Draft

ADVISORY BOARD ON

RADIATION AND WORKER HEALTH

National Institute for Occupational Safety and Health

REVIEW OF THE SITE PROFILE FOR THE SIMONDS SAW AND STEEL PLANT

Contract No. 200-2009-28555
SCA-TR-SP2012-0013

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June 2012

S. COHEN & ASSOCIATES: *Technical Support for the Advisory Board on Radiation & Worker Health Review of NIOSH Dose Reconstruction Program*	Document No. SCA-TR-SP2012-0013 Effective Date: June 13, 2012 Revision No. 0 – (Draft)
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Task Manager: ________________________ Date: ___________ John Stiver, CHP	Supersedes: N/A
Project Manager: ________________________ Date: ___________ John Stiver, CHP	Reviewer(s): William C. Thurber John Mauro

Record of Revisions

Revision Number	Effective Date	Description of Revision
0 (Draft)	06/13/2012	Initial issue

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ABBREVIATIONS AND ACRONYMS

ABRWH or Advisory Board	Advisory Board on Radiation Worker Health
AEC	Atomic Energy Commission
AWE	Atomic Weapons Employer
cm^2	square centimeter
DCAS	Division of Compensation Analysis and Support
dpm	disintegrations per minute
DWE	daily weighted exposure
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
EPC	Exposure Point Concentration
GSD	geometric standard deviation
H&S	Health and Safety
hr	hour
IMBA	Integrated Modules for Bioassay Analysis
m	meter
m^3	cubic meter
µg/L	microgram per liter
$\mu g/m^3$	microgram per cubic meter
mg/L	milligram per liter
MAC	Maximum Allowable Concentration
MCNP	Monte Carlo N-Particle code
mR/hr	milli-roentgen per hour
mrem	millirem
mrep	milli-roentgen equivalent physical
NIOSH	National Institute for Occupational Safety and Health
NLO	National Lead of Ohio
OCAS	Office of Compensation Analysis and Support
ORAUT	Oak Ridge Associated Universities Team
pCi	picocuries
R	Roentgen
rep	roentgen equivalent physical

SC&A	S. Cohen and Associates (SC&A, Inc.)
SEC	Special Exposure Cohort
SRDB	Site Research Database
TBD	Technical Basis Document
TIB	Technical Information Bulletin

1.0 EXECUTIVE SUMMARY

This draft report presents the results of an independent review conducted by S. Cohen and Associates (SC&A) of ORAUT-TKBS-0032, *Site Profile for Simonds Saw and Steel* (ORAUT 2011), the Simonds Saw and Steel technical basis document (TBD), which was issued by the National Institute for Occupational Safety and Health (NIOSH) as a summary site profile document. SC&A conducted this review during the period August 2011 through May 2012.

This review was conducted in accordance with SC&A's Board-approved *Standard Operating Procedure for Performing Site Profile Reviews* (SC&A 2004). SC&A evaluated the site profile for completeness, technical accuracy, adequacy of data, compliance with regulatory objectives, and consistency with other site profiles. Review criteria and methods are described in greater detail in Section 2.0 of this report.

On March 8, 2010, Simonds Saw and Steel Company qualified for a Special Exposure Cohort (SEC) evaluation by NIOSH for the period of January 1, 1948, through December 31, 2006. On October 29, 2011, NIOSH recommended that SEC status be awarded to Simonds Saw and Steel for the period of January 1, 1948, through December 31, 1957, for all Atomic Weapons Employer (AWE) employees who worked an aggregate of 250 workdays. The basis of the SEC recommendation was the inability to reconstruct doses to thorium because of insufficient information on the quantity or frequency of thorium processing. On December 8, 2010, the Advisory Board on Radiation Worker Health (ABRWH or Advisory Board) recommended that the SEC be accorded for the NIOSH-recommended period at Simonds Saw and Steel. Consequently, the TBD will be used for dose reconstructions for AWE employees at Simonds who worked less than 250 days, did not have one of the cancers specified under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA), and those who were employed during the residual period from January 1, 1958, to present.

Simonds Saw and Steel is a steel rolling and fabrication facility located in Lockport, New York, that intermittently processed uranium and thorium beginning in early 1948. The frequency of radiological operations at the site varied from year to year until the end of 1957, when all radiological operations ceased. The primary material handled at Simonds Saw and Steel was natural uranium, although it is known that some enriched and depleted uranium were also handled in addition to thorium.

Radiological/industrial hygiene controls at the site varied; however, it was known early on that certain steps needed to be taken to reduce the exposure potential to workers in the facility. Such improvements were implemented gradually from 1948 until about 1952, after which many of the controls and policies were removed or ignored. Radiological monitoring at the site consisted of air sampling (general air, process and breathing zone) as well as a urinalysis sampling program that was employed intermittently from late 1948 until the end of 1952. Individual external monitoring was virtually nonexistent at Simonds and consisted of a single set of 20 workers who wore film badges for approximately 7 working days.

1.1 SUMMARY OF FINDINGS

A summary of SC&A's primary findings for the Simonds Saw and Steel site profile is presented below. Detailed discussions of all findings and observations can be found in Section 4.0 of this report, "Vertical Issues." It should be noted that some of the "findings" in this review represent initial concerns that may not necessarily preclude the ability to perform partial dose reconstructions, but rather are potential issues that may warrant additional analyses, discussion, or clarification.

1.1.1 Finding 1: More Substantive Discussion of the Proposed Operational External Dose Approach is Needed due to Limited Film Badge Data

Monitoring for external dose was virtually nonexistent at Simonds Saw and Steel with the exception of one brief rolling period covering 20 workers for an assumed duration of 7 working days. Because this very limited sample of external measurements may not have been representative of the typical exposure potential to workers at Simonds Saw and Steel, an alternate external dose model was developed by NIOSH to simulate likely exposure conditions for workers who were directly involved in, or were in close vicinity to, uranium rolling operations. In addition to this, surrogate data from Aliquipa Forge and a single general area Atomic Energy Commission (AEC) study of the Simonds plant are also used (AEC 1949).

When the available film badge results are extrapolated to a full year of uranium operations, it is evident they are very close in magnitude to the modeled doses developed by NIOSH. This would seemingly validate the proposed external dose model as being a realistic and accurate representation of external dose potential for Simonds workers. However, the assigned doses based on the TBD model would underestimate the potential annual external dose for 6 of the 20 monitored workers when the film badge data are extrapolated to a full year of exposure. Given the uncertainties inherent in extrapolating a single film badging period to a full year, it is not clear how numerically significant the observed differences may be. Nevertheless, NIOSH should consider these data in the context of its proposed external dose model to ensure claimant favorability.

1.1.2 Finding 2: Representativeness of Available Urinalysis Data in relation to changing Industrial Hygiene Practices and Exposure Potential

The two main monitoring practices for internal exposure to uranium at Simonds Saw and Steel were urinalysis samples and air sampling (breathing zone and general air) used in developing daily weighted exposure (DWE) profiles by job title. Throughout the Simonds Saw and Steel operational period, various engineering and industrial hygiene controls were implemented at the direction of the AEC. However, during the operational period, the effectiveness of these controls fluctuated as certain practices were ignored or safety features in the plant were removed. These changes in industrial hygiene practices are naturally coupled with changes in exposure potential; this is reflected in the DWE profiles, which show a general decrease in airborne contamination for most job categories as the various controls were implemented. It is not clear to what extent the urinalysis data and the associated derived intake values are representative of these changes in industrial hygiene and relative exposure potential. The TBD would benefit from a more substantive discussion and analysis of the representativeness of available urinalysis data in the context of these known changes in industrial practices.

1.1.3 Finding 3: Further Discussion on "Pre-roll" versus "Post-roll" Urinalysis Sampling and 1st Versus 2nd Shifts

Urinalysis reports often designated samples as either being before the rolling operation (pre-roll) or after the rolling operation (post-roll). It is not clear how these different types of samples were interpreted in developing coworker intakes. It would be beneficial for NIOSH to provide a more substantive discussion of the "pre- and post-roll" samples for individual workers and any observed fluctuations in sample results. In many cases, there was no significant increase in urine concentrations between pre-roll and post-roll, as would be expected with more soluble compounds. It is likely these observations could be a result of the rolling of insoluble materials, which would not likely show a marked increase in urine concentrations immediately after the rolling period. However, in some cases, the post-roll samples were actually lower than the pre-roll samples. The TBD might benefit from additional analysis and discussion of these variations.

Additionally, there is mention in the TBD and associated source documentation that workers on the second shift may have had less supervision and therefore had a higher exposure potential. This issue should be further discussed and potentially quantified to assure that doses assigned to workers on the "second shift" are not underestimated by the developed coworker intakes.

1.1.4 Finding 4: Representativeness of Proposed Intake Model for Different Job Types and Exposure Potential

Based on the available DWE reports, it is apparent that the exposure potential for different job classifications varied significantly. In the earlier years, the difference between the highest and lowest DWE for individual job types could vary up to a factor of 27. Because of the large variability in exposure potential shown by the DWE data, it is important for NIOSH to establish that the proposed coworker model using the available bioassay data covers these highest exposed worker classifications, and that the assigned coworker doses are bounding to these groups of workers.

1.1.5 Finding 5: Establish Claimant Favorability of Urinalysis Coworker Model versus Daily Weighted Exposure (DWE) Derived Coworker Model

The TBD presents two different methodologies for estimating coworker intakes; one is based on the DWE reports, while the other is based on the available urinalysis monitoring data (see ORAUT 2011, Tables 10 and 17). Ultimately, NIOSH has selected the urinalysis-based intake model to assign coworker doses. However, the DWE-developed intakes for Type M are significantly higher during certain time periods. Although the use of bioassay data is preferable from a data hierarchy standpoint, NIOSH should further justify the use of urinalysis sampling data in the context of developing an accurate and bounding approach to assign coworker doses, particularly to job titles with the highest exposure potential. The TBD would also benefit from a description of the upper quantiles of the DWE distributions in comparison to the urinalysis values. It should be noted that Davis and Strom (2008) recommends a standard deviation of 5 when using DWE data for dose reconstruction to account for the inherent uncertainty in this type of analysis. Davis and Strom 2008 was utilized by NIOSH in formulating a DWE model for the earlier years at Fernald (DCAS 2010).

1.1.6 Finding 6: More Quantitative and Substantive Discussion of Available External Monitoring during Residual Period

NIOSH should provide justification for the selection of certain parameters in developing external dose assignments for the residual period; for example, reducing the length of the workday from 10 hours (assumed during the operational period) to 8 hours (assumed for the residual period). Also, a more quantitative discussion of the residual surveys that took place at Simonds Saw and Steel during the 1970s and 1980s would help to demonstrate the claimant favorability of the selected external dose assignments. Additionally, Strom 2007 recommends the use of a geometric standard deviation (GSD) of 5 when additional information used to characterize the distribution is absent. NIOSH should consider this methodology when formulating external dose assignments in the residual period.

1.1.7 Finding 7: Appropriateness of Chosen Internal Methodology during Residual Period and Consistency with OTIB-0070

NIOSH developed a coworker model for the uranium intake rate at the start of the residual monitoring period using the average of general air samples from 1948[1]–1953 during the operation of the plant. However, a large portion of the air samples available at Simonds Saw and Steel are from the middle years of operation when engineering controls were in place and being utilized, which would not be reflective of operations at the end of the operational period.

Furthermore, NIOSH uses survey data taken in 2007 and assumes the same source term existed in 1983 when the plant was officially shut down. NIOSH should consider developing a correction factor to account for any degradation of the available source term during those 24 years when the plant was closed. The approach proposed by NIOSH appears to differ with the established methodology developed in ORAUT-OTIB-0070 (ORAUT 2008).

1.2 STRENGTHS

The site profile does a good job of identifying available data sources, as well as documenting the changes in site policies and institutional controls that occurred during the operational period at Simonds Saw and Steel. Of particular note was NIOSH's analysis of the DWE reports generated by the AEC during the first few years of the site's uranium operations and using these reports to generate associated intake values. This analysis was in addition to the proposed internal coworker model, which utilized the available bioassay data. These extensive air sampling and monitoring programs were relatively unique at the time and have been used as surrogate data for other uranium milling sites, such as Bethlehem Steel. As such, it is important to describe and analyze the available air sampling/DWE data as was done in the current TBD.

[1] The text of the TBD states that it used data from 1949–1953, and not the 1948 data; however, the references provided indicate that data from 1948 were included. Data from 1954 were not included.

In addition, the TBD performs a detailed calculation using the MCNP code to characterize the external penetrating exposure potential from typical radiological operations at Simonds Saw and Steel. Surrogate external measurements taken at Aliquippa Forge during a survey in 1948 (AEC 1949) were used to determine the non-penetrating external exposure potential. Also, general area film badge data measured by AEC at Simonds were used to develop ambient exposures to workers from general plant contamination. These measurements are presented in Table 19 of the TBD and shown here in Table 1. This analysis was used to reconstruct external exposures in the absence of sufficient external monitoring data, which are virtually nonexistent at Simonds Saw and Steel. External exposures during the residual period utilize maximum survey data collected at the end of the operational period, but before any significant cleanup activities had taken place.

Table 1. 1948 Survey Measurements (mrep/hr)* taken at Aliquippa Forge

Location of measurement	Dose rate
Billet assumptions	
Contact with floor next to the quench tank where oxide scale has collected	8
Contact with floor in front of rolls where oxide scale has collected	5–10
Same location but 18 in. high	2–5
Rod assumptions	
4 ft above a pile of rods in the boxcar	20
5 ft from the end of a pile of rods next to the door of the boxcar	5
2 ft from the end of the same pile	13

* These measurements are given in the units of "mrep," which stands for milli-roentgen equivalent physical and is a historical unit that is approximately equal to the millirem (mrem).

Source: ORAUT 2011, Table 19

2.0 SCOPE AND INTRODUCTION

The review of the site profile for the Simonds Saw and Steel plant was authorized by the Advisory Board during the full Board meeting held in Niagara Falls, New York, on May 19–21, 2010, and was conducted between August 2011 and May 2012 by SC&A's team of health physicists and technical personnel.

2.1 REVIEW SCOPE

This report provides a review of the TBD related to historical occupational exposures at Simonds Saw and Steel, ORAUT-TKBS-0032, Rev. 01, *Site Profile for Simonds Saw and Steel* (ORAUT 2011).

To date, the site profile has not been supplemented by site-specific technical information bulletins (TIBs), but there are three generic TIBs that provide additional guidance to the dose reconstructor and are referenced in the TBD:

- ORAUT-OTIB-0070, *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, Rev. 0, March 10, 2008 (ORAUT 2008)
- OCAS-TIB-009, *Estimation of Ingestion Intakes*, Rev. 0, April 13, 2004 (NIOSH 2004)
- ORAUT-OTIB-0060, *Internal Dose Reconstruction*, Rev. 0, February 6, 2007 (ORAUT 2007)

SC&A also reviewed other pertinent documents, including those cited on the NIOSH Site Research Database (SRDB). SC&A has critically reviewed the Simonds Saw and Steel TBD, as well as supplementary and supporting documents, against the following three evaluation criteria:

- Determine the completeness of the information gathered by NIOSH, with a view to assessing its adequacy and accuracy in supporting individual dose reconstructions
- Assess the technical merit of the data/information
- Assess NIOSH's guidelines for the use of the data in dose reconstructions

SC&A's review of the Simonds Saw and Steel site profile and supplemental documentation focuses on the quality and completeness of the data that characterized the facility and its operations, and on the use of these data in performing dose reconstruction. The review was conducted in accordance with *SC&A Standard Operating Procedure for Performing Site Profile Reviews* (SC&A 2004), which was approved by the Advisory Board.

The scope and depth of the review are focused on aspects or parameters of the site profile that would be particularly influential in dose reconstructions, bridging uncertainties, or correcting technical inaccuracies. The review includes an independent compilation and analysis of site monitoring data, including urinalysis, air monitoring (including general air, breathing zone and other samples), available DWE reports, and post-operational survey data.

The Simonds Saw and Steel site profile document serves as site-specific guidance to support dose reconstructions for EEOICPA claimants. It provides the health physicists who conduct dose reconstructions on behalf of NIOSH with consistent general information and specifications to support their individual dose reconstructions. This report was prepared by SC&A to provide the Advisory Board with an evaluation of whether and how the TBD can support dose reconstruction decisions.

The basic principle of dose reconstruction is to characterize the radiation environments to which workers were exposed, and to determine the levels of exposure the workers received in that environment through time. The hierarchy of data used for developing dose reconstruction methodologies gives the greatest weight to dosimeter readings and bioassay data, followed by coworker and workplace monitoring data, and then process description information or source term data.

2.2 ASSESSMENT CRITERIA AND METHODS

SC&A is charged with evaluating the approach set forth in the site profiles that is used in the individual dose reconstruction process. These documents are reviewed for their completeness, technical accuracy, adequacy of data, consistency with other site profiles, and compliance with the stated objectives, as defined in SC&A (2004). This review is specific to the Simonds Saw and Steel site profile; however, items identified in this report may be applied to other facilities, especially facilities with similar source terms, exposure conditions, and mobile workforces. The review identifies a number of issues and discusses the degree to which the site profile fulfills the review objectives delineated in SC&A's site profile review procedure (SC&A 2004).

2.2.1 Objective 1: Completeness of Data Sources

SC&A reviewed the site profile with respect to Objective 1, which requires SC&A to identify principal sources of data and information that are applicable to the development of the site profile. The three elements examined under this objective are (1) determining if the site profile made use of available data considered relevant and significant to the dose reconstruction, (2) investigating whether other relevant/significant sources are available, but were not used in the development of the site profile, and (3) determining if worker input was considered in the development of the site profile.

2.2.2 Objective 2: Technical Accuracy

Objective 2 requires SC&A to perform a critical assessment of the methods used in the site profile to develop technically defensible guidance or instructions, including evaluating field characterization data, source term data, technical reports, standards and guidance documents, and literature related to processes that occurred at the Simonds Saw and Steel plant. The goal of this objective is to analyze the data according to sound scientific principles, and then evaluate this information in the context of dose reconstruction.

2.2.3 Objective 3: Adequacy of Data

Objective 3 requires SC&A to determine whether the data and guidance presented in the site profile are sufficiently detailed and complete to conduct dose reconstruction, and whether a defensible approach has been developed in the absence of data. In addition, this objective requires SC&A to assess the credibility of the data used for dose reconstruction. The data adequacy analysis identifies gaps in the facility data that may influence the outcome of the dose reconstruction process. For example, if a site did not monitor all workers exposed to radioactive materials who should have been monitored, this would be considered a gap and thus an inadequacy in the data. An important consideration in this aspect of our review of the site profile is the scientific validity and claimant favorability of the data, methods, and assumptions employed in the site profile to fill in data gaps.

2.2.4 Objective 4: Consistency among Site Profiles

Objective 4 requires SC&A to identify common elements within site profiles completed or reviewed to date, as appropriate. In order to accomplish this objective, the Simonds Saw and Steel TBD was compared to other TBDs, particularly those referenced in the site profile and those related to frequently visited facilities. This assessment was conducted to identify areas of inconsistencies and determine the potential significance of any inconsistencies with regard to the dose reconstruction process.

2.2.5 Objective 5: Regulatory Compliance and Quality Assurance

Objective 5 requires SC&A to evaluate the degree to which the site profile complies with stated policy and directives contained in 42 CFR Part 82. In addition, SC&A evaluated the TBD for adherence to general quality assurance policies and procedures utilized for the performance of dose reconstructions.

SC&A's draft report and preliminary findings will subsequently undergo a multi-step resolution process. Resolution includes a transparent review and discussion of draft findings with members of the Advisory Board Work Group, petitioners, claimants, and interested members of the public. Prior to and during the resolution process, the draft report is reviewed by the DOE Office of Health, Safety, and Security to confirm that no classified information has been incorporated into the report.

All review comments apply to Rev. 01 of the Simonds Saw and Steel site profile document (ORAUT 2011), which is the most recently published version. Site expert interviews were conducted with former Simonds Saw and Steel site workers to assist SC&A in obtaining a comprehensive understanding of the radiation protection program, site operations, and historic exposure experience.

2.3 REPORT ORGANIZATION

In accordance with directions provided by the Advisory Board and with site profile review procedures prepared by SC&A and approved by the Advisory Board (SC&A 2004), this report is organized into the following sections:

(1) Executive Summary
(2) Scope and Introduction
(3) Overview of TBD Dose Reconstruction Methods
(4) Vertical Issues
(5) Overall Adequacy of the Site Profile as a Basis for Dose Reconstruction

Based on the issues raised, SC&A prepared a summary list of findings, which is presented in the Executive Summary. Issues are designated as primary findings if SC&A believes they represent deficiencies that need to be corrected and pose the potential for substantial impact on at least some dose reconstructions. Issues can be designated as secondary findings if they simply raise questions, which, if addressed, would further improve the site profile and may possibly reveal deficiencies that will need to be addressed in future revisions of the site profile. Detailed analyses of the primary and secondary findings are provided in Section 4.0 of this report. Section 5.0 summarizes the evaluation of the TBD with respect to the stated objectives.

3.0 OVERVIEW OF NIOSH METHODOLOGIES

3.1 RECONSTRUCTION OF EXTERNAL EXPOSURES DURING THE OPERATIONAL PERIOD

Film badging of individual workers at Simonds Saw and Steel was restricted to one badging period of approximately 7 working days during a rolling period in 1949. Because external monitoring was so limited at the site, NIOSH has developed an alternate method for characterizing potential external doses during the operational period that combines area film badge measurements, instrument measurements, and computerized dose modeling.

In 1949, the AEC used area film badges to characterize the general radiation environment in the plant. The results of this film badge study were used to develop the penetrating and non-penetrating exposure from the contamination of plant surfaces and also submersion in contaminated air. The MCNP transport code was used to model external penetrating exposures to uranium billets and rods. Non-penetrating exposures from uranium billets and rods were estimated using beta measurements[2] taken at Aliquippa Forge, which had similar source terms and exposure scenarios. It is important to note that the TBD assumes that exposure to uranium billets and rods was not coincidental (i.e., workers were not exposed to both sources at the same time). The results of the modeling exercise are presented in Table 20 of the TBD and are recreated here in Table 2. It is important to note that medical x-rays were performed offsite at a non-covered commercial facility and so are not applicable to the dose reconstruction process.

Table 2. Proposed External Exposure Model for Simonds Saw and Steel

Exposure Mode	Exposure Type	Exposure or Dose Rate	Basis	Assumed Exposure Time	Year	Annual Exposure	IREP Distribution
Submersion/ area contamination	Penetrating	0.26 mR/hr	Film Badge	2,500 workhours/yr	1948	0.582 R	Lognormal GSD 1.2
					1949	0.650 R	
					1950	0.650 R	
					1951	0.650 R	
					1952	0.650 R	
					1953	0.650 R	
					1954	0.650 R	
					1955	0.650 R	
					1956	0.650 R	
					1957	0.650 R	
	Non-penetrating	1.3 mR/hr	Film Badge	2,500 workhours/yr	1948	2.912 R	Lognormal GSD 2.3
					1949	3.250 R	
					1950	3.250 R	
					1951	3.250 R	
					1952	3.250 R	
					1953	3.250 R	
					1954	3.250 R	
					1955	3.250 R	
					1956	3.250 R	
					1957	3.250 R	

[2] These measurements are given in the units of "mrep" which stands for milli-roentgen equivalent physical and is a historical unit that is approximately equal to the millirem (mrem)

Table 2. Proposed External Exposure Model for Simonds Saw and Steel

Exposure Mode	Exposure Type	Exposure or Dose Rate	Basis	Assumed Exposure Time	Year	Annual Exposure	IREP Distribution
Medical x-ray					1948	Not Assigned	
					1949		
					1950		
					1951		
					1952		
					1953		
					1954		
					1955		
					1956		
					1957		
U billets	Penetrating	0.703 mrem/hr	MCNP calculation	3.5 hr/rolling day	1948	0.352 rem	Lognormal GSD 4.3
					1949	0.384 rem	
					1950	0.384 rem	
					1951	0.384 rem	
					1952	0.384 rem	
					1953	0.384 rem	
					1954	0.076 rem	
					1955	0.076 rem	
					1956	0.076 rem	
					1957	0.076 rem	
	Non-penetrating	5 mrep/hr	Instrument measurement	3.5 hr/rolling day	1948	2.503 rep	Lognormal GSD 1.5
					1949	2.730 rep	
					1950	2.730 rep	
					1951	2.730 rep	
					1952	2.730 rep	
					1953	2.730 rep	
					1954	0.543 rep	
					1955	0.543 rep	
					1956	0.543 rep	
					1957	0.543 rep	
U rods	Penetrating	0.285 mrem/hr	MCNP Calculation	3.5 hr/rolling day	1948	0.143 rem	Lognormal GSD 5.7
					1949	0.156 rem	
					1950	0.156 rem	
					1951	0.156 rem	
					1952	0.156 rem	
					1953	0.156 rem	
					1954	0.031 rem	
					1955	0.031 rem	
					1956	0.031 rem	
					1957	0.031 rem	
	Non-penetrating	5 mrep/hr	Instrument measurement	3.5 hr/rolling day	1948	2.503 rep	Lognormal GSD 2.3
					1949	2.730 rep	
					1950	2.730 rep	
					1951	2.730 rep	
					1952	2.730 rep	
					1953	2.730 rep	
					1954	0.543 rep	
					1955	0.543 rep	
					1956	0.543 rep	
					1957	0.543 rep	

Source: ORAUT 2011, Table 20

3.2 RECONSTRUCTION OF INTERNAL EXPOSURES DURING THE OPERATIONAL PERIOD

Urinalysis samples were taken at Simonds Saw and Steel from late 1948 through 1952. Many times samples were taken before and after a particular rolling period. NIOSH proposes to use these urinalysis samples to construct coworker intakes to unmonitored workers. A summary of available bioassay data is presented in Table 5 of the TBD and recreated here in Table 3 with the addition of the number of bioassay samples by date. Four intake periods were calculated using the data in Table 17 and are recreated here in Table 4.

Table 3. Available Uranium Urinalysis Data at Simonds Saw and Steel

Bioassay Date	Number of Bioassay Results	GM Bioassay (mg/L)	84^{th}-Percentile Bioassay (mg/L)	Maximum Bioassay (mg/L)
11/1/1948	12	0.021	0.045	0.140
11/3/1948	12	0.022	0.042	0.090
11/4/1948	11	0.022	0.043	0.070
11/8/1948	11	0.011	0.018	0.030
11/11/1948	10	0.016	0.031	0.050
11/15/1948	11	0.016	0.035	0.050
1/6/1949	11	0.006	0.016	0.018
4/27/1949	12	0.017	0.028	0.036
11/4/1949	16	0.016	0.036	0.272
11/17/1949	52	0.001	0.010	0.164
1/6/1950	49	0.002	0.009	0.026
1/19/1950	49	0.010	0.024	0.035
5/15/1950	25	0.005	0.014	0.022
5/23/1950	25	0.008	0.019	0.034
8/14/1950	20	0.027	0.041	0.102
8/28/1950	18	0.016	0.022	0.033
9/23/1950	20	0.002	0.009	0.020
9/25/1950	19	0.011	0.018	0.024
10/20/1950	19	0.006	0.026	0.067
10/25/1950	19	0.005	0.016	0.043
11/9/1950	19	0.003	0.010	0.030
11/16/1950	40	0.005	0.014	0.028
12/14/1950	40	0.006	0.015	0.080
12/20/1952	62	0.016	0.035	0.066
12/22/1952	62	0.015	0.033	0.054

Source: ORAUT 2011, Table 5

Table 4. TBD Derived Coworker Intake Values

Radionuclide	Start	End	Intake Route	Absorption Type	Intake (pCi/d)	GSD
U-234 (Choose M or S intake scenario, not both)	2/24/1948	12/1/1948	Inhalation	M	5.76E+02	3.0
	12/1/1948	12/15/1950	Inhalation	M	2.36E+02	3.0
	12/15/1950	12/31/1952	Inhalation	M	4.49E+02	3.0
	1/1/1953	12/1/1957	Inhalation	M	5.76E+02	3.0
	2/24/1948	12/1/1948	Inhalation	S	1.72E+04	3.0
	12/1/1948	12/15/1950	Inhalation	S	2.40E+03	3.0
	12/15/1950	12/31/1952	Inhalation	S	7.26E+03	3.0
	1/1/1953	12/1/1957	Inhalation	S	1.72E+04	3.0
Np-237*	1/1/1953	12/1/1957	Inhalation	M, if U is M	1.05E+00	3.0
	1/1/1953	12/1/1957	Inhalation	S, if U is S	3.13E+01	3.0
Pu-239*	1/1/1953	12/1/1957	Inhalation	M, if U is M	1.05E+00	3.0
	1/1/1953	12/1/1957	Inhalation	S, if U is S	4.50E+01	3.0

*Np and Pu intakes are based on the contaminant ratios of 0.00182 and 0.00261, respectively.
Source: ORAUT 2011, Table 17

It should be noted that bioassay data were only used to calculate intakes for the first 3 periods displayed (February 24, 1948–December 1, 1948; December 1, 1948–December 15, 1950; and December 15, 1950–December 31, 1952). From 1953 onward, the intake rates were assumed to be equal to those in the pre-December 1, 1948, intake period. This is reflective of the loss of engineering controls designed to reduce dust levels during this period, which would have been similar to the earlier period at Simonds.

3.3 RECONSTRUCTION OF EXTERNAL EXPOSURES DURING THE POST-OPERATIONAL PERIOD

To reconstruct external doses in the residual period, NIOSH utilizes a survey that was performed at Simonds Saw and Steel by National Lead of Ohio (NLO) prior to the closeout of its contract with NLO. The stated objective of the survey trip was described as follows:

> *The purpose of this visit to Simonds was to make a preliminary radiation survey to determine if further clean-up or decontamination of those portions of the Simonds' Plant, which had been used for work with radioactive materials under the National Lead contract, would be required before termination of the contract.* (Heatherton 1957)

It is not clear to what extent the plant had been decontaminated at that point. The results of external radiation levels found during the survey are presented in Table 5.

Table 5. Measurements Taken at Locations Higher than 0.2 mreps Combined Beta/Gamma

Location	Rough Dimensions of Contamination	Beta-gamma Contact Readings (mreps/hr)	Beta Readings at 3 ft (mreps/hr)	Gamma Readings at 3 ft (mR/hr)
10” Bar Mill Bed	75 ft^2 × ½” thick	10–20	1.0–1.7	0.04, 0.05
Front of Shear	10 ft^2 × 1” thick	1–2	0.4	0.08
Between Floor Plates on Mill Floor	Unavailable	0.15	0.05	Not Detected
Forge Area	Unavailable	0.7–1.2	0.2	0.02
Top of Furnace	150 ft^2 × 2” thick	1.0	Not Measured	Not Measured

Source: Heatherton 1957, Table 1

In order to reconstruct external doses during the residual period, the TBD states:

> *To reconstruct external exposure to residual radioactivity after the end of AEC operations, this analysis assumed that workers were exposed to 0.08 mR/hr penetrating radiation, which was the upper end of the gamma exposure rate readings at 1 m in 1957. The residual penetrating radiation exposure was estimated by assuming that 0.08 mR/hr was the median rate and the beta/gamma exposure rate at 3 ft (0.4 mrep/hr) was the 95th-percentile rate, which yields a GSD of 3.5. A nonpenetrating external exposure was estimated by assuming that 0.2-mrep/hr beta/gamma reading at 3 ft from the floor in the forge area was the median rate and that the 1-mrep/hr beta/gamma reading at contact was the 95th percentile rate, which yields a GSD of 2.6.* (ORAUT 2011)

These external dose rates were converted to annual doses assuming an 8-hour workday and 250 workdays per year (nominally 2,000 hours/year).

3.4 RECONSTRUCTION OF INTERNAL EXPOSURES DURING THE POST-OPERATIONAL PERIOD

To determine the internal exposure intake rate at the start of the residual period, NIOSH assumes that the average of general air samples taken at Simonds Saw and Steel from 1949[3]–1953 represents a bounding value of the contamination present at the cessation of operations. This results in an airborne contamination level of 94 µg/m^3 and an associated intake rate of 422 pCi/calendar day.

To evaluate the intake rate at the end of the residual period, surface contamination (beta) measurements made during a 2007 remedial investigation were used (Earth Tech 2010). The TBD states:

> *Surface contamination measurements performed during this investigation were used to derive Exposure Point Concentration (EPC) values to be used in exposure*

[3] Although the TBD states that it used general air samples starting in 1949, the references provided indicate that samples from 1948 were also included.

> *and risk assessment studies. The EPC values represent the 95% upper confidence limit values for each particular parameter reported.* (ORAUT 2011)

These exposure point concentration values are reported in Table 22 of the TBD and recreated here in Table 6.

Table 6. 2007 Exposure Point Concentration (EPC) Values at Simonds Saw and Steel (dpm/100 cm^2 – beta)

Building	Maximum	Average	EPC Value
1	21,000	300	600
2	140,100	200	400
3	145,900	3,500	4,600
4/9	30,700	1,100	1,300
5	2,200	1,000	1,200
8	58,300	2,600	6,800
24	124,200	5,400	9,300
35	2,800	300	400

Source: ORAUT 2011, Table 22

The TBD uses the highest EPC value (9,300 dpm/100 cm^2 in Building 24) and assumes a resuspension factor of 10^{-6}. Additionally, the assumption is made that the total uranium surface activity is 1.93 times the total beta value. This results in an intake rate of approximately 5.5 pCi/d. This intake rate is assumed to be constant from 1982 through the present. An exponential decrease in intake rate is assumed from the initial intake rate (422 pCi/d in 1958) to the ending intake rate (5.5 pCi/d in 1982); this exponential rate constant is 0.18/yr.

Thorium intake rates during the residual period are estimated by assuming that the thorium intake was 1% of the uranium intake, which is consistent with the relative level of production on a mass basis[4] of thorium versus uranium at Simonds Saw and Steel.

[4] The intake of thorium is based on 1% of the ***activity*** of uranium, not the mass, though historical documentation indicates production of thorium was approximately 1% of the ***mass*** of uranium processed.

4.0 VERTICAL ISSUES

4.1 FINDING 1: MORE SUBSTANTIVE DISCUSSION OF THE PROPOSED OPERATIONAL EXTERNAL DOSE APPROACH IS NEEDED DUE TO LIMITED FILM BADGE DATA

Worker film badging was not a regular practice at Simonds Saw and Steel; in fact, only one set of film badge data exists, which covers a period from October 11, 1949–October 19, 1949. Because of the severely limited external exposure records for workers, NIOSH adopted a combination of survey readings along with a modeling approach using MCNP to derive the following external exposures:

- Submersion in air contaminated with uranium dust
- Exposure from contaminated surfaces
- Non-penetrating exposure (beta) at the surface of uranium billets and rods
- Penetrating exposure (gamma) to uranium billets and rods

The results of NIOSH's analysis are shown in Table 20 of the TBD, which is recreated here in Table 7. It is important to note that the TBD assumes that workers were exposed to uranium rods for 3.5 hours per rolling day and uranium billets for 3.5 hours per rolling day. The TBD states:

> *Several air exposure records were reviewed to estimate a worker's time near a billet or rod versus being in the general area. The records indicated that for most workers the time near the uranium billet or rod was less than 5 hr/shift, but some workers could have spent 6.5 hours near the rods and billets. Because workers changed jobs, this analysis assumed that workers were near the billets for 3.5 hr/rolling day and near the rods for 3.5 hr/rolling day.* (ORAUT 2011, pg. 35)

NIOSH should clarify why it is not plausible that workers could have been coincidentally exposed to uranium rods and billets, but rather that the two source terms represent separate exposure configurations (for example, process descriptions, special separation of the two source terms). It would also be instructive for NIOSH to provide specific examples of air exposure records that support the proposed exposure duration to each source term (billets versus rods), particularly those higher-risk jobs, such as the roughing and finishing roll operators.

Table 7. Derived External Exposure Values

Year	Exposure Scenario	Exposure type	Annual Exposure (Roentgen)	Annual Total (Roentgen)
1948	Submersion, contaminated surfaces	Penetrating	0.582	1.08 γ 7.92 β Total: 9
		Nonpenetrating	2.912	
	U Billets	Penetrating	0.352	
		Nonpenetrating	2.503	
	U Rods	Penetrating	0.143	
		Nonpenetrating	2.503	
1949–1953	Submersion, contaminated surfaces	Penetrating	0.650	1.19 γ 8.71 β Total: 9.90 rem
		Nonpenetrating	3.250	
	U Billets	Penetrating	0.384	
		Nonpenetrating	2.730	
	U Rods	Penetrating	0.156	
		Nonpenetrating	2.730	
1954–1957	Submersion, contaminated surfaces	Penetrating	0.650	0.76 γ 4.34 β Total: 5.10 rem
		Nonpenetrating	3.250	
	U Billets	Penetrating	0.076	
		Nonpenetrating	0.543	
	U Rods	Penetrating	0.031	
		Nonpenetrating	0.543	

Source: ORAUT 2011, Table 20

TBD-6000 (Battelle 2006, pg. 36) recommends using a 10:1 ratio for beta versus gamma dose to parts of the body other than the hands and arms. Based on the modeled gamma doses shown in Table 2 of Section 3.1, this would result in beta doses of approximately 2 mrep[5]/hr for billets and 7 mrep/hr for rods. This is consistent with the TBD assumed value of 5 mrep/hr for both exposure configurations. However, when workers directly handle the uranium billets and rods, the beta dose would increase to approximately 230 mrep/hr (Battelle 2006, pg. 36). NIOSH should explore the potential for workers to directly handle uranium materials at Simonds Saw and Steel, and how that may affect the assumed beta dose estimates.

Table 8 shows the external film badge data taken in October of 1949 for comparison with the derived doses during that period (1.18 γ, 8.71 β). The film badge data were taken over a period of 9 days, which included a weekend (Tuesday to the following Wednesday). In order to extrapolate these recorded doses to a full year of work, it was assumed that the badges were worn for a 7-day rolling operation and extrapolated to 156 rolling days per year. For example, Badge Reference #1 showed 595 mR over an assumed 7 days of uranium rolling operations. This could then be extrapolated to an assumed full year of rolling by normalizing to a single day and multiplying by 156 rolling days per year:

$$595\ [\text{mR/7days}] / 7\ [\text{days}] * 156\ [\text{rolling days/yr}] / 1{,}000\ [\text{mR/R}] = 13.26\ [\text{R/yr}]$$

[5] Unit of millirep is based on the rep (roentgen equivalent physical), which is a historical unit of dose equivalence approximately equal to a rem

This can then be compared with the TBD-assigned value of 9.90 R to show a difference of 3.37 R (13.26 - 9.90 = 3.36) between the extrapolated film badge results and the MCNP-modeled external dose.

Table 8. Film Badge Data from October 11, 1949–October 19, 1949 Extrapolated to a Full Year of Rolling

Badge Reference* No.	Original values (milli-Roentgen)			Extrapolated to 1 Year** (Roentgen)			Difference with TBD-Derived Values (R)
	Beta	Gamma	Total	Beta	Gamma	Total	
1	520	75	595	11.59	1.67	13.26	3.36
2	300	50	350	6.69	1.11	7.80	-2.09
3	160	0	160	3.57	0.00	3.57	-6.32
4	310	55	365	6.91	1.23	8.13	-1.76
5	400	75	475	8.91	1.67	10.59	0.70
6	260	105	365	5.79	2.34	8.13	-1.76
7	330	0	330	7.35	0.00	7.35	-2.54
8	390	50	440	8.69	1.11	9.81	-0.08
9	270	55	325	6.02	1.23	7.24	-2.65
10	430	0	430	9.58	0.00	9.58	-0.31
11	360	0	360	8.02	0.00	8.02	-1.87
12	1250	105	1355	27.86	2.34	30.20	20.31
13	520	75	595	11.59	1.67	13.26	3.37
14	Lost Badge			Lost Badge			NA
15	190	0	190	4.23	0.00	4.23	-5.66
16	320	75	395	7.13	1.67	8.80	-1.09
17	815	115	930	18.16	2.56	20.73	10.84
18	370	95	465	8.25	2.12	10.36	0.47
19	320	75	395	7.13	1.67	8.80	-1.09
20	300	75	375	6.69	1.67	8.36	-1.53
21	300	55	355	6.69	1.23	7.91	-1.98

* Note: Actual badge numbers have been replaced with a random reference number for Privacy Act concerns.
** A full year of rolling assumes that 156 days per year were spent processing uranium metal assumed in the TBD.

As shown in Table 8, 6 of the 20 TBD-derived external values are lower than the corresponding values obtained by extrapolating the 7-day film badge readings to 156 days; those TBD values corresponding to badges #12 and #17 are lower by factors of 20 and 10, respectively. Note that the differences may be greater than indicated in Table 8, because the annual doses extrapolated from the film badge readings do not include any external doses accrued from contamination present in the plant during non-uranium rolling operations. Hence, for some workers, the coworker model may underestimate the annual dose to workers. However, it is not clear to what extent these numerical differences are significant, given the uncertainties inherent in extrapolating the badge readings and those related to modeling. NIOSH should perform a similar comparison in the TBD to demonstrate that their chosen methods for assigning external dose are bounding.

4.2 FINDING 2: REPRESENTATIVENESS OF AVAILABLE URINALYSIS DATA IN RELATION TO CHANGING INDUSTRIAL HYGIENE PRACTICES AND EXPOSURE POTENTIAL

NIOSH proposes to use only the urinalysis results and not the DWEs in determining internal dose during the operational period. Figure 1 shows the distribution of the number of bioassay samples taken during the operational period. Table 9 shows an overview of the bioassay results based on SC&A's independent compilation of the urinalysis data. The table also displays the TBD-proposed intake periods and specific intake rates (pCi/d) as seen in Table 17 of the TBD.

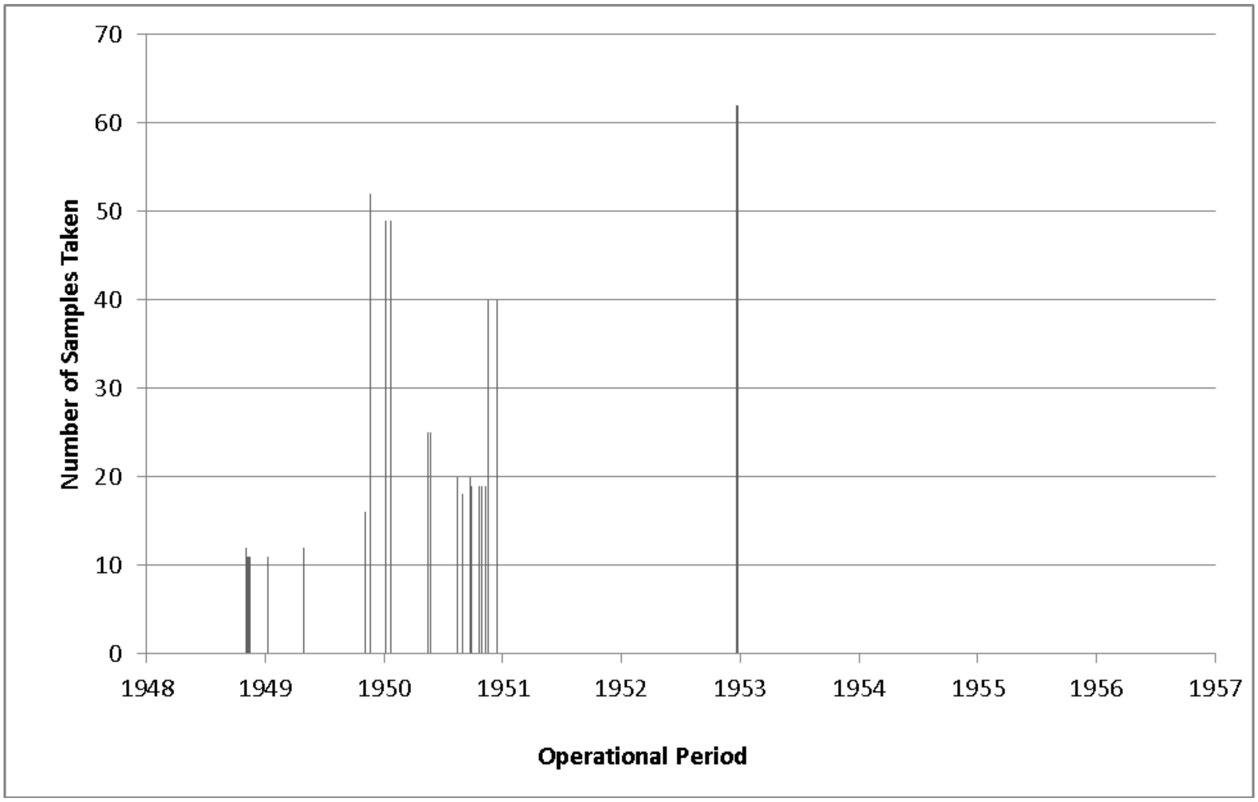


Figure 1. Distribution of Urinalysis Results during the Operational Period (1948–1957)

Table 9. Overview of Urinalysis Data during the Operational Period

Date of Samples Covering Period	Number of Samples	Pre-roll or Post-roll Designation	Results (mg/l)			Proposed Intake Period	Calculated Intake from TBD Table 17 (pCi/d)
			Arithmetic Average	Median	Maximum		
11/1/1948	12	Unknown	0.031	0.020	0.140	2/24/48–12/1/48	Type M: 5.76E+02 Type S: 1.72E+04
11/3/1948	12	Unknown	0.028	0.020	0.090		
11/4/1948	11	Unknown	0.028	0.020	0.070		
11/8/1948	11	Unknown	0.012	0.010	0.030		
11/11/1948	10	Unknown	0.019	0.015	0.050		
11/15/1948	11	Unknown	0.018	0.020	0.040		
1/6/1949	11	Pre-roll	0.009	0.009	0.018	12/1/48–12/15/50	Type M: 2.36E+02 Type S: 2.4E+03
4/27/1949	12	Pre-roll	0.019	0.019	0.036		
11/4/1949	16	Pre-roll	0.031	0.014	0.272		
11/17/1949	52	Post-roll	0.008	0.001	0.164		
1/6/1950	49	Pre-roll	0.005	0.002	0.026		
1/19/1950	49	Post-roll	0.013	0.015	0.035		
5/15/1950	25	Pre-roll	0.007	0.007	0.022		
5/23/1950	25	Post-roll	0.010	0.014	0.034		
8/14/1950	20	Pre-roll	0.030	0.028	0.102		
8/28/1950	18	Post-roll	0.017	0.017	0.033		
9/23/1950	20	Unknown	0.004	0.000	0.020		
9/25/1950	19	Post-roll	0.012	0.013	0.024		
10/20/1950	19	Pre-roll	0.014	0.004	0.067		
10/25/1950	19	Post-roll	0.009	0.006	0.043		
11/9/1950	19	Unknown	0.005	0.004	0.030		
11/16/1950	40	Unknown	0.008	0.006	0.028		
12/14/1950	40	Unknown	0.009	0.007	0.080		
12/20/1952	62	Unknown	0.020	0.017	0.066	12/15/50–12/31/52	Type M: 4.49E+02 Type S: 7.26E+03
12/22/1952	62	Unknown	0.019	0.016	0.054		
Remaining Operational Period	0	N/A	*Assumes 2/24/48–12/1/48 derived intake rates*			1/1/53–12/31/57	Type M: 5.76E+02 Type S: 1.72E+04

Source: ORAUT 2011, Table 17

Section 3.1.1 of the TBD outlines how the bioassay data were interpreted and analyzed to obtain the intakes as described in Table 9 (see ORAUT 2011, Table 17). The TBD assumes a detection limit of 0.01 mg/L for uranium urine bioassay. This value is based on a reported sensitivity of 5 to 10 µg/L for uranium fluorimetry urinalysis in the early years (Wilson 1958). In addition, several early Simonds bioassay reports noted that the results of less than 10 µg/L were insufficient for reliable detection (Author unknown 1948). Intake rates are adjusted from milligrams/day to picocuries/day by multiplying by 682.91 pCi/mg.

It is not clear how accurately the urinalysis data and potential gaps in the data reflect the changes in exposure potential over the plant's occupational history or whether a plausible upper bound intake can be derived from the data. There are documented changes in engineering controls and industrial hygiene practices that were implemented during the first few years of the AEC contract, but these were incrementally removed or no longer used during later years of operation. Attachment 1 displays a timeline of the use and removal of these controls.

The air sampling data collected from 1948 to 1953 reflect changes in airborne dust levels that resulted from the implementation and subsequent removal of engineering controls. Figures 2 and 3 are plots of the number of urinalysis samples and the average and median DWE data by job category for the intake periods proposed by NIOSH.[6] The vertical black lines on Figures 2 and 3 delineate the intake periods as outlined in Table 9 (see ORAUT 2011, Table 17).

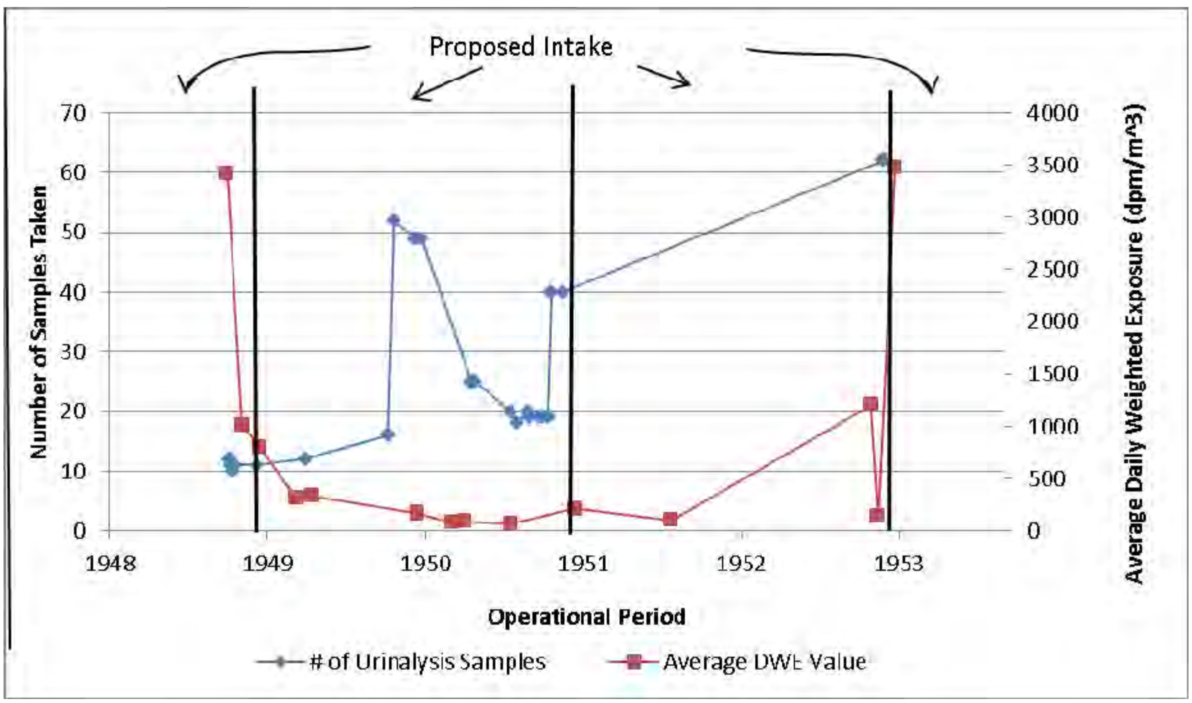


Figure 2. Chronological Plot of the Uranium Urinalysis Sampling versus the Average Daily Weighted Exposure over the same Timeframe

[6] Note: this is not reflective of the DWEs for all workers included in the sample. Each job title is given equal weight.

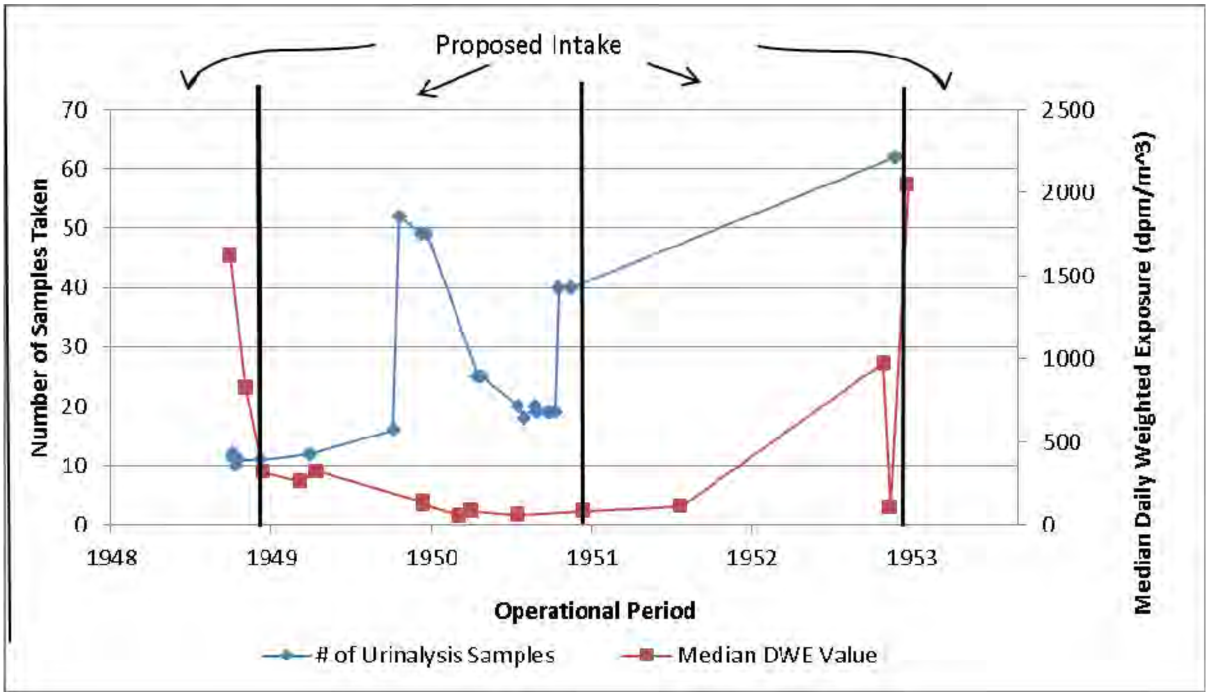


Figure 3. Chronological Plot of the Uranium Urinalysis Sampling versus the Median Daily Weighted Exposure over the same Timeframe

The sharp reduction in average and median DWEs between the first intake period (1948) and second intake period (1949 to 1951) demonstrates the large-scale improvements in radiological control practices that were introduced during that timeframe. The first DWE report was for operations on October 27, 1948, and the first urinalysis samples were taken a few days later (November 1, 1948), with follow-up samples taken over the next 2 weeks Also, as noted in Table 9, the derived Type S average annual intake rates based on bioassay data decline from 1.72E4 pCi/y in the first period to 2.4E3 pCi/d in the second time period.

Most of the AEC-recommended radiological controls had not been in use during the October 27, 1948, rolling, with the exception of the use of a central vacuum, instead of standard broom sweeping. There are no DWE reports prior to the October rolling. Though records indicate a gradual introduction of other radiological safety improvements, such as the issuance of two sets of protective clothing for a rolling in late July of 1948 (previously, workers only wore protective gloves and were responsible for washing their own clothes), those improvements did not include respiratory protection and would therefore not be expected to have mitigated inhalation intakes by workers. Thus, while the urinalysis samples taken in November 1948 are probably representative of intakes that occurred during the October rolling, it is not clear that extrapolating these results to earlier rollings before dust control measures (e.g., vacuum cleaning) were employed will result in bounding intakes.

The continuing downward trend in average DWEs during the second intake period (December 1, 1948–December 15, 1950) is indicative of more improvements in radiological control as additional precautions were taken, such as:

- Ventilation installed over the rolls, vacuum cleaner and pressure quencher exhausted through the roof (January 20, 1949)
- Exhaust over the descaler installed (February 15, 1949)
- Partial installation of floor grating to decrease the resuspension of dusts (April 5, 1949)
- Lucite plastic sheeting installed over the rolling ventilation hoods (June 7, 1949)
- Improvement in dust collection efficiency for the finishing rolls exhaust system (September 7, 1949)
- Installation of the rest of the floor grating (sometime after September 7, 1949)
- Improvement of the quencher exhaust system, elimination of rod shearing operation, exclusive use of the lead bath furnace instead of gas fired furnace system (April 14, 1950)

The median urine concentrations and NIOSH-derived intakes for the second intake period are substantially lower than for the first period. While urinalysis samples during the second period were taken as early as January 6, 1949, all were designated as pre-roll samples until after the November rolling (November 17, 1949) (Table 9). It is not clear to what extent they reflect the retention of insoluble forms of uranium from internal exposures accrued during first period rolling operations (when radiological controls were incrementally being installed). For the remainder of the period, urinalysis samples were taken before and after rolling operations in January, May, August, September, and October of 1950.[7] Samples were also taken on December 14, 1950, though it is unknown whether they represent pre- or post-roll samples.

The bioassay results for the third intake period (December 15, 1950–December 31, 1952) are higher than for the previous period and likely reflect increased dust levels that resulted from less effective institutional controls, notably:

- Pressure quenching changed to dip quenching, which left more scale on the rods; use of a continuous water stream on some rods, which caused higher localized air contamination; removal of the plexiglass (Lucite) shields over the rolling ventilation hoods[8] (January 10, 1951)
- Intermittent use of the floor grating (March 8, 1951)
- Grating directly in front of the rolls had been removed, broom sweeping was regularly being employed with only 'intermittent' use of the vacuum cleaner, lack of adequate protective clothing (August 15, 1951)
- Floor grating had been pounded flat by continued pounding by the weight of the rods; vacuum cleaner still not being used (December 9, 1952)

[7] While not specifically labeled as pre-roll or post-roll, it is likely that samples taken on November 9, 1950, and November 16, 1950, represent pre- and post-roll samples.

[8] The AEC report states, "It was learned that the omission of shields on the hoods in the beginning was through oversight. After that, no one bothered to put them on" (Heatherton 1951a). Plexiglass shields were not reinstalled until August 21, 1951.

Despite the removal and degradation of radiological control practices as described above, the DWE data for the third period remain fairly consistent with the previous intake period. The lack of an apparent upward trend in DWE data during this time may indicate incomplete air concentration measurements in the affected rolling and quench areas. That is, the highest concentrations may have been missed due to the timing of air sampling measurements relative to uranium rolling operations. Davis and Strom (2008) demonstrated that the general air and breathing zone air samples that comprise DWE data are highly variable due to spatial and temporal fluctuations in air concentrations, and recommend a GSD of 5 be applied to such data for the purposes of coworker modeling.

There appears to be a brief spike in the DWE data in late 1952 (third from last measurement); however, this is reflective of a thorium operation that occurred on the unventilated 10” bar mill, as opposed to the normally ventilated 16” bar mill. Specifically, the AEC report for this operation (Klevin and Weinstein 1953b) notes:

> *Aside from the lack of suitable dust control measures for this operation which include local exhaust ventilation over the three rolls, floor gratings in front of the rolls and a central vacuum cleanup system, there were malpractices of good industrial hygiene procedures which contributed to the high alpha concentrations. These were:*
>
> > *1 – No cleanup during the entire rolling operation*
> > *2 – Sweeping of steel plate floor are* [sic] *with brooms after completion of rolling*
> > *3 – Stamping of thorium rods on flat steel bed of conveyor*
> > *4 – Tracking of dust from the rolls to the rest areas*

Though this thorium rolling may not directly reflect the type of exposures encountered during uranium rolling, they are likely indicative of the type of practices occurring at the site during that time.

The last DWE point represents the rolling of “Special E” or enriched material. The AEC report for this rolling (Heatherton 1953) states:

> *Ventilation on the 16" mill was the same as normally used in uranium rollings at the Simonds plant. No ventilation was provided for work on the 10” mill. Air dust results indicate that workers on the 10” mill had weighted exposures while rolling ranging from 5.4 to 130 MAC. The operation was a one-time operation and was not meant to be repeated… General air results indicate an overall contamination of the building as a result of performing the operation without ventilation. A repetition of this operation could seriously contaminate the whole building and result in immediate and prolonged exposure of building occupants to concentrations in excess of the maximum allowable amount.*

Thus, the high median DWE for the “Special E” rolling was due not only to the higher specific activity of enriched versus natural uranium, but also to the lack of ventilation on the 10” mill.

The only urinalysis samples taken during this intake period were at the very end of the period (December 20–22, 1952), though it is not clear whether these represent pre-roll or post-roll samples (or both). Considering the degradation of radiological controls throughout the defined intake period and the insoluble nature of the uranium metal and oxides, these urinalysis samples can probably be assumed to reflect a bounding intake scenario for the rolling operations during intake period 3.

Figure 4 depicts the timeline of changes in industrial hygiene practices in relation to the number of urine bioassay samples. Figures 5 and 6 plot the median DWE values for the proposed intake periods and the proposed NIOSH intakes based on bioassay (Types M and S respectively) for the defined intake periods and include the timeline of industrial hygiene changes.

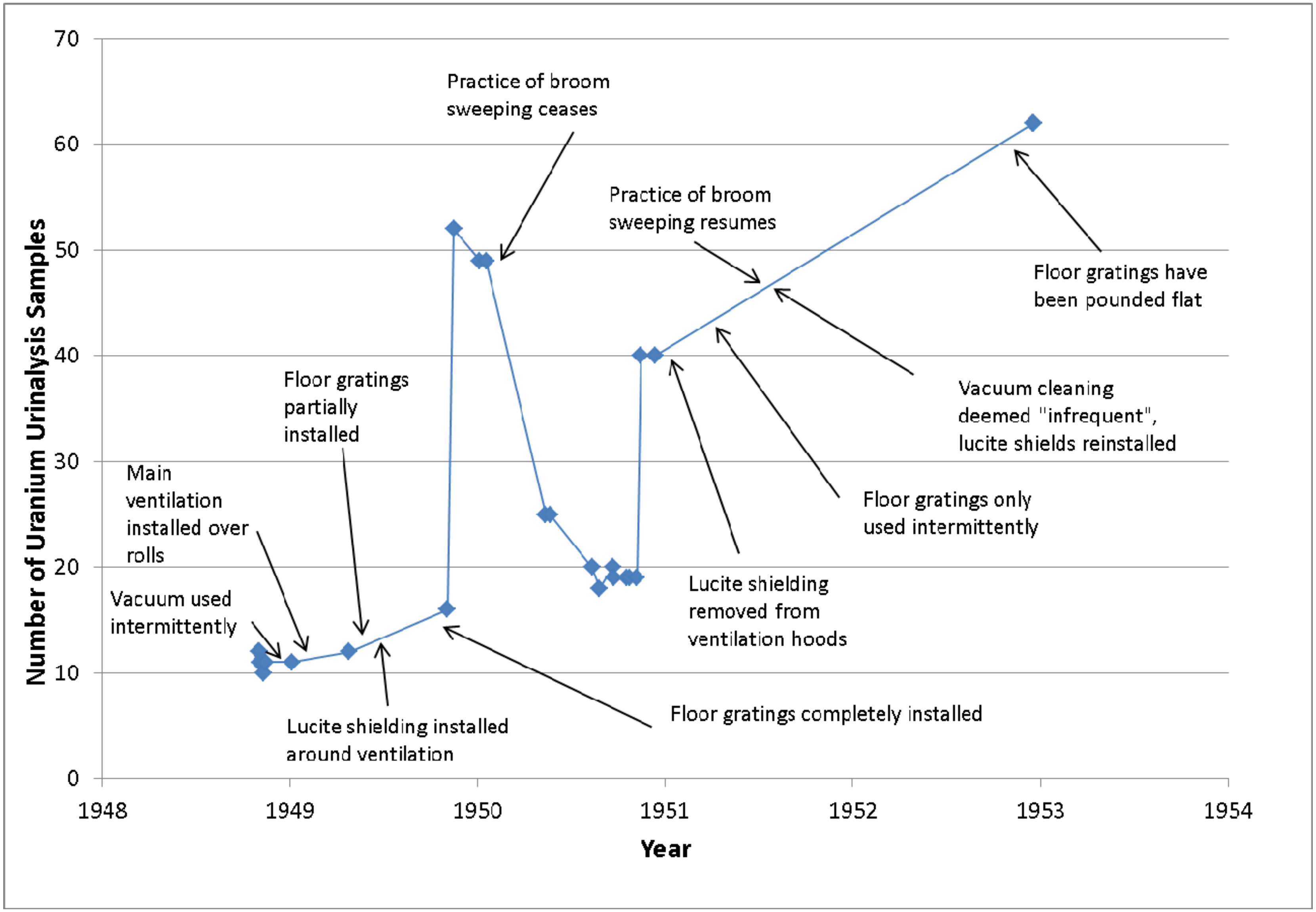


Figure 4. The Number of Uranium Urinalysis Results Plotted versus the Timeline of Significant Changes in Industrial Control

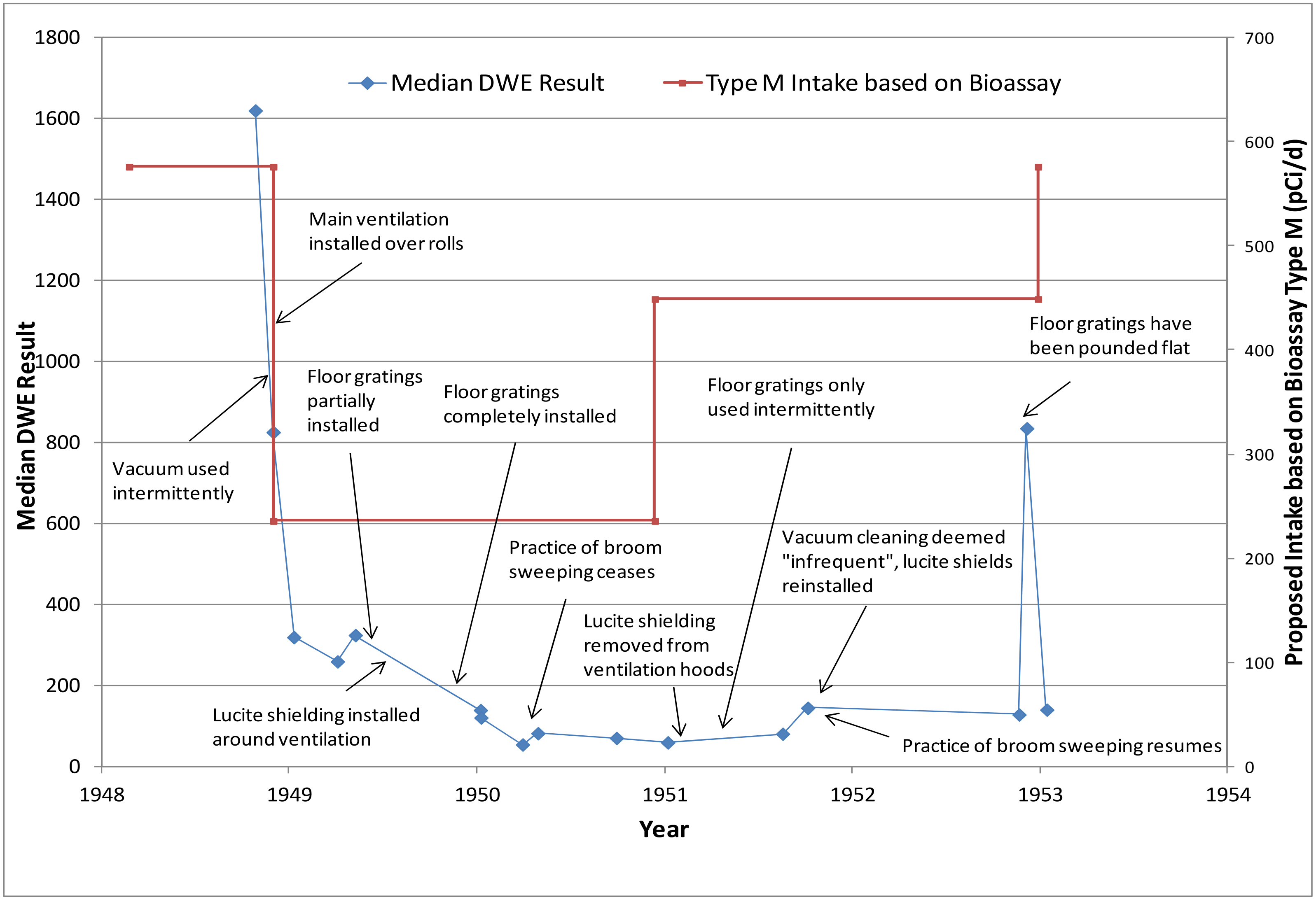


Figure 5. Median Daily Weighted Exposure and Proposed Type M Intakes based on Bioassay Data Plotted versus the Timeline of Significant Changes in Industrial Control

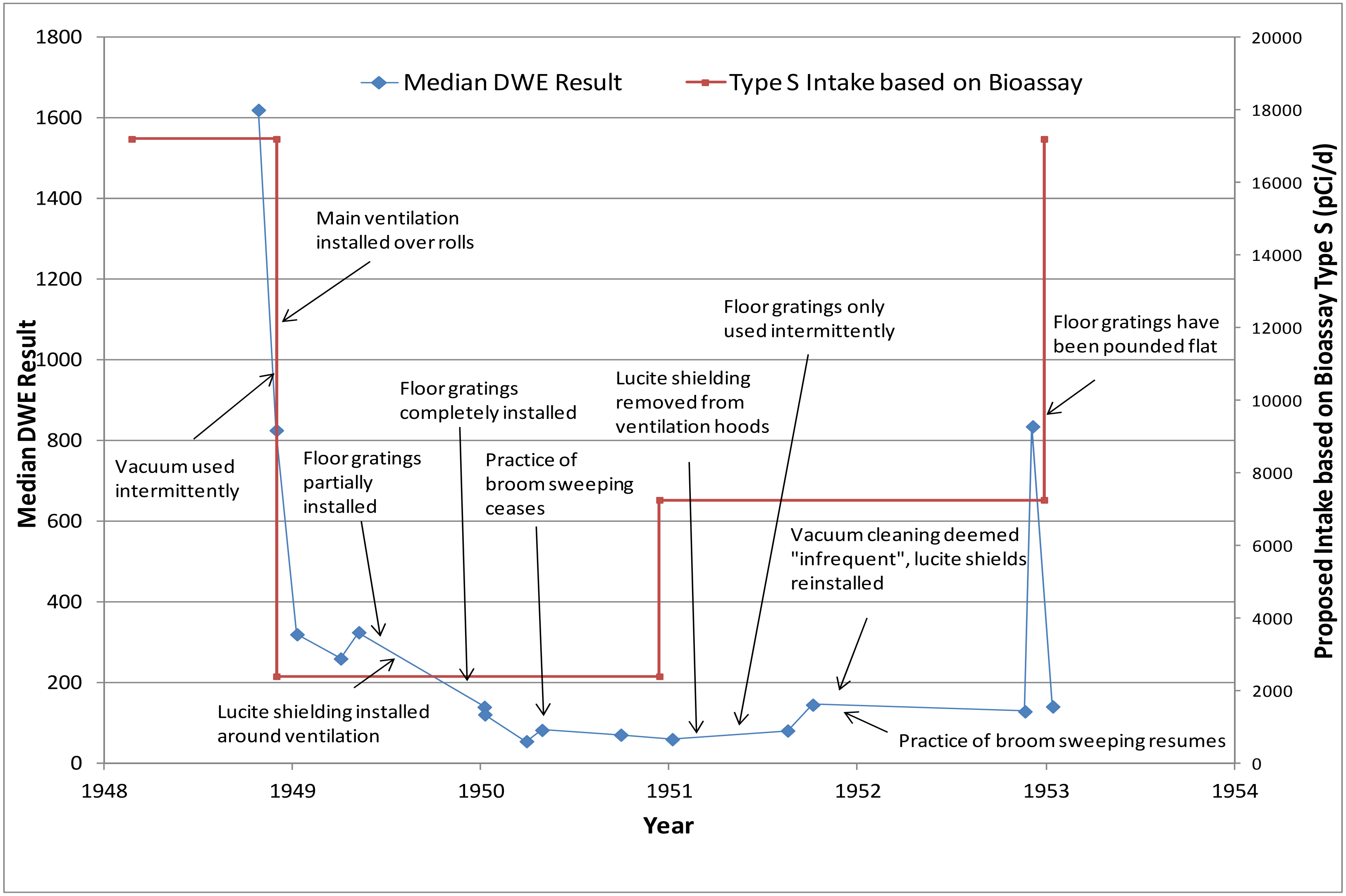


Figure 6. Median Daily Weighted Exposure and Proposed Type M Intakes based on Bioassay Data Plotted versus the Timeline of Significant Changes in Industrial Control

It is evident from Figures 4–6 that the bioassay and DWEs trend together, though the strongest correlation is seen in the first and second intake periods. It is also evident that the installation of main ventilation hoods and vacuum cleaning in late 1948 had the biggest impact on reducing air dust concentrations for the second intake period. NIOSH should analyze the available bioassay data in the context of industrial changes and observed DWE data to ensure that the derived intake values are representative of the changing exposure potential at Simonds Saw and Steel.

4.3 FINDING 3: FURTHER DISCUSSION ON "PRE-ROLL" VERSUS "POST-ROLL" URINALYSIS SAMPLING AND 1ST VERSUS 2ND SHIFTS

As shown in Table 9, there are several instances where urinalysis samples were collected before and after a specific uranium rolling operation. It is not clear how these different types of samples may have been interpreted in developing coworker intake values.

Of the 25 separate days when uranium samples were taken:

- 6 sampling days were designated as "post-roll"
- 7 sampling days were designated as "pre-roll" (2 of which did not have a corresponding "post-roll" sampling)
- 12 sampling days were not specifically labeled

Notably, the 12 sampling days that were not specifically labeled as "pre-roll" or "post-roll" occurred either at the beginning of urinalysis sampling (first 6 sampling events) or at the end of urinalysis sampling (last 6 sampling events). These periods generally correspond with the decreased use of radiological engineering controls over the operational period of the plant.

A comparison of pre-roll and post-roll samples for five pairs of urinalysis data is presented in Table 10; the first column provides a number for reference. The average pre-roll samples are higher than the average post-roll samples for three of the five pairs (#1, #4, and #5) and all samples overall.[9] When comparing the median values, this was the case for two of the five pairs (#1 and #4). For more highly soluble compounds, one would expect the post-roll urinalysis results to universally be higher than the pre-roll samples. However, it is likely the uranium inhaled by workers at Simonds Saw and Steel was in the form of metal and uranium oxide, both of which are Type S (insoluble) materials. Thus, as time went on, one would expect to see increasing urine concentrations, because the body burden should be increasing, even though engineering controls were changing. Therefore, short-term (i.e., pre- versus post-roll) fluctuations in urine concentration would not necessarily be discernible through urine bioassay with Type S materials. However, it is not clear what circumstances might cause the urinalysis results to decrease during a rolling period, and a more detailed statistical analysis of these results may be warranted.

[9] The 'All Post-roll' and 'All Pre-roll' categories in Table 10 include all samples designated as post- or pre-roll, not just the pairs.

Table 10. Comparison of Pre-Roll and Post-Roll Sampling

Reference #	Date	#	Percentage of Total	Average	Median	Maximum
1	11/4/1949	16	-	0.031	0.014	0.272*
	11/17/1949	52	-	0.008	0.001	0.164
2	1/6/1950	49	-	0.005	0.002	0.026
	1/19/1950	49	-	0.013	0.015	0.035
3	5/15/1950	25	-	0.007	0.007	0.022
	5/23/1950	25	-	0.010	0.014	0.034
4	8/14/1950	20	-	0.030	0.028	0.102
	8/28/1950	18	-	0.017	0.017	0.033
5	10/20/1950	19	-	0.014	0.004	0.067
	10/25/1950	19	-	0.009	0.006	0.043
All Post-roll**		182	28%	0.011	0.010	0.164
All Pre-roll**		152	24%	0.014	0.009	0.272
Unknown		310	48%	0.016	0.011	0.140

* Though there is no information in the source documentation (Author Unknown 1949–1951) that would invalidate the sample, the value of 0.272 on November 4, 1949, may have been due to a contaminated sample and could be considered an outlier. The worker in question gave a sample prior to a rolling period that was 0.272 mg/l; 2 weeks later (presumably after the rolling period), the same worker sampled at 0.010 mg/l. When that data point is removed, the average drops to 0.015 and the median to 0.013, and the average for all Pre-roll samples drops to 0.012.

** The ‘All Post-roll’ and ‘All Pre-roll’ categories in Table 10 include all samples designated as post- or pre-roll, not just the pairs.

Additionally, it has been suggested in source documentation for Simonds that there may have been differences in the exposure potential between the first and second shift. One radiological monitoring report in particular (Heatherton 1950b, covering the rolling period from August 14, 1950 to August 28, 1950) sampled workers both before and after the rolling operation. Worker samples that were taken ‘post-roll’ were actually lower than the ‘pre-roll’ samples for 14 of the 18 workers. The reference states the following possible reasons:

> *It is difficult to single out a reason for the results of urine samples collected in August. Possible explanations are:*
>
> ***1 – The group sampled work the second shift which has less supervision and consequently there are higher exposures*** [Emphasis added]
> *2 – There was an error in the analysis*
> *3 – All or most of the samples were contaminated*
> *4 – The group received a very high exposure a few hours before the pre-roll samples were collected and large amounts of uranium were still being excreted at the time of the post-roll sampling.*

It is not clear under what conditions scenario 4 could be a viable explanation, given that inhaled materials were predominantly insoluble Type S. Scenarios 2 and 3 would seemingly invalidate this particular batch of bioassay data. If scenario 1 is correct, then it is important to establish which shifts were sampled for uranium. SC&A attempted to compile data to tie specific workers to the first or second shift, so that the urinalysis results of the two groups could be compared; the results of the comparison are shown in Table 11. As seen in the table, the average and median values for the first and second shift are comparable. The highest value for the two groups occurred for the second shift. This does not appear to support the notion that the exposure potential was significantly greater for the second shift; also it does not appear that one shift was sampled more frequently than the other.

Table 11. Comparison of Urinalysis Samples for the Two Different Shifts

Shift Designation	Number of Samples	Percentage of Total	Percentage of Zero Samples	Average	Median	Max
First	93	14%	10%	0.017	0.015	0.066
Second	114	18%	15%	0.016	0.016	0.102
Unknown	437	68%	20%	0.013	0.009	0.272

4.4 FINDING 4: REPRESENTATIVENESS OF PROPOSED INTAKE MODEL FOR DIFFERENT JOB TYPES AND EXPOSURE POTENTIAL

Based on the DWE data collected, it is apparent that different job classifications had significantly different exposure potential, particularly in the early years. Table 12 presents DWE data collected by the AEC for the main job titles at Simonds Saw and Steel. For the job titles designated as 'rollers,' even the position on a particular roll has a significant impact on the exposure potential. For example, workers on the east side of the roughing roll had DWEs that were between 2 and 12 times higher than the west side of the roll (on average, the exposures are about 5 times higher). On any given sampling date, the ratio of the highest DWE to the lowest DWE ranged from ~2.7 to as high as ~27. On average, the ratio from the highest DWE to the lowest DWE was approximately 10. It is also important to note that the DWEs represent snapshots in time that may well have missed some of the highest air concentrations. The high variability and uncertainty in the DWE data is the reason why Davis and Strom (2008) recommend a GSD of 5 be applied to DWE data for use in dose reconstruction.

With such diverse exposure potential within the same plant, it is important that the proposed intake model does not underestimate unmonitored doses to higher-risk job classifications. SC&A compiled job title information, where available, in order to compare the urinalysis results for the most common job titles found in the DWE reports. Approximately 25% of the urinalysis results could be matched to one of these job titles. An overview of these urinalysis results is found in Table 13. Not surprisingly, the roughing and finishing rollers had the highest average and median urinalysis results, with the east side of the rolls generally higher than the west.[10] It has not been established that the proposed intake values properly bound exposures to the job titles with higher exposure potential.

[10] The furnace man shows the highest average results in Table 13; however, once the value of 0.272 µg/l is removed, the average drops significantly, as noted.

Table 12. Daily Weighted Exposures (dpm/m^3) for the Most Common Job Categories

Date	Drag Down Operator	Finishing Roll - East	Finishing Roll - West	Foreman	Furnace Man	Pressure Quencher	Rod Stamper	Roughing Roll - East	Roughing Roll - West	Straightener (shearman)	Ratio of Highest DWE to Lowest DWE
10/27/1948	620	8394	797	1760	527	1471	1944	13700	1620	-	26.0
12/1/1948	732	2496	1028	908	274	477	826	1574	826	-	9.1
1/10/1949	105	1010	290	320	96	2580	1870	693	263	-	26.9
4/5/1949	180	400	430	220	150	260	590	470	92	-	6.4
5/10/1949	370	470	200	290	122	360	840	390	170	150	6.9
1/9/1950	70	145	310	135	61	370	258	185	85	100	6.1
1/10/1950	310	214	96	90	135	208	108	385	90	57	6.8
4/1/1950	60	215	75	50	45	40	90	200	30	75	7.2
5/1/1950	131	232	120	110	17.6	39.4	111	195	33.2	45	13.2
10/1/1950	55.5	96.2	72.4	58.8	58	35.9	34.2	112	61.5	49.4	3.3
1/9/1951	90.4	945	53.5	81.5	81.5	91.7	82.3	622	48.5	57.3	19.5
8/21/1951	116	175	114	149	99	91	75	124	132	65	2.7
12/9/1952	60	96.5	286	97.4	76.7	230	297	120	162	125	5.0
1/17/1953	-	-	-	701	-	-	2041	1061	372	7031	18.9
Average	**223.1**	**1145.3**	**297.8**	**355.1**	**134.1**	**481.1**	**654.8**	**1416.5**	**284.7**	**775.5**	**10.6**
Median	**116.0**	**232.0**	**200.0**	**142.0**	**96.0**	**230.0**	**277.5**	**387.5**	**112.0**	**70.0**	**5.5**
Max	**732**	**8394**	**1028**	**1760**	**527**	**2580**	**2041**	**13700**	**1620**	**7031**	**26**

Table 13. Urinalysis Results for the Most Common Job titles Identified in DWE Reports

Job title	# Samples	Percentage of total Samples	Average	Median	Maximum
Dragdown Operator	8	1%	0.009	0.009	0.017
Finishing Roll - East	20	3%	0.020	0.022	0.048
Finishing Roll - West	16	2%	0.015	0.015	0.041
Foreman	15	2%	0.011	0.003	0.066
Furnaceman	8	1%	0.043	0.012	0.272*
Pressure Quencher	21	3%	0.011	0.003	0.046
Rod Stamper	13	2%	0.010	0.011	0.023
Roughing Roll - East	13	2%	0.017	0.017	0.033
Roughing Roll - West	19	3%	0.016	0.016	0.044
Shear Man/ Straightener	28	4%	0.010	0.009	0.031

* If the outlier value of .272 is omitted, the average and median values for the furnace man drop to 0.01 and the maximum value to 0.027.

4.5 FINDING 5: ESTABLISH CLAIMANT FAVORABILITY OF URINALYSIS COWORKER MODEL VERSUS DAILY WEIGHTED EXPOSURE (DWE) DERIVED COWORKER MODEL

The TBD presents derived inhalation intake values based on both the DWE reports (ORAUT 2011, Table 11) and urinalysis data (ORAUT 2011, Table 17). A comparison of both calculated intakes are recreated below in Table 14 and shown visually in Figures 7–9. SC&A notes that no statistical parameters were provided for the DWE-based intakes. Therefore, it is not possible to compare upper quantiles of the DWE distribution to the urinalysis-based values. As previously noted, Davis and Strom (2008) performed an uncertainty analysis on DWE data for prospective use in coworker model development and recommends a GSD of 5. A comparison of intakes at Simonds Saw and Steel based on DWE data versus urine bioassay might benefit from an evaluation of upper quantile values. It is noteworthy that NIOSH has accepted the Davis and Strom analysis for their thorium coworker model at Fernald (DCAS 2010)

Since the last identified DWE report was issued in January 1953, it is not clear how the intakes for the latter periods were calculated. Also, the current TBD methodology using urinalysis assumes that the internal exposures after 1952 are equivalent to those in 1948. Figures 8 and 9 show how the DWE-derived intakes would change if this same methodology had been applied.

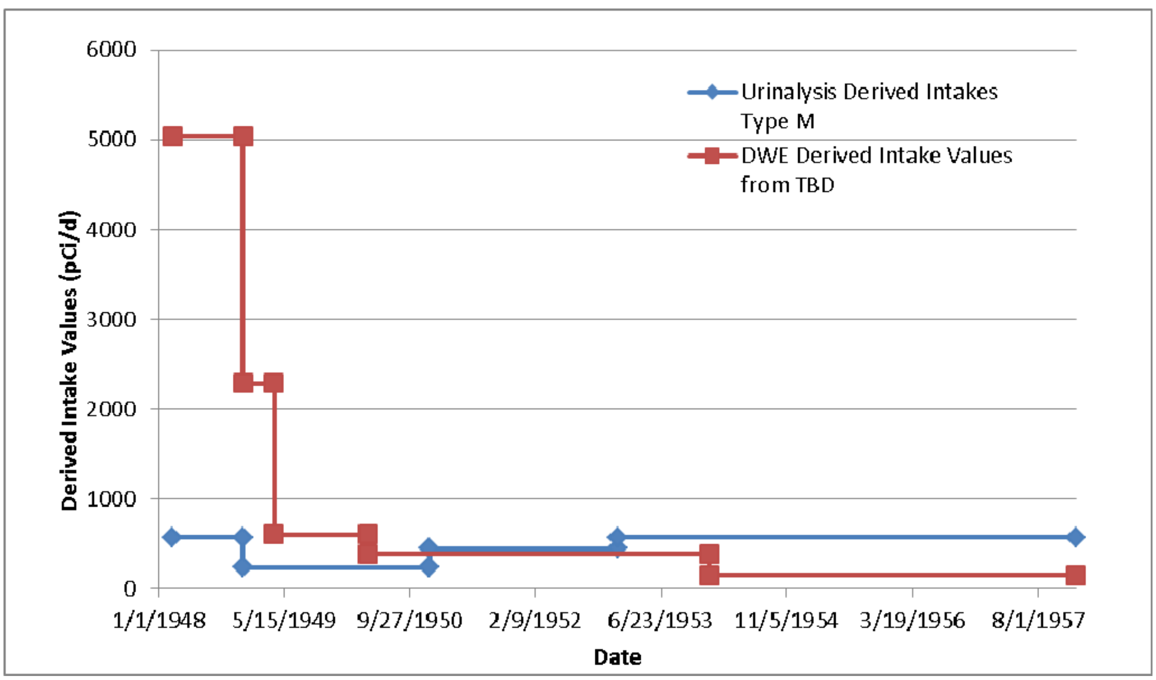
It is generally accepted that bioassay data are a preferable basis for developing coworker intakes when compared with other monitoring data, such as air sampling. However, given the large differences in Type M intakes between the DWE-derived intakes and urinalysis-derived intakes for certain periods, NIOSH should further demonstrate that the urinalysis model is reflective and bounding to the highest-exposed worker populations and represents a more accurate basis for the development of coworker intakes.

It should be noted that if Type S intakes based on bioassay data are applied, then the DWE-based intakes become less favorable to the claimant than bioassay-based intakes. The comparison of bioassay Type S intakes to DWE-based intakes is shown in Figure 9.

Table 14. Comparison of TBD-Derived Intake Values based on Daily Weighted Exposure Reports and Urinalysis Samples

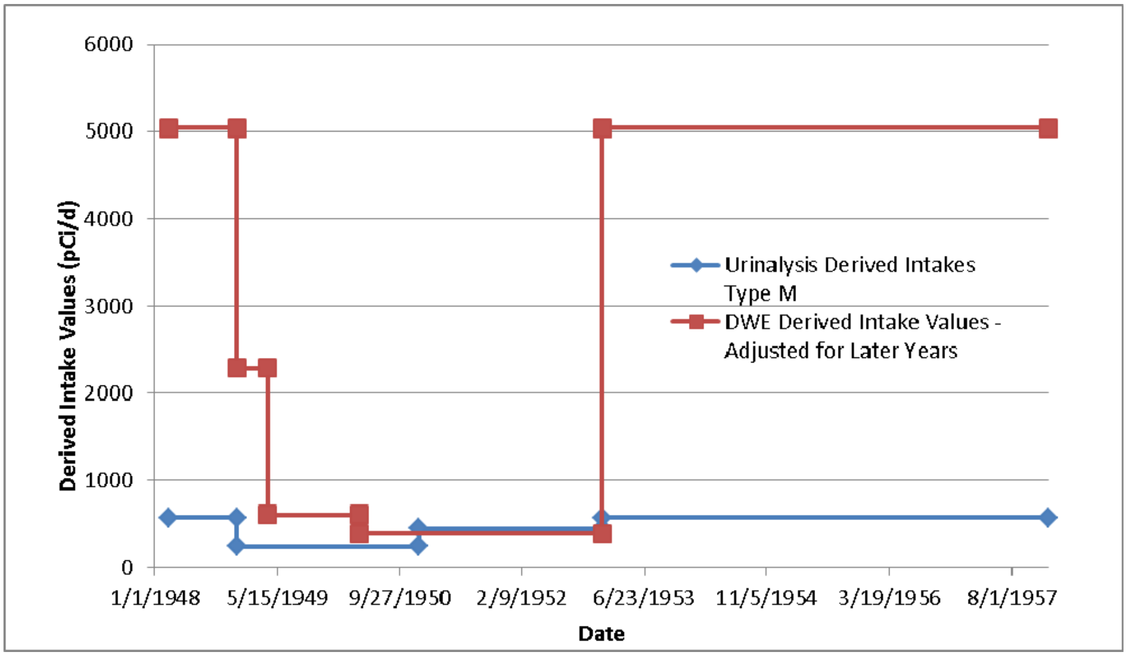
Urinalysis Derived Inhalation Intakes*			DWE Derived Inhalation Intakes		
Intake Period	**Absorption Type**	**Urinalysis Derived Intake (pCi/d)**	**Intake Period**	**Absorption Type**	**DWE Derived Intake (pCi/d)**
2/24/48–12/1/48	M	576	2/24/48–12/1/48	M, S	5,040
	S	17,200			
12/1/48–12/15/50	M	236	12/1/48–4/5/49	M, S	2,290
	S	2,400			
12/15/50–12/31/52	M	449	4/5/49-4/13/50	M, S	605
	S	7,260	4/13/50–1/1/54	M, S	387
1/1/53–12/1/57	M	576	1/1/54–12/31/57	M, S	153
	S	17,200			

*TBD recommended coworker intakes



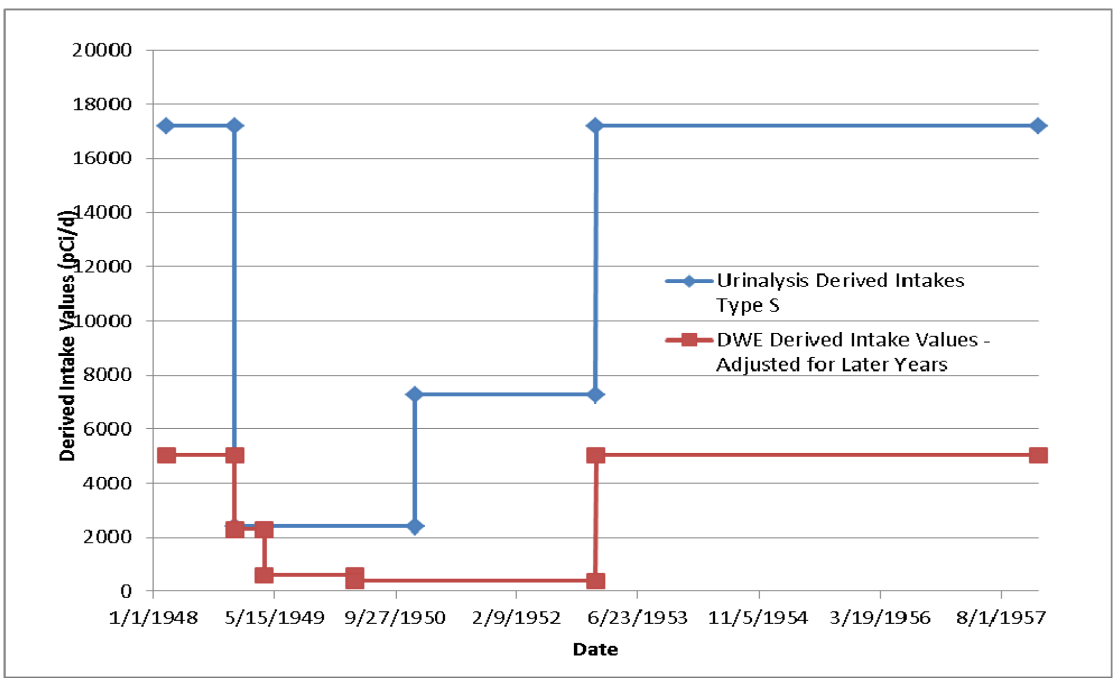
Source: ORAUT 2011, Table 11 (DWE data) and Table 17 (urinalysis data)

Figure 7. Comparison of Derived Intake Values based on Urinalysis and DWE Data



Source: ORAUT 2011, Table 11 (DWE data adjusted) and Table 17 (urinalysis data adjusted)

Figure 8. Comparison of Derived Intake Values (Type M) based on Urinalysis and DWE Data Adjusted for Later Year Methodology



Source: ORAUT 2011, Table 11 (DWE data adjusted) and Table 17 (urinalysis data adjusted)

Figure 9. Comparison of Derived Intake Values (Type S) based on Urinalysis and DWE Data Adjusted for Later Year Methodology

4.6 FINDING 6: MORE QUANTITATIVE AND SUBSTANTIVE DISCUSSION OF AVAILABLE EXTERNAL MONITORING DURING RESIDUAL PERIOD

In order to reconstruct external doses for workers during the residual period of operation, NIOSH proposes to use values identified during a survey of the Simonds plant immediately preceding the termination of their contract with NLO (Heatherton 1957). The purpose of the 1957 survey was to determine whether further cleanup operations would be needed subsequent to the contract closeout. Although much of the actual measurement data is not provided, the survey document makes the statement:

> *With the exception of two small areas, the radiation readings at 3 feet above the floor never exceeded 0.2 mreps/hr combined beta and gamma radiation.*
> (Heatherton 1957)

The measurements of the “two small areas” are then presented here in Table 15 (see Heatherton 1957, Table I). To assign penetrating dose, NIOSH proposes to use the gamma reading of 0.08 mR/hr (as shown for the “Front of Shear”) as the median exposure and assume the value of 0.4 mreps/hr-beta as representative of the 95th percentile exposure, which results in a GSD of 3.5.[11] It should be noted that Strom 2007 recommends using a GSD of 5 in the absence of other information.

Also, it is not clear why a beta measurement would be used to represent external penetrating dose. However, it is possible that the source documentation is mislabeled and that this in fact represents a combined beta/gamma measurement instead of strictly beta. The TBD would benefit from a more substantive discussion as to why the specific penetrating dose values were chosen for the residual period.

Table 15. Measurements Taken at Locations Higher than 0.2 mreps Combined Beta/Gamma

Location	Rough Dimensions of Contamination	Beta-gamma Contact Readings (mreps/hr)	Beta Readings at 3 Feet (mreps/hr)	Gamma Readings at 3 Feet (mR/hr)
10” Bar Mill Bed	75 ft^2 × ½” thick	10–20	1.0–1.7	0.04, 0.05
Front of Shear	10 ft^2 × 1” thick	1–2	0.4	0.08
Between Floor Plates on Mill Floor	Unavailable	0.15	0.05	Not Detected
Forge Area	Unavailable	0.7–1.2	0.2	0.02
Top of Furnace	150 ft^2 × 2” thick	1.0	Not Measured	Not Measured

Source: Heatherton 1957, Table I

As seen in Table 15, the highest beta measurements were taken for the 10” Bar Mill Bed. It would be important to establish whether residual workers might have regularly worked on, or in close vicinity of, the 10” Bar Mill Bed in order to ensure that the external doses assigned using this survey data are favorable to the highest potentially exposed workers. It should also be noted

[11] It appears, based on the values selected, that the GSD should be 2.65 (0.08*GSD^1.65=0.4 therefore GSD=(0.4/0.08)^(1/1.65)=2.65)

that these values are extrapolated to annual doses assuming an 8-hour workday in the TBD, though during the operational period, a 10-hour workday was assumed. NIOSH should provide the basis for this assumed reduction in hours worked per day during the residual period.

Finally, a more quantitative discussion of residual surveys undertaken since the end of radiological operations at Simonds would help to demonstrate the claimant favorability of the proposed external dose assignments. Specifically, a discussion on the amount of available data that was collected and analyzed, and its relative magnitude compared to the assumed external dose values for the residual period would help strengthen the proposed approach.

4.7 FINDING 7: APPROPRIATENESS OF CHOSEN INTERNAL METHODOLOGY DURING RESIDUAL PERIOD AND CONSISTENCY WITH OTIB-0070

For internal doses associated with the start of the residual period, NIOSH proposes to use the average of the general air samples measured at the plant from 1949–1953 (listed as 94 $\mu g/m^3$) to establish a daily intake rate of 422 pCi/day. Specific criteria for how air sampling data were identified and compiled were not provided in the TBD, so it is not clear what sampling data were included and what were discarded. Also, it is not clear why air sampling data from 1954 were not included in the analysis. Similar to the external dose methodology, the TBD assumes an 8-hour work day for the residual period, though a 10-hour work day was assigned for the operational period.

SC&A independently compiled available air sampling reports for comparison with the stated airborne contamination levels; the total number of records identified for the sampling types is shown in Table 16. As shown in the table, air sample results often were not labeled as specifically being “general air” or “breathing zone,” and it is not known if these samples (which were not specifically labeled) were included in NIOSH’s compilation. Also, many individual samples contained in the hardcopy records were repeat measurements of the same location, activity, and work day. It is not clear whether these repeat measurements were treated as individual results or were combined into a single average result in NIOSH’s data analysis. In SC&A’s analysis presented here, repeat samples were combined into a single average result to avoid biasing the available data with repeated measurements of the same activity/timeframe. Table 16 also shows that a large proportion of the general air samples identified were taken in 1949–1950 when institutional controls and associated contamination levels would be the lowest.

Tables 17-19 present the average, median, and geometric mean results for the different categories of air samples by year. Figure 10 plots the number of general air samples versus the average annual result; the years with higher numbers of air sampling results generally had lower average contamination results. As shown in Table 17, the average general air sample for all years was approximately 479 dpm/m^3. Assuming natural uranium, this would roughly translate to 316 $\mu g/m^3$, which is significantly higher than the number quoted in the TBD (94 $\mu g/m^3$). However, it is also worth noting that the median and geometric mean results from 1948–1954 are significantly less than 94 $\mu g/m^3$ (48 and 50 $\mu g/m^3$, respectively).

Because operations at the end of the operational period would likely have been similar to those in 1954 and are not necessarily reflective of earlier years when institutional controls were in place, it may be more appropriate to only consider samples from 1954. This would be in accordance with the methodology presented in ORAUT-OTIB-0070, which utilizes air monitoring data at the end of the operational period to represent the airborne contamination at the very beginning of the residual period.

Table 16. Total Number of Air Samples by Year

Year	General Air	Breathing Zone	Not Specifically Labeled GA or BZ
1948	37	3	50
1949	174	32	96
1950	225	84	92
1951	56	25	44
1952	53	45	11
1953	49	30	46
1954	16	13	10

Table 17. Average Air Sampling Results by Year (dpm/m^3)

Year	General Air	Breathing Zone	Not Specifically Labeled	All Air Samples
1948	1794.1	878.0	5603.3	3879.8
1949	680.1	1378.4	592.7	726.3
1950	177.1	539.7	2020.6	676.0
1951	148.7	309.3	156.3	183.5
1952	272.1	5712.0	316.1	2522.4
1953	705.2	306.3	210.7	427.5
1954	633.7	635.6	5732.7	1941.8
All Sampled Years	**478.7**	**1613.4**	**1720.2**	**1063.5**

Table 18. Median Air Sampling Results by Year (dpm/m^3)

Year	General Air	Breathing Zone	Not Specifically Labeled	All Air Samples
1948	325.0	630.0	1691.0	861.7
1949	95.0	520.0	270.0	150.3
1950	50.0	112.5	154.0	75.3
1951	91.0	100.0	104.2	91.0
1952	78.0	176.0	226.0	140.0
1953	83.0	108.2	27.0	61.0
1954	97.5	15.0	2290.0	100.0
All Sampled Years	**72.5**	**150.0**	**209.0**	**106.0**

Table 19. Geometric Mean Air Sampling Results by Year (dpm/m^3)

Year	General Air	Breathing Zone	Not Specifically Labeled	All Samples
1948	332.3	716.6	2036.0	933.3
1949	103.8	627.1	208.6	159.0
1950	52.0	126.5	221.7	86.8
1951	80.7	137.7	110.9	100.4
1952	97.4	430.0	229.9	196.0
1953	106.0	124.7	35.2	73.4
1954	191.2	43.7	1760.5	207.4
All Sampled Years	**84.9**	**193.5**	**228.8**	**133.7**

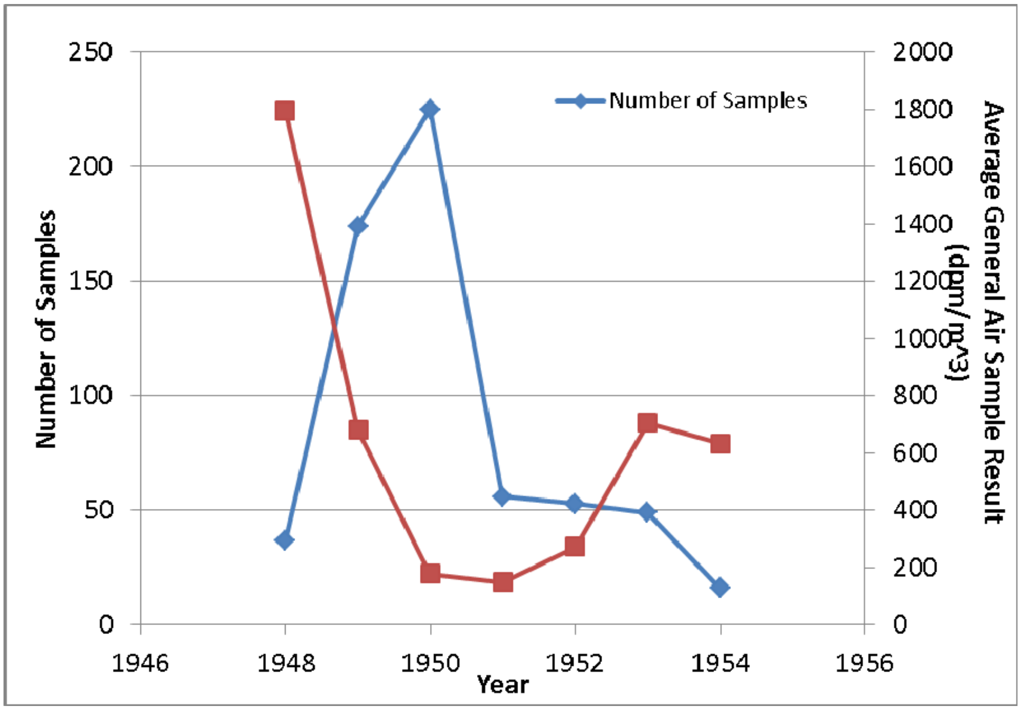


Figure 10. Comparison of the Number of Air Samples to the Average Air Sample Value by Year

To determine the internal dose at the end of the residual period, NIOSH proposes to use EPCs developed from a comprehensive 2007 survey of the site. The TBD states:

> *Surface contamination measurements performed during this investigation were used to derive Exposure Point Concentration (EPC) values to be used in exposure and risk assessment studies. The EPC values represent the 95% upper confidence limit values for each particular parameter reported.* (ORAUT 2011)

The TBD would benefit from a more substantive discussion as to how EPC values were calculated and what "parameters" were used in developing the 95th percentile value.

Additionally, the assumption is made that the source term as measured in 2007 is the same source term that would have been observed in 1982. This assumption is not likely to be claimant favorable, as one would expect the source term to decrease over the 25-year span from 1982 to 2007 by means such as weather removal. A 2010 walkthrough of the Simonds plant revealed that the operational areas were essentially "open air," as there were holes in the roof and many broken windows. Figures 11 and 12 illustrate the condition of the plant during that walkthrough. According to ORAUT-OTIB-0070, the date of the measurement during the residual period (2007) should be used to develop an exponential interpolation factor for evaluating internal doses. The TBD should justify why an alternate method than that presented in ORAUT-OTIB-0070 is preferable for Simonds Saw and Steel.

It should be noted that thorium intakes during the residual period are applied as 1% of the uranium activity intake. The assumption of 1% is based on historical estimates on the ratio (by weight) of thorium to uranium processing at Simonds. The specific activity of natural uranium is approximately six times the specific activity of thorium, so the assignment of this thorium intake is a conservative and claimant-favorable assumption.

Figure 11. Photo of the Main Operational Area of the Simonds Plant in 2010

Figure 12. Photo of the Condition of the Roof at the Simonds Plant in 2010

5.0 OVERALL ADEQUACY OF THE SITE PROFILE AS A BASIS FOR DOSE RECONSTRUCTION

The SC&A procedures call for both a "vertical" assessment of a site profile for evaluating specific issues of adequacy and completeness, and a "horizontal" assessment considering how effectively the profile satisfies its intended purpose and scope. This section addresses the latter objective in a summary manner by assessing:

(1) How, and to what extent, does the site profile satisfy the five objectives defined by the Advisory Board?

(2) How usable is the site profile as a generalized technical resource for the dose reconstructor when individual dose records are unavailable?

(3) Have generic technical or policy issues been identified that transcend any single site profile and need to be addressed by the Advisory Board and NIOSH?

5.1 OBJECTIVE 1: COMPLETENESS OF DATA SOURCES

NIOSH analyzed both DWE data and available urinalysis data when characterizing the internal dose potential at Simonds Saw and Steel. Daily weighted exposure (DWE) data exist from early on in the site's operational history (October 1948) into early 1953. Urinalysis data are available over a similar timeframe (November 1948 to December 1952). Internal monitoring studies/data do not exist past this timeframe, though some air sampling data do exist as late as October 1954.

Individual external monitoring data rarely existed at Simonds Saw and Steel and were restricted to only 21 workers for a period of approximately 9 days. NIOSH utilizes a combination of onsite measurements (area film badges), surrogate data (survey measurements at Aliquippa Forge), and computerized models (MCNP) in order to develop an external dose coworker model.

Finally, the ever-changing industrial hygiene controls at Simonds were well documented in the available SRDB documentation. These changes were thoroughly represented in the TBD, which gave a generally complete and accurate characterization of operations at Simonds based on available records.

5.2 OBJECTIVE 2: TECHNICAL ACCURACY

NIOSH has performed a comprehensive search of available documentation on the SRDB relating to Simonds Saw and Steel, including a series of available reports titled, *Occupational Exposure to Radioactive Dust*, which document internal exposure potential, via both urinalysis and air sampling, at various times during Simonds Saw and Steel's operation. Intakes based on bioassay data were analyzed using the Integrated Modules for Bioassay Analysis (IMBA) Expert OCAS-Edition Version 3.2.20 and assumes a uniform error of 1 and normal error distributions for each result. Intakes based on DWE data use site-specific information on the number of rolling periods, worker exposure times, and typical breathing rates for light work based on ICRP 60 (ICRP 1991).

External exposures were characterized by a combination of general area film badge measurements for exposures from general plant contamination, as well as surrogate data from Aliquippa Forge to develop non-penetrating radiation dose assignments for uranium operations. Due to the general absence of operation-specific external exposures, NIOSH has adopted a modeling approach using MCNP to determine the potential external dose to Simonds workers during radiological operations. It would be beneficial for NIOSH to provide more specific descriptions of the parameters and assumptions used in the MCNP model to characterize operational external exposures.

Residual exposures are based on site-specific data taken at the end of the period (in the case of external exposure), and a combination of operational data and survey data from the end of the residual period for the site. Because these approaches utilize real data from the site, they are deemed technically accurate.

5.3 OBJECTIVE 3: ADEQUACY OF DATA

As stated previously in Sections 5.1 and 5.2, NIOSH has performed a detailed and thorough review of available documentation for Simonds Saw and Steel and has analyzed available internal exposure data to develop plausible intakes. As stated in the TBD, the latter years of the site had less detailed and complete records on plant conditions and operations. However, given that available records from earlier in the period represent a cross section of different levels of industrial control and operations, SC&A believes the available data are sufficient and adequate to be used as a surrogate for periods where records are unavailable or missing during the operational period.

Data to characterize external exposures were generally incomplete at Simonds Saw and Steel. Ambient external exposure potential was able to be characterized by a single general area film badge study performed by AEC to determine the levels of contamination and resulting external doses in the plant. Film badging at Simonds was restricted to a single short-term badging period and may not be representative of typical operations. Despite this absence of data, SC&A believes that sufficient information exists in the form of source characterization, computer modeling, and surrogate data to overcome this deficiency.

Residual external exposures are based on site survey data taken at the end of the operational period, and we believe that they are adequate for dose reconstruction purposes. Internal exposures at the start of the residual period are based on operational survey data and may not reflect the condition of the plant at the end of operations. However, SC&A believes that sufficient data exist towards the end of the operational period that could feasibly be used to develop a reasonable characterization of the plant at the end of operations.

5.4 OBJECTIVE 4: CONSISTENCY AMONG SITE PROFILES AND OTHER NIOSH DOCUMENTS

In evaluating external exposures during the operational period, NIOSH used a combination of site-specific data, surrogate data from similar uranium processing sites, and computer modeling using the MCNP software. Surrogate data and exposure models are only preferable in the absence of site-specific data, as was the case with external exposures during radiological operations; though it is important to note that there was a limited set of film badge data from which meaningful comparisons could likely be made.

Internal dose was evaluated using available bioassay data, which is preferable to other sources of data, such as air monitoring, surrogate data, or other source-based modeling and characterization. This is consistent with standard dose reconstruction procedures and approaches taken at other AWE sites. It should be noted, however, that there was also an extensive DWE program that was analyzed by NIOSH and produced significantly higher intakes for soluble forms of uranium. It is recommended that NIOSH re-examine the differences in the two intake models and assure that their chosen internal dose assignments are sufficiently bounding.

External dose during the residual period was based on site-specific measurements taken at the end of the operational period at Simonds, which is consistent with established procedures. Internal dose during the residual period deviated slightly from the established procedures in ORAUT-OTIB-0070 (ORAUT 2008). Specifically, the starting intake values are based on general air samples taken during the middle of the operational period and not the end of the period,[12] which would be more reflective of residual operations. Also, the intakes for the very end of the residual period were based on survey data from 2007, which would normally be consistent with OTIB-0070. However, the 2007 data were assumed to be reflective of the condition of the plant in the early 1980s, which differs from the methods described in OTIB-0070.

5.5 OBJECTIVE 5: REGULATORY COMPLIANCE AND QUALITY ASSURANCE

SC&A performed a comprehensive data compilation of urinalysis and air sampling data for comparison with the NIOSH results. SC&A found no issues with the urinalysis data compilation. SC&A could not exactly match the results of the air sampling analysis presented in the TBD; however, the results were reasonably consistent and within the range of expected uncertainty in that type of data compilation and analysis.

5.6 INCONSISTENCIES AND EDITORIAL ERRORS IN THE SITE PROFILE

(1) Pg. 10: SC&A could not verify the start date based on the reference provided in the TBD (AEC 1948a)

(2) Pg. 11: "The process generated a considerable amount of waste, as evidenced from a 1952 Tonawanda Progress Report (AEC 1952a): 'Approximately fifty drums of [uranium contaminated] scrap and oxide were received from Simonds at the completion of the January rolling.'" SC&A could not find the provided reference based on the SRDB REF ID. SC&A found an equivalent document (AEC 1952b), but could not find mention of the 'fifty drums' therein.

(3) Pg. 11: "Information on material processing was compiled from all available Simonds-related documents and places the total quantities of uranium and thorium processed at

[12] Actual general air samples are not available in the final few years of operation at Simonds; however, air sampling was performed as late as 1954 which was not used in developing residual intakes.

11,500 tons and 114,000 pounds respectively [NIOSH 2010]. These values exceed the amounts stated in various documented historical narratives by about a factor of three." It appears the factor of 3 only applies to the amount of thorium processed.

(4) Pg. 17: Paragraphs one and three are essentially identical.

(5) Pg. 20: "It was assumed that operations in 1953 continued at the same level as those in 1952, although the available records indicate significant curtailment at the end of 1953." Table 3 shows the number of rolling days in 1953 as 20% of the load in 1952 – this assumption (per the text) shouldn't be applied until January 1, 1954. The title for Table 3 should be clarified to number of uranium rolling days per year.

(6) Pg. 20: Table 4 only extends to January 1, 1957, and should be December 31, 1957.

(7) Pg. 22: "In addition, some postrolling samples might have been collected at the rolling day's end (i.e., at the very end of rolling, not after rolling)." It is unclear what this sentence is meant to convey and should be clarified.

(8) Pg. 27: "Several assumptions included in the dose reconstruction are likely to be overestimating assumptions, which increase the estimate of the median intakes from air concentrations." These assumptions should be described and some idea of the quantitative effect on the dose reconstruction discussed.

(9) Pg. 32: Table 16 displays assumed contaminant ratios for Np, Pu and Tc; however, the intakes displayed in Table 17 only display intake rates for Np and Pu.

(10) Pg. 33: Row for Np-237 instructs to use absorption Type M "if U is S." This is likely a typo and should be Type S "if U is S."

(11) Pg. 39: "The average of general area air sample results reported during air monitoring studies conducted between 1949 and 1953 was used as an estimate of the air concentration at the start of the residual period [AEC 1948b and 1949; Heatherton 1950a, 1950b, 1951b, and 1953; Klevin 1948a, 1949a, 1949b, 1949c, 1950; and 1951, Klevin and Weinstein 1953a and 1953b]." Sentence should likely say it used the average of general area air samples reported from **1948**–1953.

(12) Pg. 39: The text shows the intake rate starting in 1982 as 5.5 pCi/d; however, the table on the following page lists it as 5.4 pCi/d.

(13) Pg. 41: Column 3 of Table 24 appears to have the wrong footnote.

6.0 REFERENCES

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ATTACHMENT 1: TIMELINE OF THE IMPLEMENTATION AND USE OF RADIOLOGICAL CONTROLS AT SIMONDS SAW AND STEEL

Date	Description of Engineering Controls	REFERENCE ID
5/19/1948	Workers are only provided with gloves and are responsible for doing their own laundry.	11229 (Hayden 1948)
7/30/1948	Two sets of clothing per man provided by AEC. Ventilation and vacuum plans have been made, but not yet installed. Installation of floor grating deferred until it can be determined if frequent vacuuming can keep the dust levels down.	10876 (Reichard 1949)
10/27/1948	Vacuum cleaner had been installed, but was used only intermittently; reports indicate the vacuum discharge was simply re-entering the plant.	10883 (Klevin 1948a) and 10167 (Klevin 1948b)
12/1/1948	Vacuum cleaner set to discharge outside and exhausts for rolls installed, temporary enclosure over the descaler installed. It is recommended that exhaust ventilation be installed over the descaler and floor gratings be installed on the mill floor.	10167 (Klevin 1948b)
1/20/1949	"The present study was made after complete ventilation had been installed, vacuum exhaust vented outside the mill area and exhaust fan from pressure quencher exhausted through roof. All the original recommendations of the Health and Safety Branch had been complied with except for the placement of gratings on each side of the roller floor."	10908 (Klevin 1949a)
2/15/1949	Exhaust for descaler installed.	11996 (AEC 1949)

Date	Description of Engineering Controls	REFERENCE ID
4/5/1949	Floor gratings partially installed on the mill area floor: "it was noted that the gratings used on the date of the survey did not cover an area large enough to prevent uranium dust from being kicked up by the personnel in areas directly adjacent to the rolls." (pg. 4) Pedestal fan installed by the pressure quencher to decrease exposures to operators and rod stampers; however, this increased exposures to workers downstream of the fan – recommend that they cease using the pedestal fan and instead increase the ventilation hood over the quenching area. H&S recommend stamping rods after they are descaled; otherwise the installation of a hood over the stamping area should be undertaken.	16230 (Klevin 1949b)
5/20/1949	Floor gratings were still only partially installed.	4609 (Klevin 1949c)
6/7/1949	Lucite plastic sheeting to be installed onto rolling ventilation hoods. Floor gratings only partially installed. Ventilated housing for stamping operations or an exhaust hood is recommended.	10876 (Reichard 1949)
7/6/1949	Recommendations made to add floor grating to pressure quencher and rod stamping area.	11225 (Belmore and Wolf 1949)
9/7/1949	Exhaust fans over finishing rolls operating speed increased, which will increase the dust collection efficiency. All floor gratings have been received at Simonds; however, had not been installed yet as they were being outfitted with rollers. It is assumed all will be in service by the end of the rolling period.	10876 (Reichard 1949)
1/10/1950	Recommends adding a ventilated conveyor; no additional controls appear to have been implemented.	10184 (Klevin 1950)
2/20/1950	No additional controls have been implemented. Recommended that all broom sweeping cease; report directs Simonds personnel to refer to previous recommendations made.	11224 (Harris 1950)

Date	Description of Engineering Controls	REFERENCE ID
4/14/1950	Increased airflow on the quencher exhaust system lowered the general air concentrations in the plant. Exclusive use of the lead bath furnace for heating the billets. Rod shearing operation has been eliminated.	16310 (Heatherton 1950a)
8/14/1950	Notes that continuous water stream is used in the quenching area, which sprays directly onto the floor; recommends extending quenching hood to cut down on the spray and improve ventilation.	17024 (Heatherton 1950b)
1/10/1951	Pressure quenching operation changed to dip quenching, which left more scale on the rods when removed from the quenching tank causing higher exposures to rod stampers and workers in the quench tank area. Continuous water stream used to wet 2 of the 7 rolls, which caused a higher air contamination from increased carry off of fine fumes in the steam cloud. Plexiglass shields had been removed from the ventilation hoods over the rolls: "It was learned that the omission of shields on the hoods in the beginning was through oversight. After that, no one bothered to put them on." (pg. 5)	16353 (Heatherton 1951a)
3/8/1951	Noted that the plexiglass shields were still removed from the rolls and that the floor grating was only used intermittently.	81453 (Heatherton and Harris 1951)
8/21/1951	Grating directly in front of the rolls was moved to 2 feet west of the rolls; broom sweeping was employed in most areas instead of vacuum cleaning, which was deemed 'infrequent.' Plexiglass shields have been reinstalled. Recommends using a more powerful vacuum to remove dust from in between grates. "The practice of flinging small rod shearings (6" to 8" long) across the West rolling area to the pressure quencher should be eliminated as it creates both a health and a safety hazard... Common sanitary considerations dictate that two sets of coveralls should be issued to each man on the rolling crews for any rolling longer than 5 days. A uniform change every four days would eliminate the present practice of changing into their own clothes during the uranium rolling operation."	17017 (Klevin 1953a), 16314 (Klevin 1951)
11/22/1952	"Aside from lack of suitable dust control measures for this operation which include local exhaust ventilation over the three rolls, floor gratings in front of the rolls and a central vacuum cleanup system, there were malpractices of good industrial hygiene procedures which contributed to the high alpha concentrations. These were: 1 - No cleanup during the entire rolling operation, 2 - Sweeping of steel plate floor area with brooms after completion of rolling, 3 - Stamping of thorium rods on flat steel bed of conveyor, 4 - Tracking of dust [f]rom the rolls to the rest areas."	17025 (Klevin 1953b)

Date	Description of Engineering Controls	REFERENCE ID
12/9/1952	Similar conditions found in August 1951; gratings were noted to have been pounded flat by the weight of the rods; recommendations made in August (including consistent use of the vacuum cleaner and elimination of broom sweeping) were not implemented.	17017 (Klevin 1953a)
1/17/1953	Special 'E' material processed on the 16" and 10" bar mill – no ventilation was available on the 10" mill.	14150 (Heatherton 1953)
8/6/1954	Operators wear coveralls and a cape supplied by NLO; shoe covers were supplied but not worn. It appears the floor grating has been replaced with steel sheeting. “[The Plant Manager] told me that radioactive material had been processed for many years without any adverse effects. He also intimated that if it became necessary to install elaborate dust eliminating equipment, further work of this nature would have to be abandoned.”	14154 (Polson 1954)
10/11/1954	“Doubtful practices” noted by NLO H&S: 1- Dropping of billets on floor prior to rolling, 2 - Wire brushing billets to observe temperature, 3 - Sweeping of floor instead of vacuum cleaning, 4 - Use of cloth gloves… “These practices have been going on for as long as anyone connected with the operations can remember. Many attempts have been made to caution the operators about the dust contamination. There appears to be no fear on the part of most of the personnel at Simonds as to the toxicity of the normal uranium and thorium dust created during fabrication.”	14154 (Polson 1954)