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SHIELDALLOY METALLURGICAL CORPORATION

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C. SCOTT EVES  
VICE PRESIDENT - ENVIRONMENTAL SERVICES

March 14, 1995

Mr. Thomas T. Martin, Regional Administrator  
United States Nuclear Regulatory Commission  
475 Allendale Road  
King of Prussia, Pennsylvania 19406

**Re: Confirmatory Action Letter No. 1-95-004**

Dear Mr. Martin:

As set forth in the Confirmatory Action Letter No. 1-95-004 (CAL-1-95-004), the purpose of this letter is to transmit Shieldalloy Metallurgical Corporation's (SMC) actions in response to CAL-1-95-004. Attached is a summary of agreed-upon items, the action taken to date, the current status of each item (open or closed), and a description of pending action.

Please contact me at (609) 692-4200 if you have any questions or if I can provide you with additional information. We will continue to keep you informed of the status of our efforts regarding CAL 1-95-004. Our next status report will be forwarded to you by May 15, 1995.

Sincerely,

C. Scott Eves, RSO  
Vice President, Environmental Services

cc: H. Nils Schooly  
Ken Pugh

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**SHIELDALLOY METALLURGICAL CORPORATION  
STATUS REPORT FOR  
CONFIRMATORY ACTION LETTER NO. 1-95-0048**

March 13, 1995

**Item 1: Perform an evaluation of workers' intakes of thorium and uranium and determine the occupational doses for all potentially exposed workers, as required by 10 CFR 20.1501. These dose assessments will be based on accurate and validated thorium to alpha ratios, exposure times and air sampling data.**

Action (Determination of Isotope-to-Gross Alpha Ratios): As part of the inventory control program, the concentration of all radioactive materials in pyrochlore (the feed material for ferrocolumbium production) is measured on a quarterly basis.<sup>1</sup> Also, as part of the CANAL processing operation, the concentration of the parent and daughter radionuclides in ferrocolumbium slag was measured.<sup>2</sup> All of the measurement results confirm that the parents and the daughters in the pyrochlore and in the slag are in equilibrium. Therefore, the yield-corrected alpha activities of each daughter present in the sample during analysis can be used to determine the thorium-to-gross alpha ratio in the materials. This analysis reveals a mean ratio of  $0.076 \pm 0.011$ . Likewise, the mean uranium-to-gross alpha ratio is  $0.061 \pm 0.007$ . Attachment 1 shows the data from which this ratio was determined.

Action (Evaluation of Worker Stay Time for 1994): An evaluation of each ferrocolumbium production worker's "stay time" was performed.<sup>3</sup> This evaluation, which included a review of time card information and production logs, revealed that the mean stay time for ferrocolumbium production personnel is  $939 \pm 917$  hours per year. The maximum value was 2478 hours, and the minimum value was 12 hours. A review of the production logs revealed that ferrocolumbium was produced for 236 shifts in 1994. Cleanup and furnace repairs involving source material were performed for an additional 33 shifts. However, some of those activities, which are normally performed during the night shift, occurred during the day shift for a brief period in 1994.

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<sup>1</sup> See TMA/E Report of Analysis dated 9/19/94, Teledyne Report of Analysis dated 6/14/94, Teledyne Report of Analysis dated 6/30/94, and TMA/E Report of Analysis dated 10/17/94.

<sup>2</sup> See letter from C. D. Berger, Integrated Environmental Management, Inc., to C. Scott Eves, Shieldalloy Metallurgical Corporation, "Slag Sampling Program Summary", October 3, 1994.

<sup>3</sup> See memo from David R. Smith, Shieldalloy Metallurgical Corporation, to Carol D. Berger, Integrated Environmental Management, "D.111 Employee Work Hours for CY 94", February 28, 1995, and memo from David R. Smith, Shieldalloy Metallurgical Corporation, to Carol D. Berger, Integrated Environmental Management, Inc., "D.111 Job Assignment and Duration for (\*) and (\*)", March 9, 1995.

Action (Dose Assessment for 1994): Based upon area air monitoring, individual breathing zone sampling, individual time card data, and personnel dosimetry results, the Committed Dose Equivalent (CDE) to the Bone Surfaces and the Total Effective Dose Equivalent (TEDE) was determined for all monitored personnel. Attachment 2 contains a listing of results.<sup>4</sup>

Current Status: Closed.

Pending Action: None required.

**Item 2: Perform an evaluation of doses for potentially exposed members of the public that may receive the highest whole body exposure in the unrestricted area surrounding your facility, as required by 10 CFR 20.1501.**

Action (Evaluation of Emissions from D.111): An air consultant has been retained to evaluate the means by which emissions from the two baghouses in D.111 can be effectively measured.<sup>5</sup> The consultant's on-site assessment took place on Thursday, March 9, 1995.

Action (Off-site Population Dose Estimation for 1994): In 1993, Shieldalloy evaluated the airborne emissions from the plant in a report entitled "Radiation Dose Estimates for Members of the General Public at the Newfield New Jersey Facility".<sup>6</sup> In that report, emissions from the D.111 baghouses and radon emanation rates from the materials in the Storage Yard were estimated. From this information, the maximum individual off-site

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<sup>4</sup> The values listed in Attachment 2 are considered to be over-estimates of the true doses incurred by these individuals for a variety of reasons. (1) The intakes were determined from the results of breathing zone sampling during ferrocolumbium production only. All other operations performed in D.111 were conservatively assumed to generate the same level of airborne activity. (2) The Derived Air Concentrations (DACs) used for the dose assessments are based on the assumption that the inhaled particulates have a diameter of one micrometer AMAD (activity median aerodynamic diameter). The DACs are also based on the assumption that the radioactive daughters of thorium and uranium, born in the body after intake, are metabolized similar to their parent, and that deposition is uniformly-spread in an infinitely thin layer over the relevant surfaces of the bone, without regard for burial under new bone material. These assumptions are artifacts of the ICRP 30 methodology and serve to overestimate true depositions. (3) The metabolic model for <sup>232</sup>Th is derived, primarily, from studies of thorotrast patients, wherein a colloidal form of thorium was injected directly into the blood stream and taken up by bone. The thorium in the possession of Shieldalloy is in a tightly-bound matrix of parents and daughters that, if inhaled, is likely to be tenaciously retained in the lung. Thus the lung, rather than the bone surfaces, is the target organ of interest; the stochastic, rather than the non-stochastic dose is limiting; and the DACs contained in 10 CFR 20 Appendix B are artificially low.

<sup>5</sup> APEX Environmental, Inc., Oak Ridge, Tennessee is providing the consultant.

<sup>6</sup> IT Corporation, "Radiation Dose Estimates for Members of the General Public at the Newfield, New Jersey Facility", IT Corporation Report No. IT/NS-93-107, February 16, 1993.

dose was calculated using the CAP88-PC computer code. Conservative assumptions were made as input to the code when site-specific information was not available. This analysis demonstrated that the maximum annual radiation dose from particulate emissions (0.22 millirem CEDE) occurred 300 meters East Southeast of the D.111 stack. Likewise, the maximum annual radiation dose from radon (0.009 millirem CEDE) occurred 50 meters East Southeast of the Storage Yard.<sup>7</sup>

As part of its radiation protection program, Shieldalloy deploys environmental dosimeters (TLDs) at various locations on the perimeter fence of the Newfield facility. These are used to estimate the external component of the off-site population dose. In 1994, each TLD remained in place for approximately one quarter, at which time they were retrieved, processed, and the doses were recorded. (New dosimeter assemblies were then deployed for the next quarter.) For the TLDs on the perimeter fence only, the mean measured doses for the first, second and third quarters of 1994 were  $77.7 \pm 110.6$  millirem,  $93.8 \pm 119.8$  millirem, and  $71.4 \pm 176.2$  millirem, respectively.

Fourth-quarter 1994 TLD were retrieved and mailed to the dosimeter processor during the week of February 13, 1995. Results are expected by March 31, 1995. For the first three quarters of 1994, the maximum measured perimeter exposure rate occurred due north of the Storage Yard, at a distance of about 30 feet from the slag piles (Station 6).<sup>8</sup> However, ambient exposure rates measured during an environmental assessment indicated that this exposure rate drops by a factor of five at a distance of about 30 feet from the boundary fence. An equivalent annual average exposure rate (assuming continuous occupancy) of 100 millirem occurs at a distance of 108 feet north of the measurement location.<sup>9</sup>

The closest residence to the Newfield plant is over 85 feet south of the property line, which is over 150 feet from the slag piles. The ambient gamma exposure rate at this location is not discernible from background.

There are only three potential exposure scenarios for members of the general public. They involve (1) constant and continuous presence 85 feet south of the Storage Yard; (2) periodic presence (e.g., less than one hour per week) at any randomly-selected location around the perimeter fence; or (3) periodic presence (e.g., less than one hour per month)

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<sup>7</sup> Ferrocolumbium production procedures in 1994 did not differ from those of 1993. Therefore, the findings of this 1993 analysis are assumed to be representative, and were used to determine 1994 population doses pursuant to 10 CFR 20.1301.

<sup>8</sup> A municipal landfill abuts the north boundary of the Shieldalloy property at this location.

<sup>9</sup> IT Corporation, "Assessment of Environmental Radiological Conditions at the Newfield Facility", IT Corporation Report No. IT/NS-92-106, April 1, 1992.

only at Station 6, which is the location of maximum measured exposure.<sup>10</sup> The maximum possible annual exposure of a member of the general public for each of these scenarios, with the maximum dose contribution from particulate and radon emissions included in the assessment, is 0.23 , 2.15 and 3.43 millirem, respectively. These values, which overestimate the true dose that may have been incurred by any single individual, are still well below the 100 millirem per year limit specified in 10 CFR 20.1301.

Current Status: Open.

Pending Action: The recommendations from the air consultant regarding measurement of baghouse emissions are anticipated by March 30, 1994. The Radiation Safety Committee will meet within 15 days after receipt of the consultant's report to evaluate the findings and implement applicable recommendations. The assessment of 1994 population doses for particulate emissions will be repeated once additional measurement data are obtained.

**Item 3: Immediately following the completion of the above dose assessments, implement interim ALARA measures to minimize workers' thorium and uranium intakes. A comprehensive ALARA program showing your long term plans with documented procedures, equipment, engineering controls, and personnel training will be submitted.**

Action Taken: A standard operating procedure entitled "ALARA Program" was drafted and is under review by the Radiation Safety Committee. This procedure describes the Shieldalloy ALARA program.

Action Taken: Ferrocolumbium and CANAL production operations are presumed to generate primarily large (e.g., greater than one micrometer AMAD) particles. To improve interpretation of air sampling results in the vicinity of these operations, the particle size distribution was measured using a Graseby/Andersen Model Mark III Particle Fractionating Sampler. Three samples were collected during the trial CANAL crushing operation. The results of these analyses, shown in Attachment 3, indicate mean particles sizes of 8.65, 7.90 and 8.04 micrometers AMAD. Additional samples were collected during ferrocolumbium production (second floor of D.111) beginning on February 16, 1995. On February 21, 1995, the filters were forwarded to a commercial analytical laboratory for analysis. Results are anticipated by March 18, 1995. Sample collection in the vicinity of the pyrochlore mixing process (first floor of D.111) began on March 5, 1995 and continued until March 8th. These filters were forwarded to the laboratory and results are anticipated in early April.

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<sup>10</sup> A stay-time of one hour per month at this location is conservative in that there is no physical evidence that individuals frequent this area. Furthermore, monitored Shieldalloy employees who frequent the area for durations greatly in excess of one hour per month, incurred exposures that were only slightly above the detection limits of the dosimetry system.

Current Status: Open

Pending Action: The particle size analyses are expected to be completed by April 15, 1995. The first quarter, 1995 surveillance results, including the results of breathing zone sampling and external exposure rate measurements, are expected to be completed by March 31, 1995. The Radiation Safety Committee will then to finalize draft standard operating procedures for radiation protection, and set initial ALARA goals based upon the information obtained during the particle size analysis and first quarter's surveillance. A written statement indicating senior management commitment to the ALARA concept will be finalized, signed, and posted in appropriate locations within the plant by May 15, 1995.

**ATTACHMENT 1**  
**ISOTOPE-TO-GROSS ALPHA RATIOS**

Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium Pyrochlore-9401 9/17/94  
 pCi/g  
 Th-232 Concentration: 848.40  
 U-238 Concentration 557.10

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	848.40
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	839.92
Ra-224	1.00	1.00	848.40
Rn-220	1.00	1.00	848.40
Po-216	1.00	1.00	848.40
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	296.94
Po-212	1.00	0.64	542.98
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	557.10
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	557.10
Th-230	1.00	1.00	557.10
Ra-226	1.00	1.00	557.10
Rn-222	1.00	1.00	557.10
Po-218	1.00	1.00	556.99
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.11
Bi-214	1.00	1.00	556.99
Po-214	1.00	1.00	556.99
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	557.10
Tl-206	0.00	1.00	0.00
	TotAlpha		10087.11
	Th/Alpha		0.084
	U/Alpha		0.055



Determination of Gross Alpha to Isotopic Ratio

Series Equilibrium Pyrochlore-9402 9/17/94  
 pCi/g  
 Th-232 Concentration: 549.60  
 U-238 Concentration 521.60

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	549.60
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	544.10
Ra-224	1.00	1.00	549.60
Rn-220	1.00	1.00	549.60
Po-216	1.00	1.00	549.60
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	192.36
Po-212	1.00	0.64	351.74
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	521.60
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	521.60
Th-230	1.00	1.00	521.60
Ra-226	1.00	1.00	521.60
Rn-222	1.00	1.00	521.60
Po-218	1.00	1.00	521.50
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.10
Bi-214	1.00	1.00	521.50
Po-214	1.00	1.00	521.50
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	521.60
Tl-206	0.00	1.00	0.00
	TotAlpha		7980.80
	Th/Alpha		0.069
	U/Alpha		0.065

Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium      Pyrochlore-9405      10/14/94  
 pCi/g  
 Th-232 Concentration:      869.30  
 U-238 Concentration      433.40

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	869.30
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	860.61
Ra-224	1.00	1.00	869.30
Rn-220	1.00	1.00	869.30
Po-216	1.00	1.00	869.30
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	304.25
Po-212	1.00	0.64	556.35
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	433.40
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	433.40
Th-230	1.00	1.00	433.40
Ra-226	1.00	1.00	433.40
Rn-222	1.00	1.00	433.40
Po-218	1.00	1.00	433.31
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.09
Bi-214	1.00	1.00	433.31
Po-214	1.00	1.00	433.31
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	433.40
Tl-206	0.00	1.00	0.00
	TotAlpha		9098.84
	Th/Alpha		0.096
	U/Alpha		0.048

# Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium    Pyrochlore-9406    10/14/94  
 pCi/g  
 Th-232 Concentration:    804.70  
 U-238 Concentration    405.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	804.70
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	796.65
Ra-224	1.00	1.00	804.70
Rn-220	1.00	1.00	804.70
Po-216	1.00	1.00	804.70
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	281.65
Po-212	1.00	0.64	515.01
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	405.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	405.00
Th-230	1.00	1.00	405.00
Ra-226	1.00	1.00	405.00
Rn-222	1.00	1.00	405.00
Po-218	1.00	1.00	404.92
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.08
Bi-214	1.00	1.00	404.92
Po-214	1.00	1.00	404.92
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	405.00
Tl-206	0.00	1.00	0.00
	TotAlpha		8456.94
	Th/Alpha		0.095
	U/Alpha		0.048

Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium      Pyrochlore-9403      8/5/95  
 pCi/g  
 Th-232 Concentration:      717.00  
 U-238 Concentration      484.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	717.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	709.83
Ra-224	1.00	1.00	717.00
Rn-220	1.00	1.00	717.00
Po-216	1.00	1.00	717.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	250.95
Po-212	1.00	0.64	458.88
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	484.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	484.00
Th-230	1.00	1.00	484.00
Ra-226	1.00	1.00	484.00
Rn-222	1.00	1.00	484.00
Po-218	1.00	1.00	483.90
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.10
Bi-214	1.00	1.00	483.90
Po-214	1.00	1.00	483.90
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	484.00
Tl-206	0.00	1.00	0.00
	TotAlpha		8643.47
	Th/Alpha		0.083
	U/Alpha		0.056

# Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium      Pyrochlore-9404      8/5/95  
    pCi/g  
 Th-232 Concentration:      751.00  
 U-238 Concentration      515.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	751.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	743.49
Ra-224	1.00	1.00	751.00
Rn-220	1.00	1.00	751.00
Po-216	1.00	1.00	751.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	262.85
Po-212	1.00	0.64	480.64
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	515.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	515.00
Th-230	1.00	1.00	515.00
Ra-226	1.00	1.00	515.00
Rn-222	1.00	1.00	515.00
Po-218	1.00	1.00	514.90
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.10
Bi-214	1.00	1.00	514.90
Po-214	1.00	1.00	514.90
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	515.00
Tl-206	0.00	1.00	0.00
	TotAlpha		9125.77
	Th/Alpha		0.082
	U/Alpha		0.056



# Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium      Slag-2      7/29/94  
    pCi/g  
 Th-232 Concentration:    470.00  
 U-238 Concentration      408.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	470.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	465.30
Ra-224	1.00	1.00	470.00
Rn-220	1.00	1.00	470.00
Po-216	1.00	1.00	470.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	164.50
Po-212	1.00	0.64	300.80
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	408.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	408.00
Th-230	1.00	1.00	408.00
Ra-226	1.00	1.00	408.00
Rn-222	1.00	1.00	408.00
Po-218	1.00	1.00	407.92
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.08
Bi-214	1.00	1.00	407.92
Po-214	1.00	1.00	407.92
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	408.00
Tl-206	0.00	1.00	0.00
	TotAlpha		6482.44
	Th/Alpha		0.073
	U/Alpha		0.063

Determination of Gross Alpha to Isotopic Ratio:

Series Equilibrium      Slag-3      7/29/94  
    pCi/g  
 Th-232 Concentration:    501.00  
 U-238 Concentration      409.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	501.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	495.99
Ra-224	1.00	1.00	501.00
Rn-220	1.00	1.00	501.00
Po-216	1.00	1.00	501.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	175.35
Po-212	1.00	0.64	320.64
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	409.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	409.00
Th-230	1.00	1.00	409.00
Ra-226	1.00	1.00	409.00
Rn-222	1.00	1.00	409.00
Po-218	1.00	1.00	408.92
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.08
Bi-214	1.00	1.00	408.92
Po-214	1.00	1.00	408.92
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	409.00
Tl-206	0.00	1.00	0.00
	TotAlpha		6676.82
	Th/Alpha		0.075
	U/Alpha		0.061



Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium Slag-4 7/29/94  
 pCi/g  
 Th-232 Concentration: 317.00  
 U-238 Concentration 323.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	317.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	313.83
Ra-224	1.00	1.00	317.00
Rn-220	1.00	1.00	317.00
Po-216	1.00	1.00	317.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	110.95
Po-212	1.00	0.64	202.88
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	323.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	323.00
Th-230	1.00	1.00	323.00
Ra-226	1.00	1.00	323.00
Rn-222	1.00	1.00	323.00
Po-218	1.00	1.00	322.94
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.06
Bi-214	1.00	1.00	322.94
Po-214	1.00	1.00	322.94
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	323.00
Tl-206	0.00	1.00	0.00
	TotAlpha		4802.53
	Th/Alpha		0.066
	U/Alpha		0.067

Determination of Gross Alpha to Isotopic Ratio:

Series Equilibrium Slag-5 7/29/94  
 pCi/g  
 Th-232 Concentration: 322.00  
 U-238 Concentration 323.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	322.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	318.78
Ra-224	1.00	1.00	322.00
Rn-220	1.00	1.00	322.00
Po-216	1.00	1.00	322.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	112.70
Po-212	1.00	0.64	206.08
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	323.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	323.00
Th-230	1.00	1.00	323.00
Ra-226	1.00	1.00	323.00
Rn-222	1.00	1.00	323.00
Po-218	1.00	1.00	322.94
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.06
Bi-214	1.00	1.00	322.94
Po-214	1.00	1.00	322.94
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	323.00
Tl-206	0.00	1.00	0.00
	TotAlpha		4832.43
	Th/Alpha		0.067
	U/Alpha		0.067

Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium Slag-6 7/29/94  
 pCi/g  
 Th-232 Concentration: 401.00  
 U-238 Concentration 455.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	401.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	396.99
Ra-224	1.00	1.00	401.00
Rn-220	1.00	1.00	401.00
Po-216	1.00	1.00	401.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	140.35
Po-212	1.00	0.64	256.64
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	455.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	455.00
Th-230	1.00	1.00	455.00
Ra-226	1.00	1.00	455.00
Rn-222	1.00	1.00	455.00
Po-218	1.00	1.00	454.91
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.09
Bi-214	1.00	1.00	454.91
Po-214	1.00	1.00	454.91
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	455.00
Tl-206	0.00	1.00	0.00
	TotAlpha		6492.80
	Th/Alpha		0.062
	U/Alpha		0.070

Determination of Gross Alpha to Isotopic Ratios

Series Equilibrium      Slag-7      7/29/94  
    pCi/g  
 Th-232 Concentration:    304.00  
 U-238 Concentration      301.00

RN	alpha/dis	Br Ratio	Alpha
Th-232	1.00	1.00	304.00
Ra-228	0.00	1.00	0.00
Ac-228	0.00	1.00	0.00
Th-228	0.99	1.00	300.96
Ra-224	1.00	1.00	304.00
Rn-220	1.00	1.00	304.00
Po-216	1.00	1.00	304.00
Pb-212	0.00	1.00	0.00
Bi-212	0.35	1.00	106.40
Po-212	1.00	0.64	194.56
Tl-208	0.00	0.36	0.00
U-238	1.00	1.00	301.00
Th-234	0.00	1.00	0.00
Pa-234m	0.00	1.00	0.00
Pa-234	0.00	0.00	0.00
U-234	1.00	1.00	301.00
Th-230	1.00	1.00	301.00
Ra-226	1.00	1.00	301.00
Rn-222	1.00	1.00	301.00
Po-218	1.00	1.00	300.94
Pb-214	0.00	1.00	0.00
At-218	1.00	0.00	0.06
Bi-214	1.00	1.00	300.94
Po-214	1.00	1.00	300.94
Tl-210	0.00	0.00	0.00
Pb-210	0.00	1.00	0.00
Bi-210	0.00	1.00	0.00
Po-210	1.00	1.00	301.00
Tl-206	0.00	1.00	0.00
	TotAlpha		4526.80
	Th/Alpha		0.067
	U/Alpha		0.066

**ATTACHMENT 2**  
**1994 TEDE REPORT**

# SHIELDALLOY METALLURGICAL CORPORATION - 1994 TEDE REPORT

Clock No.	Quarterly Work Hrs in D111	Mean BZA (uCi/ml)				TLD mr				Th-232 DAC-hr (NS)				Th-232 DAC-hr (S)				U-238 DAC-hr (S)				CDE(BS) Rem	TEDE Rem
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
1448	3	1.90E-12								0.43	0.38	0.38	0.38	0.29	0.25	0.25	0.25	0.02	0.02	0.02	0.02	0.039	0.003
1717	539.25	2.32E-12				18	17	17		95.08	68.20	68.20	68.20	63.39	45.47	45.47	45.47	3.82	2.74	2.74	2.74	12.788	0.582
1689	433.75	1.03E-12	1.15E-12		1.10E-12			12		33.86	54.86	54.86	36.26	22.57	25.27	36.57	24.17	1.36	1.52	2.20	1.46	7.374	0.300
1257	526.75	1.10E-12	1.20E-12		8.40E-13	0	0	14		44.04	48.04	66.62	33.63	29.36	32.03	44.42	22.42	1.77	1.93	2.67	1.35	8.207	0.354
1935	11	1.55E-12								1.30	1.39	1.39	1.39	0.86	0.93	0.93	0.93	0.05	0.06	0.06	0.06	0.233	0.010
1569	112.25		1.10E-12			0	0	0		14.20	9.38	14.20	14.20	9.46	6.26	9.46	9.46	0.57	0.38	0.57	0.57	2.218	0.092
1737	80.25				2.33E-12			0		10.15	10.15	10.15	14.20	6.77	6.77	6.77	9.46	0.41	0.41	0.41	0.57	1.905	0.079
1800	121.25				1.75E-12			0		15.34	15.34	15.34	16.15	10.22	10.22	10.22	10.77	0.62	0.62	0.62	0.65	2.652	0.110
1727	157.75				1.80E-12	0	0	0		19.95	19.95	19.95	21.58	13.30	13.30	13.30	14.39	0.80	0.80	0.80	0.87	3.475	0.144
1995	10				5.80E-12					1.26	1.26	1.26	4.41	0.84	0.84	0.84	2.94	0.05	0.05	0.05	0.18	0.350	0.014
1841	203.5				1.00E-12			0		25.74	25.74	25.74	15.47	17.16	17.16	17.16	10.31	1.03	1.03	1.03	0.62	3.955	0.164
1548	619.5				6.60E-13	19	0	10		78.35	78.35	78.35	31.07	52.24	52.24	52.24	20.72	3.14	3.14	3.14	1.25	11.356	0.499
0750	0					0	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
1473	0									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
1092	0					0	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
1083	0						0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
6508	0					0	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
1965	0							0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000
1700	0							0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000

**ATTACHMENT 3**  
**PARTICLE SIZE DATA FROM THE CANAL CRUSHING OPERATION**

Location	Stage	Effective Cut Diameter (microns)	Total Activity (micrograms)	Percent of Total Activity	Cumulative (Percent Less Than)
West of feed hopper on crusher	0	13.6 and above	.1034	.128831	.8711687017
	1	8.6	.301	.375031	.496137553
	2	5.6	.0756	.094194	.401943683
	3	4.0	.0492	.061301	.3406429105
	4	2.5	.0806	.100424	.2402192873
	5	1.3	.0743	.092574	.1476451533
	6	1.8	.028	.034887	.1127585348
	7	.54	.0221	.027536	.0852230252
	Final	Less than 0.54	.0684	.085223	6.93889E-17
		TOTAL		.8026	
South of crusher on stairs, pointing east	0	13.6 and above	.1438	.221572	.7784283513
	1	8.6	.162	.249615	.5288135593
	2	5.6	.0798	.122958	.4058551618
	3	4.0	.0598	.091834	.3140215716
	4	2.5	.0887	.136672	.1773497689
	5	1.3	.0449	.069183	.1081664099
	6	1.8	.064	.098613	.0095531587
	7	.54	0	0	.0095531587
	Final	Less than 0.54	.0062	.009553	2.25514E-17
		TOTAL		.649	

Location	Stage	Effective Cut Diameter (microns)	Total Activity (micrograms)	Percent of Total Activity	Cumulative (Percent Less Than)
South of crusher on stairs, pointing north	0	13.6 and above	.1975	.348263	.6517369071
	1	8.6	.0704	.12414	.5275965438
	2	5.6	.0835	.14724	.3806561982
	3	4.0	.0791	.139482	.2408746253
	4	2.5	.0782	.137895	.1029800741
	5	1.3	.0213	.03756	.0654205607
	6	1.8	.0289	.050961	.0144595309
	7	.54	0	0	.0144595309
	Final	Less than 0.54	.0082	.01446	6.93889E-17
		TOTAL	.5671		