12-12-05P12:37 RCVD

SEC Petition
Office Of Compensation Analysis and Support
NIOSH
4627 Columbia Parkway, MS-C-47
Cincinnati, OH 45226

Attention: SEC Review Board

I respectfully submit this petition on behalf of the Fernald workers; the living, the deceased and their families.

I believe that NIOSH was not able to determine with reasonable accuracy the radiation doses incurred by the workers at Fernald. Based on insufficient accurate information, they were unable to estimate the maximum radiation dose that could have been incurred by any member of this class.

Documents indicate there was no monitoring for specific types of ionizing radiation known to be present. The monitoring was limited in frequency and to limited groups of workers. The monitoring was inaccurate due to sampling techniques and dosimeter limitations. Some data could not be interpreted due to deficiencies in the record keeping procedures. Worker assignments often changed as they were rotated to different locations in an attempt to limit exposure levels.

Dose reconstructors believed 'Good housekeeping' practices were followed at the site. This misconception and limited data resulted in inaccurate default assumptions. Data was reconstructed for the thorium processes because the records had been destroyed in 1970, but it lacks validity due to gross error.

Therefore, I believe it is not feasible to estimate with sufficient accuracy the radiation dose that the workers at Fernald received and that those radiation doses endangered the health of those workers, and possibly their families.

Respectfully submitted,

Special Exposure Cohort Petition — Form B

Use of this form and disclosure of Social Security Number are voluntary. Failure to use this form or disclose this number will not result in the denial of any right, benefit, or privilege to which you may be entitled.

General Instructions on Completing this Form *(complete instructions are available in a separate packet)*:

Except for signatures, please **PRINT** all information clearly and neatly on the form.

Please read each of Parts A — G in this form and complete the parts appropriate to you. If there is more than one petitioner, then each petitioner should complete those sections of parts A – C of the form that apply to them. Additional copies of the first two pages of this form are provided at the end of the form for this purpose. A maximum of three petitioners is allowed.

If you need more space to provide additional information, use the continuation page provided at the end of the form and attach the completed continuation page(s) to Form B.

If you have questions about the use of this form, please call the following NIOSH toll-free phone number and request to speak to someone in the Office of Compensation Analysis and Support about an SEC petition: **1-800-356-4674.**

If you are:			
	☐ A Labor Organization,	Start at D	on Page 3
	☐ An Energy Employee (current or former),	Start at C	on Page 2
	☒ A Survivor (of a former Energy Employee),	Start at B	on Page 2
	☐ A Representative (of a current or former Energy Employee),	Start at A	on Page 1

A Representative Information — Complete Section A if you are authorized by an Employee or Survivor(s) to petition on behalf of a class.

A.1 **Are you a contact person for an organization?** ☐ Yes (Go to A.2) ☐ No (Go to A.3)

A.2 **Organization Information:**

Name of Organization

Position of Contact Person

A.3 **Name of Petition Representative:**

Mr./Mrs./Ms. First Name Middle Initial Last Name

A.4 **Address:**

Street Apt # P.O. Box

City State Zip Code

A.5 **Telephone Number:** ( ) -

A.6 **Email Address:**

A.7 ☐ Check the box at left to indicate you have attached to the back of this form written authorization to petition by the survivor(s) or employee(s) indicated in Parts B or C of this form. An authorization

If you are representing a Survivor, go to Part B; If you are representing an Employee, go to Part C.

Name or Social Security Number of First Petitioner:

B Survivor Information — Complete Section B if you are a Survivor or representing a Survivor.

B.1 **Name of Survivor:**

Mr./Mrs./Ms. First Name Middle Initial Last Name

B.2 **Social Security Number of Survivor:**

B.3 **Address of Survivor:**

Apt # P.O. Box

City State Zip Code

B.4 **Telephone Number of Survivor:**

B.5 **Email Address of Survivor:**

B.6 **Relationship to Employee:**
- ☐ Spouse
- ☒ Son/Daughter
- ☐ Parent
- ☐ Grandparent
- ☐ Grandchild

Go to Part C.

C Employee Information — Complete Section C UNLESS you are a labor organization.

C.1 **Name of Employee:**

Mr./Mrs./Ms. First Name Middle Initial Last Name

C.2 **Former Name of Employee** (e.g., maiden name/legal name change/other):

Mr./Mrs./Ms. First Name Middle Initial Last Name

C.3 **Social Security Number of Employee:**

C.4 **Address of Employee** (if living):

Deceased

Street Apt # P.O. Box

City State Zip Code

C.5 **Telephone Number of Employee:** ( ) -

C.6 **Email Address of Employee:**

C.7 **Employment Information Related to Petition:**

C.7a Employee Number (if known):

C.7b Dates of Employment: Start -52 End -63

C.7c Employer Name: National Lead of Ohio

C.7d Work Site Location: Feed Materials Production Center (FMPC) Fernald, Ohio

C.7e Supervisor's Name: NA

Go to Part E.

Name or Social Security Number of First Petitioner: _

Special Exposure Cohort Petition — Form B

D Labor Organization Information — Complete Section D ONLY if you are a labor organization.

D.1 **Labor Organization Information:**

____
Name of Organization

____
Position of Contact Person

D.2 **Name of Petition Representative:**

____

D.3 **Address of Petition Representative:**

____
Street Apt # P.O. Box

____
City State Zip Code

D.4 **Telephone Number of Petition Representative:** (____) ____-______

D.5 **Email Address of Petition Representative:** ______________________

D.6 **Period during which labor organization represented employees covered by this petition** (please attach documentation): Start ________ End ________

D.7 **Identity of other labor organizations that may represent or have represented this class of employees** (if known):

____

Go to Part E.

Name or Social Security Number of First Petitioner: ______

E Proposed Definition of Employee Class Covered by Petition — Complete Section E.

E.1 Name of DOE or AWE Facility: Feed Materials Production Center (FMPC)

E.2 Locations at the Facility relevant to this petition:

All Locations

E.3 List job titles and/or job duties of employees included in the class. In addition, you can list by name any individuals other than petitioners identified on this form who you believe should be included in this class:

All Employees &
All Sub-Contractors

E.4 Employment Dates relevant to this petition:

Start 1951 End thru 1989
Start ______ End ______
Start ______ End ______

E.5 Is the petition based on one or more unmonitored, unrecorded, or inadequately monitored or recorded exposure incidents?: ☐ Yes ☒ No

If yes, provide the date(s) of the incident(s) and a complete description (attach additional pages as necessary):

Go to Part F.

F Basis for Proposing that Records and Information are Inadequate for Individual Dose — Complete Section F.

Complete at least one of the following entries in this section by checking the appropriate box and providing the required information related to the selection. You are not required to complete more than one entry.

F.1 ☒ I/We have attached either documents or statements provided by affidavit that indicate that radiation exposures and radiation doses potentially incurred by members of the proposed class, that relate to this petition, were not monitored, either through personal monitoring or through area monitoring.

(Attach documents and/or affidavits to the back of the petition form.)

Describe as completely as possible, to the extent it might be unclear, how the attached documentation and/or affidavit(s) indicate that potential radiation exposures were not monitored.

See Continuation Page

F.2 ☒ I/ We have attached either documents or statements provided by affidavit that indicate that radiation monitoring records for members of the proposed class have been lost, falsified, or destroyed; or that there is no information regarding monitoring, source, source term, or process from the site where the employees worked.

(Attach documents and/or affidavits to the back of the petition form.)

Describe as completely as possible, to the extent it might be unclear, how the attached documentation and/or affidavit(s) indicate that radiation monitoring records for members of the proposed class have been lost, altered illegally, or destroyed.

See Continuation Page

Part F is continued on the following page.

Name or Social Security Number of First Petitioner: ______

F.3 ☐ I/We have attached a report from a health physicist or other individual with expertise in radiation dose reconstruction documenting the limitations of existing DOE or AWE records on radiation exposures at the facility, as relevant to the petition. The report specifies the basis for believing these documented limitations might prevent the completion of dose reconstructions for members of the class under 42 CFR Part 82 and related NIOSH technical implementation guidelines.

(Attach report to the back of the petition form.)

F.4 ☐ I/We have attached a scientific or technical report, issued by a government agency of the Executive Branch of Government or the General Accounting Office, the Nuclear Regulatory Commission, or the Defense Nuclear Facilities Safety Board, or published in a peer-reviewed journal, that identifies dosimetry and related information that are unavailable (due to either a lack of monitoring or the destruction or loss of records) for estimating the radiation doses of employees covered by the petition.

(Attach report to the back of the petition form.)

Go to Part G.

G Signature of Person(s) Submitting this Petition — Complete Section G.

All Petitioners should sign and date the petition. A maximum of three persons may sign the petition.

Signature ____________ Date 12-9-05

Signature ____________ Date ____________

Signature ____________ Date ____________

Notice: Any person who knowingly makes any false statement, misrepresentation, concealment of fact or any other act of fraud to obtain compensation as provided under EEOICPA or who knowingly accepts compensation to which that person is not entitled is subject to civil or administrative remedies as well as felony criminal prosecution and may, under appropriate criminal provisions, be punished by a fine or imprisonment or both. I affirm that the information provided on this form is accurate and true.

Send this form to:
SEC Petition
Office of Compensation Analysis and Support
NIOSH
4676 Columbia Parkway, MS-C-47
Cincinnati, OH 45226

If there are additional petitioners, they must complete the Appendix Forms for additional petitioners. The Appendix forms are located at the end of this document.

Public Burden Statement

Public reporting burden for this collection of information is estimated to average 300 minutes per response, including time for reviewing instructions, gathering the information needed, and completing the form. If you have any comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, send them to CDC Reports Clearance Officer, 1600 Clifton Road, MS-E-11, Atlanta GA, 30333; ATTN:PRA 0920-0639. Do not send the completed petition form to this address. Completed petitions are to be submitted to NIOSH at the address provided in these instructions. Persons are not required to respond to the information collected on this form unless it displays a currently valid OMB number.

Privacy Act Advisement

In accordance with the Privacy Act of 1974, as amended (5 U.S.C. § 552a), you are hereby notified of the following:

The Energy Employees Occupational Illness Compensation Program Act (42 U.S.C. §§ 7384-7385) (EEOICPA) authorizes the President to designate additional classes of employees to be included in the Special Exposure Cohort (SEC). EEOICPA authorizes HHS to implement its responsibilities with the assistance of the National Institute for Occupational Safety (NIOSH), an Institute of the Centers for Disease Control and Prevention. Information obtained by NIOSH in connection with petitions for including additional classes of employees in the SEC will be used to evaluate the petition and report findings to the Advisory Board on Radiation and Worker Health and HHS.

Records containing identifiable information become part of an existing NIOSH system of records under the Privacy Act, 09-20-147 "Occupational Health Epidemiological Studies and EEOICPA Program Records. HHS/CDC/NIOSH." These records are treated in a confidential manner, unless otherwise compelled by law. Disclosures that NIOSH may need to make for the processing of your petition or other purposes are listed below.

NIOSH may need to disclose personal identifying information to: (a) the Department of Energy, other federal agencies, other government or private entities and to private sector employers to permit these entities to retrieve records required by NIOSH; (b) identified witnesses as designated by NIOSH so that these individuals can provide information to assist with the evaluation of SEC petitions; (c) contractors assisting NIOSH; (d) collaborating researchers, under certain limited circumstances to conduct further investigations; (e) Federal, state and local agencies for law enforcement purposes; and (f) a Member of Congress or a Congressional staff member in response to a verified inquiry.

This notice applies to all forms and informational requests that you may receive from NIOSH in connection with the evaluation of an SEC petition.

Use of the NIOSH petition forms (A and B) is voluntary but your provision of information required by these forms is mandatory for the consideration of a petition, as specified under 42 CFR Part 83. Petitions that fail to provide required information may not be considered by HHS.

Name or Social Security Number of First Petitioner: ______

F.1

The ORAU TBD for dose reconstruction at FEMP, identified the following areas in which monitoring was not available to Fernald workers:

*No monitoring for internal exposure for Ru contaminants. *No smears or air sampling filters were analyzed specifically for: Plutonium, Neptunium or Thorium isotopes, before Feb. 1989. *No RU contaminants were reported in analysis before 1989. **In Vivo* counts were not performed frequently enough to be of significant value in TRU dose reconstruction. *Internal dosimetry was not introduced until 1986. *Before DOE Order 5480.11 (89) bioassay data was not routinely used to estimate intake and internal organ dose. *No routine air monitoring was used to establish internal intake or exposure estimates. **In Vitro* bioassays for thorium were not performed. *No records were found of any bioassay results for Radium or daughter products during this time. *No non-uranium urinalysis was conducted. *No fecal sampling has ever been a part of the routine bioassay program. *No monitoring for non-uranium radionuclides. *No monitoring to detect TRU contaminants with the MIVRML. *No neutron dosimetry.

The above items are highlighted in a summary of the TBD to assist in their location.

In addition to the above I would like to add, the uranium urinalysis that was performed was based on chemical toxicity and not radiological toxicity. So therefore, *no radiological uranium urininalysis monitoring was performed. (In a Fernald document entitled 'Radiation Hazards at Fernald' the writer says "Before discussing the steps taken to protect personnel against the inhalation of radioactive dust, the writer would like to indicate that the present maximum allowable concentration for uranium dust is based on the chemical toxicity of uranium rather than the radiological toxicity. This can be verified by reading the footnote for the uranium concentration in the National Bureau of Standard's Handbook 52, <u>Maximum Permissible Amounts of Radio-isotopes in the Human Body and Maximum Permissible Concentrations in Air and Water</u>." That footnote: a) Values calculated but not used in final determination.) This will be confirmed with additional documentation.

F.2

The ORAU TBD states that much of the thorium data has been lost, and the plant bioassay monitoring data recovered to date has been sparse. A large number of <u>records and files were destroyed in the early 1970s</u> during declassification efforts (Dolan and Hill 1988).

The TBD states that no information was identified to address the uncertanties in the positive recorded photon dose for FEMP workers during years that film dosimeters were used. I would suspect the source of the exposure is missing from the records. The TBD also states there is no analogous validation for data obtained before 1987 and especially back to the1950s.

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I believe that NIOSH was not able to determine with reasonable accuracy the radiation doses incurred by the workers at Fernald. Based on insufficient accurate information, they were unable to estimate the maximum radiation dose that could have been incurred by any member of this class.

Documents indicate there was no monitoring for specific types of ionizing radiation known to be present. The monitoring was limited in frequency and to limited groups of workers. The monitoring was inaccurate due to sampling techniques and dosimeter limitations. Some data could not be interpreted due to deficiencies in the record keeping procedures. Worker assignments often changed as they were rotated to different locations in an attempt to limit exposure levels.

Dose reconstructors believed 'Good housekeeping' practices were followed at the site. This misconception and limited data resulted in inaccurate default assumptions. Data was reconstructed for the thorium processes because the records had been destroyed in 1970, but it lacks validity due to gross error.

Therefore, I believe it is not feasible to estimate with sufficient accuracy the radiation dose that the workers at Fernald received and that those radiation doses endangered the health of those workers, and possibly their families.

Respectfully submitted,

Attached to this petition are many documents that reflect a portion of the evidence against NLO as presented in the class-action lawsuit in 1990. They demonstrate the gross dis-regard for human safety. They also give a glimpse into the workplace and it's excessive radiation exposure potential.

Included by section are:

1.) The TBD summary and evidence as noted from the summary.

2.) GAO statement concerning 'data' requirements.

3.) Institute for Energy and Environmental Research (IEER) documents.

4.) Documents that reveal the attitudes and practices of the FMPC management that endangered workers and permitted high levels of exposure to exist.

5.) Thorium processing documents. (Most were reported to be destroyed in 1970.)

6.) Thorium processing documents for Plant 6. (This data was omitted from the reconstructed data used for dose reconstruction.)

7.) Documents that reflect plant operations and exposure potential at various production, technical, and storage sites. (Also documents on Plutonium.)

8.) Reference document for F1 of SEC petition.

It was my desire to best represent 'All' the workers at FMPC with this petition. The time span is a vast one, some 38 years, and the documents are numerous. Exposures occurred through the production years by way of new releases of ionizing radiation; but it also continued through contamination to later workers. In many cases the data is limited, which makes it impossible to fairly assess the exposure to any individual at any given time except as noted by reported incidents.

There was one document that I found especially interesting . (PE 745s) mentions increased fallout on site from "WEAPONS TESTING". I didn't know if this was part of the program at Fernald.

I hope this petition holds some information previously unavailable. I have tried to index it for easier referencing.

Thank you for your consideration.

INDEX Section 1. Summary Notes

PE 330B Charles Dees, Industrial Case Study: [Acknowledges not having up to date records.]

PE 760 Questionnaire on Radiation Record Keeping Systems: [Excretion Urinalysis data recorded but can't be used to calculate internal dose.][Average recorded doses per worker per year is 2.6.]

PE 901 Information on Forthcoming Feasibility Study. [Exposure to internal emitters is the more serious type of exposure.][We do not consider the urinary uranium excretion measurement as an accurate method to estimating either body burden or exposure.]

INDEX Section 2.

PE 515c GAO; Testimony. [Data quality requirements.]

INDEX Section 3. IEER

'Written Testimony for the Subcommittee on Immigration and Claims, Committee on the Judiciary, U.S. House of Representatives.'
'Worker Radiation Dose Records Deeply Flawed.'
'Health and Environmental Impacts of Nuclear Weapons Production.'
'Fernald Workers' Radiation Exposure.'

INDEX Section 4. Attitudes and Practices of FMPC

PE 108A Health Conditions in the Various Plants. [Permitting certain conditions for the sake of production.]

PE 149a Refinery NO2 Fume Releases. [Tell them what they want to hear.]

PE 386 Standard Operating Procedures for the Collection of Air Dust Samples. [Provide your own respirator.]

PE 387 Changes in Terminology. [We'll do it our way.]

PE 391 Testimony of Daniel J. Arthur, before The Subcommittee on Energy, Conservation & Power. [Methods Analysts/ Lead Auditor at Fernald.]

PE 397u Health Protection Appraisal; National Lead of Ohio, August 1972. [Hazardous work environment; Contaminated wrist badges/ uncertainties; Limited monitoring; Urinalysis used to monitor operating conditions.]

PE 507 Letter. [Findings from visit.] [They don't know what constitutes an incident.]

PE 509c Comment on Health Physics Appraisal. [Failure to commit to ALAP/ALARA

PE 527a Radiation from Thorium Materials
PE 535a Standard for Thorium 230. [Don't want to abide by DOE .]
PE 560 Letter. [Continue to use workers for cancer research.]
PE 720a Letter. [Non-soluble uranium compounds.]
PE 744r Weekly report. [Happy/ no overexposures.]
PE 745s Monthly report. [Weapons testing.]
PE 745y Monthly report. [Beryllium-contaminated material.][Spontaneous combustion.]
PE 745gg Monthly report. [Black oxide mistaken for soot/ sewer.][No notice of incident.]
PE 745eee Monthly report. [Contaminated gloves.][254lbs. uranium/ via the sewer.]
PE 747 Trial Affidavit. [Air monitoring practices.]
PE 782 Proposed Record System. [Oppose uniformity in record keeping.]
PE 793 Random Thoughts on Uranium.
PE 900 'A Continued Program of Analysis for Uranium in Human and Animal Tissue'. [Autopsy agreement.]
PE 917 Letter. [Possible autopsy study.]
NA---- Dosimetry Assessment Fact Sheet. [3455935-3455940.]

INDEX Section 5. Thorium Processes

PE 527b Internal Radiation Levels from Uranium and Thorium.(1955)
PE 547b Thorium Inventory. [Almost 350 tons.](1961)
PE 536 Request Authorization to Remove Thorium Residues from Inventory to Burial Ground. [9,747lbs. to Morehead, Ky.] (1968)
PE 534 Thorium NCG. [FMPC decides.] (July,1964)
PE 543L Health Protection Aspects of Thorium Production.
PE 547a Radiation Levels of More Than 0.05% Thorium Residues (Oct.,1958)
PE 543h Air Dust Concentrations in the Pilot Plant Thorium Process (1970)
PE 543f Air Dust Levels at Thorium Metal Operations. (1970)
PE 541 Monthly Thorium Inventory Position at NLO as of August 1, 1978
PE 537c Thorium Processing at FMPC. (1970)
PE 135 Annual Storage Inventory of Normal Uranium Concentrates and Thorium. [Leaks.](June,1968)
PE 537b Thorium Metal Production Housekeeping.(1970)
P--582 Ventilation for Redrumming of Thorium Residues. [Corrosion.] (1965)
PE 533 Thorium Operations at NLO - Present and Future (April,1963)
PE 543c Thorium Operations - Pilot Plant (July, 1964). [BeO.]
PE 117g BeO Air Dust Evaluation of Plasma Flame Spray Facility.(Sept.,1966)

INDEX Section 6. Thorium Processes Plant 6

INDEX Section 7. Plant Operations and Exposures

NA 53 Plant 6. [6468 MAC in 1952---154 MAC in 1953.}
PE 371c High Dust Exposure (March,1963). [608 MAC-nothing in progress to improve.]
PE 544h Plant 6. [150MAC.]
PE 310b Plant 7 Urine Sampling Program
PE 314b Labor Pool Operations. [Up to 1100 NCG.]
PE 545 Plant 8 Thorium Reverter
PE 317b Plant 8.
PE 318b Plant 8
PE 320a Plant 8. [89.5% of the personnel are exceeding the desired MAC.]
PE 324b Plant 8. [0.9 NCG in 1965—2.2 NCG in 1966.]
PE 324c Plant 8. [Stack filter loaded with material.]
PE 330a Chip Furnace. [Contamination.]
PE 392 Comparable Weighted Exposure of Plant 9 Personnel. [685 MAC high.]
PE 336d Removing Mortar and Bricks. {Done twice a week.][958 MAC]
PE 348 Rough Grinder Operator
PE 349b Development Machine Shop
PE 350a Laboratory. [729 MAC.]
PE 350b Laboratory Bldg.
PE 350c Sample Preparation Room. [20 MAC.]
PE 549b Q-11 to Temporary Hopper
PE 364b Meeting to Discuss Pit Area Dust Control
PE 365a Contaminated Industrial Vehicles
PE 366 Vehicle Contamination Survey Results.
PE 367 Industrial Truck Operator Job Assignment
PE 124 Transfer of K-65 from Deteriorated to Solid Drums
PE 368 Cleaning Subcontract Laundry Area. [Working in street clothes. Told they weren't contaminated.]
PE 369 Master Painters. [Overexposed.]
NA 85 Task Force on Recycle Material Processing. [No Plutonium accountability.]
WEST POOS History and Risk Assessment.

INDEX Section 8. Radiation Hazards/ Reference F1 SEC Petition.

PE 555 What NLO Knew About Radiation in 1950's
NA— Radiation Hazards at Fernald. [3290296-3290305.]

Based on my review of the NIOSH Site Profile, I submit the following summary of statements and paraphrases, based on the Document No. ORAUT-TKBS-0017, A Technical Basis Document for the Fernald Environmental Management Project (FEMP). It will demonstrate limitations in data and information available for dose reconstruction and provide a glimpse of the workplace, as stated by the ORAU Team. I have also included some personal notes.

Section 5-Occupational Internal Dose

This TBD provides information and assumptions for use in reconstructing employees occupational internal doses by: 1) outlining specific characteristics of the monitoring procedures, 2) identifying events or processes that were unmonitored, 3) identifying types and quantities of radioactive materials involved, 4) evaluating production processes and safety procedures, 5) identifying locations and activities of exposed individuals, 6) identifying comparable exposure circumstances for which data is available on which to base assumptions.

5.1 The information provided includes: operational documentation and professional judgment applied to fill in areas where data was missing or inadequate.

Operations involved thousands of metric tons of ore, dry powder products and corrosive chemicals in processes that were inherently dusty, producing an environment with internal intake potential.

pg7 During early years, plant workers were routinely required to wear respiratory protection because of significant radioactive dust levels approaching or exceeding FEMP airborne alpha activity guidelines referred to as maximum allowable concentration (MAC).

Fernald processed thorium from 1954 to 1979 and was the national thorium materials repository for the DOE starting in 1972.

pg8 Personnel exposed to uranium contamination could also be exposed to the RU contaminants, which could have contributed to unmonitored internal exposure.

Table 5-2 lists the primary radionuclides that could have led to internal doses during the production history of FEMP.

5.2.1 **Processes** were conducted in 10 plants.

Pilot Plant, UF6 was converted to UF4. An accident released 1200kg of uranium, resulting in elevated personnel exposure. The enrichment is unknown, and 2% should be assumed for any claimant identified as a subject of this incident.

More than 70% of thorium at FEMP was handled and processed from 1964-1979 in the Pilot Plant.

Plant1, the sampling plant, started operations in Dec.,1953. Involved dusty operations of mixing and blending etc., large quantities of uranium and thorium materials

Plant 2/3, the ore refining plants, began operations in Dec.,1953.

Plant 4, the green salt plant, converted U03 to UF4 (green salt). Began in Oct.,1953. Some air sample data sheet information indicates that a least a limited amount of thorium may have been processed.

Plant 5, the metal production plant. Chemical conversion of UF4 powder to uranium metal derby by a thermite furnace reduction process with magnesium metal. Began operations late in 1953.

Mixing of feed material led to potential inhalation exposure that were also in the higher level categories at the site.

Plant 6, the metal fabrication plant, began operations in 1953. Uranium metal fires were common and resulted in airborne uranium concentrations

Plant 7, hexafluoride reduction plant, operated from 1954 to 1957. Provided UF4 by reducing UF6.

Plant 8, scrap recovery, began in 1954. Scrap recovery of uranium and was ranked in the higher air activity level at the site. Thorium scrap and residue was processed in 1966, 1969, 1970, and 1971.

Plant 9, special products, began in 1953. Cast uranium metal and high purity recycled metal scraps into ingots. Thorium was processed as metal and briquettes in 1954 and 1955.

5.2.1.1 Uranium Enrichment. First production in 1964.

The following production years uranium was processed in a variety of enrichments ranging from depleted to as high as 20%.

Quantities of enriched material above 2% was not documented but was qualitatively reported to be small and/or insignificant in total mass.

Table 5-3 Uranium enrichments and associated isotopes.

In the absence of specific enrichment information, default assumptions for time period after 1964 is 2% enrichment for bioassay data in milligram quantities of uranium. Prior to 1964 natural uranium should be assumed.

5.2.1.2 Chemical forms and compounds. There are approximately seven steps in the process of conversion of uranium ore or other scrap recovery material to metallic uranium. Each step and compound has a different internal exposure parameters.

Table 5-4 identifies the uranium chemical forms at Fernald.

Most of the compounds were dry or granular in form and represented a dust hazard potential as the material was processed, transferred and otherwise handled.

5.2.1.3 Airborne dust potential. Production operations that involved handling dry uranium materials were generally equipped with engineered ventilation systems for controlling dust.

Standard operation procedures required the use of respiratory equipment when dusty conditions were anticipated. Good housekeeping involved the immediate cleanup of spilled uranium products was also a standing policy and practice.

There were frequent 'upset' conditions (spills, filter ruptures, etc.) that produced episodic airborne activity of the magnitude that the ventilation systems were unable to contain all the releases.

Note: A policy is a false indicator of actual practices. Fernald document PE330B describes one such respirator as the 'epitome of filth.' and that it would have been a perfect fomite for the transfer of respiratory infections between employees. Additional Fernald documents describe piles of scrap materials surrounding equipment in the work areas. Rags stuffed into equipment in an attempt to limit dust emissions, and push brooms being used to clean the floor. [Good housekeeping may have been the policy, but it wasn't the practice.]

In 2000 a FEMP team working on the DOE Ohio Field Office Recycle Uranium Project Report (DOE 2000) qualitatively rated various plant processes in relation to the potential for producing airborne dust in categories. This report was consistent with historic FEMP air activity measurements and recorded internal exposures.

Table 5-5 Fernald plant processes, materials and dust release potential.

Note: Plant 6 dust release potential was not included in this evaluation. This TBD stated early on that metal fires were common, resulting in airborne uranium concentrations. A Fernald document identifies the smoke as U3O8 airborne particles.
[How can a dose reconstruction be reasonably accurate when the exposure potential data is not inclusive for all production areas?]

5.2.1.4 Chemical Toxicity. The early basis for conducting routine urine analysis was to assure the uranium exposure controls were adequate to prevent chemical toxicity. Internal radiation doses derived from urine sample results, were not calculated until the mid to late 1980s.

Note: Fernald document PE901, dated Nov.1,1963 states 'We use urinary uranium excretion information along with air survey information to be sure that we are controlling airborne exposures to amounts that will not be harmful. We do not consider the urinary uranium excretion measurement as an accurate method of estimating either body burden or exposure. We have assumed that the determination of internal exposure by any method or combination of methods is less precise than are estimations of exposure to external radiation.

5.2.2 Recycled Uranium (RU) Processes were introduced to Fernald in Feb.,1961.

Plant 1 and other locations were protected with airline respirator equipment particularly for the 1976 shipment of tower ashes from the PGDP.

Reference indicates that the internal dose technology, techniques, procedures, and philosophy similar to Y-12's were used at Fernald.

However, this technology during the years until 1986 did not provide adequate detection for TRU or thorium.

Though TRU analyses were attempted, the limitations of the MIVRML, which included limited detection sensitivities for TRU isotopes and infrequent counts, presented capabilities that lacked the ability to detect the anticipated levels at FEMP or in fact could not detect levels that met regulatory limits for TRU isotopes.

A more formal program of internal dosimetry was introduced in 1986.

Directions were to record the results in the individual dosimetry records and perform a dose estimate calculation. The dose calculation results were not found that would serve the purposes of this report, but could appear in individual claimant files.

pg15 Before Feb.,1989 no smears or air sampling filters were analyzed specifically for plutonium, neptunium, or thorium isotopes.

Early in 1989 an *in vivo* counting facility was constructed on the Fernald site to replace the mobile facility from Y-12.

pg16 Only uranium urinalysis was performed routinely from the 1950's to 1986. There was no direct measurement of TRU contaminants during this period and the dose determined from only uranium urine results obtained during this period may underestimate a worker's internal dose.

Note: Fernald documents PE901 and PE760 state that their urine records can't be used to determine internal dose.
[Dose reconstructors attempted to use those records for that very purpose.]

Lung monitoring began in 1968 with the MIVRML and continued in 1989 with the Fernald IVEC counting facility until 2001. No RU contaminants were reported in the analysis before 1989.

The *in vivo* counts were not performed with consistency of frequency to be of significant value in TRU dose reconstruction.

Before DOE Order 5480.11 (effective in 1989), bioassay data at Fernald was not routinely used to estimate intake and internal organ doses.

Measurements of uranium in urine were compared to limits based upon preventing toxic effects from heavy metal.

In vivo counting frequency seldom exceeded once per year--even for high exposure potential work groups.

pg17 The air monitoring program was used to establish work controls, such as respiratory protection requirements for workers, and was not routinely used to establish internal intake or exposure estimates.

Annual exposure reports listed uranium lung burdens in percent of MPLB only and did not address the systemic radiological burdens.

It is not possible to develop an estimate of TRU exposure to individuals based upon their work place history, thus a reasonable default maximum is recommended for all of the processes.

Chemical forms of the RU contaminant are not known, although it is apparent from the chemical processes to which the materials were subjected during uranium processing, a variety of forms would be expected. Hence the dose reconstructor should assume the most claimant favorable solubility type for the target organ.

5.2.3 Thorium Processes. A comprehensive effort to reconstruct the effluent of uranium and thorium from Fernald plants in 1988 discovered that a large number of records and files were destroyed in the early 1970s during declassification efforts.

Thorium processes had been shut down and most of the thorium equipment had been removed prior to the effluent data reconstruction, which made the reconstruction more difficult.

Where production data was not available, estimates were based on product volume and yield information. These estimates were researched from various files of FMPC, Oak Ridge, AEC, and FMPC customers.

Part of the reconstruction process involved interviews of long-time current and retired employees about thorium production. The interview included 9 questions.

Note: The question not asked was; What other plants processed thorium? [That seems so basis, if you're reconstructing destroyed records.]

This information was used to develop process flow sheets and locations of possible emission sources that were identified from the components of each process.

pg19 The data reconstruction indicates that thorium processing was limited to three plants over short periods in the 38 year production history of FEMP.

Table 5-13 provides a tabular presentation of the thorium production estimates in MT by year, compared to uranium production in the same plants. The production values in Table 5-13 represent only the uranium and thorium production in the specific areas as identified in the studies.

Note: Previously in 5.2.1, in the description of processes by plant, thorium is also mentioned in Plant1 and Plant4.

Fernald document PE745ww, dated March 6, 1963 states: **Thorium Furnace--Plant 6**: 'Air dust samples taken during the operation of the thorium furnace show levels far exceeding the MAC for thorium. Breathing zone air show levels of various operations range from 10 to 1.770 MAC. This is believed to be due to the decrease in ventilation (the fan is delivering less than 1/2 of its rated capacity) and to lack of adequate maintenance. The exposure levels have exceeded acceptable value since as early as 1960; however, the current conditions are by far the worst on record..

The following table (5-15), shows 0 emissions for years 1960-1963 that were above the MAC. The above mentioned document doesn't indicate if thorium was processed in Plant 6 prior to 1960.

pg 21 Table5-15 Estimated thorium emissions (kg) in comparison with uranium. Realizing that the thorium data are not measurements, but are the best values that the TBD technical staff (Dolan 1988) could reconstruct on the basis of available records, recollections of professional engineers, and best estimates on the basis of process knowledge, this information represents the best available.

Note: In 42 CFR Part 82 (final rule) Federal Register/ Vol. 67, No. 85/ Thursday, May 2, 2002/ Rules and Regulations pg22323 ; in response to a comment on possible recall difficulties. 'It is well recognized from health, behavioral, and social research that there are substantial limitations and variations in the ability of people to accurately recall past

events, and that these limitations generally increase with the time elapsed since the past event.'
However, all of the sources of information available to NIOSH in conducting dose reconstructions potentially involve substantial limitations.

pg21 Some records have been recovered that indicate that basic air activity levels were recorded in fractional MAC for thorium processing.

From the limited data examined, the measured MAC levels during the thorium campaigns do not appear to approach the higher MAC levels measured during the processing of uranium. The practices of wearing respiratory protection preventively for operations known to produce dusty conditions were administered for thorium operations as they were for uranium operations.

pg22 A fundamental difficulty of dose reconstruction for thorium processing is that either 1) *in vitro* bioassays for thorium were not performed or 2) data is not available until after 1986. An additional consideration is that air sampling data was not used to calculate intake and dose until after 1986. Air monitoring was used only to control exposures to levels below the MAC.

Urine sampling was performed for uranium only.

After 1986 thorium air sampling was used to estimate internal exposure using continuous lapel air samples as breathing zone (BZ) evaluations. From that time until the present air monitoring is used to conservatively estimate internal intake even when the worker wore respiratory protection.

The data from the report (Dolan 1988) indicates that just the Pilot Plant, Plant8, and Plant9 processed thorium. A single air sampling data sheet was found that indicated a thorium equipment repair operation in Plant 4 during which there were air activity concentrations above MAC.

Based on evaluation of the available information, dose reconstructors should assume thorium exposure for any employee whose records establish work, and therefore exposure potential, primarily in the Pilot Plant from 1964 1979, in Plant 9 in 1954 or 1955, or in Plant 8 in 1966, 1969, 1970, or 1971.

Note: [How is it claimant favorable to ignore a documented exposure?]

There is some evidence of urine analyses for thorium in claimant files as early as 1955, but to date no information has been found regarding how to interpret it.

pg23 Based on the information a default exposure is assigned.

Note: Previously mentioned in this TBD review, are thorium materials in Plant 1 and Plant4, however no provision is made for exposure in the dose reconstruction. The site description (sec. 2, pg24) indicated that production quantities are not available for ThF_4 production in Plant 4. The ORAU team failed to discover the thorium furnace in Plant 6, which was vital in their attempt to reconstruct data.

5.2.4 K-65 Silo Processes.

Silo 1&2 disposed of raffinates from Plant 2/3 and received pitchblende raffinate wastes shipped from MCW in 55-gallon drums. Shipping began in 1951 and by July 1952, 13,000 drums had been stored on the pad around Plant 1. The waste was transferred into the silos from July 1952 through Sept. 1958. The total radium -containing residue from processing uranium ore is 10,000MT.

Silo 3 stored 'cold metal oxide' extraction separations and contains approximately 138,000 cu.ft. of raffinate.

Silo 4 contained contaminated water. (The concrete silos cracked and leaked.)

Information on the K-65 silo processes is derived from air sample and external radiation dose data sheets from the 1953 period.

pg25 The information that is available upon which to base estimates of intake of radium and its daughter products to an unknown number of workers consists of a few air sample data sheets in late 1952 to early 1953 with alpha analyses.

Description of this operation was inferred from brief descriptions contained on the air sample data sheets from 1952 and 1953.

pg26 On a couple of data sheets there was a note that no respirators were worn. It is presumed that the note was made to record an unusual event.

Note: There is no basis for that assumption. However, it seems to run throughout the dose reconstruction. Repeatedly doses based on airborne exposure have been calculated on the assumption that all workers were protected with respirators. I haven't seen any indication that the effectiveness of the respirators was ever considered.

No records were found of any bioassay results for radium or daughter products during this time.

The information on the data sheet indicates that in spite of the fact that the contents of the drums were wet, the operation resulted in significant airborne contamination.

Radiation dose rate survey records are not available.

Calculations assume that doses above 4rem would not be administratively planned to avoid exceeding the 5rem/year limit.

Note: Dose limits can't be assumed to have been enforced based on Fernald's admission that they 'often do not have a complete work history'. (PE330b)

pg27 Radon gas was released as the drum lids were removed.

It is evident that these estimates are based upon assumptions that are cumulatively conservative.

5.3.1 Radiological Controls Program was in place from the beginning of FEMP operations. The internal dose control program consisted of 1) An air sampling program in all processing areas to evaluate internal exposure potential via inhalation 2) Urine samples submitted after at least a two-day work break to allow elimination of uranium cleared rapidly via the GI tract. 3) *In vivo* analysis.

Note: I thought the stomach and intestines were in the GI tract, not the bladder. Unless they are referring to the non-soluble uranium particles that are ingested. These may become imbedded in soft tissue and may not be passed.

Other elements of the protection program include routine monitoring of the workplace and personnel for radiation and contamination, personnel protection in the form of protective clothing and respiratory protection in all of the operational areas as needed, and restricting workers from workplaces with elevated airborne radioactivity concentrations when the level of uranium in the urine or *in vivo* counting results exceeded specified plant action limits.

5.3.2 Air Monitoring Program

Routine air samples were taken in every plant and operational area. This program was the primary means of controlling intakes.

In the 1960s the samples were counted for both alpha and beta activity.

Workers were directed to use respiratory protection in the form of dust masks or supplied respirators depending on the anticipated or measured airborne radioactivity concentration.

The air activity ranged from a fraction of the MAC levels to hundreds of times those levels.

pg30 From 1953 to 1986, the air monitoring program was conducted as a primary control element. However, the measured air concentration levels from the routine sampling program typically were not used to establish worker intakes, and workers were required to submit routine urine samples for uranium analysis only for the purpose of verification of site air sample-based controls.

5.3.3 Bioassay Program

The initial study was based solely on heavy-metal toxicology limits for kidney damage.

pg31 (notation under Table 5-19) MDA is accepted as the most reliable representation for historical MDAs for this analytical procedure.

5.3.4 Environmental Levels and Fecal Sampling Program

The value of fecal samples was recognized even in the early years and has been well understood since 1986. Several samples are recorded as part of a study in 1968. However, fecal sampling has never been a part of the routine bioassay program at FEMP. Fecal sampling can provide useful information, particularly in cases of exposure to less soluble compounds (types M&S)

5.3.5 Analytical Program

MDA (MDL) was not formally established in the early periods (as evidenced by a record search). In addition, the large fluctuation in uranium in the diet of nonoccupationally exposed personnel provided implied limits (although apparently not well understood in the early periods).

5.3.6 *In Vitro* Procedures for Other Radionuclides

The primary bioassay for the first 35 years (1951-1986) of Fernald operational experience was urine analysis for uranium metal.

Even for those special cases, they have been so few in number that the review of records for the TBD efforts did not reveal a dose record with non-uranium urinalysis results. There are records of special studies, but no documented intent to analyze for radionuclides other than uranium.

As early as 1958, the Fernald site reported internal dose experience to the AEC in an annual report.

Note: Fernald document PE760 is a Questionnaire On Radiation Recordkeeping Systems At DOE/DOE Contractor Facilities; dated June 29, 1984, to Battelle-Northwest Laboratory. It includes the following responses about current workers: 'All employees are not monitored by in vivo counting for internal exposure and doses cannot be computed from urinalysis data.'

In the epidemiologic report 'Mortality Among a Cohort of White Male Workers at a Uranium Processing Plant: Fernald Feed Materials Production Center, 1951-1989', a study was conducted at the Center for Epidemiologic Research, Oak Ridge Institute for Science and Education. (From pg6 of that report) ' Internal exposure monitoring for radiation first began with a urinalysis program in 1952. Workers were monitored on a non routine basis as a control measure and by 1958 urinalysis became a primary means of internal monitoring.'

[The above statement has been misinterpreted in the TBD and does not substantiate the ORAU *team dose reconstructors claim that the Fernald site reported* internal dose experience.]

Note: Notation under Table5-23 states: *Various annual reports reported the units in mgL, which is an obvious typographical error. The permissible urine concentration, averaged throughout the year, was 0.05mgL

[Is it possible that the report was correct, but because it didn't fit the ORAU assumptions it was rejected?]

5.3.7 *In Vivo* Analysis

Lung counting became available in 1968 in the form of a mobile lab.

Thorium-230 is not readily detectable by *in vivo* measurements. There appeared to be no attempt to detect TRU contaminants with the MIVRML.

pg35 The workers, who had known exposures to high air concentrations, had high urine results or were involved in an incident, were counted on first priority each time the MIVRML visited the site. Other workers were counted based upon their job exposure potentials.

Note: Because Fernald chose to monitor exposure based on job classification, does not give validity to the dose reconstructors to assume that because a person was not monitored more frequently their exposure potential was less.

Note: If Fernald records had been adequately reviewed by the ORAU team, discrepancies in data should have been discovered. A discrepancy exists in the data provided by Dolan and Hill 1988 (pg18 sec.5), which differs from data by Alvarez 1984(pg18 sec.6) Both are in regard to locations of thorium processes.

Section 6-Occupational External Dose

6.1 The Introduction

Fernald processed such large quantities of radioactive material, in this case uranium, up to 10,000MTU annually and a small amount of thorium with a staff of up to almost 2,900. (date?)

The occupational dose received by the workers at FEMP was a function of the physical location of the worker on the site, the process, and the type and quantities of material.

The dose also varied with respect to the radiological decay of the material being processed.

The introduction of recycled uranium at FEMP started in 1958 and peaked in 1970. This product contained 99TC, which emits beta energy at an activity rate approximately 4 orders of magnitude greater than that of uranium.

Table6-1 lists the Uranium beta and gamma emissions of interest.

Workers at FEMP who might have been exposed to the source of radiation discussed in this TBD were employed during the period starting in late 1951. Of most concern are those employed from the late 1950s to the mid 1970s.

No early radiological policy documentation at FEMP was found during the TBD investigations. However, individual doses from personal dosimeters worn by the workers are available, and the TBD pertains to the analysis of these records.

6.2 (Dose limits changed.)

FEMP became DOELAP accredited in 1987. While this accreditation is of significant value in validating data from 1987 and later, there is no analogous validation for data obtained before 1987 and especially back to the 1950s. The accuracies of the dosimetry system(s), their recorded doses, and their comparability to current systems depend on: 1) Administrative practices and requirements, 2) Workplace radiation field, materials, quantities, etc. 3) Dosimetry technologies and calibrations. 4) Process technologies and5) Training and practices

Note: Fernald documents demonstrate the record keeping, practices in PE330B, PE760.

[ORAU failed to recognize accurately the radiation fields, materials, and quantities in regard to thorium and probably other exposure potentials.] The accuracy of the dosimeter is dependent on it being attached to the clothing at the proper location. A Fernald document indicated that a worker was observed working with his head inside the equipment. His breathing zone obviously wasn't near the dosimeter. [This definitely demonstrates the need for improved training and safety practices.]

6.3.1 Site History

Some of the raw ores contained considerable amounts of radium that later became a worse problem.

Table 6-2 lists the quantities of recycled materials along with radionuclides and their sources from key shipping sites.

The radiological properties of thorium are different than those of uranium since it has higher energy gamma rays and a shorter time to re-establish equilibrium with its daughters after processing.

Note: The workers in areas where thorium processes were not known to exist would not have doses attributed to them for this beta exposure potential. The TBD does not differentiate metering for uranium vs. metering for thorium.
[The table also indicates years of uncertainty.]

pg9 During these periods dose or exposure limits changed with the lowering of limits as more knowledge was gained with respect to radiation protection practices.

pg10 While current minimum detection limits (MDLs) are well defined, earlier limits were not. Since it is difficult to estimate MDLs for the early dosimetry systems, the values provided in this TBD are those given for the analogous ORNL system..

Important dose reconstruction parameters for FEMP workers are based on administrative practices.

6.3.2 Site Dosimetry Technology.

FEMP followed the ORNL program for dosimeter design and calibration.

There was no neutron dosimetry at FEMP.

Extremity dosimetry involved the use of wrist rather than finger dosimeters. A correction factor was applied to the wrist dosimeter value to estimate dose to extremity. However, it was not a particularly accurate practice.

Note: Extremity dosimetry is mentioned but the dates of implementation are not indicated. I have a copy of a clothing issue record for my father, it indicates no gloves were issued even though he routinely handled uranium metal for testing. His records show he was not monitored for hand exposure during almost 12 years of employment.

After reviewing the tables in this TBD it is possible to determine that the preponderance of the radiation consists of beta particles and while this form of radiation can deliver substantial dose to bare skin in proximity it does not penetrate deeply into the body.

Note: Scientific documents state that high energy beta particles can penetrate the skin up to 1 inch in depth. If it enters veins or arteries near the skin's surface, the particles could be transported via the bloodstream.

pg11 An additional radiological concern at several locations At FEMP occurred when workers were subjected to high level of radioactive material-bearing dust So at times the dosimeters were enclosed in plastic bags for protection against dust contamination.

Note: What irony! [If dust could effect the dosimeter, what assurance is there that they would provide an accurate reading?]

There is a discrepancy as to when the ORNL dosimeter was firts used 1953 or 1971, and TDLs were introduced around 1978 or 1979.

pg12 The algorithm developed by this study proved to be less than adequate, although the system did satisfy American National Standards Institute Standard. The system lacked sufficient precision in estimating beta energies.

6.3.3 Calibration

Potential errors in recorded doses depend not only on the response of the specific dosimeter to the radiation to which it is exposed and calibrated, but also on the dosimeter geometry, how it is worn, and the simple variables in shielding afforded by clothing and other materials. The shielding effect is especially significant when the radiations are primarily beta or low energy photons, both of which are predominant with uranium.

6.3.3.2 FEMP Beta/Photon Dosimeters

Dosimeters were originally calibrated using 226RA for gamma energy and uranium for beta and low energy photons.

The use of mrep unit is somewhat unique to FEMP because it declined in use after the 1950s. (This TBD assumes that a rep is approximately 93ergs/g of tissue.)

6.3.4 Workplace Beta/Photon Radiation Fields.

The radiation fields consist of a complex mixture of beta, x-rays and gamma energies. These were supplemented by higher energy gamma radiation associated with 226RA transitions that account for the dose rates associated with the K-65 silos.

6.3.4.1 FEMP Beta/Photon Response

No data or evidence has been identified of early response testing of FEMP dosimeters.

NLO skin dose results were usually high but satisfactory.

pg14 After these tests, NLO conducted several projects to improve it ability to determine incident beta energies.

6.3.4.2 FEMP Beta/Gamma Response

The processing of the metal resulted in separation of uranium daughter products, which produced much higher rates in portions of the product, process equipment and by products.

Coveralls worn by workers reduced uranium beta exposure to the skin by approximately 20%.

pg15 The forms of radiation encountered at FEMP varied from plant to plant with plants 5 and 9 exhibiting the highest potential workplace dose rate. These plants were involved with metal reduction, casting and rolling, and these processes generated the separation and migration of daughter products 234TH and 234PA. 234PA contributed approximately 95% of the total beta dose rate; therefore any location in the process where this material accumulated resulted in the potential for higher exposure rates. Other areas of potential high radiation exposure included areas where daughter products contaminated other materials (i.e. crucibles, saw, and rolling mills, where large quantities of parent material were present.

Note: Thorium is one of those daughter products mentioned. [The areas TBD-5 failed to discover were given no dose consideration in this exposure.]

pg15 These dose rates were established for plants 5, 6, and 9 being the highest and 5 the lowest.

6.3.5 FEMP Neutron Dosimetry

FEMP did not include any reference to neutron dosimetry with exception of high-range, gamma sensitive 1290 film.

Even though there were large quantities of UF4 and UF6. Enrichments were low enough (typically <2%)

Note: Earlier TBD-5 reported enrichment levels up to 20% with levels not documented as to quantity.

6.3.5.1 Neutron to Photon Ratio

It was determined that the vast majority of enriched material at Fernald was approximately 1% enrichment.

To develop a neutron to photon ratio for UF4 (green salt), photon survey data is also required. Unfortunately Baker (1995) only measured the neutron dose rate of individual canisters.

The factors that affect an individual's neutron dose include: 1) the quantity of uranium processed, 2) the enrichment, and 3) the time an employee worked within a process or storage area.

Most of the uranium work prior to about 1965 was natural uranium with a decrease beginning around 1960 at which time the percentage of enriched uranium received increased. By 1970, relatively little work with natural uranium was conducted by Fernald. Beginning in the mid 1960's, work with depleted uranium began to increase. By the 1970s, work with depleted uranium constituted the majority of the uranium work at Fernald. In order to simplify the dose reconstruction, the low enriched uranium neutron to photon ratio should be used. Fernald is known to have processed large quantities of uranium metal, yellow cake, black oxide, etc.

6.3.5.2 Workplace Neuron Radiation Fields
To date, specific neutron energy spectra of UF4 has not been located or modeled.

6.5 Adjustments to Recorded Dose.
Corrections to the FEMP reported dose are required due to uncertainties in the recorded data and lack of significant data especially prior to 1980.

Note; I was under the impression that adjustments in dose were necessary solely for the purpose of adaptation to the IREP software used to determine the probability of causation.

6.61 Missed Beta/Photon Dose
It can be assumed with some certainty that there have been missed doses in the recorded doses for FEMP workers. Missed dose from MDLs is especially important then there are short exchange periods, generally through the 1950s and 1960s. That period also had higher MDLs.

6.6.2 Missed Neutron Dose.
It is not known for certain how the neutron dosimeters used by Baker (1995) were calibrated.

6.6.3 Missed Dose for Unmonitored Workers
Female workers at FEMP were not routinely monitored. (500mrem per year will be assigned as an upper bound.)

6.7 Organ Dose
Worker orientation is a primary consideration for this process; however no definite method is available to evaluate this factor.

6.8 Bias and Uncertainty
No information was identified to address the uncertainties in the positive recorded photon dose for FEMP workers during the years that film dosimeters were used..

F7.2 211803

NATIONAL LEAD COMPANY
OF OHIO

P.O. BOX 158
MT. HEALTHY STATION
CINCINNATI 31, OHIO

October 12, 1953

CENTRAL FILES

TO CHARLES DEES, INDUSTRIAL CASE STUDY
FROM DR. QUIGLEY
REFERENCE DR. DURKIN

On Wednesday morning, noticed a worker enter the shower room shortly after nine o'clock. His body was covered with black dust, and the worker volunteered that this material was <u>black oxide, U3O8</u>, which he had encountered in cleaning the Bag House in the area of the Chip Burner. It was noted by both and I that the man's mouth and nose as well were filled with the black dust. Realizing that this offered an opportunity to initiate a case study, I asked the man to shower and report to the Medical Department.

The employee, was examined and laboratory studies, such as routine urinalysis, blood count, and urinary level of uranium, were carried out. Both the employee and his immediate superior, were most helpful in securing a work history in regard to this man's activities.

is in the roving maintenance crew and during the period from worked on the third shift and spent approximately three to four hours nightly cleaning out the Bag House adjacent to the Chip Burner. After this man was transferred to the first shift and has spent approximately two hours once a week in cleaning out the Bag House adjacent to the Chip Burner. stated that he is aware of the Health and Safety recommendations as to time spent in cleaning the Bag House. He states that is the most familiar man with the operation and can do such a cleaning operation in two to three hours where another maintenance man may need six to eight hours to do the job. At the present time, however, he is breaking in two man to do the same job has been doing.

Exposure may vary depending on the shift worked and efficiency level of the employee

The following letters were sent from the Industrial Hygiene and Radiation Department in regard to recommendations concerning maintenance men in closed areas such as the Bag House. These letters are as follows:

PLAINTIFF'S EXHIBIT 330B

F/W 043

In brief these letters limited the time allowed within the Bag House and also recommended that gloves and respirators be worn at all times.

supplied this man's radiation exposure record which was within normal limits except for the week of when he had an excessive exposure of while working in the Furnace area of 3005. I understand that this has been investigated by

On the afternoon of and I visited the Chip Burner area to survey the surroundings. In the shack-type office in the area, there were two Dust-Foe respirators hanging on hooks. Further comment on their condition will be seen in a later paragraph. There were no other unusual findings seen in the area at the time.

But what were they looking for

From the medical standpoint there were no unusual findings in regard to condition, and we shall not issue a further statement on this man unless there is a change in his status. However, and his group may desire to supplement this report or conduct further studies in regard to the dust exposure of men within the Bag House during these cleaning operations. stated he would be glad to cooperate in any way. He anticipates his next major cleaning operation will be the weekend of

This brief case study also afforded an opportunity to realize two major problems confronting this division. First, we often do not have a complete work history, especially of roving maintenance men, such as However there are men in other departments who are working in other areas or have been transferred, and our first knowledge at least in the Medical Department of their job locations is when they present themselves for medical care. The man then reveals that he is working in a different area from the one noted on his medical records. I cannot argue with anyone who says our records are not up to date, but often we are not notified of transfers to specific areas and we do not have the personnel to scout each man.

The other problem that became apparent in this situation is the poor care being given to the dust respirators. The ones observed by and myself near the Chip Burner were the epitome of filth. Apart from this, it would have been a perfect fomite for the transfer of respiratory infections between employees. This simply corroborates the reiteration of that something should be done about the respirator situation—either the men must take better care of them, or central service must be provided.

Yours truly,

J. W. Durkin, Jr., M.D.
Medical Department

JWD:mk

CC: R. C. Heatherton
Reading File

P. O. BOX 39158

CINCINNATI, OHIO 45239

PHONE: AREA CODE 513-738-[illegible]

JUN 29 1984

2117010

Dr. Richard J. Traub
Battelle-Northwest Laboratory
Box 999
Richland, Washington 99352

Dear Dr. Traub:

QUESTIONNAIRE ON RADIATION RECORDKEEPING SYSTEMS AT DOE/DOE CONTRACTOR FACILITIES

Ref: Letter, M. R. Theisen to R. M. Spenceley, "Radiation Exposure Records," dated June 11, 1984

Our completed copy of the subject questionnaire is attached. Also attached are responses to previous questionnaires regarding our employee radiation monitoring program which contain information about radiation recordkeeping systems.

Sincerely yours,

Original Signed By
R. M. SPENCELEY
Manager

R. M. Spenceley
Manager

TAD/vvs

attach.

cc: M. W. Boback
T. A. Dugan
W. J. Grannen
S. L. Kinnefeld
J. R. Martin
A. A. Schneider
M. R. Theisen
R. E. Weidner
C. E. Randel
Central Files
G. C. Smith

0036451

QUESTIONNAIRE ON RADIATION RECORDKEEPING SYSTEMS AT DOE/DOE CONTRACTOR FACILITIES

0036454

INTRODUCTION

This questionnaire relates to recordkeeping systems at DOE/DOE contract facilities. The records of interest are those of lifetime radiation exposur (doses) to workers. The major question to be answered by this questionnaire is: Do you have the data to provide an accumulative lifetime radiation dose for every worker at your facility for both internal and external exposures, and if so, how much effort will be required to provide those estimates. A secondary but very important question is, if you do not have the data, what data are missing?

The impetus for this is to determine the impact of various schemes to compensate radiation workers who develop cancer. These schemes are based o attributable risk tables which purport to state the probability that a give cancer was caused by radiation. The attributable risk tables are broken do by organ, sex, age at exposure, dose received, and latency period. In orde to judge the impact of these attributable risk tables, it is necessary that DOE/DOE contractor facilities be able to analyze the radiation doses receiv by workers in the same categories as contained in the tables.

This questionnaire should be filled out by the facility which has resp ibility for keeping radiation exposure records. Please be as complete as possible in that the purpose of this questionnaire is, in part, to determi the ability of current systems to provide the requested data and the costs necessary to upgrade the current systems. If your radiation worker record system has been documented in any form or described either in internal documents or publications, please provide copies of those documents.

In order to prevent double counting of records systems, this question naire should be completed only by those DOE/DOE contractor facilities whic are responsible for records.

Questions of a technical nature should be directed to Richard J. Trau FTS (509) 375-6851.

0036455

B. LIFETIME DATA, INTERNAL EXPOSURES

The purpose of this section is to determine whether sufficient data ex- to estimate the cumulative exposures to body organs from internal exposures. The interest is whether the facility can provide estimates dose equivalent. This requirement is over and above knowledge of excretion rates or radioactive content of the body.

1. Can your facility provide the lifetime or annual internal radiatic exposure data for all your currently employed workers, by individu (i.e., are the data available)?

   _____ Yes (also see questions B2, B3, B4, B5, B7 and following)

   __x__ No (also see questions B2, B6 and following) all employees monitored for internal exposure; see ans

2. Can yourfacility provide the lifetime cumulative internal radiati exposure for all workers who have been employed at your facility date of termination)?

   _____ Yes (also see questions B3, B4, B5, B7 and following)

   __x__ No (also see questions B6 and following) all employees are monitored for internal exposure; see ans

3. If the above answer is yes, what data are recorded?

   _____ Integrated air concentrations

   _____ Bioassay results (urine or fecal analysis)

   _____ Whole body count results

   _____ Evaluation of mathematical models to estimate deposition

   _____ Calculated internal dose

   _____ Other (please explain)________________________________

   ____

   ____

4. If Yes, what level of effort would be required to obtain this information? If costs are predominately computer costs, please indicate this fact and provide an estimate of cost. If costs ar predominantely due to staff labor, please indicate the estimate man-hours to complete.

For current workers ______________________

____

____

For all workers ______________________

____

____

5. If B1 or B2 are Yes, within what period of time could you provide this information (e.g., 2 weeks, etc.)?

	With Current Staffing Levels	With Additional Staff (state additional sta[ff] required)
For current workers		
For all workers		

6. If B1 or B2 are No, please explain why this would not be possible. Please be specific. For example, internal doses are not recorded, internal doses are not readily computed from existing data.

Current workers All employees are not monitored by in vivo counting internal exposure and doses cannot be computed from urinalysis data.

All workers In vivo count data not available for all employees and doses cannot be computed from urinalysis data.

7. Do you calculate a dose equivalent to the critical organ from internally deposited radionuclides?

_____ Yes

__x__ No

8. If you do not calculate radiation dose equivalents from internall[y] deposited radionuclides, please describe what data you record concerning internal exposures and the types of analyses which ma[y be] possible to perform on the data (e.g., record urine excretion da[ta] only, record excretion data and in vitro whole body/organ count [data] and estimated organ burdens, etc.).

1. Amount of deposited nuclide determined from lung count is recorded [and can] be used to calculate lung burdens.
2. Excretion (urinalysis) data recorded but this cannot be used for c[alcu]lating internal doses.

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9. If the data requested in B1 or B2 can be provided for some workers but not for others, please explain the reasons for the differences and provide data similar to B3, B4, and B5 for each category.

Data available for some but not all present and former employees. Als available, entire employment period is usually not covered. Complete only be provided for workers who began employment in 1968 or thereafte would include about 150 workers. (Continued at bottom of page)

10. If there are exposures to short-lived emitters, such as ^{24}Na, ^{125}I, ^{131}I, how is this data recorded and how is the dose integrated into an annual dose?

N/A

11. Does your facility include internally deposited radionuclides, for which the whole body is the critical organ, e.g., ^3H, into the whol body penetrating dose category?

___ Yes

x No

12. If the answer to question B9 is Yes, how do you indicate that such an addition has been made (e.g., do you have a separate category fo internal emitters)?

N/A

13. Which radionuclides do you include in the whole body penetrating dose category?

N/A

9. Continued:

For the approximately 150 workers monitored during entire employment pe

A. Data recorded: lung counts

B. Effort required to complete:

For current workers - about 200 man-hours.

For all workers - about 250 man-hours.

C. Period of time to provide information:

	With Current Staff	With Additional Staff
For current workers	6 months	N/A
For all workers	6 months	N/A

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E. GENERAL

The purpose of these questions is to assist in determining the present state of recordkeeping systems. The data which these questions will provide will help to estimate costs to automate the records systems at DOE facilities. These costs will include not only the size of machines which may be required to process the data but also the time necessary to enter the exposure data into the computer on a continuing basis and, if necessary, all past exposure records.

1. What is the number of currently employed workers for which you have radiation dosimetry records? (Please list the numbers separately for each DOE/DOE contractor facility)

   997

2. What is the total number of workers (current and terminated) for which you have records? 6165

3. What is the average number of dose entries per worker per year?

   506,280 total entries/(6165 workers x 32 yrs) = 2.6

4. Is all data for current employees maintained (check all that apply)?

   x on site

   x government storage center

   ___ other, (please describe) ______

5. Is all data for past (terminated) employees maintained (check all that apply).

   x onsite

   x government storage center

   ___ other, (please describe) ______

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CENTRAL FILES

C.P.

NATIONAL LEAD COMPANY OF OHIO

P. O. BOX 39158 CINCINNATI 39, OHIO

November 1, 1963

2151983

William T. Doran, M. D.
Division of Operational Safety
U. S. Atomic Energy Commission
Washington, D. C. 20545

Subject: Information on Forthcoming Feasibility Study on "Correlation of Lifetime Health and Mortality Experience of AEC and AEC contractor Employees with Occupational Radiation Exposure"

COPY

Dear Bill:

It was a pleasure to see you last week in Pittsburgh and to discuss with you the subject feasibility study. Prior to our meeting I had been somewhat concerned about the scope of the study. My doubts had been raised by references to "amounts of radiation" and the reference to NCRP standards regarding lifetime exposure to "penetrating" radiation. I had postponed answering the letter from Mr. Karl to our Manager, Mr. Noyes, pending some clarification of these points.

First of all I would like to say that I very much favor the proposal to undertake a feasibility study. I quite agree that radiation in its broad sense should encompass both exposure to external (penetrating) radiation and also to internal deposition of radioactive materials. The gathering of medical information should not be too difficult, though it certainly will be time-consuming and tedious work. Relating these findings to external or penetrating radiation will be relatively simple, since at all AEC contractor sites complete exposure data to penetrating radiation has been accumulated since the days of the Manhattan project. I am somewhat more concerned, however, with the adding of a factor or factors for internal emitters.

PLAINTIFF'S EXHIBIT 901

I would like to suggest that the portion of the feasibility study dealing with people exposed primarily to uranium be scheduled somewhat later and possibly after the completion of the "Epidemiological Study of Uranium Workers--Feasibility" presently being conducted at Mallinckrodt and here at National Lead of Ohio. I am still hopeful that our study may be of some assistance in handling estimates

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of internal dose to uranium workers, though frankly this is one of the most difficult problems we have encountered.

Exposure to internal emitters is the more serious type of exposure at the feed materials centers and probably also at the mills which prepare concentrates for the feed materials centers. I have an impression that airborne exposure at other sites is a relatively minor portion of the overall exposure; at Fernald, however, this is not so. Exposures to external penetrating radiation are relatively minor here and always have been less than the current Federal Radiation Council Guides of 5 R per year of gamma and 30 reps of beta.

Part of the problem with determining internal dose can be illustrated by the following table. This table gives breathing zone (BZ) concentrations of airborne uranium and daily weighted exposure (DWE) concentrations for seven operations in our metal production plant for the years 1959 and 1962. All concentrations are listed in $\mu c/cc$; all numbers are multiples of 10^{-11} $\mu c/cc$. The maximum permissible air concentration for a 40-hour week for natural uranium given in NBS Handbook 69 is $6x10^{-11}$ $\mu c/cc$.

	1959		1962	
Job Description	**BZ**	**DWE**	**BZ**	**DWE**
Rockwell operator	$.64x10^{-11}$	$.64x10^{-11}$	$.64x10^{-11}$	$.48x10^{-11}$
Furnace Pot Delidding opr.	$40.0x10^{-11}$	$10.7x10^{-11}$	$2.1x10^{-11}$	$1.4x10^{-11}$
Derby Breakout operator	$9.5x10^{-11}$	$7.8x10^{-11}$	$2.2x10^{-11}$	$1.8x10^{-11}$
Pot Hook-up operator	$142.0x10^{-11}$	$12.1x10^{-11}$	$11.6x10^{-11}$	$.64x10^{-11}$
Residue operator	$190.0x10^{-11}$	$22.0x10^{-11}$	$2.2x10^{-11}$	$.8x10^{-11}$
Derby Cleaning helper	$13.4x10^{-11}$	$7.8x10^{-11}$	$3.3x10^{-11}$	$2.2x10^{-11}$
Reduction Area laborer	$11.4x10^{-11}$	$1.1x10^{-11}$	$190.0x10^{-11}$	$9.9x10^{-11}$

As you can see from the above table, a Rockwell operator has had a relatively low exposure in 1959 and 1962, and from my information also in the intervening years. In 1959 the Residue operator had a high exposure and in 1962, a low exposure; it is obvious that by 1962 conditions had improved. The Reduction Area Laborer has a record of low exposure in 1959 and a high exposure in 1962. As you can see from these examples, exposures from various jobs will fluctuate considerably over a period of time.

When the air dust concentration for a job results in exposures above a control level, we require the use of a respirator to perform the job. Thus the determination of the internal exposure becomes further complicated since we can never be sure of how much of the airborne dust is being removed from the air which is breathed.

Another serious problem in determining internal exposure is the difficulty in obtaining good work records, which show how long an individual has worked in various jobs. Five of the jobs in the table are performed by employees with the job classification of "chemical operator." The other two are classified "chemical operator helper" and "laborer." We have records which tell us to which plant a person is assigned and in which job classification he worked; however, these records do not tell us the specific job operation he performed. It is obvious from the table that all chemical operators in our metal production plant will not receive the same exposure to airborne uranium.

We use urinary uranium excretion information along with air survey information to be sure that we are controlling airborne exposures to amounts that will not be harmful. We do not consider the urinary uranium excretion measurement as an accurate method of estimating either body burden or exposure. We have assumed that the determination of internal exposure by any method or combination of methods is less precise that are estimations of exposure to external radiation.

We have wrestled with this problem of estimating internal exposure in the course of our Epidemiological Study of Uranium Workers here and at Mallinckrodt. It is my personal opinion, however, that because of the wearing of dust or airline respirators, the exposure to airborne radioactive material and hence internal emitters has not been in serious proportions either here or at Mallinckrodt. Our urinary uranium excretion records substantiate this opinion.

I will be happy--and I believe Mr. Mason will be also--to further discuss with you and your study committee the problems we have encountered and the experience we have gained in connection with estimating internal exposure.

Sincerely your,

Original signed by
J. A. QUIGLEY, M. D.
Dir. of Health & Safety

J. A. Quigley, M. D.
Director of Health & Safety

JAQ/mb

cc: C. L. Dunham, M. D.
C. L. Karl, lx
J. H. Noyes, lx

0181506

United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives

For Release on Delivery
Expected at
10:00 a.m. EST
Thursday
March 17, 1994

HEALTH AND SAFETY

Protecting Department of Energy Workers' Health and Safety

Statement of Jim Wells, Associate Director,
Energy and Science Issues,
Resources, Community, and Economic
Development Division

GAO/T-RCED-94-143

a 1991 report by the Office of Technology Assessment.[7] The report noted that a review of six weapons facilities by DOE's own Tiger Teams through December 1989 revealed many problems with the practices for monitoring radiation and assessing doses. For example, air sampling techniques were inadequate at 83 percent of the facilities assessed and shortages of personnel trained in radiation measurements were found at several sites.

We also found information in the technical safety appraisals regarding problems with the completeness of the exposure data collected at the sites. For example, at Rocky Flats, some dosimeters were not returned to the contractor prior to final processing. Yet in these instances, the contractor did not require an estimate of exposure. This situation can result in errors in the data reported to DOE and to the employees in their exposure report cards.

During our review of the Health Surveillance Program, we interviewed the Pacific Northwest Labs staff scientist who chairs a DOE group working on issues concerning the radiation dosimetry data to be included in a comprehensive data base. He noted problems with the comparability and accessibility of exposure data. Specifically, he pointed out that for most DOE facilities, the methods used to calculate recorded radiation doses for workers varied considerably over the years and that the documentation of historical dosimetry practices is fragmented. The documentation for workers employed in the early periods of DOE's operations is particularly uncertain and individuals with direct knowledge about workers' exposure are rapidly retiring and leaving DOE. He also noted that the status of radiation protection records is highly variable among DOE facilities. In many cases, electronic files of dosimetry information do not exist, and manual retrieval is difficult, expensive, and time-consuming.

Finally, the National Research Council addressed the issue of data quality in its 1989 review of workers' health and safety in the weapons complex. The council stated that the data collected at DOE sites during ongoing monitoring and surveillance programs are useful in assessing risks to workers' health only to the extent the data are accurate, comprehensive, accessible and comparable. The data collected ~~in the~~ past, the Council concluded, are inadequate--because of both the kinds of data collected and the means in which they are stored.

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[7] Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production, Office of Technology Assessment (Feb. 1991).

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Written Testimony for the Subcommittee on Immigration and Claims, Committee on the Judiciary, U.S. House of Representatives

Delivered by Lisa Ledwidge, Outreach Coordinator and Editor of *Science for Democratic Action*,
Institute for Energy and Environmental Research
representing
Dr. Arjun Makhijani, President of the Institute for Energy and Environmental Research

September 21, 2000

My name is Lisa Ledwidge. I am the Outreach Coordinator of the Institute for Energy and Environmental Research and editor of its quarterly newsletter *Science for Democratic Action*. IEER is a non-profit technical institute that provides the public and policy-makers with thoughtful, clear, and sound scientific and technical studies on a wide range of issues. Our aim is to bring scientific excellence to public policy issues to promote the democratization of science and a healthier environment.

My education includes Masters' degrees in environmental science and public affairs, and a Bachelor of Science in Biology. I am here representing Arjun Makhijani, the president of IEER, who is away. Dr. Makhijani, as well as his colleague Bernd Franke, are among the authors of the studies and articles that I will be discussing in this testimony, and have worked in the radiation and health field for about 20 years each.

I prepared this testimony under Dr. Makhijani's guidance. You may have questions that I am not able answer here. I that case, I or other IEER staff will provide answers to the subcommittee for the record as soon as possible after this hearing.

Dr. Makhijani and I appreciate this opportunity to present some of the findings of the work of the Institute for Energy and Environmental Research before you.

I will be discussing 3 IEER studies of nuclear worker exposures and off-site radiation releases. I will conclude with recommendations.

USA Today Study

IEER recently completed a study for *USA Today* newspaper. We would like to request that our report of this study be made part of the record.

This study assessed internal radiation doses of workers at three nuclear materials processing facilities, two in New York and one in Ohio. The plants were selected, in part, because they all were privately owned and performed a variety of uranium processing operations during portions of the 1940s and 1950s. The study was a preliminary and partial evaluation of worker exposure. Its purpose was to perform screening-type calculations to ascertain whether the doses to workers in at least some locations or job categories were high enough to cause serious health concerns. We used government and contractor records of workers and workplace conditions. Further details about the study's methodology used can be found in the written report.

I will describe 3 of IEER's main findings:

1) We found that working conditions at these three plants were extremely poor. Workers were severely overexposed, even for then-prevailing standards. Based on our screening calculations, doses to many workers are likely to have exceeded the dose limit which was then about 15 rem per year. This chart [slide #1] shows the cumulative lung dose per worker as it relates to the number of months exposed (i.e. on the job), and also to different multiples of the then-prevailing Maximum Allowable Concentration (MAC) of uranium in the air. It shows that the more months a worker was exposed, the higher the cumulative lung dose, and the higher the level of uranium in the workplace air (i.e. the higher the number of multiples of MAC), the higher the dose.

The data and our calculations suggest that the highest exposed workers had a high probability of dying from cancer as a result of the exposure. The estimated mean lung dose in the highest exposure category (8,400 rem) would be equivalent to an effective dose (or "whole body" dose) of approximately 1,000 rem. Using the International Council for Radiation Protection (ICRP) cancer risk factor of 0.04%, this corresponds to about a 40% risk of dying from cancer. This is a 200 percent increase in fatal cancer risk compared to unexposed persons.

Other types of health problems, including kidney damage, would also be likely among those workers exposed to the more soluble forms of uranium. We found that the government and the contractors seem to have completely ignored the air concentration limit established for protecting the kidney from uranium toxicity – we found no evidence that the contractors followed it, or that the government enforced it. Plant documents indicate that kidney damage among workers was in fact reported.

We have arrived at these conclusions even though our dose calculations are partial and do not cover the entire periods of plant operation and all types of doses. It also should be noted that the amount of material processed does not necessarily correspond to individual worker exposure level. In other words, the plant that processed the smallest amount of uranium did not necessarily have the lowest worker doses.

2) IEER's study also found evidence that plant authorities and the Atomic Energy Commission (AEC), which contracted with these private companies to process material for its nuclear weapons program, were aware that workers at these plants were being overexposed over prolonged periods of time. Furthermore, there is no indication that the authorities shared this overexposure information with the plant workers. In fact, there are documents that indicate that plant authorities and AEC personnel lied to the workers about the levels of radiation to which they were being exposed. For example, in a January 1948 letter to the Vice President of Harshaw Chemical Co., Harshaw's Medical Manager wrote: "...it is obvious that concentrations considerably above the preferred level are common in Area C." (Area C is an area in the Harshaw plant.) He also wrote, "...a distinct hazard does exist in Area C." In the same letter he states that the Medical office "still believes" that the "logical method of approach" is to continue telling the employees at Area C "that all of our records indicated that no unusual hazard existed..."

3) One of the most surprising outcomes of our findings is that they call into question whether the doses to these workers were less than their Soviet counterparts. Until now, we have assumed, based on available evidence, that worker exposures were far higher in the Soviet Union than in the United States. But the partial estimates that we have made in this study are so high that this assumption may need to be revisited for many of the workers at these nuclear weapons plants. A comparative evaluation of US and Soviet nuclear materials processing plants of that era should be done.

Fernald Worker Study

In 1994, IEER performed a study of worker doses at the Feed Materials Production Center, located in Fernald, Ohio, near Cincinnati. The Fernald plant is similar to the three facilities that IEER analyzed for *USA Today* in that uranium processing took place there. This study was completed as part of expert testimony in a class action lawsuit filed by Fernald workers against National Lead of Ohio, the Department of Energy's contractor there until 1985. The aim of the study was to examine whether then-prevailing dose limits had been violated. This study was, to our knowledge, the first independent assessment of internal radiation doses based on raw data from official DOE and contractor records of the workers. We are submitting this study and request that it be part of the record.

I'll describe 2 findings of IEER's Fernald worker study:

1) Similar to the 3 aforementioned facilities, IEER found that the working conditions at the Fernald uranium processing plant were appalling, especially in the 1950s and early 1960s. They were typified by high air concentrations of uranium in many areas of the plant. They often exceeded the Maximum Allowable Concentration (MAC) by tens, hundreds, even thousands of times. One 1960 plant document lists the air dust concentration in the breathing zone of a worker cleaning under a certain piece of equipment as 97,000 times

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the MAC. I am submitting this document for the record.

This chart [slide #2] shows the proportion of workers at the Fernald plant who were exposed to more than the allowable limits due to lung burdens of uranium. It summarizes IEER's conclusions: that doses due to uranium inhaled by workers between 1952 and 1962 were above then-allowable limits *(15 rem per year to the lung) in more than half the cases in every year but* one. In 1955, the worst year for worker exposure, IEER estimated that almost 90 percent of workers were exposed to more than the allowable lung dose limit. As you can see, significant proportions of workers continued to suffer overexposure after 1962.

2) Similar to our analysis of worker doses at the 3 private uranium processing facilities, Fernald workers were not told about their internal radiation overexposures by AEC and its successor agencies nor by contractor officials until at least 1989. One of the most startling findings in the course of this study was that the urine and lung counting data (in other words, internal dose measurements) of the Fernald workers had never been converted into radiation dose estimates. Worker radiation dose records - that is, the records actually given to workers when they ask for them -- contained only external radiation doses, such as those recorded on film badges worn by workers. Therefore, we found that the assurances given to workers by that they were, on the whole, well protected, were based on very partial information. In the case of Fernald, these assurances did not even take account of the most important route of exposure: inhalation of contaminated dust.

Just after the presentation of IEER's findings in court in 1994, the Department of Energy settled the lawsuit on behalf of National Lead of Ohio, providing workers with lifetime medical monitoring and other benefits.

Our suspicion that the situation at Fernald may not have been an exception in this regard was confirmed when, three years later, the Department of Energy finally admitted that from the beginning of the nuclear era until 1989, radiation doses from radioactive materials inhaled or ingested by workers were not calculated or included in worker dose records, even though the data had been collected and was available to the DOE and its contractors.

While there was no regulatory requirement until 1989 for DOE to actually calculate worker doses, the lack of internal radiation dose estimates in worker dose records means that the records of workers who were at risk of internal exposures are incomplete, misleading, and inaccurate. The overall result is that large numbers of workers have received information about their radiation exposures systematically understating their actual exposures.

The state of the *external* dose records is also troubling. For instance, in a 2-1/2 page document titled "Deficiencies in Reporting of Worker Exposure to Radiation and Toxic Material," the DOE admitted that:

> "The type, use, and positioning of dosimetry was poor in some cases, resulting in inaccurate determination of radiation exposures."

"In some cases, occupational radiation exposure records are missing years of radiological dose data."

"Radiation exposure data stored on electronic media did not accurately reflect the data on the original record."

"Employee files do not contain the required information related to occupational radiation exposure and radiological working conditions."

"Internal and external occupational exposure records were found to be incomplete."

"Because of inadequate administrative procedures and practices employees that had lost their dosimetry badges were able to enter radiation areas before obtaining replacement dosimetry."

According to the document, this information was obtained from Technical Safety Appraisals conducted during the period 1989 to 1992. It was submitted by the Department of Energy at a hearing of the House Subcommittee on Oversight and Investigations on March 17, 1994.

This photo [slide #3] further illustrates some possible flaws in external worker dose data. This worker is stamping a label on a uranium ingot, a job that was done routinely throughout the history of the Fernald plant. The external dose to the worker's gonads, and hence the effective whole body dose equivalent that might be calculated from that, are likely to be far in excess of what was recorded on the film badge. First, the film badge is not facing the radiation source, which allows some of the radiation to escape detection. Second, the distance between the radiation source and his gonads is shorter than that between the source and his film badge. Because radiation deposits its energy relative to distance, the dose to this worker's gonads is likely much greater than what his film badge would indicate.

Fernald Off-Site Release Study

The Fernald worker study was actually the second Fernald study performed by IEER. The first one, completed in the late 1980's, was done as part of expert work in a lawsuit filed by neighbors of the Fernald plant. This study was the first ever independent assessment of radiation releases form a nuclear weapons plant. IEER focused its work on estimating uranium losses because uranium was the main material processed there and because data on other materials released to the air were scarce or non-existent.

IEER found that radioactive releases of uranium from Fernald were at least double the official calculations by the Department of Energy and its contractors. After the study was released, the Centers for Disease Control and Prevention commissioned an independent study of the radiation doses to the public arising from Fernald's operation. That study, done by John Till, corroborated IEER's findings in regard to uranium releases. As shown in this table [slide #4], the official sources (NLO and Westinghouse) had greatly and systematically underestimated releases.

These underestimates were largely due to scientific flaws in the estimates and in the way in which the records were kept and the measurements were made (or not made). For example, for a number of years, many entries showed zero releases when no measurements had actually been made. As another example, the plant made an assumption that scrubbers, designed to remove uranium from highly acidic exhaust, always operated within manufacturer specified efficiency, despite internal plant data to the contrary. The formula used by the contractor to calculate releases from the scrubber was wrong under conditions of variable efficiency and resulted in high release estimates when actual releases were low and low release estimates when actual releases were high. Moreover, this method was known to plant officials to be wrong, since it was described in a 1971 plant document as "inherently deceptive."

The DOE, which defended the lawsuit on behalf of the contractor, National Lead of Ohio, settled the suit for $78 million in mid-1989, but admitted no wrong-doing or even any technical problems in its own or its contractors' work. (Under the terms of its contract with the government, National Lead of Ohio was immune from all liability, including that arising from negligence or violations of regulations.)

These two Fernald studies are summarized in IEER's newsletter from October 1996, which I am submitting for the record. Information on the serious flaws in Department of Energy worker data is described in the November 1997 issue of *Science for Democratic Action*, which I am also submitting for the committee's record.

In conclusion, IEER has found that when worker exposures and off-site releases are carefully and independently studied, the results indicate that worker overexposure and environmental releases of radioactivity are larger than officially acknowledged. These, as well as other, similar findings over the past several years have been important pieces leading up to the official announcement that was made in April by Energy Secretary Bill Richardson -- after decades of denial by the US government -- that the production of nuclear weapons has harmed workers.

I will conclude with 3 recommendations for your consideration:

1. First, health monitoring, treatment, and where appropriate compensation of the affected workers, is an urgent priority because many are very sick and dying. Practical recognition of the role of the government and its contractors in their suffering is long overdue.

2. It is important to not force workers to prove their exposure to the last decimal point. The burden of proof should be on the government and its contractors, which failed to keep good records, failed to make sufficient measurements, and all too often assured workers of their safety when conditions were unsafe. Where there are large uncertainties due to lack of sound data, the benefit of the doubt should be given to the sick workers.

There also is limited understanding about the health effects of exposure to chemicals used in nuclear weapons production. Examples include fluorine gas, carbon tetrachloride, tricloroethylene (TCE), hydrofluoric acid, nitric acid, chlorine trifluoride, and beryllium. According to the Agency for Toxic Substances and Diseases Registry, high exposures to these substances, which might be expected for at least some workers, can cause lung, liver, kidney and central nervous system damage, cancer, impaired heart function, impaired fetal development, and in some cases death. Exposure to toxic substances could also aggravate the health effects of radiation exposure (and vice versa) yet there is little or no research on the possible synergisms.

3. A process should be created for fairly and responsibly addressing the Cold War health legacy. There is a lot of information out there about the harm to human health and the environment from nuclear weapons production, and this is typical of all nuclear weapons states. To its credit, the United States so far has been more forthcoming about this problem, but problems continue to fester and many are still coming to light in a haphazard fashion, through efforts of public interest groups, media stories, congressional investigations, and lawsuits. Workers should be centrally involved in creating this process, because they were, on the whole, the most exposed group of people. But it should be acknowledged that non-workers were also exposed, including workers' family members, downwinders, those downstream, and other neighbors. The process for deciding how community exposures can be fairly and responsibly addressed, without the anguish and expense of lawsuits like the one at Fernald, should begin.

Attachments

- Slide #1: Estimated Cumulative Lung Doses at Harshaw for Different Multiples of Maximum Allowable Air Concentration and Differing Times of Exposure

- Slide #2: Percent of workers with an Inferred Annual, Average Uranium Lung Burden Corresponding to a Lung Dose of 15 Rem or More (Fernald)

- Slide #3: Worker Sitting on Depleted Uranium Metal Ingot (Photograph by Robert Del Tredici)

- Slide #4: Summary of Estimates of Uranium Releases (Fernald)

Supporting documents

- Arjun Makhijani, Bernd Franke and Hisham Zerriffi, *Preliminary Partial Dose Estimates from the Processing of Nuclear Materials at Three Plants during the 1940s and 1950s.* Prepared by the Institute for Energy and Environmental Research under contract to USA TODAY, 6 September 2000.

- B. Franke and K.R. Gurney, *Estimates of Lung Burdens for Workers at the Feed Materials Production Center, Fernald, Ohio*, (Takoma Park, Maryland: IEER), July 1994.
- Memo from F.J. Klein to R.H. Starkey, "Subject: Cleaning Under Burnout Oxide Conveyors--Plant 5," National Lead Company of Ohio, December 7, 1960.
- *Science for Democratic Action*, volume 5 number 3, October 1996 (Takoma Park, Maryland: IEER)
- *Science for Democratic Action*, volume 6 number 2, November 1997 (Takoma Park, Maryland: IEER)

IEER Home Page

Institute for Energy and Environmental Research

Comments to Outreach Coordinator: ieer@ieer.org
Takoma Park, Maryland, USA

September 2000

SDA Vol. 6 No. 2

Worker Radiation Dose Records Deeply Flawed

By: Arjun Makhijani and Bernd Franke

As part of its responsibility for the production and testing of nuclear weapons, the Department of Energy (DOE) and its predecessor agencies (the *Atomic Energy Commission, 1947-1974; and the Energy Research and* Development Administration, 1974-1977) have been responsible for ensuring that workers were not exposed to more than the allowable amounts of radiation. The DOE has also been responsible to adhere to what is called the "ALARA" principle -- the idea that radiation exposures should be kept "As Low As Reasonably Achievable" with available technology.

The goal of setting radiation dose limits and following the ALARA guideline is to protect worker health by limiting exposure. But if exposure is not properly measured, radiation exposure regulations cannot be enforced, nor can guidelines be followed. Health monitoring personnel may not be aware of instances when workers are overexposed. Diseases that workers may be at greater risk of contracting may go undetected, harming them and their families. Health studies based on worker dose data would produce misleading results because dose records would be incomplete and knowledge of doses would be inaccurate.

From the beginning of the nuclear era until 1989, **radiation doses from radioactive materials inhaled or ingested by workers were not calculated or included in worker dose records.** This was revealed by DOE in a background paper sent to IEER on April 7, 1997.[1] DOE and its predecessor agencies did make measurements of internal exposure to radioactive materials, though often sporadic (see below), mainly by taking urine samples. After the mid-to-late 1960s, there was also selective use of more sophisticated counters that directly measure radionuclides in workers' bodies. The DOE was not required by regulations to calculate worker doses, but only to keep records of whether workers were internally exposed to more than certain amounts of radionuclides.

The lack of historical internal dose data in worker dose records has important consequences for public policy on health issues, for scientific investigations of radiation risk, and most of all for the more than half-a-million workers (and their families) who have been involved since the Manhattan Project in *making and testing* US *nuclear warheads*. In 1989, DOE began to correct this historical problem by initiating a program of integrating internal and external worker doses.

Exposure Limits

Limits for allowable exposure have varied over the years, and have generally tended to decline as evolving knowledge about the cancer risks from radiation indicated that the dangers it posed were greater than previously thought. (See Centerfold article on standards.) In order to ensure that workers are not overexposed, the most important routes of exposure must be properly monitored. Consideration must also be given to the fact that ionizing radiation affects people in various ways.

When only external radiation is involved, measurement of worker dose is accomplished by the use of film badges, (small photographic plates sensitive to gamma and beta radiation), or thermoluminiscent dosimeters (reusable devices that measure external gamma radiation -- also referred to as TLDs). These devices can measure how much radiation a worker has been exposed to, but not the amount of radiation that may have been taken into the body through inhalation, ingestion or other means.

Internal radiation exposure occurs when radioactive materials get inside the body and decay, irradiating nearby tissues. Internal radiation is often more organ-specific than external radiation. If the radionuclides become lodged in particular parts of the body, such as the lungs or bones, for instance, these areas are irradiated far more than others. Risk of internal exposure is high in workplaces where the air becomes contaminated with radioactive materials or dust, as has frequently occurred in various kinds of uranium processing plants and in uranium mines. Workers can also be exposed internally through ingestion of radioactive materials (if the radioactive materials get into the mouth from the air, for example) or by absorption through wounds or cuts.

Internal exposure is less likely in situations where the radioactive materials are sealed or separated in some other way from the work environment, such as in glove boxes. However, if accidents occur in these situations, or if equipment such as a ventilating system or glove box is not efficient or in proper working order, then workers could be exposed internally as well.

For almost the entire period of nuclear weapons production, limits have been imposed on exposure from both internal and external routes. Some current limits apply to combined external and internal exposure, while past limits have applied specifically to particular organs, such as the lungs. For instance, the limit for lung exposure until 1958 was 15 rem per year for workers and off-site populations. It was lowered for off-site populations to 1.5 rem per year in 1959.

Monitoring Doses

Internal dose is monitored in various ways. One common way is to measure radionuclide concentrations in urine. If one knows the rates of excretion corresponding to various body burdens, then is possible to calculate these body burdens and thereby infer the radiation dose.

Another method is to measure the radiation being emitted by the radionuclide inside the body. Since a portion of gamma radiation penetrates the body, a fraction of the gamma rays emitted by radionuclides inside the body escape outside it. This is measured by putting the worker or part of his or her body into a "counter," which is a chamber that measures gamma radiation. Thus, we have "whole body counters," "lung counters," and so on. Care must be taken to exclude or adjust for other sources of environmental radioactivity in the measurement of internal body burdens, notably radon and its decay products.

Internal doses can also be assessed indirectly by measuring the concentrations of radionuclides in the air in the plant. In areas where exposure is more likely, workers can wear portable air monitoring devices to measure concentrations of radionuclides in the "breathing zone" -- that is, in the air very close to their faces. Internal worker doses can be estimated if breathing rates, efficiencies of protective devices worn by workers (if any), and other factors are known.

It is essential that radiation monitoring be carried out accurately and in sufficient detail. For instance, film badges and TLDs must be stored properly when not in use, so that they are not contaminated between worker exposure times. Also, workers at risk of internal exposures must be monitored frequently enough to accurately determine internal body burdens of radionuclides. This is because over time the body eliminates radionuclides; some are excreted in a very short time, while others are eliminated very slowly. (The amount of time it takes to eliminate half of the body burden of a radionuclide is called its biological half-life.) It is also important to know the chemical form of the inhaled or ingested radionuclide because the rate at which it is eliminated from the body depends on the solubility of the particular chemical compound.

Failure to Monitor

The April 7, 1997 background paper sent to IEER by the US Department of Energy Office of Worker Protection Programs and Hazards Management clearly set forth what IEER had suspected for several years, that

> ...[u]ntil 1989 in DOE, and 1991-1994 in the nuclear industry (NRC and Agreement States) internal radiation doses were not calculate [sic] for workers. Radiation activity in excreta or percent of body burdens were recorded in the DOE prior to 1989.

Thus, while workers were being monitored for internal body burdens, these body burdens were not being translated into radiation dose estimates; nor were any radiation dose estimates corresponding to internal radionuclide body burdens entered into the dose records of workers.

While there was no regulatory requirement to actually calculate worker doses, the lack of internal radiation dose estimates in worker dose records means that the records of workers who were at risk of internal exposures are incomplete, misleading, and inaccurate. The degree of incompleteness and inaccuracy will vary from one worker to the next, from one historical period to the next, and from one facility to the next. But the overall result is that

large numbers of workers have received information about their radiation exposures which systematically understates their actual exposures.

Another consequence of the incomplete internal dose records before 1989 is that in compensation cases involving workers who had internal exposures, the DOE and its contractors may have based their arguments on incomplete data that underestimated exposures. Many cases may therefore have been unjustly decided against workers. Whether the DOE or its predecessor agencies knowingly omitted internal dose information from some worker compensation cases is, at this time, an open question, but a reasonable one to pose.

While it is not possible to give an accurate estimate of the proportion of the 500,000 to 600,000 workers who have worked for the DOE that were at risk of exposure beyond allowable limits, we note that at the uranium processing plant in Ohio, commonly called the Fernald Plant, most workers were at risk in the early years. In fact, in 1955, the worst year for worker exposure, IEER estimates that almost 90 percent of workers were exposed to more than the allowable dose limit of 15 rem to the lung. (See SDA Vol. 5 No. 3.)

There are a number of other direct consequences of seriously incomplete dose records:

- Internal exposures of uranium workers may also have led in some cases to heavy metal poisoning, notably of the kidneys. Such cases could have been better detected had internal dose information been a part of dose records.

- Improper medical diagnoses may have resulted in some cases because dose records were incomplete.

- Corrective measures to improve working conditions were likely delayed or not implemented in many cases because dose records did not show overexposures.

The problem was most acute in the period before the mid-to-late 1960s for two reasons. First, evidence indicates that this was the period when workplace conditions were the dirtiest and when workers were at higher risk of exposure. This observation cannot be used to arrive at conclusions about specific workers or even specific plants. But to date, most of the evidence we have examined indicates that for various reasons, exposures were generally highest in this period.

Second, this period is prior to the availability of counting techniques that allowed for direct measurement of body burdens. Action levels were set for radionuclides in urine. So long as the content of specific radionuclides was below these action levels, body burdens and worker doses were assumed to be below the maximum allowable limits. After lung- and body-counters became available in the early 1960s, there were delays in using them. Even after they were brought into use, for example in 1968 at Fernald, urine measurements continued to be *the main method for monitoring internal dose.*

Unfortunately, the monitoring procedure adopted by the DOE and its contractors was flawed. IEER's analysis of Fernald dose records in 1985 revealed the following problems:

- The lung burden inferred from urine data was consistently underestimated because of improper assumptions about the ratio of urinary excretion per unit of uranium lodged in lung tissues.

- Urine was not monitored for all radionuclides.

- Urine monitoring was generally too infrequent to allow for accurate determination of body burdens and their change with time. Since many chemical forms of radionuclides are excreted relatively rapidly, infrequent monitoring was likely to miss doses from accidents and other occasional but high exposures. Further, in many cases, urine measurements were so infrequent that even chemical forms with relatively long biological half-lives would not have been accurately detected. As a result, low urine concentrations may not have corresponded to low exposure, but merely to a long time lapse between the intake of the radionuclide and the taking of urine samples (or lung counts).

- The solubility of the compound inhaled or ingested was not determined or, if known, was not recorded.

- The relationship of urine sampling time to exposure was, in most cases, unknown.

As a result of all these factors, the assumption that the dose was below allowable limits if the concentration of a radionuclide in urine was below the action level was scientifically unsound. Even when the actual doses were below allowable limits, the internal doses should have been entered into worker dose records and added to external doses in appropriate ways.

Whole-Body and Organ-Specific Doses

Radiation standards limit dose both to specific organs as well as to the whole body. Consider, for example, doses to the lung. The lung may be exposed by external gamma radiation from sources outside the body, resulting in doses essentially equal to those for other organs in the body. It may also be exposed from inhaled radionuclides. In order to ensure compliance with the lung dose limit, which was 15 rem in the 1950s through 1980s, DOE and its contractors only had to consider internal body burdens of radionuclides. (However, as we have indicated, before 1989 internal doses were not calculated from these data.) In most cases, such as at the Fernald plant, lung doses were inferred from measurements of uranium in urine. If these were found to be below allowable concentrations, compliance with the 15 rem/year limit was assumed to have been demonstrated.

In the period since the late 1980s, the regulatory practice has been to use "committed effective dose equivalents."[2] In this model, "effective dose" is calculated by multiplying doses to individual organs or tissues, like the thyroid, bone tissue, or the lung, with a weighting factor that accounts for the relative likelihood of cancer mortality from exposure to a particular organ. This allows exposures to a single organ and exposure of the whole body to be considered together. Further, internal organ doses are calculated on the basis of a fifty-year "committed" dose – that is, the entire dose from a radionuclide to an organ over a fifty year period (in most cases, the majority of the dose is delivered in a few years or less). These two concepts, "effective dose equivalent" and "committed dose" are put together to arrive at "committed effective dose equivalent." For regulatory purposes, the entire committed dose is attributed to the year in which the radionuclide is incorporated into the body. But even in this new practice, the organ doses arising from internal radiation must be known, because without that data, the correct effective dose equivalent cannot be calculated. This change in regulations requiring calculation of effective dose equivalents caused DOE to begin to move to a policy of integrating internal and external radiation doses.

While the unavailability of precise scientific techniques before the mid-1960s would have precluded accurate internal dose assessment, the doses could have been inferred from urine data and integrated into dose records, but were not. After the mid-1960s, the AEC and its contractors could have made relatively accurate worker dose estimates, but still failed to do so. It would appear that the same institutional outlook that put weapons production before environmental protection also relegated sound worker dose records into second place until the Cold War began to wind down.

Consequences of Underestimating Dose

Underestimation of internal doses is not just poor practice for worker health protection. It also creates problems for epidemiological studies. Accurate epidemiological work is needed to estimate the health risk of radiation exposure, and this requires studies with sound data on doses to various groups of workers.

Cohort studies, for example, compare the health status of people with various degrees of exposure. Such studies are common among worker populations and help to assess the risk of exposure to radiation (or other disease-causing agents). But if worker dose records are distorted by omission of a crucial component of dose, highly exposed workers and workers with low exposures could be jumbled up in ways for which no statistical control is possible.

For instance, studies that consider external exposure only would group workers with low external doses together and those with high external doses in another group. If some or all of the low external exposure group workers had higher internal doses than the high external exposure group, the study would be comparing workers with high exposure to others also with high exposure![3] Such a study would be misleading and tend to underestimate risk estimates. By contrast, if the high external exposure group had even higher internal exposures, the study would also be misleading and would tend to overestimate radiation risk.

The April 1997 DOE background paper also points out that lifetime dose records have not been carefully maintained though the risk to workers is based on lifetime radiation dose. If dose records are not transferred from one contractor to the next at a plant, or from one plant to another when the worker changes jobs, worker health as well as public health is compromised because it becomes impossible to accurately track the health effects of occupational exposure. Of course, this is another complicating factor in doing epidemiological studies and assessing radiation risk.

External Exposure Data

The state of external dose data also needs to be carefully examined. The DOE has admitted the following problems[4]:

- External exposure data are often incomplete and unreliable.
- Raw dose data and electronic versions of the data (which are often used by researchers in studies) do not always agree.
- In some cases, worker dose records contain entries stating that the dose was zero, regardless of what the actual dosimeter reading may have been.

Finally, there were very few measurements made of worker exposure to non-radioactive hazardous materials. But we do know from the nature of work done at nuclear weapons plants that many workers were exposed to or were at risk of exposure to acids, organic solvents, beryllium, fluorine and fluorides, and heavy metals.

As a result of all of these problems we can conclude that knowledge of workplace exposure during nuclear weapons production and testing was poor, and the results of at least some epidemiological studies are likely to be misleading. At present, it is impossible to say what health effects might be revealed by properly conducted studies. But we can say with confidence that the radiation doses for large numbers of workers were higher than those that are apparent from their dose records because internal doses were omitted until 1989, and because there were many deficiencies in other dose records.

Chronology of External Radiation Exposure Standards

1931-34	US Advisory Committee on X-Ray and Radium Protection (precursor to the National Council on Radiation Protection and Measurements) adopts X-ray "tolerance dose" of 0.1 roentgen *per day.*
1940-41	US Advisory Committee proposes, but does not implement, lowering the X-ray tolerance dose to 0.02 roentgen *per day.*
1942	U. of Chicago Metallurgical Laboratory adopts a "maximum permissible exposure" standard of 0.1 roentgen *per day.* Becomes standard for entire Manhattan Project.
1954	Atomic Energy Commission adopts National Bureau of Standards recommended dose limit of 5 rem *per year.* Sets additional limits for internal exposures at 15 rem per year for most organs.
1959	Dose limit for workers remains 5 rem per year. AEC also adopts dose limts for the public equal to one-tenth of those allowed for workers: 0.5 rem for external exposure; and 1.5 rem for most organs for internal exposure."
late 1980s - 1990	Department of Energy adopts dose limit for the public of 100 millirem (0.1 rem) per year; dose limit for workers remains 5 rem per year. A new model for calculation of internal doses to workers is adopted, the "*committed effective dose equivalent.*" (See main article.)
1991	International Committee for Radiological Protection recommends worker dose limit be reduced to 2 rem per year. Recommendation is not adopted by DOE.

NOTE: For external radiation sources, roentgen and rem are considered to be equivalent.

Sources: 1931-34, 1940-41, and 1942: Barton Hacker, *The Dragon's Tail,* (Berkeley: University of California Press, 1987), Appendix A, pp. 163-64; 1954: US Atomic Energy Commission, AEC Manual, TN-000-22, Chapter 0522, Vol. 0000, Part 0500, AEC-0522-01, BMBP, (US AEC, Feb. 26, 1954), 0522-01.h; and National Bureau of Standards (NBS) *Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissile Concentrations in Air and Water*, Handbook 52, (Washington: US Dept. of Commerce, March 20, 1953); *1959*: NBS, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure,* Handbook 69, (Washington: US Dept. of Commerce, June 5, 1959), pp.4-6; late 1980s - 1990: US Dept. of Energy, Office of Environmental Safety and Health, *Order: DOE 5400.5,* (US DOE, February 8, 1990), II.1a; 1991: International Commission on Radiological Protection, *1990 Recommendations of the International Commission on Radiological Protection,* ICRP Publication 60, Annals of the ICRP, Vol. 21, No. 1-3, (Oxford, New York: Pergamon Press, 1991), p. 72, parg. (S25).

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ENDNOTES

1. The background paper was faxed to IEER on April 7, 1997 as preparation for a meeting an IEER staff member was attending with the staff of DOE's Office of Worker Protection Programs and Hazards Management on April 14, 1997.

2. This model is referred to as the "ICRP 30 dosimetric model." ICRP is the International Committee on Radiological Protection. The model was announced in publication 30.

3. This kind of situation is quite possible because many important radionuclides, including uranium-238, plutonium-239, strontium-90, and tritium would typically provide low external doses but high internal doses.

4. For more on problems with DOE's external dose data see A. Makhijani, H. Hu, and K. Yih, eds., *Nuclear Wastelands*, (Cambridge: MIT Press, 1995), pp. 262-63.

Health and Environmental Impacts of Nuclear Weapons Production

Assessments of the harm done by nuclear weapons plants to both workers and neighbors have generally relied on the radiation data provided by the Department of Energy (DOE) and its contractors. Detailed studies of the DOE's uranium processing plant near Fernald, Ohio, (commonly called the Fernald plant), show that DOE and contractor assessments are fundamentally flawed in numerous ways and that harm to both neighbors and workers was far greater than the DOE acknowledged. Further, preliminary indications are that the conditions that gave rise to the DOE's false reassurances of safety and environmental compliance are also likely to be present at a number of other nuclear weapons plants.

This issue of the newsletter has three articles on health and environmental impacts of nuclear weapons production: i) a general overview of how health and dose reconstruction studies are done; ii) a case study of the Fernald plant regarding radiation exposure and health risk to its neighbors; and iii) a case study of worker exposure at the Fernald plant

We will continue this series in future newsletters. Note that these evaluations only address exposures for the period when nuclear weapons plants were operating. They do not include risks posed by the wastes that have been created since, or from decontamination and decommissioning operations that are needed at all weapons plants and test sites.

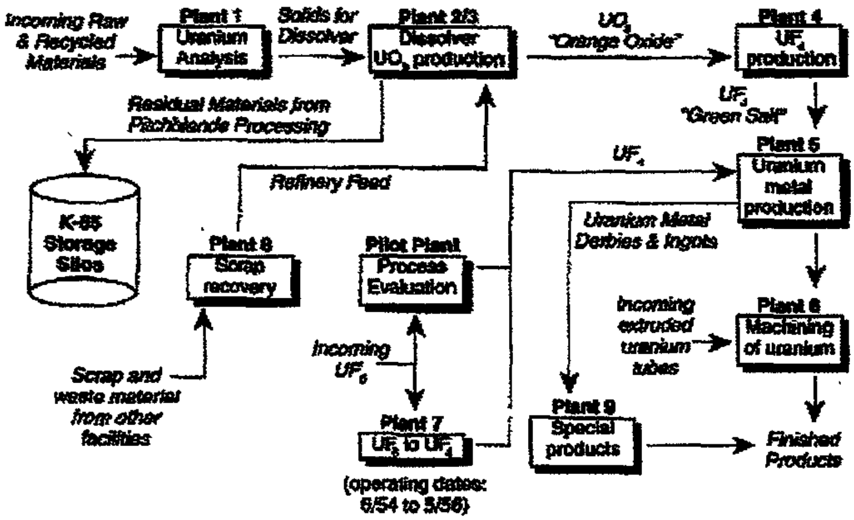
Radioactivity in the Fernald Neighborhood

By: Arjun Makhijani

The Department of Energy's Feed Materials Production Center (also called the Fernald plant), located near Fernald, Ohio, produced uranium metal mainly for use in plutonium production at the Savannah River Site in South Carolina and at Hanford in Washington state. The plant was operated by National Lead of Ohio (NLO) from 1951 through 1985. In 1986 it was taken over by Westinghouse. NLO had a number of subcontractors, (the Alba Craft plant in Oxford, Ohio, for example), who performed a variety of tasks such as machining of uranium metal. The Fernald plant closed in 1989, and the site now has a new name: the Fernald Environmental Restoration Management Corporation (FERMCO). It is currently being remediated by the DOE contractor, Fluor Daniel.

The Fernald plant consisted of 10 production operations (called "plants") as well as other support buildings. In these facilities, uranium in various forms, including ore concentrates, scrap, and recycled material containing uranium were processed to produce uranium metal. The six waste pits at the site contain both radioactive and non-radioactive chemicals, including uranium isotopes, thorium-230 (a waste material from the uranium production process), thorium-232, and barium salts. In addition, the K-65 silos located on the site contain radium-226, a decay product of uranium which emits radon (see centerfold). Figure 1 shows a schematic diagram of uranium processing operations at Fernald.

FIGURE 1: Uranium Processing at the Fernald Plant



Voillequé et al., *Fernald Dosimetry Reconstruction Project, Tasks 2 and 3: Radionuclide Source Terms and Uncertainties* (Neeses, SC: Radiological Assessments Corporation, 1995), p. B-2

Source: Voilleque et al., *Fernald Dosimetry Reconstruction Project, Tasks 2 and 3: Radionuclide Source Terms and Uncertainties* (Neeses, SC: Radiological Assessments Corporation, 1995), p. B-2.

Throughout the history of the plant's operation the DOE and its contractors consistently asserted that the offsite residents were not harmed by its operation and that exposures were within allowable limits. These assertions were challenged in a 1985 class-action lawsuit brought against NLO by neighbors of the plant. In that year, Lisa Crawford, the lead plaintiff, had discovered that the well that she and her family had been using for drinking water was contaminated with uranium. She also found out that the DOE and NLO had discovered the contamination four years earlier but had not informed her. Ms. Crawford realized her well was contaminated after she requested monitoring data in the aftermath of a highly publicized accidental uranium release from the plant in late 1984.

The Fernald plant had, in fact, released a number of radioactive and non-radioactive pollutants to the air and water, but DOE had very partial data for some of these materials, and none at all for many others. Among the pollutants were: uranium, thorium, radon gas, radium, technetium-99, ammonia, hydrofluoric acid, fluorine, nitric acid, kerosene, chromium, and lead. The most important radioactive pollution consisted of releases of uranium and radon gas to the air. Detailed evaluations of non-radioactive pollutant releases have not yet been done and few data exist on which such evaluations can be based.

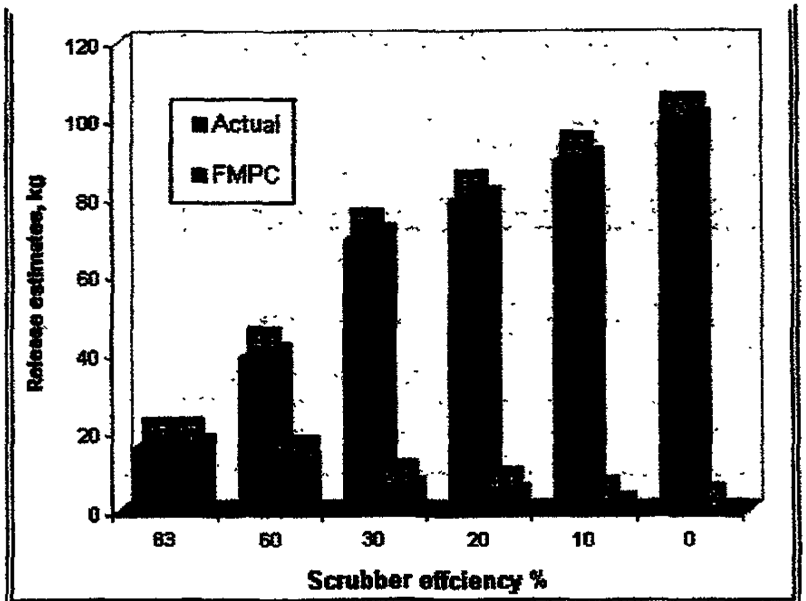
Uranium releases

Internal evaluations of the plant's operations were initiated in 1985 and they continued until the plant was shut down in 1989. In early 1985, NLO estimated that the releases of uranium over the 34-year period from 1951, when parts of the plant were started up, to 1984 were about 200,000 pounds. The NLO estimate was increased to 300,000 pounds by 1987 after inclusion of estimates of some of the most serious emissions during the 1950s. There were a number of evident deficiencies in these official estimates. Among the more egregious errors were:[1]

- An assumption that releases were zero when there were no data.
- An assumption that scrubbers designed to remove uranium from highly acidic exhaust always operated within manufacturer specified efficiency, despite internal plant data to the contrary.
- The use of an incorrect formula to calculate scrubber releases under conditions of variable efficiency.
- Inclusion of fabricated data that showed that releases were zero at locations and times when no measurements were being made.
- A failure to account for poor dust collector efficiency and frequent problems with dust collector equipment.
- Poor industrial hygiene practices, such as leaving radioactive materials to dry in trays in doorways, and operating equipment that was in poor condition.

IEER was retained in 1987 by the law firm of Waite, Schneider, Bayless, and Chesley to do some of the expert studies for the class action lawsuit. IEER's review of the historical documents showed that plant officials were aware of many of these deficiencies. For instance, the use of the incorrect formula for scrubber releases was pointed out in a 1971 memo by a plant engineer, who called it "inherently deceptive" because it resulted in release estimates that grew smaller as the scrubber efficiency deteriorated -- the opposite of the truth. Figure 2 shows the actual releases of uranium compared to the NLO estimates for an example in which uranium in the air going into the scrubber was 100 kilograms.

FIGURE 2: Variation of Efficiency of Airborne Uranium Releases from FMPC Scrubbers for an Assumed Inlet Uranium Loading of 100 Kg*



Source: Makhijani and Franke, 1989
* This is the amount of uranium in the gas going into the scrubber.

A 1955 document pointed to early problems with uranium release estimates: "We realize in most instances that these estimates [for stack losses from plants 4 and 7] are far below your true stack losses."[2] Plant 7 was shut down in 1956 due to operational problems. Plant 4 continued to operate until Fernald shut down, and the problem of corrosion of dust collector equipment by acidic exhaust continued for decades.

The following example also illustrates the poor industrial hygiene practices at the plant:

> Probably the worst housekeeping problem in the facility is the Ball Mill. The equipment leaks excessively at practically every joint. All horizontal surfaces have a thick covering of dust....Since the ventilation is inadequate and these is no proper enclosure, a bucket was placed under the largest leak to help contain the spilled dust.[3]

Such discharges of radioactive materials were not measured and were disregarded in the official release estimates and public reassurances.

Under the glare of public scrutiny and the class-action lawsuit, Westinghouse, the new contractor (and not named as a defendant), revised the official figures for the 1951-1985 period again and stated that the releases were in the range of 395,000 to 552,000 pounds. While these estimates were higher, they still disregarded many known facts. For instance, unmeasured losses over the plant's entire 37-year history were estimated at about 700 pounds, while an internal plant document stated that *unmeasured losses were more than that in a single month.*

During work on the lawsuit in 1988 and 1989, IEER focused its work on estimating uranium losses, since that was the main material processed and data on other materials released to the air were scarce or non-existent. We re-estimated losses from several important sources, notably scrubbers in the scrap recovery plant (Plant 8). We also made an estimate of uranium releases based on measurements of uranium in the soil around the plant. Our work was admittedly very preliminary, mainly since IEER was unable to obtain most of the crucial documents regarding plant operation and pollution control equipment efficiencies. Moreover, the quality of the data that we had was poor and some of it was internally inconsistent.

Still, we concluded that the official estimates were almost certainly wrong, that the releases were higher than the upper end of the official estimate of 552,000 pounds, and that uranium air concentration standards had been violated on at least some occasions. IEER estimated that uranium releases were in the range of 600,000 to 3 million pounds, with a middle estimate of 900,000 pounds. IEER also recommended further detailed work, since these estimates were of a very preliminary nature.

The DOE, which defended the lawsuit on behalf of the contractor, NLO, settled the suit for $78 million in mid-1989, but admitted no wrong-doing, or even any technical problems in its own or its contractors' work. (Under the terms of its contract with the government, NLO was immune from all liability, including that arising from negligence or violations of regulations.)

But the Centers for Disease Control and Prevention (CDC) initiated an independent study of the radiation doses to the public arising from Fernald's operation.[4] The final draft report of that $4 million study, prepared by Radiological Assessments Corporation (RAC), was released in August 1996.[5] It corroborated IEER's critique of the official estimates of uranium releases to the air and greatly narrowed the range, estimating it to be 590,000 to 790,000 pounds, with a best estimate of 680,000 pounds.

The following table summarizes the various estimates for uranium releases from Fernald. Only the best estimate, or middle estimate, made the by source is shown:

Summary of Estimates of Uranium Releases

Institution	Uranium releases to the air, pounds	Uranium releases to surface water, pounds
NLO, early 1985	200,000	160,000
Westinghouse 1987	300,000	160,000
Westinghouse, 1989	400,000	160,000
IEER 1989	900,000	not made
RAC 1993	1,000,000	180,000
RAC 1996	680,000	180,000

Sources: For discussion of all release estimates and detailed references, except RAC 1993 and RAC 1996, see Makhijani 1988 and Makhijani and Franke 1989. Note that RAC published draft estimates in 1993, which it revised in 1995 and again (slightly) in 1996.

Note: Figures are rounded to one or two significant digits, as indicated.

Radon releases

The RAC study also estimated releases of other radioactive materials. The most important was radon-222 releases from the K-65 silos used for storing high radium-content waste from Belgian Congo ores. The radium-226 in the silos decayed into radon gas (as it continues to do). The deteriorating structures and poor storage conditions and practices (which were partly rectified in 1979 and then again in the 1990s) led to huge radon releases from the silos, notably in the period up to 1979. There were a few environmental measurements of radon made in 1979. IEER's preliminary work, which was focused on uranium releases and plant compliance with regulations, missed this significant source term. RAC's estimate of the radon source term for the period up to 1979 is several thousand curies per year. The cumulative radon source term estimate is 170,000 curies for the 1951-1988 period.

Radiation doses

While official DOE and contractor reports claimed that no harm had been done and that exposures to the neighbors of the plant were well under allowable limits, IEER's work found that hypothetical maximally exposed individuals near the site boundary were likely to have been exposed above allowable limits, especially during accidents. Because IEER lacked the documents regarding pollution control efficiencies, particle sizes, and chemical composition of the pollutants, as well as other factors, a reliable detailed evaluation of population risk could not be made. Moreover, the main goal of IEER's work was compliance assessment rather than population risk assessment.

In August 1996, the Radiological Assessments Corporation made public its estimates of exposures to various hypothetical individuals in scenarios designed to typify living and working patterns of people in the area. The findings were that radon exposures due to huge releases of radon gas from the K-65 silos were the main source of increased radiation risk to the population, especially for people who lived there prior to 1980. It is noteworthy that radon was not even evaluated as a source of pollution caused by the Fernald plant until the series of RAC studies in the 1990s. Radon probably also caused significant exposures to workers at the plant, a matter that remains to be addressed (see accompanying article on workers).

Doses due to uranium exposure by inhalation were the next most important factor, with other radioactive materials and pathways being judged relatively low. The table, "Comparison of Cumulative Effective Dose Contributions from Uranium Exposure Mode and Radon Decay Products" in the centerfold shows the exposures for various scenarios as calculated by RAC. The increased risk of cancer (especially lung cancer (are substantial in all cases. In many cases, they are comparable to the risks from smoking.

Concluding observations

The history of studies of exposure to Fernald's neighbors show that the reassurances of the DOE and its contractors -- that the nuclear weapons plants were operated safely and in compliance with applicable health and safety laws and regulations -- should not be taken at face value. The work of IEER, RAC, and others at other nuclear weapons plants indicates that DOE and contractor estimates of releases of radioactive materials are generally underestimates, and are riddled with faulty data, poor science, and calculational mistakes and inaccuracies.

Despite the settling of the lawsuit against the contractor of Fernald for $78 million of taxpayer money, concerns remain. Many studies have repudiated DOE and contractor work, showing elementary scientific flaws in it, but neither the DOE nor any of its contractors have discussed what went wrong, much less how the recurrence of scientifically dubious and misleading studies might be prevented. Many issues, such as the exposure of residents to non-radioactive pollutants and non-compliance of the plant with environmental regulations, remain unaddressed.

The DOE needs to put its own work and that of its contractors in the perspective of the findings of the independent Fernald studies. That should be the first in a series of steps that it must take to create a system that would do environmental science with at least the same vigor that DOE and its contractors addressed bomb-making.

Return to SDA Vol. 5 No. 3 Main Menu
Return to SDA Main Menu
Return to IEER Home Page

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ENDNOTES

1. For details see Arjun Makhijani, *Release Estimates of Radioactive and Non-Radioactive Materials to the Environment by the Feed Materials Production Center* 1951-85, (Takoma Park: Institute for Energy and Environmental Research, 1988); and Arjun Makhijani and Bernd Franke, *Addendum to the Report 'Release Estimates of Radioactive and Non-Radioactive Materials to the Environment by the Feed Materials Production Center 1951-85,'* (Takoma Park: Institute for Energy and Environmental Research, 1989).

2. R.H. Starkey, memorandum to A. Meredith, "Estimated Stack Losses for December [1955]", National Lead of Ohio, 10 January 1956.

3. K.N. Ross to J.E. Beckelheimer, "Thorium Metal Production Housekeeping," National Lead of Ohio, 8 June 1970.

4. Unfortunately, the CDC did not ask for an evaluation of exposures to non-radioactive materials in its request for proposals.

5. RAC prepared a number of draft and final reports leading up to the draft 1996 report. The ones most relevant to this article are: Voillequé et al., *Fernald Dosimetry Reconstruction Project: Tasks 2 and 3: Radionuclide Source Terms and Uncertainties*, Draft Report (Neeses, South Carolina: Radiological Assessments Coporation, 1993); and Killough et al., *Fernald Dosimetry Reconstruction Project: Task 6: Radiation Doses and Risks to Residents from FMPC Operations from 1951-1988,* Draft Report (Neeses, South Carolina: Radiological Assessments Coporation, 1996).

SDA Vol. 5 No. 3

Fernald Workers' Radiation Exposure[1]

By: Arjun Makhijani

Like workers at other nuclear weapons plants, workers at the Feed Materials Production Center near Fernald, Ohio (commonly called the Fernald plant) were routinely assured that they were being protected and that, in general, their exposures to radiation were under the maximum legal allowable limits. These assurances, given by the Department of Energy and its contractors, have been based on records of worker doses. A careful analysis of Fernald plant data indicates that these claims are incorrect.

Three categories of radiation data were collected for workers at Fernald:

1. Direct measurements of worker external radiation doses. (Collected using film badges worn by workers, for instance.)
2. Measurements of radioactive materials inside workers' bodies. The methods included analyzing urine samples and measuring gamma radiation emanating from radionuclides trapped in workers' lungs (called "lung counting").
3. Measurements of radioactivity in the workplace environment. These are made by sampling the air in the general area where the work is done and in the "breathing zones" close to workers' faces.

The third category is not a direct measurement of dose but provides an indication of working conditions leading to exposure. Standards are set limiting the concentrations of radionuclides in the air so that the radiation doses to workers might be kept below allowable maximum limits. IEER performed an independent assessment of radiation exposure to workers as part of a class action lawsuit filed by the plant's workers against National Lead of Ohio, DOE's contractor until 1985.

Working conditions at the Fernald uranium processing plant near Cincinnati were appalling, especially in the 1950s and early 1960s. They were typified by high air concentrations of uranium in many areas of the plant which often exceeded the Maximum Allowable Concentration (MAC) by tens of times, hundreds of times, and even thousands of times. One 1960 plant document lists the air dust concentration in the breathing zone of an operator cleaning under a burnout conveyor as 97,000 times the MAC.[2]

Work procedures also contributed to the high air dust concentrations in the plants. For example, a 1968 plant document described the procedure for emptying a dust collector:

> The dust is emptied from the collector on the second floor and falls down a chute to a nonventilated drum on the first floor. The operator on the first floor signals to the operator on the second floor that the drum is full by pounding on a metal beam with a hammer. Because of the noisy conditions prevalent in the plant. the second floor operator does not always hear the signal. This results in an overflowing drum of dusty material causing a cloud of radioactive dust to fill the area which also goes up the stairwell into the second floor.[3]

In many plant situations, proper respiratory protection to prevent inhalation of this radioactive dust was not available. IEER's review revealed that workers were not properly trained regarding when to use respirators, and consequently did not wear them in many situations when air dust concentrations were high. In fact, in the early years of plant operation, workers were not even issued respirators as long as air concentrations of radioactivity remained less than ten times the MAC. In addition, a significant number of respirators cleaned for reissue remained contaminated. In some cases, the insides of respirators were contaminated. A plant doctor on an impromptu plant tour characterized some of the respirators as "the epitome of filth."[4]

Internal exposure estimates

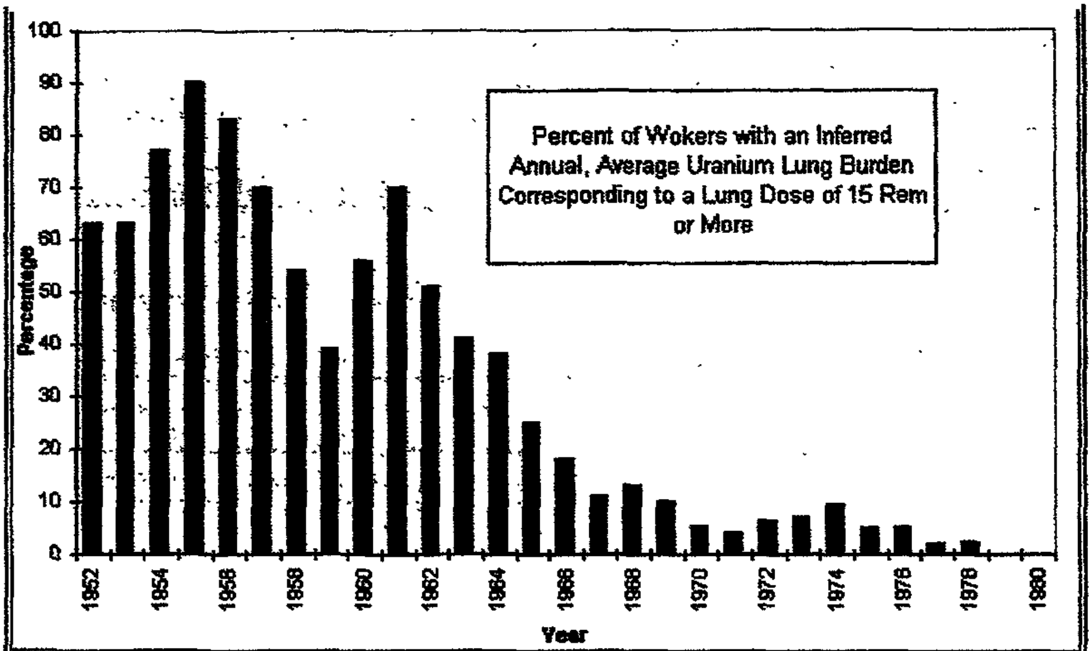
Fernald worker dose records are highly misleading because they contain no mention of radiation doses due to the uranium that workers inhaled which then irradiated their bodies, notably their lungs. These doses were not included in worker records despite the urine sampling that was done throughout the plant's history and the lung counting that was done after 1968. Thus, when workers requested dose records, they were only given information on external doses (see below).

The urinalysis program used at the Fernald plant had several shortcomings. Twenty-four hour urine samples provide a good indication of how much uranium is in a person's body. However, 24-hour samples were not regularly taken at Fernald. Instead, the program relied on "Monday morning" single samples. It was not recorded which workers drank coffee and therefore possibly diluted their urine samples.

Another problem with the program was the infrequency of the samples, especially in the early years of plant operation. After uranium is inhaled, it is excreted from the body in diminishing amounts over a period of time. The amount of time it takes for an inhaled material to be excreted depends on its chemical form. When samples are taken only every few months or even just once a year, as they were in early years of Fernald operations, it is possible for large exposures to go undetected. As a result, infrequent monitoring makes it impossible to accurately determine the magnitude of the exposure.

IEER developed a method to estimate radiation doses to the lung from urine data by calibrating that data to the direct lung count data that was available after 1968. The concept was developed by Bernd Franke in collaboration with an IEER consultant, Mike Throne, who also created the mathematical formulation of the method. Kevin Gurney wrote the computer program to manage the enormous volume of data and run it through the mathematical model.

IEER's conclusions were that doses due to uranium inhaled by workers were above then-allowable limits (15 rem per year) in more than fifty percent of the cases in every year but one between 1952 and 1962. Significant proportions of workers continued to suffer overexposure after that. A chart of the proportion of workers exposed to more than the allowable limits due to lung burdens of uranium is shown below.



Source: B. Franke and K.R. Gurney, "Estimates of Lung Burdens for Workers at the Feed Materials Production Center, Fernald, Ohio," (Takoma Park: IEER, 1994), p. 8.

The presence of large and variable amounts of radon during lung counting appears to have created measurement errors in the records of many workers. Fernald's procedure for lung counting included measurement of subtraction of ambient external radiation readings, including radiation from radon and its decay products. However, differences in radon levels between the time that background measurements were taken and the time that the lung counting was done could mean that the actual lung burden may have been higher or lower than reported. Such fluctuations would tend to cancel out in population dose estimates, such as the ones that IEER made, which are presented in this article. Further, the result of subtracting high background readings resulted in many negative estimates of lung burden, which must necessarily be rejected as false, as well as a large number of low values below 5 milligrams, which IEER considered to be too unreliable to use. IEER's work took these statistical problems in lung count data into account by omitting all lung burden estimates below 5 milligrams. Worker doses from radon and its decay products would be in addition to those from uranium lung burdens discussed above. These remain to be estimated.

External exposures

In general, external exposures were also not carefully monitored at the Fernald plant. For instance, there was a high potential for some workers to experience significant external exposures, especially to their hands. Hand exposures were not calculated at all until 1970, when some workers began to wear wrist dosimeters. In many cases, external dose records indicate readings of zero. Without further records and investigation, its is not possible to assess whether these meant that there was no significant reading above background, whether there were other problems with the data, or even whether some of the data were fabricated (as was the case with some of the uranium release data).

One example of the problems of the external radiation dose record dates from the early 1980s, when thermoluminiscent dosimeters (TLDs) were introduced in place of film badges. Contamination of the TLDs by uranium prevented accurate readings and so a "correction factor' was introduced to the raw dose reading. However, NLO used the same correction factor for all workers regardless of the working conditions and duration of exposure during the month. The result was that some workers were, after "correction," estimated to have negative radiation doses. These records were apparently referred to the Health Physics section for further action, but it is still not known what was done with the estimates. One possible outcome is that a zero was entered into the dose record.

Concluding observations

Just after the presentation of IEER's findings in court in 1994, the DOE settled the lawsuit on behalf of NLO, providing workers with lifetime medical monitoring, and other benefits. But the DOE has still not acknowledged that worker dose records are severely flawed and incomplete. So far as IEER has been able to determine, DOE and its contractors still *routinely fail to include estimates of internal doses in worker dose records. Therefore, in the* nuclear weapons plants were workers have been exposed to conditions that might cause internal exposures, the dose records would be systematically incomplete and underestimate worker exposure.

In many epidemiological studies, or at least in some cases, the general assumption that film badge data are a useful proxy for actual total exposure may not be valid. Inaccurate external dose records, lack of dose records for many high internal exposures, and the highly variable conditions of uranium dust to which workers were exposed make film badge data suspect. Finally, worker records contain almost no information about exposures to non-radioactive toxic materials, such as acids, metals, and solvents, which are routinely used in large quantities.

Nuclear weapons production in the U.S. has involved 600,000 workers, many of whom worked in uranium and plutonium processing facilities, where there were risks of internal exposures. Identifying those most at risk by estimating internal exposures is a matter of elementary justice and health protection. Efforts must also begin to find groups at high risk due to chemical exposure. Such evaluations can lead to identifying high risk worker groups. Medical monitoring may provide early detection for such workers who may otherwise not suspect that they are at risk until it is too late for them.

Return to SDA Vol. 5 No. 3 Main Menu.
Return to SDA Main Menu.
Return to IEER Homepage.

ENDNOTES

1. This article is based on the following IEER report: Bernd Franke and Kevin Gurney. *Estimates of Lung Burdens for Workers at the Feed Materials Production Center,* Fernald, Ohio. (Takoma Park: Institute for Energy and Environmental Research, 1994).

2. Memo from F.J. Klein to R.H. Starkey, "Subject: Cleaning Under Burnout Oxide Conveyors - Plant 5," National Lead Company of Ohio, December 7, 1960, p. 2

3. Memo from C. W. Zimber to Leininger, "Subject: Employing Rotex Dust Collector No,

6018," National Lead Company of Ohio September 10, 1968, p. 1

4. Memo from J.A. Quigley to C. Dees, National Lead Company of Ohio, October 12, 1953, p. 3

Institute for Energy and Environmental Research

Comments to: Outreach Coordinator: ieer@ieer.org
Takoma Park, Maryland, USA

March, 1997

62400

F-2-1

2126829

March 6, 1953

Health Conditions in the Various Plants

J. A. Quigley, M.D.

R. C. Heatherton

CENTRAL FILES

In line with our conversation of this morning regarding the conditions in the various plants, I would like to make some suggestions.

At the meeting the other night Drs. Taylor, Williams, Manhoff and Mr. Holiday all were taking a serious attitude regarding operating outside of specified permissible levels for radiation and radioactive materials. I think our permitting certain operations to continue at this site when it was known that we were well above the established permissible levels has been interpreted as permission to continue to operate in this fashion as long as there are pressing production and technical requirements to be fulfilled. A close look at the health status at the present time in the plants indicate that in most buildings that conditions have gone from bad to worse. We feel that we should not permit these to continue any longer, but should take definite steps at this time to correct all conditions which do not meet the specified requirements, if necessary alloting certain time before operations are discontinued for health reasons. In other words, I feel that any operation which cannot show a steady improvement toward operating within the prescribed maximum levels should be shut down immediately. As long as there is improvement and a definite sign that every effort is being made to correct the conditions along with the production and technical requirements, it is possible that continued operation would be permitted.

If such a recommendation were to be followed, I think that we would have to shut down most of the Pilot Plant operations and the chip furnace at a very early date. In my opinion the supervision in these areas has shown no inclination toward improving health and safety conditions but are concentrating chiefly on production requirements.

Yours truly,

R. C. Heatherton

RCH:bg

cc: E. F. Blase
A. Stefanec

PLAINTIFF'S EXHIBIT 108A

NATIONAL LEAD COMPANY OF OHIO

CINCINNATI, OHIO 45239

February 23, 1968

SUBJECT REFINERY NO_2 FUME RELEASES

TO J. A. Quigley, M.D.

FROM R. H. Starkey

REFERENCE 1) Letter, R. H. Starkey to L. M. Levy, dated 2/21/68, Dumping into F2E-11 Tank - Metal Dissolver Building.

2) Letter, R. H. Starkey and E. A. Mode to J. A. Quigley, M.D. and P. G. DeFazio, dated 1/15/68, Plant 2 Hot Side Off-Gas Ventilation Tests.

I am becoming increasingly concerned with the lack of progress being made with the control of oxides of nitrogen fumes in the Refinery. As you recall, the Oak Ridge inspectors were quite concerned with the number and severity of the fume releases in the Refinery during their review last October. Also, as you recall, we assured the AEC that this problem would receive top priority from our Engineering Division. Subsequently, I received a call from F. E. Coffman, ORO Safety Division, concerning our progress in correcting the conditions which were resulting in the fume releases. Again, I was able to satisfy him that we were making progress. I am no longer at all convinced that this is the case. In fact, I'm quite concerned that we may be regressing overall.

During December 1967 Refinery supervision recorded 21 fume releases which required that portions of the plant be evacuated. During January there were only two recorded releases and so far only one release has been recorded this month.

Having visited the Refinery many times during the past three months, I have a feeling that the releases aren't getting any less; the personnel are just becoming more used to the fuming. Admittedly, most of the releases were not large enough to evacuate the building; but the number of lesser releases were great.

As a basis for my concern, I'd like to delineate a few areas in which I feel that we have regressed. They are:

1. Since December 13, 1967, we have had two instances in the Hot Raffinate Building where Mechanical personnel have

received significant NO_2 exposures while working on the Filter Feed Tanks. Granted, we are taking corrective measures in this building; but unless more adequate communications are set up, I'm afraid we're going to seriously injure someone before the corrections can be made.

2. The NO_2 and dust releases mentioned in reference letter No. 1 have been numerous. The ventilation system is entirely inadequate to handle the Metal Dissolver and the digestion operation in F2E-11. I have recommended both verbally, and finally in writing, to L. M. Levy that this operation be ceased. Lou had agreed with R. C. Heatherton and me that he would pursue another means of processing this material. To date there is no indication that he has done so.

3. The Harshaw system has not been operating since approximately January 8. During the ensuing period the Digestion pots have had to be vented to the Nitric Acid Absorber system. This has resulted in a greatly reduced ventilation on the digesters and subsequently numerous dust and NO_2 releases, especially in the Slag Leach system. The low air flow in itself causes releases and in addition causes the vent ducts to become plugged because of the low carrying velocity. Dust and NO_2 were released virtually constantly from the Slag Leach system while material was being fed into a digester for a period of approximately two weeks. This was brought to the attention of virtually every Refinery supervisor including L. M. Levy, who was notified by phone of the problem by K. N. Ross on February 13, 1968. Finally, on February 19, 1968 the vent ducts were dropped and cleaned out. The operator told me that the one section was virtually completely plugged. After cleaning, some small fuming was occurring but not nearly as much as prior to cleaning the duct. I understood the Harshaw system is to be scheduled to go back on stream some time the week of February 26 or approximately seven weeks after it went down. This long delay may have been absolutely necessary, but discussions I have had with Plant 2 supervisors indicate that if "top priority" had been given that we could have had the Harshaw system back in operation sooner.

4. I stated in the answer to the ORO review that "the NLO Engineering Division has given the Refinery fume removal problem top priority." Of prime concern was the Digester vent systems. We had been attempting to get something moving on solving this problem for months prior to the ORO review. Finally, after an extended period of "no progress," you and I brought the problem to the attention of S. F. Audia and

NATIONAL LEAD COMPANY
OF OHIO

TITLE: STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF AIR DUST SAMPLES

AUTHOR: R. J. Ross

DATE: December 23, 1960

SCOPE: This SOP covers the methods to be followed for the collection of air dust samples.

PURPOSE:

1. To determine the air dust exposures of individuals or groups of individuals in the performance of specific jobs and while in the general vicinity of sources of airborne material.

2. To determine the sources of air dust.

3. To supply information that will aid in preparing specific recommendations designed to minimize personnel exposures.

Working specifications for air survey work include the collection of samples according to standard methods as outlined in this procedure, making use of equipment, rates, and times prescribed so as to make possible reproducible results.

CONDITIONS REQUIRING SPECIAL PRECAUTIONS:

1. Fire and Safety

   (a) There are areas where explosions may occur. Pumps with explosion-proof motors or other equipment are needed for survey work in these areas.

   (b) [illegible]rveyor shall practice good safety techniques and [illegible] all safety rules whenever collecting samples.

2. Heal[illegible]

   (a) The surveyor collecting samples in an area of high dust concentration should provide his own respiratory protective equipment which he will wear at all times in the area.

   (b) The surveyor is expected to comply with any posted radiation signs and time limits or other pertinent Health & Safety Division recommendations in the area he is sampling.

[redacted]

Dep't heads

CENTRAL FILES

2154290

NATIONAL LEAD COMPANY
OF OHIO

April 5, 1963

SUBJECT: CHANGES IN TERMINOLOGY, ABSORPTION FACTOR AND AIRBORNE ALPHA ACTIVITY LIMIT

TO: J. H. Noyes

FROM: J. A. Quigley, M.D.

As was approved by M. S. Nelson on March 28, changes have been made in 1) terminology pertaining to radiation dose and air and waterborne concentrations, 2) absorption factor used in counting air dust samples and 3) levels previously called MAC but now called NCG.

The terminology relative to levels of external radiation is being changed from "Maximum Permissible Dose (MPD)" to "Radiation Protection Guide (RPG)." This change is in compliance with the recommendation made by the Federal Radiation Council (FRC)[1] for the use of Federal Agencies. The FRC defines the RPG as "the radiation dose which should not be exceeded without careful consideration of the reasons for doing so; every effort should be made to encourage the maintenance of radiation doses as far below this guide as practicable." The numbers quoted for external radiation exposure are in accord with our present limits.

The terminology relative to concentrations of radioactive contaminants in air and in liquids is also being changed from "Maximum Allowable Concentration (MAC)" and "Maximum Permissible Concentration (MPC)" respectively to "National Lead Company of Ohio Concentration Guide (NCG)" for both. We do not propose adoption of the FRC term "Radioactivity Concentration Guide (RCG)" due to their very specific definition: "This term is defined as the concentration of radioactivity in the environment which is determined to result in whole body or organ doses equal to the Radiation Protection Guide."

In general, the reason for these changes in terminology is to avoid the erroneous connotation that is placed on our old terminology. The use of the word "maximum," in the above sense, is interpreted by many to imply that a level that exceeds this point by any amount for any period of

[1] Federal Register - Page 4402 dated 5/18/60.

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time is harmful - that there is some magic line between "safe" and "sorry." This is definitely not the case in these applications. The new terms should correct the error in interpretation; however, it will probably require some time for people to become accustomed to them.

Work carried out by Bio-assay Laboratory personnel on air dust samples collected at NLO operations demonstrate the need to change the absorption factor used in the calculation of alpha air dust levels. Extensive investigation indicates the absorption loss to be 50% rather than the 30% that has been used since the start-up of the FMPC. This change will cause an increase of 40% in the calculated levels of alpha activity for air dust levels.

Finally, NCG for airborne alpha activity is being changed from 70 alpha disintegrations per minute per cubic meter of air (70 α-d/m/M^3) to 100 α-d/m/M^3. This change will almost exactly compensate for the absorption factor change and is still well below the "special curie" number of approximately 270 α-d/m/M^3 as outlined by the FRC.

In summary, the proposed changes are:

(1) Change MPD to RPG.
(2) Change MAC and MPC to NCG.
(3) Change the absorption factor from 0.7 to 0.5.
(4) Change the NCG from 70 α-d/m/M^3 to 100 α-d/m/M^3.

These changes are being made retroactive to January 1, 1963.

J. A. Quigley
J. A. Quigley, M.D.

RHS/mjs

cc: G. W. Wunder
J. H. Noyes - 1x
All Division Directors

0188551

Copy given to D. Weichel 8/28

AUG 28 1986
WMCO
QUALITY ASSURANCE

TESTIMONY OF DANIEL J. ARTHUR

Before

THE SUBCOMMITTEE ON

ENERGY, CONSERVATION & POWER

August 12, 1986

[redacted]

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STATEMENT OF DANIEL J. ARTHUR

1. My name is Daniel J. Arthur and I would like to thank the Subcommittee for the opportunity to testify today. I understand that I am limited in my time for testimony, and unfortunately, my story is very long. I would like to submit for the record my affidavit and supporting exhibits so that the record is complete.

2. I intend to detail my experiences while I was a Methods Analyst/Lead Auditor at the Department of Energy's Feed Materials Production Center located near Fernald, Ohio. I am dismayed and outraged at how the United States government allowed this uranium reprocessing facility, so vital to our nation's defense, to degrade into a major polluter that is threatening the lives and well-being of Fernald's workers and neighbors. I hope to persuade the government to recognize not only the immensity of the problems facing Fernald, but their root causes as well. In short, it is my belief that the U.S. Department of Energy has placed production over environmental and health and safety concerns, and in so doing has needlessly jeopardized human lives. The U.S. government has created a toxic and radioactive hazard whose legacy will be felt in health and economic impacts far into the future. I hope to contribute to an understanding of why and how this situation has come to be, and I look to Congress to rectify this mess.

3. When I first reported to work at Fernald in May, 1984, I observed several serious problems. The facility was antiquated and in poor condition. The building in which I worked, the Laboratory Building, was contaminated with uranium dust from personnel tracking it into and throughout the building. Contaminated shoes and clothing were strung throughout the corridors and even placed on benches that were used for coffee breaks. A layer of radioactive dust also covered the cabinets, shelves, and horizontal surfaces throughout the building.

4. In the operation buildings, I found layers of uranium dust; magnesium fluoride, green salt, orange oxide and uranium saw chips covered the floors to a level of one-quarter inch thick. At times, the air was so full of uranium dust I had trouble breathing, and afterwards, I got a sore throat. Respirators and masks were not being worn by personnel.

5. But the main problem I encountered from Day One was in the Quality Assurance Department where I worked. The Quality Assurance function at these DOE plants is particularly important, since DOE contractors are essentially self-regulated. The quality assurance function is supposed to identify problems and assure that corrective actions are taken. Quality Assurance also plays a significant role in preventing future accidents by analyzing root causes of problems.

6. In Fernald's Quality Assurance Department, I discovered that there was no comprehensive audit program in place. I found that the department was understaffed; only three audit department personnel had responsibility for performing literally hundreds of audits, updating and revising procedures, and performing a variety of other functions. The audit department had no independence from, and in fact took orders from, production; under NLO, in particular, the Quality Assurance Department was at the bottom of the organizational chart. I was not allowed to pursue audits in certain critical areas of plant operations. On some of the audits that I performed, I was not allowed to undertake follow-ups, or I was restricted to looking at a limited area of plant operations.

7. I stated that from the beginning I was uncomfortable with the audit arrangement. Occasionally, I would perform an audit on my own which resulted in complaints from production, and in turn pressure from Mr. Tippenhauer, the head of the department, to alter, or even stop the audit entirely.

8. The bulk of my responsibilities within the first year involved audits of procedures. Procedures are like recipes for a cook. They tell the chef the steps to take to arrive at the perfect souffle. At Fernald, the chefs often cooked by memory or used faulty and incomplete recipes. This often resulted in lots of black smoke from the kitchen.

9. Despite the importance of the procedures, I consistently found that the procedure being audited was often non-existent, out-of-date, inadequate, ignored, or inaccurate. Complicating the situation was the fact that management was slow to respond. Management ignored key items for correction, and failed to implement corrective action when promised. For example, in an audit of the solid waste incinerator at Fernald in the summer of 1985, I discovered that materials contaminated with radioactive materials were being burned. Fernald does not have a license for that. Radiation could conceivably go up the stacks and into the atmosphere. Management would never know whether or not this occurred since ther are no radiation monitors on the stack. Management promised to correct the situation, but when I followed up to check the corrective actions, I found that they had not corrected the situation. I read in the newspaper that the Ohio EPA shut down the solid waste incinerator in May of this year because radioactive ash was found in the incinerator. Apparently, Fernald management had still not implemented the corrective actions. This uncaring, unprofessional attitude and practice of management continued. Massive health and safety problems uncovered during the course of many audits went unresolved.

10. Finally, follow-up audits revealed that several, sometimes none, of the corrective actions promised had been implemented. This problem was so pervasive that I wondered why I was wasting my time doing the audits at all.

11. The implications of this disarray became immediately evident in the very building where I worked. The uranium dust in the Laboratory Building was unusually thick, and I asked why such conditions were tolerated. I was informed that there was only one dust collector and that it was in the basement. A dust collector is supposed to clean the air in the building, and filter out the excess radioactive dust. I went to the basement and took a look at the dust collector, and then asked who was responsible for changing the bag on this particular collector. Nobody knew. So I asked where the procedures were for changing the collector's filter bag. I discovered that there were no procedures. The bag, as far as I could determine, had never, in the life of the plant, been replaced. Months went by, and finally, in June 1985, I insisted that the bag be replaced, which it was. Mr. Graver, Mr. Fallings and I witnessed the removal of the old bag which literally fell apart as it was removed. Uranium dust had not only been building up in the Lab Building for years, but dust was bypassing the bag and going straight up the stack. Again, there was no radiation monitor on this stack, either. Upon further inquiry, I discovered that many of the dust collectors in the production plants lacked procedures, notably the portable dust collectors.

12. Recordkeeping in the area of DOE Orders was also literally a joke. DOE "regulates" its plants through directives in the form of Orders. A DOE Order is supposed to set the requirements for the total operation and maintenance in the areas of worker protection, environmental, health and safety, reporting of accidents, and in almost every area of operation. I discovered just how seriously Fernald management viewed the DOE Order system in January, 1986, after Westinghouse took over operations at Fernald.

13. I was ordered by Mr. Grumski to get the DOE Orders out, as the Orders would be needed in performing investigations. I searched for hours but could not locate the Orders. I finally found them in the Legal Department. I discovered that the Orders were literally heaped on a shelf, in total disarray. The binders that held the Orders were not in any order, and many labels that titled the binders were on the floor. Many Orders were missing, some were not filed, and some were also on the floor. I discovered that the Legal Department had not kept up the files for over <u>five</u> years. I reported the problem to Westinghouse, but at the time of my departure, nothing had yet been done.

14. When Westinghouse took over operations at Fernald on January 1, 1986, organizational changes occurred site-wide. The Westinghouse line was, "Forget what has gone on in the past. It's a whole new ball game." I first realized the meaning of this when on January 6 I was told by Mr. Grumski, the Westinghouse Quality Assurance/Quality Control Manager not to perform any more audits, because there was "nothing to audit on a QA basis." What was meant was that there was no Quality Assurance program onsite to date. However, I felt that they should at least follow up on previous audit responses. My immediate supervisor told me and a co-worker to write an audit evaluation of each previous audit over the last year (1985) and identify outstanding deficiencies. I was told that these evaluations would be presented at the January monthly QA meeting. This was not done. Nor were they presented in February or March. Yet there were many outstanding deficiencies that needed immediate correction.

15. I expected better communications and attitudes to improve throughout the site with Westinghouse, and to some extent it was better. Westinghouse promised that Quality Assurance would be a high priority. But, when push came to shove, Production had total control. I concluded that Westinghouse was adept at saying the right things, but when it counted, it was "business as usual."

16. My first actual insight into how things were to be under Westinghouse came with my first major assignment -- investigation of the shipment of radioactive materials in vessels called "T-Hoppers." A T-hopper is a transportation vessel used to transport radioactive materials. I was to investigate the overall operation of transporting T-hopper vessels.

17. It is important to explain the background behind this incident. A shipment of an externally contaminated T-hopper from Fernald to the DOE's Hanford Washington facility in July of last year sparked a DOE investigation which heavily criticized Fernald for lack of procedures, training, quality assurance and more. I would like to submit the DOE Investigation Report for the record.

18. On January 14, 1986, DOE sent the DOE Investigation Report to Westinghouse management, and instructed them to comply with the Report's recommendations within a month. On January 28, 1986, Westinghouse responded to DOE with a letter that the guaranteed that Westinghouse was in compliance with the DOE mandate.

19. On January 31, 1986 Mr. Grumski approached me and assigned me the task of evaluating the "Action Plan" developed by NLO in response to the DOE report, as well as the Transportation Department's compliance with the Plan. The Action Plan guaranteed to DOE that corrections had been made and that the mistake of shipping contaminated and leaking T-hoppers would not be repeated in the future.

20. On February 7, 1986, I submitted my investigation report to Mr. Grumski personally. He was impressed enough with the report that he came into my office that same day and congratulated me on what he called one of the best audits to come out of Fernald. My investigation, performed seven months after the July T-Hopper incident, revealed fourteen areas that were deficient. On February 18, the Hanford facility again received another contaminated T-Hopper from Fernald. Lessons were not being learned.

21. Immediately following this incident, I was assigned what was to be my last project at Fernald. For me, it was the final straw which led to my resignation and convinced me that I had to come forward to expose the intolerable situation there.

22. The assignment was to develop procedures for processing "plutonium out of specification". The assignment was initiated because Fernald had received a shipment of plutonium-contaminated ash in 1980, and had processed a portion of that plutonium-bearing material in a manner which jeopardized the workers' health and safety. A September, 1985 DOE investigation of Fernald's handling of the plutonium-bearing material in the past was highly critical, and serves as background information for this incident. I would like to submit that report for the record.

23. Plutonium-bearing materials containing more than 10 parts per billion (PPB) require special handling, including the use of protective equipment, respirators, constant air monitoring, routine worker exposure analysis and strict adherence to quality assurance/quality control procedures. In 1982, Fernald had processed plutonium-bearing materials of up to 7,757 parts per billion without observing any safeguards. The September 1985 DOE investigation was highly critical of this practice.

24. Against this background, Westinghouse was planning to process more of this material in response to pressure from Production.

25. On February 7, 1986, I was assigned to develop procedures for the plutonium program. The assignment was to upgrade procedures. At a meeting on February 10, 1986, Mr. Weichold and I were told to write two new procedures and revise six others. Health and Safety was given the responsibility of writing a special procedure that would include information on all health and safety aspects of the operations. I stated at the time that other procedures were involved. I was told by Mr. Macaulay, Westinghouse Operations Training Manager, to stick with the eight. Two days later, February 12, management decided to add four more procedures.

26. Management gave eight calendar days to complete the procedures, and added six calendar days to complete development and implementation of training, roping off areas, procurement of disposable clothing, cleaning, and more. Management gave us a total of 14 days to complete the project. That was far too little time. I felt that at least two months were required due to the magnitude of the project, and I said as much. Despite this, Mr. Weichold and I were the only ones assigned to write and revise procedures.

27. On February 11, Mr. Weichold informed me that he would not be working on the project, and gave me the full responsibility for completing the assignment. This change definitely made it impossible to meet the deadline for the project. I had already pointed out in the earlier meeting that I believed that everyone was "unduly overly optimistic" concerning the preparation time given to process the plutonium. The unanimous response at that time was "No, we can do it." As Mr. Macaulay said, "I think you guys can get the job done."

28. The next meeting was held on February 14, 1986. At this meeting Mr. Macaulay wanted the procedures signed off. I stated that the procedures were inadequate, especially the Health and Safety Procedure. I then told him that all procedures would have to be sent around again for review. They reluctantly agreed to one more review. I also pointed out that maintenance personnel would have to be trained. No one had even thought of that. This was an amazing oversight since the head of the plutonium program was also the head of the training program.

29. Finally, a meeting was held on February 20, 1986. Mr. Macaulay wanted the procedures signed off the next day. Again I stated that the Health & Safety Procedure would be inadequate to cover all operations in a safe manner that would protect worker health and safety. This statement received no reply. I then stated that I would not sign off on the procedures as they were written, and walked out of the meeting. Worker health and safety is important to me, as a worker, and I was helplessly watching Westinghouse try to rush through procedures that would not do the job.

30. On February 21, 1986, I realized that I was expected to sign off on procedures that I considered terribly inadequate. Rather than risk being placed in this position, I submitted my application for a promotion and transfer to another department. This was blocked by my supervisors.

31. At this point, I became sick on Thursday, February 27, and called Mr. Weichold to say that I was going to a doctor for tests. I told him that I would be absent for two days. On Monday, March 3, I called Mr. Weichold to say that I was to be tested that day and would not be in. I returned to work on Tuesday, March 4, and was accused by my supervisors of not calling in, which was simply untrue.

32. Later that day my supervisors called me to a meeting to discuss my overtime. I told them that I could handle only five to eight hours a week because I was not feeling well. I was told by them that that was not enough to get the plutonium project completed. At that time Mr. Grumski accused me of not putting out the effort needed to complete the procedures. I responded: "In the last four weeks I have worked 49 hours of overtime to complete the T-Hopper investigation and work on POOS procedures." The meeting then ended.

33. I was ill again on March 6 and 7 (Thursday and Friday) and I called Mr. Weichold to say that I was too sick to come in, that I was on medication, and that I would probably not be in on Friday. I returned to work Monday, March 10, and on Wednesday, March 12, I was given a letter from Mr. Grumski. The letter was a reprimand that questioned my commitment to the plutonium program and put the future of my career with the company in doubt. I realized at this point that Westinghouse was beginning to build a paper trail in preparation for firing me. The time sheets provided by the company were not entirely accurate. They left out certain periods of overtime and put in a period that they claimed was not included. I was outraged.

34. The next day, Thursday, March 13, 1986, after seeing my physician during a scheduled appointment, I was admitted to the University Hospital for tests. My physician suspected that a tumor was causing the problems. I was released from the hospital Sunday, March 16, 1986, after an extensive series of tests. The doctors concluded that I was worn out from anxiety, stress, and fatigue. At that point, I decided that my health and the health of my fellow workers was more important than helping Westinghouse ram through a possibly dangerous program, and I resigned.

35. I felt as if a great pressure had been lifted from me. I resolved to do something about what I had seen.. It was clear to me that it was going to be business as usual at Fernald, and that the change of contractors was purely a cosmetic move. Production concerns were going to continue to take precedence over environmental, health and safety concerns.

36. While Westinghouse's assertion that it "was a whole new ball game" at Fernald may be true, it was the same umpires calling the shots - - DOE, the Department of Energy.

37. Over the two years that I worked at Fernald, no one with the audit department and QA department except the QA Manager, Mr. Tippenhauer, ever saw or met with a DOE representative. To my knowledge, a DOE representative never audited our procedures, or set foot in our office, even though our department was in charge of upkeep of all procedures. DOE had a very low profile at Fernald.

38. I never saw any DOE personnel, except at the T-Hopper meeting, and they did not come in to look at the audits. To my knowledge, the audits that I performed did not make it to DOE. As the lead auditor, I would have expected some communication from the owner of the facility.

39. In conclusion, I can hardly blame a corporation like Westinghouse for attempting to maximize production. I understand that their award fee depends upon keeping up their end. It is DOE, the regulator, which is supposed to oversee these contractors and assure that the worker's health and safety and the environment is protected. Instead, DOE itself has a built-in conflict. It too is responsible for maintaining production goals. When the inevitable clash between maintaining production and protecting human safety occurs, it is clear that production, at least at Fernald, has won out. The quality assurance program at Fernald is in itself a mini-model of the whole system of nuclear weapons production. Quality concerns that serve the function of protecting human health and safety are controlled by a management that has to worry about the ledger sheet. The entire quality assurance system is simply advisory --it has no real power, no real independence.

40. Without an effective regulatory system, Fernald will remain a quagmire of environmental poisons. I hope and pray that this committee, the U.S. Congress and the public put a stop to DOE's neglect and incompetence. Failure to act will allow the Fernald slow-motion bomb to continue its shower of deadly fallout on the Cincinnati community and the Fernald workforce.

Thank you.

AFFIDAVIT OF DANIEL J. ARTHUR

My name is Daniel J. Arthur and I am submitting this affidavit freely and voluntarily to Tom Carpenter of the Government Accountability Project. I am 34 years old, and currently reside in Cincinnati, Ohio. I am submitting this sworn statement to detail my experiences while I was a Methods Analyst/Lead Auditor at the Department of Energy's Feed Materials Production Center (hereinafter, "Fernald") located near Fernald, Ohio. Through this statement, I hope to express my feelings of disgust and outrage at how the United States government allowed this uranium reprocessing facility, so vital to our nation's defense, to degrade into a major polluter that is threatening the lives and well-being of Fernald's workers and neighbors. Through this statement, I hope to persuade the government to recognize not only the immensity of the problems facing Fernald, but their root causes as well. In short, it is my belief that the U.S. Department of Energy has placed production over environmental and health and safety concerns, and in so doing has needlessly jeopardized human lives. The U.S. government has created a toxic and radioactive hazard whose legacy will be felt in health and economic impacts far into the future. I hope to contribute to an understanding of why and how this situation has come to be, and I look to Congress to rectify this mess.

PERSONAL BACKGROUND

I am originally from Iowa, and I graduated from high school there in 1970, and entered directly into military service with the Army. I was stationed at Ft. Lewis, Washington, for basic training, and received advanced individual training as an electronics technician at Ft. Monmouth, New Jersey. In 1972 I was granted a top secret clearance and worked as a communications technician on cypher equipment at the backup for the Pentagon, Ft. Ritchie, Maryland. In November 1972 I was sent to Korea where I performed essentially the same functions in the communications area. In June 1973 I received a letter of appreciation stating ". . . Your technical expertise and professionalism, coupled with your willingness to work long hours have evoked many favorable comments from NCO's and Commanders alike. . . ." I left Korea and the service three months early to attend Iowa Central College, where I completed a two-year program with an Associated Arts degree in 1976. Upon graduation, I enrolled in the University of Northern Iowa, and earned my B.A. in economics in 1978.

From 1981 to 1983, I was Quality Control Unit Manager with Control Data Corporation in Minnesota where my job responsiblities included supervising 15 electronic technicians, determining test goals and the yearly budget, and initiating and revising Standard Operating Procedures and Manufacturing Specifications. Previous to that, I was Production Control Supervisor at Nortronics Company, Inc., where I established short and long term production goals and schedules, programmed