

## SEC Petition Evaluation Report

### Petition SEC-00055

Report Rev # 0

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Subject Expert(s):	Monica Harrison-Maples, Mike Kubiak (Corporate COI), Mike Mahathy, Jack Beck
Site Expert(s):	
Independent Technical Reviewer:	

Petition Administrative Summary											
Petition Under Evaluation											
Petition #		Petition Type		Qualification Date			DOE/AWE Facility Name				
SEC-00055		83.14		February 28, 2006			Nevada Test Site				
Feasible to Estimate Doses with Sufficient Accuracy?											
Single Class				Multiple Classes				Determination Established for All Classes			
Yes		No	X	Yes		No	X	Yes	X	No	

Initial Class Definition
All employees at the Nevada Test Site (NTS) for the period from January 27, 1951 through December 31, 1962.

Proposed Class Definition (Abbreviated)
Employees of the DOE or DOE contractors or subcontractors who were monitored or should have been monitored at the Nevada Test Site (NTS) for a number of work days aggregating at least 250 work days during the period from January 27, 1951 through December 31, 1962 or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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

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

<b>ORAU Lead Technical Evaluator:</b> (Document Owner)	<u>Signature on file</u> <i>Monica Harrison-Maples</i>	<u>4/10/2006</u> <i>Date</i>
<b>Peer Review Completed By:</b>	<u>Signature on file</u> <i>LaVon Rutherford</i>	<u>4/14/2006</u> <i>Date</i>
<b>SEC Petition Evaluation Reviewed By:</b>	<u>Signature on file</u> <i>Jim Neton</i>	<u>4/14/2006</u> <i>Date</i>
<b>SEC Evaluation Approved By:</b>	<u>Signature on file</u> <i>Larry Elliott</i>	<u>4/14/2006</u> <i>Date</i>

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## Evaluation Report Summary: SEC-00055, NTS

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) covers a class of employees proposed for addition to the Special Exposure Cohort (SEC) in Petition SEC-00055 in accordance with the *Energy Employees Occupational Illness Compensation Program Act of 2000*, 42 USC § 7384 et. seq. (EEOICPA) and 42 C.F.R. § 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*.

The petition was submitted by an EEOICPA claimant who had been employed at the Nevada Test Site (NTS), whose dose reconstruction could not be completed by NIOSH because of a lack of sufficient information. As provided under Health and Human Services (HHS) regulations covering this circumstance and type of SEC petition (42 C.F.R. § 83.14), NIOSH has defined a class of employees subject to this evaluation. This class includes Employees of the DOE or DOE contractors or subcontractors who were monitored or should have been monitored at the Nevada Test Site (NTS) for a number of work days aggregating at least 250 work days during the period from January 27, 1951 through December 31, 1962.

In this SEC Evaluation Report, NIOSH provides its findings on the feasibility of estimating radiation doses of members of this class with sufficient accuracy (i.e., the feasibility of dose reconstruction) and on health endangerment, as required for NIOSH evaluations of SEC petitions under EEOICPA and 42 C.F.R. § 83. This report will be considered by the Advisory Board on Radiation and Worker Health and by the Secretary of 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.

### Feasibility of Dose Reconstruction

The feasibility determination for the class of employees covered by this evaluation report is governed by the requirements of the EEOICPA and 42 C.F.R. § 83.13(c) (1) and § 83.14(b). Section 83.13(c)(1) states that “Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class, or if NIOSH has established that it has access to sufficient information to estimate the radiation doses of members of the class more precisely than an estimate of the maximum radiation dose.” Section 83.14(b) states that HHS will consider the determination by NIOSH that there was insufficient information to complete a dose reconstruction, as indicated in this present case, “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.”

NIOSH has documented in this evaluation that it cannot complete the dose reconstruction related to this petition. The basis of this finding is specified in this report, which 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. As a result of above-ground nuclear detonations, members of this

class at the NTS may have received radiological exposures to a variety of fission products and other radionuclides deposited in the soil and throughout the environment at the site. NIOSH lacks sufficient information, necessary to estimate the potential internal exposure(s) to which the proposed class may have been exposed. Specifically, NIOSH has discovered data deficiencies relating to: available internal monitoring data, the physical characteristics of suspended or re-suspended radiological material that the members of the class may have inhaled or ingested, and radiological source information.

### Health Endangerment

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(c) and § 83.13(c) (3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also make a determination whether or not there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires 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 whether 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.

The NIOSH evaluation did not identify evidence from the petitioners or from other sources that would establish the class was exposed to radiation during an unplanned, uncontrolled, discrete incident likely to have involved exceptionally high level exposures as described above. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated substantial chronic dose as a result of episodic occupational exposure to radionuclides or sources. Consequently, NIOSH has determined 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.

### Proposed Class Definition

This evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes employees of the DOE or DOE contractors or subcontractors who were monitored or should have been monitored at the Nevada Test Site (NTS) for a number of work days aggregating at least 250 work days during the period from January 27, 1951 through December 31, 1962 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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## 1.0 Purpose

The purpose of this report is to provide an evaluation of the feasibility of reconstructing the dose for employees of the DOE or DOE contractors or subcontractors who worked at the Nevada Test Site in Nye County, Nevada, for the period from January 27, 1951 through December 31, 1962. The report completes the NIOSH evaluation in response to SEC Petition SEC-00055.

This evaluation was conducted in accordance with the requirements of EEOICPA, 42 C.F.R. pt. 83, and the guidance contained in NIOSH's Internal Procedures for SEC Evaluations, OCAS-PR-004. This evaluation provides information and analyses germane to considering a petition for adding a class of employees to the SEC. It does not provide any determinations concerning the feasibility of dose reconstruction that necessarily apply in the particular case of any individual energy employee who might require a dose reconstruction from NIOSH.

## 2.0 Introduction

The *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*, 42 C.F.R. pt. 83, requires NIOSH to evaluate qualified petitions requesting HHS to add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether or not it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.<sup>1</sup> If it is not feasible, the regulation requires NIOSH to make a determination with respect to the health endangerment of the class of employees. Specifically, 42 C.F.R. § 83.14(b) states that HHS will consider the determination by NIOSH that there was insufficient information to complete a dose reconstruction, as indicated in this present case, "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."

NIOSH is required to document the evaluation in a report, which is provided to the petitioners and to the Advisory Board on Radiation and Worker Health (the Board). 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 decisions on behalf of HHS. The Secretary of HHS will make final decisions, 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 proposed decisions issued by the Secretary of HHS.<sup>2</sup>

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

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

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

This NIOSH report provides a summary of the methods and findings of the NIOSH SEC evaluation for employees of the DOE or DOE contractors or subcontractors who worked at the NTS for the period from January 27, 1951, through December 31, 1962. During this period, employees at this facility were involved in atmospheric testing of nuclear devices, device safety testing, and nuclear reactor testing, potentially receiving exposures from a range of fission and activation products. Exposure-causing operations of significance during atmospheric nuclear testing include: sample and measurement device recovery, scientific testing operations, and various other operations exposing workers to terrestrial and airborne fallout.

The evaluation responds to a petition (SEC-00055) submitted by an EEOICPA claimant who had been employed as a laboratory assistant at the facility from September 14, 1961, through January 17, 1964, whose dose reconstruction could not be completed by NIOSH because of a lack of sufficient dosimetry-related information. The determination by NIOSH that it is unable to complete a dose reconstruction for a EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

### **4.0 Feasibility**

In the case of a petition submitted to NIOSH under 42 C.F.R. § 83.9(b), NIOSH has already completed research to determine that a dose reconstruction cannot be completed for an employee at the DOE or Atomic Weapons Employer (AWE) facility. This determination by NIOSH provides the basis for the petition by the affected claimant. Further consideration by NIOSH is given to defining the extent of the class of employees who are similarly affected, as indicated by the completed research, and hence, as a class of employees, dose reconstruction is similarly not feasible. In accordance with 42 C.F.R. § 83.14(a), NIOSH also considers whether or not the completed research provides a basis for evaluating an additional class at the facility, for whom it might appear to NIOSH that dose reconstruction is unlikely to be feasible. If NIOSH were to identify such a basis, it would undertake a separate SEC evaluation to conduct necessary research on the additional class. This would allow NIOSH, the Board, and HHS to complete, without delay, their consideration of the class including a claimant for whom NIOSH has already determined a dose reconstruction cannot be completed and hence whose only possible remedy under EEOICPA would be through the addition of a class of employees to the SEC.

This section of this report provides a summary of 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. The determination relies on the same statutory and regulatory criteria that govern consideration of all SEC petitions. As in all SEC evaluation reports, this feasibility evaluation summarizes the radiological exposures of concern, the availability of information related to reconstructing radiation doses associated with the radiological exposures summarized, and analyzes separately and to the extent necessary the feasibility of reconstructing the radiation doses from internal and external exposures.

## 4.1 Statutory and Regulatory Criteria

The feasibility determination for the class of employees, covered by this SEC Evaluation Report, is governed by EEOICPA and 42 C.F.R. § 83.13(c) (1). Under the Act and rule, NIOSH must establish whether or not it has access to sufficient information to either estimate the maximum radiation dose 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. If NIOSH were to have access to the information sufficient for either case, then dose reconstruction would be considered feasible (NIOSH would consider it feasible to estimate radiation doses with sufficient accuracy).

In making the determination that a dose reconstruction cannot be completed, NIOSH systematically evaluates the sufficiency of all relevant data to this determination, which include the different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum dose the employee might have incurred, or a more precise estimate reflecting close monitoring of the employee's exposures or doses for part or all of the employee's career in nuclear weapons work.

The determination by NIOSH that a dose reconstruction cannot be completed, together with its substantive basis, are sufficient, in and of themselves, to support the determination by the Secretary of HHS that it is not feasible to estimate with sufficient accuracy the radiation dose potentially received by a class of employees, once the Board has provided the Secretary with a recommendation. As specified under Section 83.14(b), HHS will consider this determination "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." The remaining issues for consideration by NIOSH, the Board, and HHS are the appropriate scope of the determination (which is to be specified by the definition of the class of employees to which this determination is applied), and the health endangerment determination.

## 4.2 Dose Reconstruction Findings

NIOSH determined, pursuant to 42 C.F.R. § 82.12, that a radiation dose reconstruction could not be completed for the employee identified in SEC Petition SEC-00055, who was a laboratory assistant at the facility employed during a portion of the period from January 27, 1951, through December 31, 1962. Upon a review of all the available records concerning this facility, NIOSH has not obtained or located sufficient internal personnel monitoring data that could be used to estimate the amount of internal exposure to radiological materials the laboratory assistant may have incurred in his duties at the NTS during atmospheric testing. In addition, NIOSH found the available records, which include program history, personnel dosimetry, environmental records, and air monitoring history records, to be insufficient to estimate maximum internal radiation exposures to the employee under plausible conditions. The research basis for these findings and other facility-specific research NIOSH completed concurrently are summarized in Sections 4.3 through 4.6 below.

### 4.3 Radiological Exposures

The Nevada Test Site is located in Nye County in southern Nevada, about 65 miles northwest of Las Vegas. The site currently encompasses approximately 1,375 square miles and is buffered for public access by vast, federally-owned land. The site was established in 1951 to conduct field tests of nuclear devices in connection with the research and development of nuclear weapons. It was the primary location for testing nuclear explosive devices since 1951. Above-ground testing at NTS began with the January 27, 1951, Able test (Operation Ranger), and concluded with the Little Feller I test (Operation Sunbeam) on July 17, 1962. Radiological operations at the NTS included atmospheric weapons detonations, safety tests, and other experimental reactor testing. (ORAUT-TKBS-0008-2)

U.S. atmospheric weapons testing included: air drop detonations of nuclear devices; detonations from towers ranging from 30 m to 213 m (100 ft to 700 ft) in height; detonations of devices lifted by helium-filled balloons up to 457 m (1,500 ft) above the earth; and detonations on the earth's surface. These tests were conducted in Areas 1 through 5, 7 through 11, and Area 18. The Limited Test Ban Treaty, signed in August, 1963, mandated that all further nuclear weapons tests be performed underground.

The extent and distribution of contamination from an atmospheric nuclear weapons test varies depending on the height of detonation, the type of device and its yield, and the weather conditions surrounding the test. Due to the repeated deposition and re-suspension of the radionuclides previously deposited by any prior blasts at the NTS, NIOSH finds it is unable to determine the levels and characteristics of terrestrial and airborne contamination present during atmospheric testing at any given time. Internal exposures to fission product contamination are considered likely not only for those employees present during fallout from a particular detonation, but also for any employees exposed to re-suspended contamination with characteristics that changed with each subsequent blast. This re-suspension and mixing of previously-deposited contamination would have been very significant as a result of the blast waves associated with the detonation of each nuclear device. Without protective equipment, such as respirators, individuals in or around such re-suspended contamination would have a significant potential for internal exposure.

Most participants in atmospheric testing had some potential for external radiation exposure to gamma- and beta-emitting fission products. These are more fully addressed by the technical basis documents (TBDs) that comprise the NTS Site Profile (ORAUT-TKBS-0008-1 through -6).

While indications are that most personnel were positioned out of the forward areas until well after detonation, and thus, were not exposed to prompt neutrons or the high-activity fission products, there were participants with the potential to be exposed to the conditions nearly immediately after detonation. According to reports and interviews, all AEC personnel would have worn external dosimetry in the form of film badges during forward area activities. (Interview Notes, 2006)

It may be conservatively assumed that participants operating in forward areas had the potential to be exposed to fission products still suspended in the blast cloud. The fission products of a nuclear detonation consist of over 200 different nuclides of approximately 36 elements, most of

which are radioactive. Most elements decay to stable nuclides by emission of beta particles with gamma rays. The amount of fission products formed depends on the fission yield of the weapon (Klement, 1965). According to interviews with former workers who operated in the forward areas, such personnel wore full-face respirators, but they were not participating in a routine bioassay program. (Interview notes, 2006) In fact, records indicate that while bioassay monitoring was initiated in 1958, routine bioassay was not conducted until 1961. Once started, bioassays were performed in an attempt to determine Pu-239, tritium, and gross fission product uptake.

Safety tests involving the above-ground detonation of nuclear devices were designed to evaluate the safety of nuclear weapons in accident scenarios. The safety tests dispersed mixtures of plutonium and uranium using conventional explosives. Concurrent with and after these detonations, extensive studies were conducted to understand the dispersal and transport of these radionuclides in the environment. The residual contamination could potentially be re-suspended and inhaled or ingested by personnel working in the area. (ORAUT-TKBS-0008-1)

Area 25, also known as Jackass Flats, was the site selected for a series of ground tests of reactors, engines, and rocket stages as part of a program to develop nuclear reactors for use in the nation's space program. In the early 1960s, the Atomic Energy Commission (AEC) and the National Aeronautics and Space Administration (NASA) negotiated an interagency agreement to establish and manage a test area at the NTS designated as the Nuclear Rocket Development Station. Area 26, within the Reserved Zone, occupies 57 km<sup>2</sup> (22 mi<sup>2</sup>) in the south-central area of the NTS. Areas 25 and 26 were used for a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests between July, 1959, and September, 1969. The goal of the nuclear rocket engine test program was to develop an operational nuclear rocket for space travel. Engine exhaust dispersed radioactive material as the core and cladding degraded during operation of the engine. (ORAUT-TKBS-0008-1)

The Bare Reactor Experiment, Nevada (BREN) experiments were conducted in Area 4 of Yucca Flat from 1962 to 1966. The experiment bombarded Japanese-style houses, built for the experiment, with various intensities of radiation from a small, unshielded reactor on the BREN tower to develop a way to accurately estimate the radiation doses received by selected survivors of the atomic bombings of Nagasaki and Hiroshima, Japan.

NIOSH has compiled and published a more complete summary of the information available to evaluate exposures at NTS. This information is summarized in the technical basis documents (TBDs) that comprise the NTS Site Profile (ORAUT-TKBS-0008-1 through -6). These TBDs are available online at [www.cdc.gov/niosh/ocas](http://www.cdc.gov/niosh/ocas).

## 4.4 Summary of Data Resources and Limitations

The primary data used for determining internal exposures are from personal monitoring data, such as urinalysis, 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 radiological source term.

The 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 for determining external exposures to the cancer site. If there are no personal monitoring data, exposure rate surveys, process, 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, *Internal Dose Reconstruction Implementation Guide*, and OCAS-IG-002, *External Dose Reconstruction Implementation Guide*. These documents are available at: [www.cdc.gov/niosh/ocas/ocasdose.html](http://www.cdc.gov/niosh/ocas/ocasdose.html).

### 4.4.1 NTS Internal Personnel Monitoring Data

The primary emphasis of the radiation safety program at the NTS was guided by the belief that external exposure was the controlling factor. It was felt that if the external dose was controlled, the internal doses would be low; therefore, little effort was expended by NTS on monitoring internal exposure prior to 1958.

There was no formal bioassay program for the NTS prior to 1958. In 1958, Reynolds Electrical and Engineering Company (REECO) started to adopt much of the Los Alamos National Laboratory (LANL) program for internal monitoring (routine bioassay monitoring did not begin until 1961). After 1961, all workers classified as having a potential for radiological exposure were on quarterly bioassay program. That included tunnel workers, miners and drillback operators. In addition, all Wackenhutt security guards were on quarterly bioassay. There was a control group, (about 30 individuals) working at Mercury that were considered not to have any potential exposure that were on bioassay as a control group. There was a group of laboratory workers with potential for tritium exposure on bioassay as well. Anyone involved in a contamination event or incident with contamination was followed up with a bioassay sampling. Internal monitoring data and estimates of internal dose for the class period are very limited when they exist at all. Bioassay samples were taken by the radiological safety professionals as a screening tool to evaluate internal exposure to workers when they were suspected. The results of these biological samples have not been located by NIOSH, and appear to have not been maintained.

A review of the dosimetry data currently available to NIOSH indicates 351 current claims that have work histories within the 1951 to 1963 timeframe. Of those 351 claims, 202 have no recorded internal monitoring data. There are 128 claims with NTS *in vitro* data, and 44 claims

with NTS *in vivo* results. Many of the internal bioassay monitoring data are from periods after 1962, and therefore, may have limited usefulness in addressing potential exposures during the period of above-ground testing at the NTS.

#### **4.4.2 NTS External Personnel Monitoring Data**

The NTS external dosimetry program is well documented and the associated records are available to NIOSH. LANL provided the dosimetry service for NTS in the early years, with REECO taking over the dosimetry functions in 1958. REECO adopted the LANL dosimetry protocols. As the NTS test program progressed, efforts to quantify external exposure and limit dose improved.

The radiation monitoring and control programs instituted at NTS in the late 1950s and early 1960s included personnel dosimetry, area monitoring, source term characterization, and measurement of fallout dispersion (ORAUT-TKBS-0008-6). Film badges were used during that time to determine external exposure. After the resumption of the nuclear testing program in 1961, the film badges were exchanged on a regular schedule. It is not an unreasonable assumption that the film badges were exchanged on some regular schedule prior to 1961.

Self-reading pocket dosimeters (Pocket Ionization Chambers or PICs) were issued to provide a trigger for follow-on action if an individual exceeded an administrative exposure limit. The PIC results were not considered a record of dose. If the film badge dosimeter was damaged or compromised, the PIC result was sometimes recorded as the dose-of-record, usually only when a special investigation of an incident was initiated.

To date, 615 NTS claims having potential employment during the evaluation period were reviewed in support of this evaluation. Of the 615 claims, all but 54 have reported external monitoring data.

#### **4.4.3 Summary of Available Workplace Monitoring**

In addition to personnel monitoring information, NIOSH seeks to locate workplace monitoring records and data to determine the field characteristics and amounts of radioactivity to which workers may have been exposed. Relevant workplace monitoring data ideally would include: air monitoring to determine if radiological particles and/or gasses were airborne in the spaces being monitored; ambient area radiation monitoring to determine if significant radiation fields existed and what the characteristics of those fields might have been; and other studies or data that might support the understanding of what source terms contributed to on-site radiological conditions.

A review of various historical reports by the Defense Nuclear Agency (now the Defense Threat Reduction Agency [DTRA]) on each nuclear test operation indicate an air monitoring program of limited scope existed at the NTS for each test series, developed primarily for tracking fallout and ensuring that contamination did not travel off site. Indications are that this program was not intended to qualify or quantify personnel exposure and did not include particle size studies or determine the chemical characteristics of any airborne particulates. (DNA 6041F)

Due to the nature of the events being studied at NTS, and the role of the test site, significant amounts of the work were performed in the open. Individuals were not exclusively located

indoors as is the case at many other DOE/AEC operational plants. Area monitoring was performed at selected NTS locations, but the application of those data to dose reconstruction is substantially limited by the lack of information regarding work locations of individuals relative to the air sampling locations. Limited environmental monitoring data is available to NIOSH prior to 1964, when REECO established an environmental surveillance program.

The source term due to each above-ground test at NTS was specific to each testing event, including the residual contamination from previous events. The quantities of some specific radionuclides inherent to individual events cannot be determined with data currently available to NIOSH. While studies have been reported that provide partial source term information, the ratios of plutonium and uranium for various tests are specifically missing from the open source literature.

The physical and chemical characteristics of nuclear debris depend on the type of nuclear detonation and on the environment found at the location of the detonation. The amount and composition of radioactivity produced are determined to a large extent by the fission and thermonuclear yield of the device and the extent of involvement of surrounding material. The fissionable material used also affects the amounts of fission products resulting from the detonation. Due to the wide variations between tests, NIOSH does not have sufficient data to quantify the source term for the individual testing events across multiple test locations and times.

#### **4.4.4 Nuclear Test Personnel Review (NTPR)**

The Nuclear Test Personnel Review program was established in 1978 to: develop histories of the U.S. atmospheric nuclear weapons tests; define radiation safety policies and procedures in effect during the tests; identify participation and radiation doses for DOD military and civilian personnel who took part in the tests; and make the resulting information available for review by scientific organizations (DNA 6041F). Since its inception, NTPR has provided radiation dose information and data to military veterans who: participated in U.S. atmospheric nuclear tests; served with American occupation forces in Hiroshima and Nagasaki, Japan; or were prisoners of war in Japan at the conclusion of World War II. The program performs dose reconstructions for these veterans using film badge dosimetry, and develops models to determine dose based on military unit activities and understood radiological conditions. NIOSH has relied heavily on the work by the NTPR to develop the histories and capture the documented radiological safety policies and procedures in effect during atmospheric nuclear weapons testing. The program is administered by the Defense Threat Reduction Agency (DTRA), the Department of Defense (DOD) Executive Agent for the NTPR program.

### **4.5 Feasibility of Estimating Internal Exposures**

As indicated in Section 4.4, both the internal personnel monitoring data and sufficient workplace monitoring data required for estimating internal exposures are lacking.

Internal dose cannot be measured directly; it must be estimated based on models and assumptions incorporating environmental information, and ideally, bioassay monitoring results obtained at, or relatively near, the time of exposure. Very limited bioassay results exist for NTS employees from 1951 through 1962. Once it was determined that insufficient personnel

monitoring data were available for internal dose reconstruction for NTS energy employees for the period under investigation, NIOSH attempted to determine if sufficient air monitoring data were available to lieu of personnel monitoring data.

The determination of credible upper-bound inhalation doses from air monitoring data requires reasonable exposure scenario information, and well-defined source term information. Though a credible air monitoring program existed at NTS, the analysis of the samples did not provide empirical information that would allow accurate estimates of the radionuclide composition or the distribution of particle size in the atmosphere at the time of the sampling. Particles sizes of nuclear debris vary widely depending on the characteristics of the nuclear device and its detonation. For high-yield air bursts, sizes range from submicron to a few hundred microns. Shots associated with large amounts of silicate generally result in larger particles that may be as large as several thousand microns.

As particles are transported through the atmosphere, association between nuclear debris and non-nuclear material normally found in the atmosphere takes place. Such associations may involve chemical reactions between constituents, or other phenomena. These “combining” effects may result in considerable change in particle size and in the chemical properties of the aerosol containing the nuclear debris in surface air. Also, some nuclide compounds may be dissolved in precipitation and subsequently released; this process may alter the radioactivity content of the particles (Klement). Without an air monitoring program conducted under the same conditions as atmospheric testing, and designed specifically to characterize particle size and chemical properties, any information developed regarding size and composition during NTS atmospheric testing would necessarily be of a theoretical nature. The NTS air monitoring program at that time was not intended or designed to assess particle size or the spectrum of the radionuclides present in the air. Particle-size distribution information is evaluated to understand the transport and deposition of the radiological material in the body, which is critical to an accurate dose reconstruction. NIOSH has determined that the NTS air monitoring program in place at that time was not sufficient to substitute for bioassay monitoring in the performance of internal dose reconstruction.

In the absence of adequate bioassay data and sufficient air monitoring data, the remaining approach is to use site-specific monitoring and source term information to establish a credible upper-bound estimate of potential exposures resulting from NTS above-ground testing. NIOSH is lacking sufficient data regarding the nuclear devices and the behavior of the radionuclides in the fallout (dispersion, fractionation, and conditions of re-suspension) to estimate the concentration of fission products and nuclides present after each detonation. NIOSH has no clear, defensible method of determining the concentrations of radionuclides present, or enough exposure scenario information to credibly determine an upper-bound estimate of internal exposure for participants or observers based on source term information.

NIOSH further attempted to determine the magnitude of potential internal doses by relating them to measurements of recorded NTS external doses. NIOSH found this approach to be insufficient for adequate determination of internal doses due to the lack of actual measurement data sufficient to verify the results of the proposed modeling, and the inability to adequately account for particulate re-suspension due to the blast waves from repeated tests in a relatively short period of time. NIOSH cannot at this time develop a direct correlation between recorded external exposure and intake that would generally apply to NTS workers.

As identified in Section 4.4.4, the NTPR program employs a method for completing internal dose reconstructions for veterans who participated in U.S. atmospheric nuclear tests. NIOSH has examined the models used for the NTPR program. In addition, NIOSH has reviewed the issues identified by the National Research Council in their review of the NTPR program. The NRC review identifies several technical issues that NIOSH feels make the NTPR model insufficient for estimation of doses in the EEOICPA program. NIOSH feels the levels of uncertainty associated with various NTPR model parameters have not been quantified sufficiently at this time for use in the EEOICPA program.

Consequently, based on the available data, NIOSH is unable to estimate with sufficient accuracy internal exposures and resulting doses for the class of employees covered by this evaluation. The initial class for which feasibility was considered by NIOSH in response to SEC Petition SEC-00055 comprised laboratory assistants who worked at the NTS from January 27, 1951, through December 31, 1962. The basis for the infeasibility of dose reconstruction for the petitioner's specific claim was the inability of NIOSH to adequately address potential exposures associated with the changing and undefined source term during multiple atmospheric tests at the NTS. While it is very likely that individuals operating in the forward areas during atmospheric nuclear testing would have received exposures exceeding those of other groups of workers, NIOSH has been unable to identify data sufficient to segregate job descriptions to specific locations across the site. Without information regarding job duties and location, NIOSH is unable to determine which workers were or were not potentially exposed to the changing radiological conditions during atmospheric nuclear testing. Consequently, the feasibility findings above apply to all employees at the facility, including but not limited to, laboratory assistants.

Above-ground testing at the NTS began on January 27, 1951, and concluded on July 17, 1962. NIOSH considers reconstruction of internal doses at the NTS feasible for periods after cessation of atmospheric testing beginning on January 1, 1963. During the period of atmospheric testing, the source term to which workers were exposed changed with each detonation, due mainly to re-suspension and mixing of fallout caused by the blast waves. After the final above-ground test, NIOSH considers the radiological source term to be sufficiently stable so as to allow assumptions adequate for dose reconstruction. The extension of the SEC period through December 31, 1962, approximately six months after the last atmospheric test, allows time for the stabilization of the source term and for decay of the shorter-lived radionuclides associated with the final atmospheric tests.

## 4.6 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor. As noted above, HHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Consequently, it is not necessary for NIOSH to evaluate the feasibility of reconstructing external radiation exposures in this case. NIOSH expects, however, that such exposures can be estimated with sufficient accuracy.

Individual worker photon and beta external doses were measured and administratively controlled at NTS beginning with the start of nuclear testing in January, 1951. Only a small fraction of NTS workers were likely to receive any occupational exposure to neutrons; the potential for neutron exposure was much more limited than that for photon or beta exposure (ORAUT-TKBS-0008-6 §6.3.2.2). Neutron dosimetry was implemented in 1966. Information regarding the administrative practices, radiation type, energy, and characteristics of the dosimeter response is available from NTS program records. For a detailed description of this information, refer to the Occupational External Dose TBD (ORAUT-TKBS-0008-6).

Exposure to contaminated surface soils containing measurable amounts of long-lived radionuclides at NTS locations was controlled through regular monitoring and controlled access to areas where the soil was heavily contaminated. In 1964, REECO) established an environmental surveillance program designed to measure general radiological conditions throughout the site. Prior to 1964, there were various fallout and environmental studies conducted to determine the impact of a specific test program or event. The Occupational Environmental Dose TBD for NTS (ORAUT-TKBS-0008-4) uses the information from these studies, and the annual environmental reports, to support the NIOSH process for determining the environmental contribution to the probability of causation.

In addition to the occupational external exposures from facility operations and environmental contamination, the occupational medical exposures from routine X-ray examinations given to the energy employee as a condition of employment are also included in the external exposures. These exposures are estimated using technical information pertinent to the type of X-ray equipment used at the facility.

Pre-employment X-ray procedures were an NTS occupational requirement that contributed to the radiation exposure of site workers. The history of the medical program administering these X-rays is well documented from 1951 to the present; NIOSH has access to those records. The technical factors affecting diagnostic X-ray dose (i.e., beam quality, distance from target, collimation and waveform characteristics, current and exposure time, and uncertainty for this type dose) are understood and accounted for during the NIOSH dose reconstruction procedures. For specific details, refer to the Technical Basis Document for the Nevada Test Site - Occupational Medical Dose (ORAUT-TKBS-0008-3)

NIOSH considers the available data and methods for performing external dose reconstruction, as supported by the NTS site profile documents and other NIOSH technical documents, to be adequate for estimating with sufficient accuracy the external radiation doses of members of this class.

#### **4.7 Summary of Feasibility Findings**

This report evaluated the feasibility for estimating the dose, with sufficient accuracy, for employees of the DOE or DOE contractors or subcontractors at the NTS from January 27, 1951, through December 31, 1962. NIOSH determined that it lacks sufficient personnel monitoring, air monitoring, or source term data to adequately reconstruct the internal exposures at the facility during this time period. Consequently, NIOSH finds that it is not feasible to estimate with sufficient accuracy the radiation doses resulting from internal exposures received by members of this class of employees.

Given the currently available external monitoring data, the NIOSH-approved technical basis documents, and NIOSH procedures for external dose reconstruction at the NTS, NIOSH determined that it is possible to adequately reconstruct or bound the occupational external doses, and the medical doses potentially received by members of this class of employees.

### **5.0 Health Endangerment**

The health endangerment determination for the class of employees covered by this SEC Evaluation Report is governed by EEOICPA and 42 C.F.R. § 83.14(b) and § 83.13(c) (3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also make a determination whether or not there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires 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 whether 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 it is not feasible to estimate with sufficient accuracy radiation doses from potential internal exposures, and that the health of the employees covered by the proposed class definition provided in Section 6.0 of this evaluation may have been endangered.

The NIOSH evaluation did not identify any evidence that would establish that the class was exposed to radiation during a discrete incident or similar conditions resulting from the failure of radiation exposure controls and likely to have produced levels of exposure similarly high to those occurring during nuclear criticality incidents. The evidence reviewed during this evaluation

indicates that it is likely that workers in the class potentially received episodic unmonitored internal exposures combined with external exposures to gamma, beta, and neutron radiation resulting from nuclear detonations. 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 (excluding aggregate work day requirements) within the parameters established for one or more other classes of employees in the SEC.

## **6.0 Class Definition**

This evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes employees of the DOE or DOE contractors or subcontractors who were monitored or should have been monitored at the Nevada Test Site (NTS) for a number of work days aggregating at least 250 work days during the period from January 27, 1951 through December 31, 1962 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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## 7.0 References

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