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Department of Energy

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JUN 10 1998

DOE-0872-98

Mr. Tom Schneider, Stakeholder
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Schneider:

DRAFT FINAL AUTHORIZED LIMITS DOCUMENT FOR FERNALD COPPER INGOTS

Thank you for your comments on the draft *Authorized Limits Document for Fernald Copper Ingots*. During the past year, the Department of Energy (DOE) has been working on this project to develop authorized limits for release of about 59 metric tons (130,000 pounds) of copper ingots that contain slight amounts of residual radioactivity. Approval of authorized limits is contingent on analyses demonstrating that release will not result in any significant impacts to human health or the environment and that all exposures are maintained As Low as Reasonably Achievable (ALARA). Throughout the process, DOE has involved stakeholders to ensure decisions reflect public concerns and input.

The enclosed "Response to Comments Document" is being provided for your review. It summarizes stakeholder comments on the project and the DOE's approach to addressing the comments in the final Authorized Limits Document. While the comments are not anticipated to result in a significant change in the outcome of the analysis, they all serve to improve the quality of the document.

DOE is requesting that any additional input on the "Response to Comments Document" be provided to Gary Stegner, DOE Public Information Director, by June 22, 1998. DOE plans to issue the final Authorized Limits Document following the completion of verification sampling and analysis and incorporation of the verification data into the Authorized Limits Document.

Recycled and Recyclable

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If you have any additional questions or comments on the copper ingot project, please contact Gary Stegner at (513) 648-3153.

Sincerely,

Johnny Reising

FEMP:Yerace

Johnny W. Reising
Associate Director
Environmental Management

Enclosure: As Stated

cc w/enc:

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Authorized Limits for Fernald Copper Ingots

Response to Comments Document

May 29, 1998

Prepared for:

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and

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1.0 Introduction

Stakeholder coordination is an important part of the process for developing authorized limits for release of non-real property containing residual radioactive materials. DOE guidance[1] directs that input be solicited from both institutional stakeholders (e.g., state and federal EPA, state Department of Health, US Nuclear Regulatory Commission) as well as public stakeholders. Stakeholder input provides an opportunity for review of the process by individuals from a variety of technical backgrounds and experiences. Institutional stakeholders are typically concerned that DOE implements a sound technical approach for controlling release to minimize any public exposures or environmental impacts. Public comments often reflect public sentiment and societal values relative to the proposed release. In addition, public stakeholders committed to meaningful participation in the process provide another source for valuable technical input based on their often-diverse real-world experiences.

DOE has embraced stakeholder input throughout the process of developing authorized limits for 59 metric tons of copper ingots currently stored at the Fernald site. The DOE Ohio Field Office coordinated the project with the DOE Fernald Site acting as project lead. Argonne National Laboratory and Trinity Environmental Systems provided technical support. DOE Headquarters provided guidance on implementation of the project, primarily from the Office of Environment and Safety (EH).

Initial technical analyses on the project were completed in the spring of 1997. DOE introduced the copper project at a public meeting held in July 1997 and responded to stakeholder questions regarding Fernald material release programs. During the fall of 1997, the project was shared with representatives from Ohio EPA, US EPA Region V, the Ohio Department of Health and the Nuclear Regulatory Commission Region III. Stakeholder coordination culminated in December 1997 with a final presentation of the project for stakeholder comment. Following the public meeting, DOE followed up with both institutional and public stakeholders to respond to comments or input on the process.

This document summarizes responses to stakeholder comments received through the stakeholder coordination process. Several of the comments identified specific elements of the analysis that could be refined to provide a more defensible package. Other comments reflected either individual or general stakeholder sentiment on the proposed release. While none of the comments resulted in a significant change in the outcome of the analysis, they generally served to improve the quality of the final product. Thoughtful consideration of stakeholder input supports the DOE objective to maintain an open decision-making process that is responsive to stakeholder concerns.

[1] DOE Handbook for Controlling Release for Reuse of Recycle of Non-Real Property Containing Residual Radioactive Material, 1997.

2.0 Index of Comments

Table 1 provides an index to the comments received from the USEPA Region V (USEPA), the Ohio EPA and Ohio Department of Health (Ohio), and local public stakeholders (public). In cases where more than one commenter raised essentially the same issue, the comments are addressed together with a single response. The detailed response to comments is provided in the sections that follow. These comments are being incorporated into the Authorized Limits Document or into implementing documents (e.g., the sampling and analysis plan) as appropriate.

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Table 1
Summary Index of Stakeholder Comments

COMMENT NUMBER	AREA OF CONCERN	COMMENTER(S)
Dose Assessment Code and Input Parameters		
1	Release status and peer review of RESRAD-RECYCLE computer code	USEPA (GC #3), OEPA (#6)
2	Basis for selecting the partitioning coefficient for technetium-99 in copper	Public
3	Need for additional studies to refine partitioning coefficients	OEPA (#3)
4	Inhalation and ingestion rates used as input parameters in the RESRAD-RECYCLE code	USEPA (GC #3)
5	Dose assessment assumptions used in modeling exposures to the slag worker	USEPA (GC #4)
6	Population of people potentially exposed to the estimated collective dose	Public
7	Amount of copper present in each of the end-use products modeled	USEPA (SC #3)
8	Mass of copper to which workers are exposed in individual steps of the dose assessment	USEPA (SC #4)
9	Dust loading parameter appears to be misstated as g/cm^3 where it probably should be g/m^3	USEPA (SC #5)
Characterization of Copper Ingots		
10	Statistical treatment of production data to derive input numbers for the dose assessment	OEPA (#7), Public
11	The activity distribution (^{234}U, ^{235}U and ^{238}U) used as input to the dose assessment	Public
12	Presence of ^{236}U in uranium from reactor site recycle materials	USEPA (SC #2), Public
13	Background levels of uranium that exist in commercially available copper	OEPA (#4)
14	Sampling and analysis required to verify compliance with authorized limits prior to release	OEPA (#9)
15	Nomenclature used for the "less than 20 ppb" results for ^{99}Tc	Public
Waste Management Issues		
16	Authorized limits compared to Fernald on-site disposal facility waste acceptance criteria	OEPA (#5)
17	Regulatory status of slag produced at a refinery processing the copper ingots	USEPA (GC #2)
Basis of Cost Estimate for Implementing Release		
18	Detailed basis of cost estimate for preparing copper ingots for release	USEPA (SC #6), Public
19	Monitoring rate (ft^2/hr) assumed for a radiation technician	USEPA (SC #7)
Miscellaneous Issues		
20	Authorized limits expressed as maximum or average radionuclide concentrations	USEPA (SC #1)
21	Conversion of dose to increased cancer risk	OEPA (#2), Public
22	Measurement and reporting of surface dose rates prior to release	OEPA (#7)
23	Further consideration of restricted reuse alternatives for copper ingots	USEPA (GC #1)
24	Reference documentation requested by stakeholders	OEPA (#1), Public

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3.0 Response to Stakeholder Questions and Comments

Stakeholder comments have been grouped into five general areas for response:

- Dose assessment code and input parameters
- Characterization of Fernald copper ingots
- Waste management issues
- Basis of cost estimate for implementing release
- Miscellaneous issues

Each comment is presented in italics with the commenter(s) identified. The response to the comment follows immediately after the comment in regular font.

3.1 Dose Assessment Code and Input Parameters

1. Release status of RESRAD-RECYCLE computer code.

Comment: *Several commenters questioned the use of the RESRAD-RECYCLE computer code since it is currently available for use as "beta" version software. [Commenters: USEPA and OEPA].*

Response: The RESRAD-RECYCLE computer code is a pathway analysis tool developed by DOE and designed to calculate potential radiation doses resulting from recycling radioactive scrap metal. The code is currently released in a "beta" version for test users to comment on the user interface. The code utilizes the same basic core code used in other computer models in the RESRAD family of code. As code developer, Argonne National Laboratory is qualified to use the RESRAD-RECYCLE code on dose assessment projects, subjecting results to an internal quality assurance review process. Argonne National Laboratory is coordinating with individual stakeholders interested in obtaining more information on RESRAD-RECYCLE and the RESRAD family of dose assessment code.

2. Basis for selecting the partitioning coefficient for ^{99}Tc in copper.

Comment: *One commenter requested justification for selection of the partitioning coefficient selected for ^{99}Tc in the copper. [Commenter: Individual member of the public].*

Response: In the copper melt, ^{99}Tc was modeled to partition 10% to the metal phase, 100% to the slag phase and 0.1% to the baghouse dust. These partition coefficients were based on a reference study specifically focusing on copper and aluminum recycling.[2] Under most dose assessment models, the slag worker received the highest individual doses attributable to ^{99}Tc. Since the slag worker represents the limiting dose for ^{99}Tc exposures, the assumption used in the modeling for the Fernald copper ingots should provide the most conservative estimate of risk to the MEI.

[2] Radiological Protection Criteria for the Recycling of Materials from the Dismantling of Nuclear Installations, Part 2: Recycling of Copper and Aluminium, Draft 1994.

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The stakeholder pointed out that, for ferrous metals, dose assessments generally assume that ^{99}Tc partitions 100% to the metal phase and 100% to the slag phase. Even if the partitioning coefficients for ferrous metal melts were applicable, making this change in the modeling would not be expected to significantly impact on the modeled exposures. First, the dose contribution to ^{99}Tc is low compared to the uranium dose contribution. Second, the modeling completed already assigned the most conservative value (100% partition) to the most critical pathway (partitioning to slag). In the final Authorized Limits Document, a sensitivity analysis will be included to evaluate the impact of varying the ^{99}Tc partitioning coefficient on individual and collective doses.

3. Need for additional studies to refine partitioning coefficients.

Comment: *One commenter suggested that DOE should sponsor a study to collect more data on partitioning coefficients for radionuclides in copper. [Commenter: OEPA].*

Response: Partitioning coefficients were used to estimate how much of a particular component in the scrap metal feed to the melting process ends up in the metal, slag and dust streams that result from the process. Conservative estimates of partitioning coefficients were used in the pathway analysis to model dose associated with release of the Fernald copper ingots. For example, 100% of the uranium was modeled as partitioning into both the slag phase and the metal phase during melt refining operations. This conservatism artificially doubles the amount of radioactive material released and overestimates collective dose. It may, or may not, also tend to overestimate the dose received by the MEI.

DOE recognizes that additional information on how individual radionuclides partition under specific processing conditions will ultimately provide more accurate estimates of dose when metals containing residual radioactive materials are released under authorized limits. The Ohio Field Office is working with the National Metal Recycle Program at Oak Ridge to identify areas where additional data may be collected to support metals release programs. DOE may need to sponsor studies to support larger scale initiatives to release metals containing residual radioactive materials (e.g., metal released from D&D of the gaseous diffusion plants). Until these additional studies are determined to be necessary and are properly scoped, funded and implemented, however, DOE believes that the responsible approach is to proceed with recycling initiatives using conservative partitioning factors that are protective and tend to overestimate potential doses.

4. Inhalation and ingestion rates used as input parameters in RESRAD-RECYCLE code.

Comment: *One commenter noted that the inhalation and ingestion rates that were used in the RESRAD-RECYCLE code were not provided in the text. [Commenter: USEPA].*

Response: The complete data report generated from the RESRAD-RECYCLE computer run, including specification of basic assumptions including inhalation and ingestion rates, will be included as an appendix to the Authorized Limits Document. The text of the Authorized Limits Document will discuss important parameters used in the code. The inhalation rate used for the dose assessment was 1.2 m^3/hr and the ingestion rate used was 6.25×10^{-3} g/hr.

5. Dose assessment assumptions used in modeling exposures to the slag worker

Comment: *One commenter questioned the results of the dose assessment especially as related to slag worker exposures. The commenter accurately completed a short-hand dose estimate using the information provided in Tables 8 and 9 of the Authorized Limits Document to arrive at a dose to the slag worker of 3.5 mrem from the inhalation pathway alone. [Commenter: USEPA].*

Response: The work completed by the commenter was accurate given the information used in the calculation. However, the Authorized Limits Document failed to report the inhalation rate used and, more significantly, contained an error in Table 9 in the input data used in the dose assessment. First, the dose assessment used an inhalation rate of 1.2 m^3/hr as opposed to the 2.5 m^3/hr used by the commenter.

Second, mass of the slag listed in Table 9 incorrectly reported the mass of the copper contained in the slag and not the entire mass of the slag. Copper of similar purity as the Fernald copper ingots would be melted in a refining furnace at a copper refinery generating a small amount of dross with relatively high copper content. This dross would be recycled directly to the smelter furnace (e.g., scrap blast furnace) where it is added with low copper content scrap feed and be smelted to produce "black copper". Black copper is in turn further refined in a converter furnace and copper from the converter furnace refined in a refining furnace. Slag from the converter furnace and dross from the refining furnace are both recycled to the smelter. Slag resulting from the overall melt-refining process generally contains one to two percent copper. The overall mass of one to two percent copper slag that contains 660 kg of copper is 33,000 to 66,000 kg. The activity concentration of the dust inhaled by the slag worker thus must be reduced accordingly. In the initial dose assessment the dose attributable to inhalation was reduced by a factor of 100 to account for the activity concentration associated with the slag dust that is inhaled. To remain consistent with conservative assumptions made throughout the process, a more conservative factor of 50 should be selected resulting in a doubling of the inhalation exposure to the slag worker.

As with the inhalation pathway, the dose associated with the ingestion exposure pathway should also be reduced to accurately model the ambient dust and particulates likely to be ingested by a slag worker. The direct exposure pathway remains conservative by assuming that all of the contamination is contained in the 660 kg mass of copper.

6. Population of people potentially exposed to the estimated collective dose.

Comment: *One commenter pointed out that the Authorized Limits Document did not summarize in the text the total number of individuals in the population potentially exposed during recycle, manufacturing and use of copper products. [Commenter: Individual member of public].*

Response: The number of people in the population potentially exposed to receive the estimated collective dose was not explicitly summarized in the Authorized Limits Document. The total collective dose was 0.008 person-rem total effective dose equivalent (TEDE). The population potentially exposed consisted of 226,028 individuals receiving exposure under either the worker

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scenarios (58 individuals receiving 2.9 x 10^{-5} person-rem) or end-use product scenarios (225,970 individuals receiving 0.008 person-rem).

7. Amount of copper present in each of the end use products.

Comment: *One commenter noted that some of the end-use products are made from alloys that include the copper and questioned whether the activity associated with the product was determined using the entire mass of the product or accounting only for the activity associated with the copper content in the product. The commenter noted the flatware and trumpet as specific examples. [Commenter: USEPA].*

Response: The activity associated with sterling silver (flatware) and the brass products (i.e., trumpet and plumbing hardware) were not reduced to account only for the copper portion of the alloy (7.5% Cu for sterling silver; ~65% copper for yellow brass). The entire mass products and the geometry of the products were parameters used in completing the dose assessment. To provide a more realistic estimate of dose associated with these products, the activity should be reduced in each of the products in proportion to the copper content. This is projected to result in a reduction of dose to the MEI associated with the sterling silver of over 90% and a reduction in dose to the MEI from brass products of about one-third. The population dose for each should remain about the same.

8. Mass of copper to which workers are exposed in individual steps of the dose assessment.

Comment: *One commenter noted that the mass of copper that workers were exposed to in different scenarios (steps) of copper handling were different and should be either standardized or explained. In addition, the commenter felt that the selection of intermediate forms did not account for all of the end-use products, noting that some products, such as musical instruments, involve significant handwork in fitting parts together. [Commenter: USEPA].*

Response: Workers are exposed to different masses under different scenarios because the intermediate product that they are modeled to be handling (e.g., copper coil or copper sheet) are different sizes. The number of workers involved in each scenario and the number of hours worked contribute to give an overall picture how long each individual piece may be handled by a worker. Worker exposures for final assembly and wholesale and retail handling of finished products were not estimated in the dose assessment. These exposures will generally be far less than the exposures received during the intimate and extended contact by end-users of the products and thus were deemed insignificant.

9. Dust loading parameter shown as g/cm^3 where it probably should be g/m^3.

Comment: *One commenter pointed out that the units on the dust loading parameter were misstated as g/cm^3 where it probably should have been g/m^3. [Commenter: USEPA].*

Response: This correction will be made in the final revision of the Authorized Limits Document.

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3.2 Characterization of Fernald Copper Ingots

10. Statistical treatment of data to derive input numbers for the dose assessment.

Comment: *Several commenters requested additional information on, and justification for, the statistical approach used to treat the sampling data for the copper ingots in order to arrive at input numbers to conduct the dose assessment. [Commenters: OEPA and an individual member of public].*

Response: During production 100% of all ingots were sampled to determine chemical and radiological characteristics (498 ingots). Samples were initially collected by casting an egg in the bottom of the mold and then removing the egg from the cast ingot to collect a sample. Later, samples were collected from the saw cuttings that were generated during the top cropping of each ingot. Top cropping was used to remove the rough upper surface of the ingot where any contaminants were prone to migrate along with any remaining slag as the ingot cooled. There were no notable differences in uranium levels from samples collected from the cast eggs and samples collected from saw cuttings.

Data points associated with copper ingots released to Hanford were removed from the data set using lot marking information and ingot identifications contained in the Miscellaneous Shipping Orders to identify ingots that were shipped. A total of 215 ingots were identified and removed from the population leaving a total of 283 ingots remaining in the data set. Of the remaining 283 ingots, all but four contained between zero and four parts per million of uranium, demonstrating a fairly tight distribution.

Statistical analysis on data for the remaining ingots was performed to provide estimates of the mean uranium concentration and enrichment. The dose assessment is concerned with the radioactive source term associated with the population of copper being released. Estimates of the mean uranium concentrations provide the best estimate of source term associated with release of the copper ingots. For sample sizes of greater than 30, regardless of the shape of most populations, the Central Limit Theorem guarantees good results using parametric statistics. Using the Student t-test, a 95% confidence limit (one-tail test) was calculated for the mean of the total uranium concentration and the enrichment.

Descriptive statistics for the mean and enrichment data are provided in Table 1. The mean for total uranium was 1.58 ppm with a 95% confidence limit at 1.85 ppm. The mean for the enrichment was 0.70% ^{235}U (on a total U basis) with a 95% confidence limit at 0.73% ^{235}U (very close to the enrichment of natural uranium). The dose assessment initially completed used a mean total uranium concentration of 1.6 ppm and an enrichment of 1.81% ^{235}U.

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Table 1
Descriptive Statistics for Copper Ingots

Ingots Retained – U total		*Ingots Retained - U-235*	
Mean	1.58	Mean	0.70
Standard Error of Mean	0.16	Standard Error of Mean	0.01
Median	1.00	Median	0.74
Mode	1.00	Mode	0.76
Standard Deviation	2.76	Standard Deviation	0.22
Sample Variance	7.62	Sample Variance	0.05
Range	35.00	Range	1.59
Minimum	1.00	Minimum	0.22
Maximum	36.00	Maximum	1.81
Sum	447.00	Sum	199.36
Count	283.00	Count	283.00
Confidence Level of Mean (90.0%)	0.27	Confidence Level of Mean (90.0%)	0.02
Confidence Limit of Mean (95.0%)	1.85	Confidence Limit of Mean (95.0%)	0.73

11. The activity distribution (^{234}U, ^{235}U and ^{238}U) used as input to the dose assessment relative to that predicted for materials enriched at a gaseous diffusion site.

Comment: *One stakeholder recognized that the activity distribution of ^{234}U, ^{235}U and ^{238}U used as input values for the dose assessment did not correlate to the activity distribution that one would expect from enriched products coming from the gaseous diffusion process. [Commenter: Individual member of public].*

Response: The dose assessment had artificially allowed the ^{235}U concentration to be input at the highest reported enrichment (1.81% ^{235}U) as a conservative estimate. The dose assessment had not, however, increased the ^{234}U activity correspondingly. After consideration of stakeholder comments, it was decided that the best approach for treatment of the production data was to use the activity distribution predicted for gaseous diffusion enriched products at the enrichment determined by using a 95% confidence limit above the mean enrichment value.

Once the production data were re-evaluated and subjected to statistical treatment as described above, the mean ^{235}U enrichment was determined to be 0.70% ^{235}U (on a total uranium basis) with a 95% confidence limit at 0.73% ^{235}U. The activity concentrations of the ^{234}U, ^{235}U and ^{238}U isotopes could then be calculated to determine the activity distribution for input into the RESRAD-RECYCLE dose assessment model. The activity concentrations for each of the uranium isotopes in the copper were determined as follows:

^{234}U = 2.29 pCi/g
^{235}U = 0.11 pCi/g
^{238}U = 2.29 pCi/g

The total uranium activity in the copper is 4.69 pCi/g. This is about a ten-percent increase over the 4.25 pCi/g initially used as an input to the dose assessment. Based on this increase in the source term associated with the copper ingots, the dose is expected to increase by a comparable amount (i.e., dose to the MEI may increase from 0.018 mrem/yr to about 0.020 mrem/yr).

12. The potential for ^{236}U associated with contamination from reactor site recycle materials.

Comment: *Several stakeholders questioned whether there could be additional radionuclides present in the copper ingots from contamination associated with enrichment of recycle uranium from reactor sites (e.g., Hanford). [Commenter: USEPA and an individual member of the public].*

Response: Several stakeholders questioned whether the ingots could contain any ^{236}U activity as a result of contact with recycle uranium from the reactor sites. The copper ingots originated from gaseous diffusion plant equipment that was in service before the early seventies. The uranium products that the equipment came into contact with over the course of its service life were likely to be predominantly, if not exclusively, from non-reactor recycle sources. The fact that no ^{236}U was reported when isotopic uranium analyses were conducted using mass spectroscopy-analysis methods seems to support this conclusion as well.

To address the issue of potential ^{236}U contamination in the copper ingots, isotopic analyses for ^{236}U will be specifically requested in the sampling conducted to verify compliance with the authorized limits. The sampling and analysis approach for compliance verification is discussed in detail below.

13. Background levels of uranium (if any) that exist in commercially available copper.

Comment: *Several commenters suggested that more information on the amount of uranium that occurs naturally in copper from ore and copper from recycle sources would provide an alternate basis for comparing the amount of uranium found in the Fernald copper ingots. [Commenters: OEPA and an individual member of the public].*

Response: Several stakeholders questioned what levels of uranium are typically found in copper products in commerce (i.e., from non-DOE sources). Some stakeholders thought that there would be essentially no background levels, while others thought that background levels could be high enough that the copper ingots being considered for release would have less uranium than copper found in commerce.

During the original recycling project to produce the copper ingots in 1980, DOE collected three samples of copper from commercial sources to evaluate background levels of uranium. Two of these sources were reported to contain 1 ppm of uranium and the third was reported to contain 2 ppm of uranium. This compares favorably with the average uranium concentration found in the Fernald copper ingots of about 1.6 parts per million. It is not surprising to find some background level of uranium in copper. Uranium minerals are found in association with copper porphyry

deposits and with vein deposits of copper, lead, and precious metal sulfide ores.[3] While uranium from natural sources may be substantially separated from the copper ores during processing, the extent of separation depends on the specific refining steps that are utilized (e.g., electrolytic copper is refined to a much higher purity than fire-refined copper).

DOE is coordinating with copper industry contacts to collect available data on background levels of radionuclides in intermediate and final copper products. The DOE also proposes to collect several samples of commercial copper and analyze for residual radioactive materials to provide a reference background. A sampling plan will be prepared using a judgmental sampling scheme to ensure that samples are collected from copper originating from representative refining processes (i.e., blister copper, fire refined copper, and electrolytic refined copper) and/or end-use products (e.g., electrical wire, plumbing tube, and jewelry). Collected samples will be analyzed for total uranium, thorium, and radium as well as gross alpha and beta activity. Data on radionuclide concentrations at different processing steps for commercial copper sources may also provide some inferences about how radionuclides partition during progressive refining steps.

14. Details on the sampling and analysis that will be conducted to verify compliance with authorized limits prior to release of the material.

Comment: *Additional details on the verification sampling that will be performed prior to release of the copper ingots was requested by several commenters. [Commenters: USEPA and OEPA].*

Response: During the production sampling campaign, each and every ingot produced was sampled to determine radiological content. These samples were analyzed by the Fernald radiological chemistry laboratory that participated in the development of many of today's standard procedures for uranium analysis. While DOE has a high level of confidence in its production sampling results, the data were not generated with the same quality indicators as data collected under the Site-Wide CERCLA Quality Assurance Project Plan (SCQ) that governs collection of environmental samples at the Fernald site today. Therefore, additional sampling is warranted to ensure that decision-making is based on a data set that demonstrably meets current data quality requirements.

Based on the production sampling results the Fernald copper ingots contained, at 95% confidence, less than 1.85 ppm of slightly enriched uranium (4.69 pCi/g of copper). The dose assessment estimated that release of 59 metric tons of copper ingots would result in a dose to the Maximally Exposed Individual (MEI) of about 0.02 mrem/yr. In order to approve authorized limits for unrestricted release, DOE requires that dose to the MEI be less than a few mrem/yr (nominally less than 1 mrem/yr). The US Environmental Protection Agency is proposing regulations for the recycle of metal containing residual radioactive materials that will constrain dose to the MEI at one of the following: 15 mrem/yr, 1 mrem/yr or 0.1 mrem/yr. At 1.85 ppm of slightly enriched uranium, release of the Fernald copper ingots will result in less than one-fifth of the most conservative dose constraint proposed by EPA.

[3] Technical Report on Naturally Occurring Radioactive Materials in the Southwestern Copper Belt of Arizona, US Environmental Protection Agency, Office of Solid Waste, August 1996.

With an estimate of the mean and variability of a population, it is possible to calculate the minimum number of samples that must be collected to show that the mean is less than some threshold limit. In our case, we may select the threshold limit to be the uranium concentration that corresponds to a dose to the MEI of 0.1 mrem/yr. For purposes of estimation, we may assume the threshold limit is 5 times 1.85 ppm, or 9.25 ppm of slightly enriched uranium. The calculated number of samples to show that the mean is less than 9.25 ppm with 95% confidence is a very small number (less than one). Therefore, the number of samples may be selected based on other criteria such as the cost associated with sample collection and analysis.

It is proposed that fifteen random samples be collected which would comprise about 5% of the copper ingots. The samples collected would be subjected to uranium isotopic analysis as well as analysis for technetium. This extension of the data to explicitly address ^{236}U would answer the question raised above regarding the presence of ^{236}U. Data would be collected and analyzed under SCQ protocols to ensure that the data were of known and sufficient quality. The results from sampling would be statistically treated to form 95% upper confidence limit of the mean to serve as inputs to the RESRAD code. Based on these verified inputs, the model would be re-run to demonstrate that the dose to the MEI was below the target threshold limit selected (i.e., less than 0.1 mrem/yr dose to the MEI).

15. Nomenclature used for the "less than 20 ppb" results for ^{99}Tc.

Comment: *One commenter questioned the nomenclature used to characterize the "less than 20 ppb" results reported for ^{99}Tc. [Commenter: Individual public member].*

Response: In the authorized limits document, the nomenclature used for the "less than 20 ppb" reported values of ^{99}Tc was referred to as "below the instrument detection limit". This may more accurately be called the minimum detectable activity. In a subsequent revision to the authorized limits document this term will be substituted.

3.3 Waste Management Issues

16. Levels of ^{99}Tc under authorized limits for copper ingots compared to levels allowed for disposal in the onsite disposal facility at Fernald under the waste acceptance criteria.

Comment: *One commenter stated that it would be unacceptable to allow release of copper ingots under authorized limits that allowed higher levels of ^{99}Tc than are allowed in the FEMP onsite disposal cell. [Commenter: OEPA].*

Response: During production sampling conducted in 1980 the copper ingots were sampled and analyzed for ^{99}Tc. After the first two-thirds of the ingots sampled returned ^{99}Tc results less than the minimum detectable activity (526 pCi/g), analysis for ^{99}Tc was ceased. On the basis of profiles of radionuclide distributions from the gaseous diffusion plant sites, the ^{99}Tc concentrations would be expected to be on the order of 0.3 pCi/g. To complete the initial dose assessment, ^{99}TC was conservatively assumed to be present at the minimum detectable activity. Even at these levels, the ^{99}Tc did not contribute significantly to overall dose through the pathways analysis modeled using the RESRAD-RECYCLE code. This is consistent with EPA analyses completed in support of their residual radioactivity rule for metals recycle (i.e., the

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Derived Concentration Limit for 1 mrem/yr dose to the MEI is calculated by EPA to be 55,000 pCi/g or about 2 ppm).

During verification sampling ^{99}Tc concentrations will be determined using methods that reach significantly lower minimum detectable activities (i.e., less than the onsite disposal facility waste acceptance criteria (WAC) levels). It is anticipated that the actual levels of ^{99}Tc found in the copper will be less than the onsite disposal facility WAC indicating that the copper ingots could either be disposed in the onsite disposal facility or released for recycle. It is important to recognize, however, that there are legitimate differences between pathway analysis to develop a waste acceptance criteria for surface ^{99}Tc contamination in a waste disposal cell and modeled doses from volumetric ^{99}Tc contamination in ingots released to the secondary copper industry.

17. Regulatory status of slag produced at refinery processing the copper ingots

Comment: *One commenter questioned the regulatory status of slag generated from processing the copper ingots in the secondary copper industry. Specifically, the commenter suggested that the radionuclide content of the slag could be high enough to warrant regulation as low level radioactive waste and that if the slag contained sufficient impurities it could be also be regulated as hazardous waste. [Commenter: USEPA].*

Response: In practice, copper of similar purity as the Fernald copper ingots would either be used directly in alloying at a brass mill or would be refined at a copper refinery. At a brass mill no slag would be generated during the alloying process. At a refinery, the copper would be melted in a refining furnace generating a small amount of dross with relatively high copper content. This dross, with relatively high copper content, would be recycled directly to the smelter furnace (e.g., scrap blast furnace) where it is added with low copper content scrap feed and be smelted to produce "black copper". Black copper is in turn further refined in a converter furnace and copper from the converter furnace refined in a refining furnace. Slag from the converter furnace and dross from the refining furnace are both recycled to the smelter. The overall mass of one to two percent copper slag that contains 660 kg of copper is 33,000 to 66,000 kg. As a result, the activity concentration of the slag generated would be one to two times the initial activity concentration of the 60,000 kg of Fernald copper ingots or 4.7 – 9.4 pCi/g (1.85 – 3.7 ppm uranium).

Slag generated from copper refining operations is generally either used as roadbed material or disposed of as industrial waste. The secondary copper industry typically handles a wide variety of copper feed materials including copper alloys that contain greater than percent levels of lead. The Fernald copper ingots contain less than 200 ppm (0.02%) of lead on average. Since the copper industry does not regularly handle slag as hazardous waste and the Fernald copper ingots do not contain substantial amounts of lead as an impurity, the refining of Fernald copper ingots would not be expected to result in generation of a hazardous waste.

3.4 Basis of Cost Estimate for Implementing Release

18. Detailed cost estimate for preparing copper ingots for release.

Comment: *One commenter requested additional discussion in the text to support the cost estimate provided for verification sampling and analysis, including monitoring, decontamination and repackaging of the copper ingots. [Commenter: USEPA].*

Response: Additional discussion related to the cost of preparing the copper ingots for release will be provided in revised text for the Authorized Limits Document. The cost estimate will also be revisited in light of the current understanding regarding sampling and analysis and monitoring required to implement release.

19. Monitoring rate (ft^2/hr) assumed for a radiation technician.

Comment: *One commenter questioned whether in practice a radiation technician could monitor 240 ft^2/hr because cylindrical objects require at least three or four vertical scans to complete the survey and rates using standard flat geometries may not be appropriate. [Commenter: USEPA].*

Response: The monitoring rate used was based on the best judgement of several individuals surveyed who work for commercial firms engaged in decontamination and unrestricted release after explaining the geometry and number of ingots to be surveyed. The rate was used in the analysis as one of several components in the cost estimate and will be reviewed when the cost estimate is revisited (see comment number 18). Any additional information or judgement as to an appropriate working monitoring rate are welcome and will be considered as comments are incorporated into the Authorized Limits Document.

3.5 Miscellaneous Issues

20. Authorized limits expressed as maximum or average radionuclide concentrations.

Comment: *It was noted by one commenter that it was ambiguous whether the authorized limits requested in the Authorized Limits Document were average radionuclide concentrations or absolute (not to exceed) limits. . [Commenter: USEPA].*

Response: The authorized limits requested will be clarified and restated such that they are expressed more clearly. The limits will be expressed as an absolute limit on the average radionuclide concentrations as determined through verification sampling and analysis with specified statistical treatment of the data. Additional information on the sampling and analysis approach is provided in response to comment number 14.

21. Conversion of dose to increased cancer risk.

Comment: *Several commenters suggested that it would be a useful point of comparison to convert the dose to the maximally exposed individual (MEI) to an increased cancer risk. [Commenters: OEPA and individual members of the public].*

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Response: A one millirem dose gives rise to a 7.6×10^{-7} total increased cancer incidence and a 5×10^{-7} increased fatal cancer incidence. The maximally exposed individual (MEI) from release of the Fernald copper ingots is projected to receive a dose of about 0.02 mrem and will receive that entire dose during a single year. This gives the MEI an increased total cancer risk of about 1.5×10^{-8} and an increased fatal cancer risk of 1×10^{-8}. Release of the Fernald copper ingots would clearly meet the CERCLA residual risk objectives of 10^{-4} to 10^{-6} excess cancer risk.

22. Surface dose rates measured and reported prior to release.

Comment: *One commenter suggested that surface dose rates be measured during confirmatory sampling since this field measurement is not costly to collect and would provide additional information about potential dose rates associated with handling the copper ingots. [Commenter: USEPA].*

Response: In addition to verification sampling, contact dose rates will be measured and recorded prior to releasing the Fernald copper ingots under authorized limits. It is very possible that the measured contact dose rates will not be distinguishable from background. In any event, this information will be made available, with a summary of chemical and radiological data, to prospective vendors bidding on the copper under a sales agreement.

23. Further consideration of restricted reuse alternatives for copper ingots.

Comment: *One commenter felt that the restricted reuse option, screened out in the initial analysis based on poor demand, should be discussed further. Specifically, the commenter noted that the Savannah River Site is currently working on a project with Oak Ridge National Laboratory to fabricate high level waste disposal containers out of volume-contaminated stainless steel. [Commenter: USEPA].*

Response: The analysis will be revisited and the text revised to discuss the restricted reuse option in more detail. Specifically, the analysis will revisit the current design configuration and materials of construction of the various waste disposal containers under consideration by DOE and the commercial nuclear industry. It should be noted, however, that copper plays a fairly specialized role in only certain high-level waste container designs (i.e., used for heat dissipation) and may not be used in designs that have been selected for development or fabrication.

24. Information on certain reference documents requested by stakeholders

Comment: *Several stakeholders requested copies of various documents referenced in the Authorized Limits Document. [Commenters: Individual members of the public, OEPA, and USEPA].*

Response: Copies of the following materials were sent to stakeholders who specifically requested a copy. Additional copies may be obtained through the sources identified below.

- Draft Handbook for Controlling Release for Reuse or Recycle of Non-Real Property Containing Residual Radioactive Material, DOE-HDBK-xxxx-97, June 1997. The Handbook

has been issued as a DOE standard for interim use and comment. The Handbook may be downloaded from the internet at http://www.em.gov/recyc/guidintr.html or a copy may be requested from the US Department of Energy, Office of Scientific and Technical Information, Post Office Box 62, Oak Ridge, TN 37831.

- Proposed Rule, 10 CFR Part 834, Radiation Protection of the Public and the Environment, 58 Federal Register 12268, March 25. 1993. This rule is essentially a codification of DOE Order 5400.5 with an explicit reservation to incorporate risk-based approaches currently being investigated by EPA and NRC. Copies of the Federal Register are held on reserve at federal depository libraries (e.g., Hamilton County Public Library or the University of Cincinnati Langsom Library).

- Letter, from Bruce Jorgensen, NRC Region III Decommissioning Branch Chief to Jack Craig, Site Manager, US Department of Energy, Fernald Site Office, dated 12/19/97. This letter commented on DOE's open approach to developing authorized limits for Fernald copper ingots. A copy of this letter is included as an attachment to this document.

- Letter from Branch Chief, Environmental Management Branch, California Department of Health Services to Mr. Joseph Juettan, Director, Environmental and Operational Safety Division, US Department of Energy, San Francisco Operations Office, dated November 10, 1989. This letter provides approval for an exemption under 10 CFR Part 61 licensed burial requirements for 140 metric tons of copper cyclotron coil windings containing less than 20 pCi/g of Cobalt-60. The letter indicates that the material may be disposed of as ordinary non-radioactive waste or recycled at DOE's option. Note that this letter predates the 1990 issuance of DOE Order 5400.5. A copy of this letter is included in the DOE Handbook for Controlling Release for Reuse or Recycle of Non-Real Property Containing Residual Radioactive Material, at page E2-35.