neutron exposures during the period of AWE operations from January 1, 1960 through December 31, 1969. NIOSH considers the adequate reconstruction of medical dose for General Atomics workers feasible by using claimant-favorable assumptions as well as applicable protocols specified in the complex-wide ORAUT-OTIB-0006, *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures.*

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at General Atomics during the period from January 1, 1960 through December 31, 1969, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00218

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

NIOSH has determined that members of the class were not exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures from uranium, thorium, plutonium, americium, tritium, and fission and activation products associated with radiological research and production activities, including reactor and accelerator operations. Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 NIOSH-Proposed Class for Petition SEC-00218

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all Atomic Weapons Employees who worked for General Atomics at its facility in La Jolla, California, during the period from January 1, 1960 through December 31, 1969, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees included in the Special Exposure Cohort.

10.0 Evaluation of Second Similar Class

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

11.0 References

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

42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 28, 2004; SRDB Ref ID: 22001

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SNM-696, *Special Nuclear Materials License 696* (Docket 70-734); multiple dates; General Atomics; La Jolla, California; SRDB Ref ID: 19014

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Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for General Atomics, La Jolla, California

Data Capture Information	Data Capture Description	Date Completed	Uploaded into SRDB
Primary Site/Company Name: General Atomics BE 1959-1967; AWE 1960-1969; Residual Radiation 1970-1995, 2000; DOE 1996-1999 (Remediation) Other Site Names: GA Division of General Dynamics John Jay Hopkins Laboratory for Pure and Applied Science Physical Size of the Site: General Atomics occupies approximately 120 acres on two contiguous sites. The Hot Cell Facility encompassed approximately 7,400 square feet. The site contained 43 buildings in 1994. Site Population: Samples of the number of personnel monitored for radiation exposure (excluding visitors) during the SEC064 period of 1/1/1960 - 12/31/1969 based on monthly exposure printouts are: 350 (April 1960); 390 (December 1964). Note: for additional informational purposes only, there were 1400 total personnel on site in 1994.	Decontamination and decommissioning of hot cell proposal, personnel list, bioassay data, personnel termination reports, isotope committee approvals, environmental data, personnel radiation exposure, uranium scrap recovery operations, radiological surveys, site, facility, fuel material and waste characterization plan, safety evaluation report, air sample data, license SNM-69 material, hot cell area dosimeter readings, investigation reports, radiological safety guide and procedures, emergency plan, hot cell facility reports, incident reports, hot cell facility procedures, byproduct material, license 4-1611-11, decommissioning and decontamination of fuel fabrication facility, trip reports, health physics reports, determination of fast and thermal neutron dosages, license manuals, material balance reports, whole body counts, in-vivo lung and total body counter, and General Atomics notebooks. Note: Additional data capture not required per NIOSH direction.	03/22/2011	416
State Contacted: NA	Note: Additional data capture not required per NIOSH direction.	03/22/2011	0
Battelle National Laboratory - King Avenue	A hazard report.	04/11/2011	1
DOE Carlsbad	HTGR applications program contract summary and safety analysis supplement for the standard MHTGR.	08/10/2010	2
DOE Germantown	Contract AT(40-1)-3367-General Atomics, U-233 product distribution, and Westinghouse Hanford Company audit of Gulf General Atomic, toxic	06/18/2008	10

Table A1-1: Summary of Holdings in the SRDB for General Atomics, La Jolla, California			
Data Capture Information	**Data Capture Description**	**Date Completed**	**Uploaded into SRDB**
	hazards of beryllium.		
DOE Legacy Management - Grand Junction Office	Long range plan for fiscal years 1985-1988, termination dosimetry reports, thorium stockpile and use in breeder reactor, trip reports, National Lead Company of Ohio minutes of staff meeting, bills of lading for shipments, shipping logs, disposition of enriched uranium scrap, thorium sludge shipments, summary of Brazilian thorium sludge transferred to NLO, and purchasing of DOE thorium residues.	09/20/2010	28
DOE Legacy Management - Morgantown	Enriched uranium shipment information.	02/03/2011	2
DOE Legacy Management - MoundView	Bioassay information, radioactive waste management report, and a Building 21 acceptance document.	09/08/2008	9
DOE Office of Scientific and Technical Information (OSTI)	Hot cell final environmental assessment, survey of irradiation facilities, and a verification survey of the hot cell, breeder fuel development program report, and radioactive waste shipment information.	11/05/2012	10
DOE Oak Ridge Operations (ORO)	Personnel exposure records, future use and disposition of uranium-233, and special nuclear material inventory.	07/09/2012	3
Federal Records Center (FRC) - San Bruno	Analysis of nuclear radiation shields, photo induced reactions to nuclear safeguards materials, curium-224/neptunium-237 recovery from the Barnwell Nuclear Fuel Plant, monthly progress report, procedure manuals, utilization of neutron radiography, SNAP program cost and schedule report, fabrication of a thermionic reactor system using U-233, fast neutron weighting factors, summaries of fuels and materials development programs, and thorium utilization program information.	08/03/2012	19
Hanford	History of Fernald thorium process operations and monthly reports.	11/24/2008	5
Idaho National Laboratory	Lung and thyroid counter calibration information.	05/09/2012	1
Internet - Defense Technical Information Center (DTIC)	Shielding and control materials for gas cooled fast breeder reactor, displacement radiation effects report, and a progress report.	12/05/2012	4
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford operations monthly reports.	01/14/2008	5
Internet - DOE Legacy Management Considered Sites	Radiological survey data, hot cell decommissioning plan, and fuel material characterization and packing report, and a management guide.	08/01/2012	8
Internet - DOE OpenNet	Linking Legacies Appendix B and a financial report.	09/20/2012	5
Internet - DOE OSTI Energy Citations	Program summary, thorium use progress report, and processing of Pu-238.	03/28/2013	5
Internet - DOE OSTI Information Bridge	Report on shipments to and from the Nevada Test Site and counting laboratory intercalibration information, site treatment plan, emergency preparedness source term information, user facilities at the Lawrence Berkeley National Laboratory, and fission product tritium distribution in zircaloy cladding.	03/29/2013	22

Table A1-1: Summary of Holdings in the SRDB for General Atomics, La Jolla, California			
Data Capture Information	**Data Capture Description**	**Date Completed**	**Uploaded into SRDB**
Internet - Google	Annual report to Congress of the Atomic Energy Commission, hot cell characterization, decontamination and decommissioning, information on nuclear batteries, and the importance of gas cooled reactors.	04/14/2013	37
Internet - NIOSH	A beryllium contamination report.	09/14/2011	5
Internet - NRC Agencywide Document Access and Management (ADAMS)	FUSRAP sites review, NUREG-0713 excerpts, and NRC decommissioning criteria.	03/26/2013	26
Internet - Oak Ridge National Laboratory (ORNL)	Progress and status reports and out of pile studies of fission product release.	12/18/2012	19
Kansas City Plant	Radioactive sources documentation.	12/04/2012	1
National Archives and Records Administration (NARA) - Atlanta	Information on the Dragon Project, feasibility report for the General Atomic HTGR critical assembly fuel elements, and documentation regarding U-233 thorium project.	05/20/2008	4
National Archives and Records Administration (NARA) - College Park	Survey of a beryllium problem.	09/11/2002	1
National Institute for Occupational Safety and Health (NIOSH)	Establishment of compensation program.	12/12/2011	1
Nevada Test Site (NTS)	Final environmental impact statement for the Nevada Test Site.	10/01/2003	1
Nuclear Regulatory Commission PDR	Semi annual effluent report.	06/06/2011	2
Oak Ridge National Laboratory (ORNL)	Radioisotope sales and a progress report.	01/23/2013	2
ORAU Team	Documented communication and technical basis documents.	03/06/2012	4
R. S. Landauer	No relevant documents identified.	07/07/2014	0
SAIC	Radiation exposure summary.	09/02/2004	5
S. Cohen & Associates (SC&A)	Fernald related radioactive material information and license documents.	04/07/2011	4
Sandia National Laboratory - NM	A trip report.	07/10/2005	1
Savannah River Site	Visitor dosimetry cards, thoria fuel irradiation program information, and progress reports.	03/19/2012	11
Southern Illinois University, Edwardsville, IL	Environmental and health legacy of the Mallinckrodt Chemical Works.	10/29/2008	2
Unknown	Final safety analysis report, personnel external exposure information, reports on nuclear reactor program and special nuclear material license No. SNM-33.	07/31/2003	10
Westinghouse Site	Employee exposure records.	04/07/2009	1
Total			**692**

Table A1-2: Database Searches for General Atomics, La Jolla, California			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
Note: The normal prescribed publicly accessible Internet database searches are currently in progress for General Atomics.			

Table A1-3: OSTI Documents Requested for General Atomics, La Jolla, California			
Document Number	**Document Title**	**Requested Date**	**Received Date**
GA-A-15793 Ref ID: 111592	Consolidated fuel reprocessing program. Quarterly progress report for the period ending February 29, 1980	11/22/2011	06/01/2012