HILBERT ASSOCIATES, INC.
RADIOLOGICAL ENGINEERS

FINAL PROJECT REPORT
SURVEY AND SAMPLING PROGRAM
FOR FeV SLAG PROJECT NO. V40-01
AT THE SHIELDALLOY CORPORATION
NEWFIELD, NEW JERSEY

PREPARED BY

HILBERT ASSOCIATES, INC.
640 MAPLE AVENUE
SARATOGA SPRINGS, NEW YORK 12866

PREPARED FOR

SHIELDALLOY METALLURGICAL CORPORATION
WEST BOULEVARD
NEWFIELD, NEW JERSEY 08344

FEBRUARY 5, 1992

HILBERT ASSOCIATES, INC.
RADIOLOGICAL ENGINEERS

FINAL PROJECT REPORT

TABLE OF CONTENTS

1.0 INTRODUCTION AND SUMMARY

At the request of Shieldalloy Metallurgical Corporation (SMC), Hilbert Associates, Inc. was subcontracted to assist SMC with the developement of a radiological program associated with the planned crushing and stockpiling of Ferrovanadium (FeV) slag at the SMC facility in Newfield, NJ.

SMC manufactures a variety of specialty ferrous alloys from ore materials. The process methods for two of the manufactured products each produces each produces a byproduct from the operation; FeCb (ferrocolumbium) and FeV (ferrovanadium) slag. The FeCb slag is unique in that the ore contains naturally elevated concentrations of thorium and uranium. The thorium and uranium activity concentrations in the FeCb slag typically exceed 0.05% by weight and are subject to and controlled by the USNRC Source Material license held by SMC. Radioactivity concentrations for FeCb slag have previously been reported (Reference 6.1) for Th232 of 220 to 610 pCi per gram and for U238 of 180 to 320 pCi per gram. The FeV slag does not contain licensable quantities of radioactive materials. Radioactivity concentrations for FeV slag have previously been reported (Reference 6.2) for Th232 of 5 to 7 pCi per gram and for U238 of 7 to 9 pCi per gram.

SMC arranged for a contractor to provide the crushing mill equipment and labor to crush approximately 6000 tons of FeV slag. Hilbert Associates, Inc. prepared a Work Plan (Enclosure 7.1) for the project which integrated a radiological screening (survey) and sampling program with the planned work methodology. The primary objective of the radiological program was to insure that FeV slag product does not exceed the regulatory limits for radioactive source material and is not appreciably contaminated with other materials having higher concentrations of radioactivity than FeV slag. The radiological program additionally provided radiological controls surveillance, routine surveys, and verification sampling/analysis of the FeV product material. The elements of the radiological program are presented in Section 2.2 of this report.

The project was initiated on 11/18/91 and continued through completion on 12/20/91. Six 1000 ton piles of crushed FeV slag were produced and stored on the SMC site pending later disposition to the designated client. Samples of the crushed FeV product were analyzed by HpGe gamma spectroscopy for U238 and Th232 and were confirmed to be equivalent to the natural radioactivity concentration of the FeV slag. The radiation survey

program designed to identify possible fugitive FeCb slag potentially mixed with the FeV slag resulted in the identification and removal of approximately 5 tons of FeCb slag from the process pathway prior to crushing operations. The slag was marked and staged for return to the on-site FeCb slag storage area.

This report presents a detailed discussion of this project and provides the results of applicable radiological measurements.

2.0 PROJECT DESCRIPTION

2.1 Work Area Description

Both the FeV and FeCb slags are stockpiled in segregated areas located at the eastern end of the SMC property. The area is referred to as the Source Material Storage Yard (SMSY). The general work area associated with the radiation screening and crushing project was the eastern end of the SMSY extending from the western limit of the FeV slag stockpile(s) to the site security fence. The work area was adjacent to the radiologically controlled area (RCA) associated with the FeCb source material slag piles.

2.2 Project Chronology

This section presents a summary timeline of the project operations and profile of major activities.

11/18/91 Project start date. Contractor personnel on site. Radiological training and project familiarization seminar by Hilbert Associates. Site safety training seminar by SMC Safety Training and Personnel Manager.

11/19/91 Start of FeV slag removal operations and radiation screening. Personnel dosimetry issued and bioassay (urinalysis) samples collected from project personnel.

11/19/91-
12/06/91 Radiation screening of FeV slag in laydown area prior to removal to material pile designated as eligible for crushing mill. Operations involved two front end loaders for FeV transport, two radiological technicians for radiation survey of exposed FeV slag, and one

laborer to assist in removal of debris. Approximately 5000 tons of FeV slag accumulated during this time period.

12/05/91 Crushing mill arrival and setup.

12/7/91 Start crushing mill operations.

12/7/91-
12/19/91 Crushing of screened FeV slag into six 1000 ton product piles. Additional radiation screening of about 1000 tons of FeV slag to accumulate the total 6000 tons for input to crushing mill. No visible dust generated from impactor type crushing mill. Downwind air sampling performed intermittently during crushing operations. Samples of FeV product obtained during crushing operations.

12/20/91 Operations completed. Final equipment radiation/contamination surveys. Personnel dosimetry and final bioassay samples collected.

2.3 Radiological Program

The work plan implemented a radiological controls program commensurate with the known radiological status of the slag types and work area considerations. The program consisted of three elements; (1) radiological monitoring during work operations, (2) radiation screening surveys of the FeV slag in the laydown area, and, (3) verification sampling and analysis of the FeV product material.

2.3.1 Radiological Monitoring

2.3.1.1 Personnel Training and Monitoring

All project personnel attended a seminar training session on 11/18/91 for both SMC site safety training and a radiological training seminar consistent with 10CFR19 requirements for information to workers.

Whole body radiation dosimetry (TLD) and bioassay (urinalysis) requirements were explained and implemented prior to the start of work.

2.3.1.2 Radiation and Contamination Surveys

Periodic routine direct radiation and contamination surveys were performed during FeV slag screening and crushing operations. High contact areas of the contractors equipment were routinely surveyed. High contact areas for personnel (gloves and work boots) were routinely surveyed during handling operations and particularly prior to lunch breaks and upon the end of the work shift. Direct surveys in the work area were performed in low gamma radiation background areas provided by heavy equipment. There was no indication of fixed or removable contamination during the project.

2.3.1.3 Airborne Radioactivity

Sampling for airborne radioactivity was performed periodically during crushing operations in a downwind location adjacent to the impactor unit. There was no visible dust emissions from the impactor unit during operation.

2.3.2 FeV Radiation Screening Surveys

The FeV slag was removed from the FeV stockpile by the front end loader and deposited in a predetermined area called the laydown area. The slag was discharged and spread out in a planar geometry for the radiation screening of the material prior to transfer of the material to the crushing mill location.

Gamma radiation surveys were performed using 2 inch by 2 inch NaI detectors. The detectors were suspended to within a few inches of the slag and moved over the entire slag array. Due to the high radioactivity concentration of the FeCb source material relative to the FeV slag, individual FeCb slag fragments acted as discrete point sources of gamma radiation and were immediately indicated by the NaI detectors by a rapid audible increase in gamma radiation count rate. Upon indication of radiation detection at twice the background level, the immediate slag area was investigated in a detailed manner with the NaI instrumentation to identify radiation sources. Audio headsets were used to increase surveyor efficiency. Although background gamma radiation levels measured

by the sensitive NaI detectors was approximately 60,000 cpm (variable dependent upon location), the FeCb slag fragments were easily detected by the near surface survey.

Pieces of FeCb slag were immediately removed to a stockpile area or marked (painted) for removal by equipment when the size of the slag fragment was not manually handleable. Approximately 225 radiation technician manhours were utilized to screen 6000 tons of FeV slag.

2.3.3 Verification Samples of FeV Product Material

Samples of the FeV product (crushed slag) were taken and packaged in a 500 cc re-entrant geometry (Marinelli container) for later HpGe gamma spectroscopy quantatative analysis. Four samples of approximately 700 grams were taken from each of the 1000 ton product piles. The impactor unit provided a means to insure that the samples material was representative of the product pile and that the sample matrix composition was suitable for gamma spectroscopy analysis.

As the impactor unit operated, slag fines were deposited on two screening units under the impactor. These screens were removed and replaced at least daily during impactor operations. The fines collected at the screen locations and were removed at the time the screens were cleaned and replaced. The fines were selected as the sample matrix material both due to the composition of the material and the correlation of the collected material to the amount of crushed material and the respective product pile in which the crushed product was placed. The samples can certainly be called representative of the respective product pile.

Due to the efficiency of the radiation screening of the FeV slag at the laydown area, there was a high confidence that the sample(s) radioactivity concentrations should be like that of the FeV feed stock radioactivity concentrations. The results of the samples (Section 4.5) verify the original uranium and thorium radioactivity concentrations of the FeV slag.

3.0 RADIOLOGICAL INSTRUMENTATION

3.1 Instrument Identification

The radiation detection instrumentation used for this project is typical of the industry standard. The types of instruments and their primary use is discussed in this section. Calibration reports are included as Enclosure 7.2 to this final report.

3.1.1 Portable ratemeter/scaler with GM pancake detector.

Description: Eberline ESP-1 with Ludlum 44-9
General Use: Direct beta-gamma radiation measurements and smear analysis in scaler mode.

3.1.2 Portable ratemeter/scaler with NaI gamma scintillation detector.

Description: Ludlum 2221 with Ludlum 44-10
General Use: High sensitivity gamma detection used for FeV radiation screening surveys.

3.1.3 Portable ratemeter with alpha scintillation detector.

Description: Ludlum Model 2 with 43-65 alpha scintillation detector.
General Use: Direct alpha radiation surveys

3.1.4 Portable ratemeter/scaler with gas flow proportional detector.

Description: Ludlum M.2221 with 43-68 gas flow detector.
General Use: Direct beta-gamma radiation surveys

3.1.5 Regulated Air Sampler

Description: Eberline RAS-1 Regulated Air Sampler
General Use: Low volume continuous air environmental sampling

3.1.6 Radiation Sources/Standards

Description: Calibrated beta-gamma and alpha sources for portable instrument efficiency determination. Gamma

emitting source standard for gamma detection instrument response check.

3.2 Instrument Efficiencies and Detection Limits

3.2.1 Instrument Efficiency

Portable beta-gamma and alpha radiation detection instruments were checked daily for detection efficiency (cpm per dpm) using the calibrated source standards. The calculated efficiency was used to quantify field measurements.

Gamma detection instrumentation was checked daily to confirm appropriate gamma radiation response. Gamma detection efficiency was not determined since gamma detection instruments were used in a qualitative mode for FeV slag screening.

3.2.2 Detection Limits

Minimum detectable count rate (MDCR) and minimum detectable activity (MDA) or lower limit of detection (LLD) were determined for field measurements in the following manner:

$$MDCR = 4.65(Cb)^{1/2}/Ts + 3/Ts$$

and $MDA = MDCR / EFF$

where Cb is the standard deviation in the total number of background counts in thr counting interval(counts)

Ts is the count interval(min)

EFF is the counting efficiency in cpm per dpm or use with conversion factor for units of cpm per unit activity

Typical LLD Determinations

(1) Smear Analysis with 44-9 GM pancake detector/ESP-1 scaler mode

EFF = 0.10 cpm/dpm
Ts = 1 min
Background Count Rate = 50 cpm

Then MDCR = 35.9 cpm
MDA = 359 dpm per 100cm2 smear

(2) Direct beta-gamma radiation survey with 43-68 gas flow proportional detector

EFF = 0.25 cpm/dpm
Ts = 1 min
Background Count Rate = 150 cpm

Then MDCR = 60.0 cpm
MDA = 240 dpm per 100cm2 direct

(3) Direct beta-gamma radiation survey with 44-9 GM pancake detector

EFF = 0.10 cpm/dpm
Ts = 1 min
Background Count Rate = 50 cpm

Then MDCR = 35.9 cpm per detector area
MDA = 359 dpm per detector area
= 2333 dpm per 100cm2 direct

(4) Direct alpha radiation survey with 43-65 alpha scintillation detector

EFF = 0.12 cpm/dpm
Ts = 1 min
Background Count Rate = 1 cpm

Then MDCR = 7.7 cpm per detector area
MDA = 64 dpm per detector area
= 128 dpm per 100cm2 direct

4.0 RADIOLOGICAL RESULTS

Sections 4.1 through 4.5 present results of various radiological measurements performed during this project as follows:

4.1 Results of personal whole body dosimetry (TLD) radiation exposure by Teledyne Isotopes.

4.2 Results of bioassay (urinalysis) samples for project personnel; each individual obtained samples at the beginning and end of the project. Samples were analyzed by Controls for Environmental Pollution for U238 and Th232.

4.3 Results of downwind low volume continuous air samples during impactor unit operations.

4.4 Summary of radiation and contamination surveys performed during project operations.

4.5 HpGe gamma spectroscopy results for U238 and Th232 for FeV product pile samples. Samples were analyzed by Hilbert Associates, Inc.

SECTION 4.1

RESULTS OF DOSIMETRIC ANALYSES
WHOLE BODY PENETRATING RADIATION

HILBERT ASSOCIATES

RADIOLOGICAL ENGINEERS AND CONSULTANTS

REPORT OF RADIATION EXPOSURE

MONITORING PERIOD: 11/19/91 TO 12/20/91
LOCATION: SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY
TYPE OF MONITORING: WHOLE BODY
CONTRACTOR ISSUE: HILBERT ASSOCIATES, INC.
DOSIMETRY ANALYSIS: TELEDYNE ISOTOPES

RESULTS OF RADIATION MONITORING

TLD #	NAME	SSN	(1) RESULT (mRem)
014	T. ANGELINO	138-76-7852	0.00
015	T. BEAMER	142-42-3817	0.00
016	R. DUGAN	148-29-3051	0.00
017	R. D'ORAZIO	138-52-5260	0.00
018	P. BEAMER	145-52-2381	0.00
019	W. KANE	142-72-4653	0.00
020	D. GILL	521-88-4681	0.00
021	E. MURPHY	147-74-2416	0.00
022	E. LANING	174-48-1516	0.00
023	R. WHITE	144-36-8852	0.00

(1) WHOLE BODY PENETRATING RADIATION DOSE REPORT FROM TELEDYNE ISOTOPES REPORT 1/17/92.

REVIEWED BY: HILBERT ASSOCIATES, INC.

Stephen E. Miller
President

640 MAPLE AVE, RT 9 • SARATOGA SPRINGS, NEW YORK 12866 • 518 584 0166 • FAX 518 584 8529

SECTION 4.2

RESULTS OF BIOASSAY ANALYSES
URINALYSIS FOR TH232 AND U238

HILBERT ASSOCIATES

RADIOLOGICAL ENGINEERS AND CONSULTANTS

REPORT OF BIOASSAY MONITORING

MONITORING PERIOD: 11/19/91 TO 12/20/91
LOCATION: SHIELDALLOY METALLUGICAL CORPORATION
NEWFIELD, NEW JERSEY
TYPE OF MONITORING: URINALYSIS
CONTRACTOR ISSUE: HILBERT ASSOCIATES, INC.
ANALYTICAL LABORATORY: CONTROLS FOR ENVIRONMENTAL POLLUTION
SANTA FE, NM

RESULTS OF BIOASSAY MONITORING

SAMPLE DATE	NAME	SSN	(1)RESULT(dpm/L) Th232	U238
11/19/91	W. KANE	142-72-4653	< 0.03	< 0.03
11/19/91	E. LANING	174-48-1516	< 0.03	< 0.03
11/19/91	T. BEAMER	142-42-3817	< 0.03	< 0.03
11/19/91	T. ANGELINO	138-76-7857	< 0.03	< 0.03
11/19/91	R. D'ORAZIO	138-52-5260	< 0.03	< 0.03
11/19/91	D. GILL	521-88-4681	< 0.03	< 0.03
11/19/91	E. MURPHY	147-74-2416	< 0.03	< 0.03
11/25/91	R. DUGAN	148-29-3051	< 0.03	< 0.03
11/19/91	P. BEAMER	145-52-2381	1.5+/-0.6	< 0.03
11/19/91	R. WHITE	144-36-8852	< 0.03	< 0.03
12/20/91	E. LANING	174-48-1516	< 0.03	< 0.03
12/20/91	T. BEAMER	142-42-3817	< 0.03	< 0.03
12/20/91	T. ANGELINO	138-76-7857	< 0.03	< 0.03
12/20/91	R. D'ORAZIO	138-52-5260	< 0.03	< 0.03
12/20/91	E. MURPHY	147-74-2416	< 0.03	< 0.03
12/20/91	R. DUGAN	148-29-3051	< 0.03	< 0.03
12/20/91	R. WHITE	144-36-8852	< 0.03	< 0.03
12/20/91	P. BEAMER	145-52-2381	not sampled	
12/20/91	W. KANE	142-72-4653	< 0.03	8.6+/-6.3

(1) Controls for Environmental Pollution Reports #91-12-204 (1/29/92) and #91-12-590 (2/3/92)

REVIEWED BY: HILBERT ASSOCIATES, INC.

Stephen E. Miller
President

640 MAPLE AVE, RT 9 • SARATOGA SPRINGS, NEW YORK 12866 • 518 584 0166 • FAX 518 584 8529

SECTION 4.3

RESULTS OF AIR SAMPLE ANALYSES
IMPACTOR UNIT OPERATIONS

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/06/91
VOLUME OF AIR SAMPLE: 6000 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	59.6	1.33
NET SAMPLE COUNT RATE	3	1
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	1.185396E-12	1.320969E-13
MDAC (uCi per cc)	1.633955E-14	2.560147E-13

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/09/91
VOLUME OF AIR SAMPLE: 9600 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	50.6	2.33
NET SAMPLE COUNT RATE	-6	2
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	1.021222E-14	1.651211E-13
MDAC (uCi per cc)	1.021222E-14	1.600092E-13

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/10/91
VOLUME OF AIR SAMPLE: 13200 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	58	1
NET SAMPLE COUNT RATE	1.400002	.67
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	7.427068E-15	4.022951E-14
MDAC (uCi per cc)	7.427068E-15	1.163703E-13

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/11/91
VOLUME OF AIR SAMPLE: 4800 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	52.3	1
NET SAMPLE COUNT RATE	-4.299999	.67
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	2.042444E-14	1.106312E-13
MDAC (uCi per cc)	2.042444E-14	3.200184E-13

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/13/91
VOLUME OF AIR SAMPLE: 8400 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	51	1.33
NET SAMPLE COUNT RATE	-5.599998	1
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	1.167111E-14	9.435494E-14
MDAC (uCi per cc)	1.167111E-14	1.828677E-13

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/16/91
VOLUME OF AIR SAMPLE: 7200 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	50	.33
NET SAMPLE COUNT RATE	-6.599998	0
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	1.361629E-14	2.133456E-13
MDAC (uCi per cc)	1.361629E-14	2.133456E-13

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/18/91
VOLUME OF AIR SAMPLE: 16800 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	48.3	1.33
NET SAMPLE COUNT RATE	-8.299999	1
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	5.835553E-15	4.717747E-14
MDAC (uCi per cc)	5.835553E-15	9.143383E-14

AIR SAMPLE ANALYSIS REPORT

LOCATION OF AIR SAMPLE: SMC
DATE OF AIR SAMPLE: 12/19/91
VOLUME OF AIR SAMPLE: 10800 LITERS
SAMPLE IDENTIFICATION: IMPACTOR AREA
DATE OF REPORT: 01-21-1992

INSTRUMENTATION

	BETA-GAMMA	ALPHA
INSTRUMENT MODEL	LUDLUM M.2929 DUAL CHANNEL SCALER	
INSTRUMENT S/N	50718	
INSTRUMENT CAL DATE	02/18/91	
EFFICIENCY SOURCE	TC99	TH320
EFFICIENCY(cpm/dpm)	.114	.341
SELF-SHIELD FACTOR	1	1.2
GEOMETRY FACTOR	1	1
BACKGROUND COUNT TIME(min)	3	3
SAMPLE COUNT TIME(min)	3	3

ANALYSIS RESULTS

	BETA-GAMMA	ALPHA
BACKGROUND COUNT RATE	56.6	.33
SAMPLE COUNT RATE	52.3	2.33
NET SAMPLE COUNT RATE	-4.299999	2
MIN DETECTABLE COUNT RATE	61.59291	5.626692
ACT CONC (uCi per cc)	9.077527E-15	1.467743E-13
MDAC (uCi per cc)	9.077527E-15	1.422304E-13

SECTION 4.4

RESULTS OF RADIATION AND CONTAMINATION SURVEYS

RADIATION AND CONTAMINATION SURVEY SUMMARY

SURVEY DATE	SURVEY TYPE	LOCATION / DESCRIPTION	SURVEY RESULTS
11/19/91	1	2 YARD LOADER IN	ALL SMEARS LESS THAN 254 dpm/100cm2
11/19/91	1	EXCAVATOR IN	ALL SMEARS LESS THAN 254 dpm/100cm2
11/20/91	1	2 YARD LOADER - WORK AREA	ALL SMEARS LESS THAN 232 dpm /100cm2
11/20/91	2	2 YARD LOADER	NONE DETECTABLE ABOVE BACKGROUND
11/20/91	4	2 YARD LOADER	NONE DETECTABLE ABOVE BACKGROUND
11/21/91	1	2 YARD LOADER	ALL SMEARS LESS THAN 207 dpm/100cm2
11/22/91	1	EXCAVATOR - WORK AREA	ALL SMEARS LESS THAN 232 dpm/100cm2
11/22/91	1	2 YARD LOADER	ALL SMEARS LESS THAN 232 dpm/100cm2
11/25/91	1	2 YARD LOADER	ALL SMEARS LESS THAN 232 dpm/100cm2
11/25/91	2	2 YARD LOADER	NOT DETECTABLE ABOVE BACKGROUND
11/25/91	3	2 YARD LOADER	ALL MEASUREMENTS LESS THAN 239 dpm/100cm2
11/26/91	1	2 YARD LOADER	ALL SMEARS LESS THAN 207 dpm/100cm2
11/27/91	1	EXCAVATOR OUT	ALL SMEARS LESS THAN 232 dpm/100cm2
11/27/91	3	EXCAVATOR OUT	ALL MEASUREMENTS LESS THAN 267 dpm/100cm2
11/27/91	4	EXCAVATOR OUT	NOT DETECTABLE ABOVE BACKGROUND
11/27/91	2	6 YARD LOADER IN	NOT DETECTABLE ABOVE BACKGROUND
12/2/91	1	6 YARD LOADER - WORK AREA	ALL SMEARS LESS THAN 217 dpm/100cm2
12/2/91	1	2 YARD LOADER	ALL SMEARS LESS THAN 217 dpm/100cm2

DESCRIPTION OF SURVEY TYPES			
1. BETA-GAMMA CONTAMINATION		2. BETA-GAMMA DIRECT (44-9)	
3. BETA-GAMMA DIRECT (43-68)		4. ALPHA DIRECT (43-65)	
INSTRUMENT S/N	M.2221 S/N 86299	M.2 S/N 40812	ESP-1 S/N 3027
DETECTOR S/N	M.43-68 S/N 082373	M.43-65 S/N 060145	M.44-9 S/N 048271
PROJECT: SMC, NEWFIELD, NJ		DATES: 11/19/91 to 12/20/91	
PERFORMED BY: D. GILL, E. LANING		REVIEWED BY:	

HILBERT ASSOCIATES

RADIATION AND CONTAMINATION SURVEY SUMMARY

SURVEY DATE	SURVEY TYPE	LOCATION / DESCRIPTION	SURVEY RESULTS
12/2/91	3	LOADERS - WORK AREA	ALL MEASUREMENTS LESS THAN 244 dpm/100cm2
12/4/91	1	LOADERS - WORK AREA	ALL SMEARS LESS THAN 232 dpm/100cm2
12/5/91	2	IMPACTOR IN	ALL MEASUREMENTS ND ABOVE BACKGROUND
12/5/91	1	6 YARD LOADER	ALL SMEARS LESS THAN 228 dpm/100cm2
12/6/91	1	2 YARD LOADER OUT	ALL SMEARS LESS THAN 254 dpm/100cm2
12/6/91	3	2 YARD LOADER OUT	ALL DIRECT MEASUREMENTS LESS THAN 209 dpm/100cm2
12/9/91	1	IMPACTOR - WORK AREA	ALL SMEARS LESS THAN 232 dpm/100cm2
12/10/91	1	IMPACTOR	ALL SMAERS LESS THAN 215 dpm/100cm2
12/12/91	1	IMPACTOR	ALL SMEARS LESS THAN 228 dpm/100cm2
12/16/91	1	IMPACTOR	ALL SMEARS LESS THAN 246 dpm/100cm2
12/17/91	1	IMPACTOR	ALL SMEARS LESS THAN 234 dpm/100cm2
12/17/91	2	IMPACTOR	NONE DETECTABLE ABOVE BACKGROUND
12/18/91	1	IMPACTOR	ALL SMEARS LESS THAN 234 dpm/100cm2
12/20/91	1	LOADER/EXCAVATOR/BACKHOE OUT	ALL SMEARS LESS THAN 228 dpm/100cm2
12/20/91	2	LOADER/EXCAVATOR/BACKHOE OUT	NONE DETECTABLE ABOVE BACKGROUND

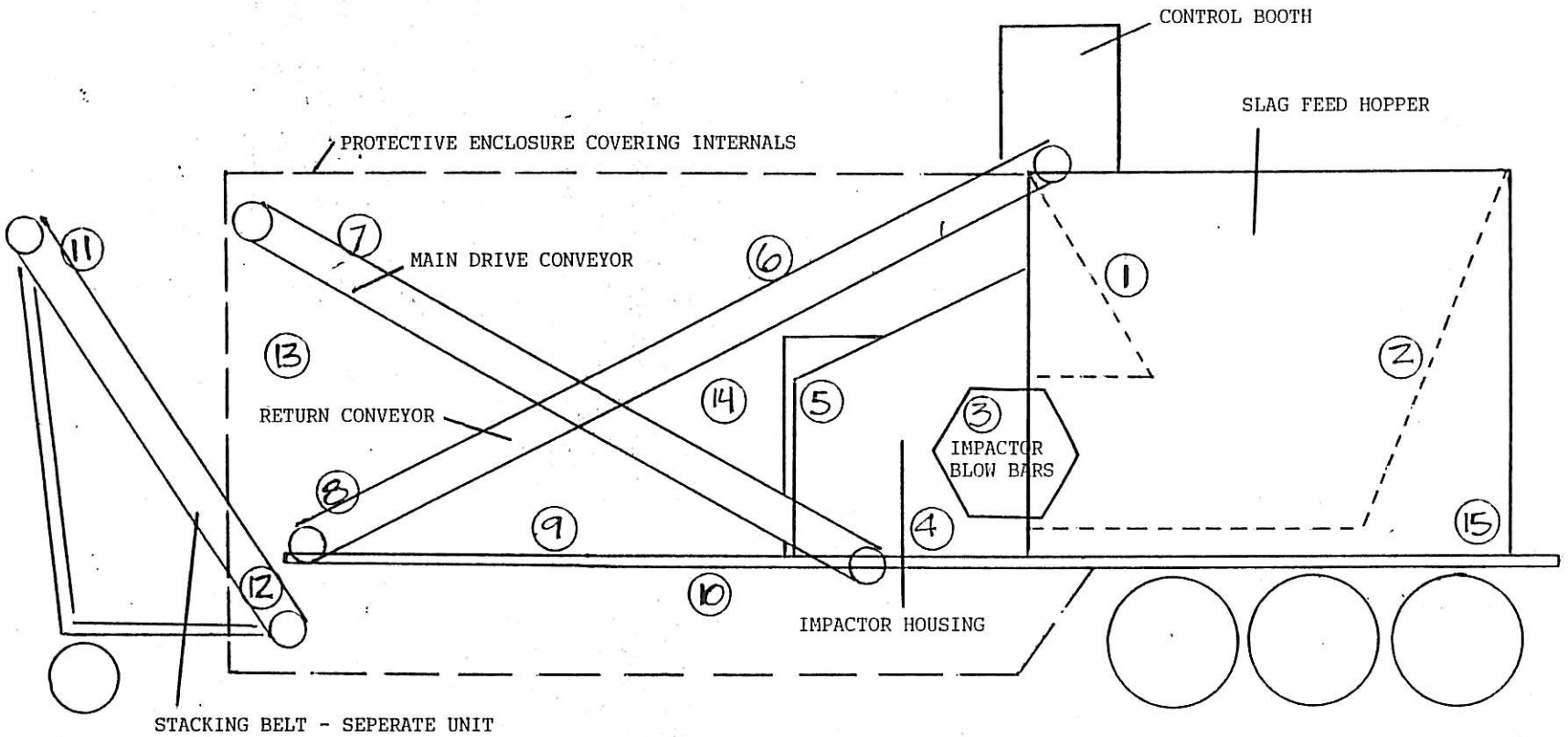
DESCRIPTION OF SURVEY TYPES			
1. BETA-GAMMA CONTAMINATION		2. BETA-GAMMA DIRECT (44-9)	
3. BETA-GAMMA DIRECT (43-68)		4. ALPHA DIRECT (43-65)	
INSTRUMENT S/N	M.2221 S/N 86299	M.2 S/N 40812	ESP-1 S/N 3027
DETECTOR S/N	M.43-68 S/N 082373	M.43-65 S/N 060145	M.44-9 S/N 048271
PROJECT: SMC, NEWFIELD, NJ		DATES: 11/19/91 to 12/20/91	
PERFORMED BY: D. GILL, E. LANING		REVIEWED BY:	

HILBERT ASSOCIATES

HILBERT ASSOCIATES, INC.

RADIATION/CONTAMINATION SURVEY MAP

SCHEMATIC OF CONTRACTOR IMPACTOR - TRAILER MOUNTED



INSTRUMENTATION	
TYPE & S/N	ESP1 s/n 3027 44-9 s/n 048271
TYPE & S/N	M.2 s/n 40812 43-65 s/n 060145
TYPE & S/N	

SMEARS (1) TO (10) INSIDE OF UNIT: LESS THAN 179 dpm/100cm2(MDA) (β,γ)

SMEARS (11) TO (15) EXTERNAL: LESS THAN 179 dpm/100cm2(MDA) (β,γ)

DIRECT SURVEY:

DIRECT BETA-GAMMA SURVEY: NO DETECTABLE ABOVE BACKGROUND
DIRECT ALPHA SURVEY: NO DETECTABLE ABOVE BACKGROUND

DIRECT SURVEY OF HIGH CONTACT AREAS INTERNAL AND EXTERNAL OF UNIT
UNIT CLEANED PRIOR TO LEAVING SITE WORK AREA

LOCATION DESCRIPTION	RELEASE SURVEY OF CONTRACTOR IMPACTOR UNIT	PREPARED BY E. LANING	DATE PREPARED 12/20/91

REVIEWED BY:

SECTION 4.5

RESULTS OF HpGe GAMMA SPECTROSCOPY
PRODUCT SAMPLE ANALYSES

DATE OF REPORT: 12-12-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-01A
SAMPLE VOLUME IS 729 GMS
SAMPLE COUNT TIME IS 35080 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY		pCi/gram			MDAC(pCi/gm)
Th234*	AT 0.093 MEV	8.5	+/-	.544	.6290599
Ra226*	AT 0.186 MEV	5.3	+/-	.3498	.4884834
Ac228**	AT 0.911 MEV	5.9	+/-	.118	9.022941E-02
Ac228**	AT 0.969 MEV	5.8	+/-	.1798	.174045
K40	AT 1.460 MEV	3.3	+/-	.2574	.2594074

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-01B
SAMPLE VOLUME IS 696 GMS
SAMPLE COUNT TIME IS 25062 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY		pCi/gram			MDAC(pCi/gm)
Th234*	AT 0.093 MEV	15	+/-	.705	.9724129
Ra226*	AT 0.186 MEV	6.2	+/-	.5208	.7205901
Ac228**	AT 0.911 MEV	9.58	+/-	.17244	.127631
Ac228**	AT 0.969 MEV	8.87	+/-	.29271	.3060497
K40	AT 1.460 MEV	1.5	+/-	.318	.3772496

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-12-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-01C
SAMPLE VOLUME IS 773 GMS
SAMPLE COUNT TIME IS 5013 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY		pCi/gram			MDAC(pCi/gm)
Th234*	AT 0.093 MEV	13.9	+/-	1.4456	2.080771
Ra226*	AT 0.186 MEV	5.3	+/-	1.1448	1.593831
Ac228**	AT 0.911 MEV	10.3	+/-	.3811	.2612862
Ac228**	AT 0.969 MEV	9.59	+/-	.56581	.5498742
K40	AT 1.460 MEV	2.2	+/-	.616	.67218

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-01D
SAMPLE VOLUME IS 736 GMS
SAMPLE COUNT TIME IS 5009 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY		pCi/gram			MDAC(pCi/gm)
Th234*	AT 0.093 MEV	14.2	+/-	1.4484	2.082673
Ra226*	AT 0.186 MEV	6.3	+/-	1.1277	1.560448
Ac228**	AT 0.911 MEV	9.8	+/-	.3724	.2634686
Ac228**	AT 0.969 MEV	9.62	+/-	.55796	.5159991
K40	AT 1.460 MEV	2.3	+/-	.667	.7065353

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-19-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-02A
SAMPLE VOLUME IS 727 GMS
SAMPLE COUNT TIME IS 20051 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY		pCi/gram			MDAC(pCi/gm)
Th234*	AT 0.063 MEV	5.5	+/-	1.265	1.812517
Th234*	AT 0.093 MEV	12.1	+/-	.847	1.152362
Ra2266*	AT 0.186 MEV	5.9	+/-	.59	.7859818
Ac228**	AT 0.911 MEV	9.5	+/-	.2185	.1687335
Ac228**	AT 0.969 MEV	6.4	+/-	.384	.4279258

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-02B
SAMPLE VOLUME IS 749 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY		pCi/gram			MDAC(pCi/gm)
Th234*	AT 0.063 MEV	3.1	+/-	2.48	5.796352
Th234*	AT 0.093 MEV	10	+/-	2.6	3.744001
Ra2266*	AT 0.186 MEV	6.4	+/-	1.792	2.506117
Ac228**	AT 0.911 MEV	9.5	+/-	.57	.4462815
Ac228**	AT 0.969 MEV	9.2	+/-	1.012	1.045225

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-19-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-02C
SAMPLE VOLUME IS 723 GMS
SAMPLE COUNT TIME IS 2002 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	4.1	+/-	3.69	5.358198
Th234* AT 0.093 MEV	10.2	+/-	2.754	3.684395
Ra2266* AT 0.186 MEV	9.5	+/-	1.71	2.194479
Ac228** AT 0.911 MEV	4.6	+/-	.506	.5182858
Ac228** AT 0.969 MEV	4.4	+/-	.66	.7057616

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-02D
SAMPLE VOLUME IS 792 GMS
SAMPLE COUNT TIME IS 2005 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	4.9	+/-	4.067	5.440339
Th234* AT 0.093 MEV	10.3	+/-	2.472	3.529031
Ra2266* AT 0.186 MEV	3.9	+/-	1.794	2.531137
Ac228** AT 0.911 MEV	8.5	+/-	.51	.2042396
Ac228** AT 0.969 MEV	6.9	+/-	1.104	1.277136

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-19-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-03A
SAMPLE VOLUME IS 659 GMS
SAMPLE COUNT TIME IS 2002 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	3	+/-	2.97	5.781175
Th234* AT 0.093 MEV	3	+/-	2.97	4.287681
Ra2266* AT 0.186 MEV	6.1	+/-	1.83	2.456221
Ac228** AT 0.911 MEV	6.5	+/-	.65	.5417445
Ac228** AT 0.969 MEV	7	+/-	.84	.8697483

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-03B
SAMPLE VOLUME IS 699 GMS
SAMPLE COUNT TIME IS 2002 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	5.1	+/-	3.723	5.511736
Th234* AT 0.093 MEV	11.8	+/-	2.596	3.607647
Ra2266* AT 0.186 MEV	7	+/-	1.68	2.315665
Ac228** AT 0.911 MEV	6.7	+/-	.603	.4466293
Ac228** AT 0.969 MEV	6.2	+/-	.744	.7819868

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-19-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-03C
SAMPLE VOLUME IS 753 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	3.3	+/-	3.267	5.294736
Th234* AT 0.093 MEV	2.3	+/-	2.277	3.949813
Ra2266* AT 0.186 MEV	4.7	+/-	1.739	2.299633
Ac228** AT 0.911 MEV	6.5	+/-	.52	.4171694
Ac228** AT 0.969 MEV	6.8	+/-	.748	.6127191

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-03D
SAMPLE VOLUME IS 634 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	4	+/-	3.8	5.582804
Th234* AT 0.093 MEV	7.6	+/-	2.66	3.796864
Ra2266* AT 0.186 MEV	5.7	+/-	1.824	2.501287
Ac228** AT 0.911 MEV	7.2	+/-	.576	.5210458
Ac228** AT 0.969 MEV	8.5	+/-	.765	.5875211

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-19-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-04A
SAMPLE VOLUME IS 538 GMS
SAMPLE COUNT TIME IS 2004 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	5.3	+/-	4.24	6.266241
Th234* AT 0.093 MEV	11.6	+/-	3.132	4.253805
Ra2266* AT 0.186 MEV	7.1	+/-	2.059	2.78113
Ac228** AT 0.911 MEV	8.5	+/-	.68	.5757946
Ac228** AT 0.969 MEV	7.2	+/-	1.008	1.057405

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-04B
SAMPLE VOLUME IS 680 GMS
SAMPLE COUNT TIME IS 2004 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	2.8	+/-	2.772	5.979997
Th234* AT 0.093 MEV	12.2	+/-	2.684	3.774364
Ra2266* AT 0.186 MEV	6	+/-	1.98	2.721814
Ac228** AT 0.911 MEV	9.8	+/-	.588	.4913207
Ac228** AT 0.969 MEV	8.5	+/-	1.02	1.131047

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 12-19-1991 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-04C
SAMPLE VOLUME IS 658 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	5.8	+/-	3.828	5.704534
Th234* AT 0.093 MEV	10	+/-	2.7	3.721446
Ra2266* AT 0.186 MEV	5.6	+/-	1.904	2.614299
Ac228** AT 0.911 MEV	7.8	+/-	.702	.542297
Ac228** AT 0.969 MEV	7.8	+/-	.78	.6570126

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-04D
SAMPLE VOLUME IS 604 GMS
SAMPLE COUNT TIME IS 20045 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	4.2	+/-	1.26	1.873989
Th234* AT 0.093 MEV	10.2	+/-	.9179999	1.227536
Ra2266* AT 0.186 MEV	5.8	+/-	.638	.8418369
Ac228** AT 0.911 MEV	8	+/-	.24	.1632227
Ac228** AT 0.969 MEV	8	+/-	.32	.2840656

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

HILBERT ASSOCIATES

RADIOLOGICAL ENGINEERS AND CONSULTANTS

DATE OF REPORT: 01-06-1992 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-05A
SAMPLE VOLUME IS 698 GMS
SAMPLE COUNT TIME IS 2002 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	4	+/-	3.04	4.788362
Th234* AT 0.093 MEV	14.2	+/-	2.272	3.179989
Ra2266* AT 0.186 MEV	4.4	+/-	1.628	2.329445
Ac228** AT 0.911 MEV	8	+/-	.56	.389051
Ac228** AT 0.969 MEV	6.8	+/-	1.088	1.264636

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-05B
SAMPLE VOLUME IS 772 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	4.8	+/-	3.36	5.256907
Th234* AT 0.093 MEV	15.5	+/-	2.48	3.380724
Ra2266* AT 0.186 MEV	5.8	+/-	1.798	2.453073
Ac228** AT 0.911 MEV	10	+/-	.6	.4014665
Ac228** AT 0.969 MEV	9.8	+/-	.9799999	.9125609

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

640 MAPLE AVE, RT 9 • SARATOGA SPRINGS, NEW YORK 12866 • 518 584 0166 • FAX 518 584 8529

DATE OF REPORT: 01-06-1992 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-05C
SAMPLE VOLUME IS 668 GMS
SAMPLE COUNT TIME IS 2006 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	3.2	+/-	3.2	5.508687
Th234* AT 0.093 MEV	16.5	+/-	2.475	3.495165
Ra2266* AT 0.186 MEV	6	+/-	1.86	2.597427
Ac228** AT 0.911 MEV	8.600001	+/-	.688	.5598404
Ac228** AT 0.969 MEV	8.5	+/-	1.02	1.053059

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-05D
SAMPLE VOLUME IS 662 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	5	+/-	3.2	5.3275
Th234* AT 0.093 MEV	13.4	+/-	2.68	3.555538
Ra2266* AT 0.186 MEV	6.5	+/-	1.755	2.498502
Ac228** AT 0.911 MEV	8.5	+/-	.595	.4552112
Ac228** AT 0.969 MEV	8.5	+/-	.935	.8653746

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 01-06-1992 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-06A
SAMPLE VOLUME IS 660 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	2.6	+/-	2.6	5.58381
Th234* AT 0.093 MEV	14.8	+/-	2.516	3.601243
Ra2266* AT 0.186 MEV	5.9	+/-	1.888	2.673747
Ac228** AT 0.911 MEV	9	+/-	.63	.4695941
Ac228** AT 0.969 MEV	8	+/-	.96	1.035472

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-06B
SAMPLE VOLUME IS 616 GMS
SAMPLE COUNT TIME IS 2005 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	2.5	+/-	2.5	5.857141
Th234* AT 0.093 MEV	16	+/-	2.72	3.779471
Ra2266* AT 0.186 MEV	8	+/-	1.84	2.539308
Ac228** AT 0.911 MEV	9.5	+/-	.665	.5026348
Ac228** AT 0.969 MEV	8.5	+/-	.935	.9468734

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

DATE OF REPORT: 01-06-1992 HILBERT ASSOCIATES, INC.

****

RADIOACTIVITY CONCENTRATIONS AND MDAC VALUES
FOR
SHIELDALLOY METALLURGICAL CORPPORATION, NEWFIELD, NJ

****

****

SAMPLE IDENTIFICATION IS 65021-06C
SAMPLE VOLUME IS 707 GMS
SAMPLE COUNT TIME IS 2003 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	3.5	+/-	3.36	5.251166
Th234* AT 0.093 MEV	15.4	+/-	2.464	3.426113
Ra2266* AT 0.186 MEV	6.8	+/-	1.768	2.405956
Ac228** AT 0.911 MEV	8.5	+/-	.595	.4863652
Ac228** AT 0.969 MEV	8	+/-	.96	1.029424

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

****

SAMPLE IDENTIFICATION IS 65021-06D
SAMPLE VOLUME IS 704 GMS
SAMPLE COUNT TIME IS 5685 SEC
SAMPLE TYPE IS MARINELLI SAMPLE MATRIX

****

NUCLIDE AND ENERGY	pCi/gram			MDAC(pCi/gm)
Th234* AT 0.063 MEV	2.4	+/-	2.064	3.150492
Th234* AT 0.093 MEV	12	+/-	1.56	2.133377
Ra2266* AT 0.186 MEV	4.8	+/-	1.056	1.48904
Ac228** AT 0.911 MEV	8.5	+/-	.34	.2380424
Ac228** AT 0.969 MEV	8	+/-	.48	.4902311

* URANIUM SERIES(U238) / ** THORIUM SERIES(Th232)
Th234 PHOTOPEAK(0.093) ELEVATED DUE TO Ac228(0.0933)

5.0 Verification Signature

The signature below verifies that the named individual has reviewed the radiological data and final project report and has found this report to be an accurate representation of project operations.

BY: _____ HILBERT ASSOCIATES, INC.
Stephen E. Miller

6.0 References

6.1 Teledyne Isotopes Report of Analysis, Work Order Number 3-3907, 11/91.

6.2 TMA Eberline Report of Analysis, Work Order Number 34232, 01/90.

7.0 Enclosures

7.1 Work Plan: Survey and Sampling Protocol for FeV Slag at the Shieldalloy Corporation, Newfield, NJ, October, 1991.

7.2 Radiation detection instrumentation calibration reports.

HILBERT ASSOCIATES, INC.
RADIOLOGICAL ENGINEERS

RADIATION DETECTION INSTRUMENTATION

REPORTS OF CALIBRATION

ENCLOSURE 7.1

Instrument Services Inc.

GP Instrument Services, Inc.

Form IS-23

CALIBRATION CERTIFICATE

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION

Customer Name: ABG Measurements, Inc.
Customer Address: 640 Maple Avenue
Saratoga Springs, NY 12866

Customer P.O.# 1522
Work Order # I-91-11-207

INSTRUMENT INFORMATION

Instrument Manufacturer Ludlum
Model 2221 Serial Number 86299
External Probe(s) 43-68 Serial # 082373

Calibration Method 99 MP-1 s/n 301
99 Tc s/n 1256
230 Th s/n 11623

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response Before Calib.	Instrument Response After Calib.	Comment
1	X1	100 CPM		100 CPM	All Calibrations Btn. + & - 10%
2		200		200	
3		400		400	Input Sensitivity is set at 10 mV
4					Digital Readout is 285
5	X10	1K		1K	
6		2K		2K	99 Tc Efficiency = 17.5%
7		4K		4K	
8					HV on digital readout is 1690
9	X100	10K		10K	
10		20K		20K	230 Th Efficiency = 17.2%
11		40K		40K	
12					HV on digital readout is 1250
13	X1K	100K		100K	
14		200K		200K	
15		400K		400K	
16					
17	LOG	400 CPM		400 CPM	
18		4K		4.2K	
19		40K		40K	
20		400K		400K	
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: James Christopher (Signed)
Calibration Date: 11-15-91
Next Calibration Due: 05-15-92

I certify that the above information is correct:
Theresa M. Debus 11-15-91
Administrative Coordinator Date

Instrument Services Inc.

GP Instrument Services, Inc.

Form IS-23

CALIBRATION CERTIFICATE

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION

Customer Name: ABG Measurements, Inc.
Customer Address: 640 Maple Avenue
Saratoga Springs, NY 12866

Customer P.O.# 1513
Work Order # I-91-08-207

INSTRUMENT INFORMATION

Instrument Manufacturer Eberline
Model ESP-1 Serial Number 3027
External Probe(s) 44-9 Serial # 048271
44-10 074139
Calibration Method MP-1 s/n 318
^{99}Tc s/n 1256
^{137}Cs s/n 107

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response Before Calib.	Instrument Response After Calib.	Comment
1	N/A	200 CPM		2.00 + 02 CPM	All Calibrations Btn. + & - 10%
2		400		3.97 + 02	
3		800		7.95 + 02	44-9 Probe
4					High Voltage = 900 Volts
5		2K		1.99 + 03	^{99}Tc Efficiency = 13.6%
6		4K		3.98 + 03	
7		8K		7.97 + 03	Instrument was calibrated in Scaler Mode
8					
9		20K		1.99 + 04	
10		40K		3.98 + 04	
11		80K		7.97 + 04	44-10 Probe
12					High Voltage = 900 Volts
13		200K		1.99 + 05	.1 mR/hr = 104,000 CPM in ^{137}Cs field
14		400K		3.98 + 05	Reading was based on 1 minute count
15		800K		7.96 + 05	
16					DT = 1.73 - 06
17					CC = 1.00 + 00
18					
19					
20					
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: James Christopher (Signed)
Calibration Date: 08-28-91
Next Calibration Due: 02-28-92

I certify that the above information is correct:
Theresa M. DeBar
Administrative Coordinator
08-28-91
Date

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

CERTIFICATE OF CALIBRATION

CUSTOMER A B G Measurements Inc ORDER NO. 91-4102
Mfg. Ludlum Model 2221 Serial No. 86308
Mfg. Ludlum Det. Model 44-9 Serial No. PR081878
Cal. Date 9-4-91 Cal. Due Date 9-4-92 Cal. Interval 1yr METERFACE 159

Check mark (✓) applies to applicable instr. and/or detector IAW mfg. spec. s. ☑ New Instrument

☐ Det. (Alpha) Bkgnd ____ cpm ☑ Det. Oper. V 950 V at 10 MV
T 25 °F RH 65 % Alt 706.8 mm Hg ☑ F/S Resp. ck ☑ Zero Reset ck. ☑ Audio ck. ☑ Meter Zeroed
☑ Bat. ck. (Min. Volt) 2.2 4.4 VDC ☐ Bat. Volt ____ VDC Instrument Volt Set 950 V
☑ Threshold Dial 100 = 10 mV Input Sens. 10 mV. ☑ Input Sens Linearity
☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 2000 V
☐ Alarm Setting ck. ☑ Window Operation ☐ Background subtract ☑ Mechanical ck.
Repair Instrument Received: ☐ Within Toler. + -10% ☐ 10-20% ☐ Out Toler. ☐ Requiring Repair

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M. 44-9 in which the front of probe faces source.

RANGE MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT METER READING	INSTRUMENT REC'D "AS FOUND READING"
X 1000	400Kcpm	400	
X "	100 "	100	
X 100	40 "	400	
X "	10 "	100	
X 10	4 "	400	
X "	1 "	100	
X 1	400 cpm	400	
X "	100 "	100	
X			
X			
X			

all Range(s) Calibrated Electronically

	Reference Cal. Point					Instrument Meter Reading					"As Found Reading"				
Digital Readout	/ 400Kcpm	/ 40Kcpm	/ 4Kcpm	/ 400 cpm	/ 40cpm	/ 400(400)	/ 40(40)	/ 4(4)	/ 40(40)	/ 4(4)	/	/	/	/	/
Log Scale	/ 50Kcpm	/ 5Kcpm	/ 5Kcpm	/ 500cpm	/ 50cpm	/ 500K	/ 50K	/ 5K	/ 500	/ 50	/	/	/	/	/

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of MIL- STD-45662A and ANSI N323-1978

☐ Cs137 Gamma s/n 1162, G112, M565 ☐ Neutron Am-241 Be s/n T-304 State of Texas Calibration License No. LO-1333

☐ Alpha s/n ____ ☐ Beta s/n ____ ☑ Other Am241 1.59uci

☑ M-500 s/n 57885 ☐ Oscilloscope s/n ____ ☑ Multimeter s/n A34153

Calibrated By: Thomas J. Hodson Date 9-4-91

Reviewed By: Patrick Brand Date 9-4-91

Form 22 — 7-81

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

CERTIFICATE OF CALIBRATION

CUSTOMER A B G Measurements Inc ORDER NO. 91-4107
Mfg. Ludlum Model 2221 Serial No. 86330
Mfg. Ludlum Det. Model 44-10 Serial No. PR088772
Cal. Date 9-4-91 Cal. Due Date 9-4-92 Cal. Interval 1yr METERFACE 159

Check mark (✓) applies to applicable instr. and/or detector IAW mfg. spec, s. ☑ New Instrument

☐ Det. (Alpha) Bkgnd ____ cpm ☑ Det. Oper. V 900 V at 10 MV
T 75 °F RH 65 % Alt 2068 mm Hg ☑ F/S Resp. ck ☑ Zero Reset ck. ☑ Audio ck. ☑ Meter Zeroed
☑ Bat. ck. (Min. Volt) 4.4 VDC ☐ Bat. Volt ____ VDC Instrument Volt Set 900 V
☑ Threshold Dial 100 ≅ 10mr Input Sens 10 mV. ☑ Input Sens Linearity
☑ HV Readout (2 points) Ref./Inst 498 / 500 V Ref./Inst 1996 / 2000 V
☐ Alarm Setting ck. ☑ Window Operation ☐ Background subtract ☑ Mechanical ck.
Repair Instrument Received: ☐ Within Toler. + -10% ☐ 10-20% ☐ Out Toler. ☐ Requiring Repair

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M. 44-9 in which the front of probe faces source.

RANGE MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT METER READING	INSTRUMENT REC'D "AS FOUND READING"
X 1000	400 Kcpm	400	
X "	100 "	100	
X 100	40 "	400	
X "	10 "	100	
X 10	4 "	400	
X "	1 "	100	
X 1	400 cpm	400	
X "	100 "	100	
X			
X			
X			

all Range(s) Calibrated Electronically

	Reference Cal. Point					Instrument Meter Reading					"As Found Reading"				
Digital Readout	/ 400Kcpm	/ 40Kcpm	/ 4Kcpm	/ 400cpm	/ 40cpm	/ 400K(0)	/ 400K(0)	/ 400(0)	/ 400(0)	/ 40(0)	/	/	/	/	/
Log Scale	/ 500Kcpm	/ 50Kcpm	/ 5Kcpm	/ 500cpm	/ 50cpm	/ 500K	/ 50K	/ 5K	/ 500	/ 50	/	/	/	/	/

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of MIL- STD-45662A and ANSI N323-1978

☐ Cs137 Gamma s/n 1162, G112, M565 ☐ Neutron Am-241 Be s/n T-304 State of Texas Calibration License No. LO-1053

☐ Alpha s/n ____ ☐ Beta s/n ____ ☑ Other Am 241 1.59 uci

☑ M-500 s/n 5285 ☐ Oscilloscope s/n ____ ☑ Multimeter s/n A34153

Calibrated By: Thomas J. Kossa Date 9-4-91

Reviewed By: Patrick Brand Date 9-4-91

Form 22 — 7-91

Form IS-23

Instrument Services Inc.

GP Instrument Services, Inc.

CALIBRATION CERTIFICATE

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		INSTRUMENT INFORMATION	
Customer Name:	ABG Measurements, Inc.	Instrument Manufacturer	Ludlum
Customer Address:	640 Maple Avenue Saratoga Springs, NY 12866	Model 2 Serial Number	40812
		External Probe(s) 43-65 Serial #	060145
Customer P.O.#	1501	Calibration Method	~~230~~ MP-1 s/n 318 Th s/n 11623
Work Order #	I-91-06-207		

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response Before Calib.	Instrument Response After Calib.	Comment
1	X0.1	100 CPM		100 CPM	All Calibrations Btn. + & - 10%
2		200		200	
3		400		395	~~230~~ Th Efficiency = 19.5%
4					
5	X1	1K		1K	
6		2K		2K	
7		4K		3.95K	
8					
9	X10	10K		10K	
10		20K		19.5K	
11		40K		37K	
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: William Owens (Signed)

Calibration Date: 06-10-91

Next Calibration Due: 12-10-91

I certify that the above information is correct:

Theresa M. DeBar — Administrative Coordinator — 06-10-91 Date

SHIELDALLOY METALLURGICAL CORPORATION

Newfield, New Jersey

CALIBRATION DATA SHEET
RAS-1 AIR SAMPLER

Date: 11/15/91

Technician: CRAIG RIEMAN

Mass Flowmeter: TELEDYNE HASTINGS-RAYDIST

Flowmeter:
Model: NALL
Serial No.: 13023

Transducer:
Model: HS-50KS
Serial No.: 17316

Cable: NF-8-NM

RAS-1 SN: 1		RAS-1 SN: 2		RAS-1 SN: 3	
ROTO	ACTUAL	ROTO	ACTUAL	ROTO	ACTUAL
5 lpm	____ lpm	5 lpm	____ lpm	5 lpm	____ lpm
10	____	10	____	10	____
15	15.0	15	15.0	15	15.6
20	20.4	20	20.0	20	20.3
25	24.9	25	24.6	25	25.3
30	29.9	30	29.6	30	30.0
35	34.4	35	34.9	35	34.8
40	39.0	40	39.1	40	39.5
45	43.1	45	42.3	45	42.4
50	45.7	50	45.9	50	46.2
55	49.8	55	49.5	55	50.0

* Readings taken from bottom of ball

REPORT OF CALIBRATION

Electroplated Beta Source S# 639/83

Description of Source:

Principal radionuclide Technetium 99

Electroplated on polished S.S. (type of metal) disc, approximately 0.79 mm thick.

Diameter, 4.45 cm active, 4.77 cm total.

Radioactive material permanently fixed to the disc by heat treatment, without any covering over the active surface.

Calibration Date: September 7, 1983

Measurement Method:

The 2π beta emission rate was measured using an internal gas flow proportional chamber. Traceability to NBS has been demonstrated, the most recent intercomparison with NBS being June and July 1974 when the EIC–NBS agreement was within 0.3%.

Measurement Result:

The total number of beta particles emitted from the surface of the disc per minute on the above date was

17,100 ± 500

The total disintegration rate, assuming 25 % backscatter of beta particles from the surface of the disc, was

27,400 ± 800 (0.0123 uCi)

The uncertainty of the measurement is 3% which is the sum of random counting error at the 99% confidence level and the estimated upper limit of conceivable systematic error in this measurement.

Information on isotopic composition or radioactive impurities:

Calibrated by: Jim Arellano
(please print or type)

(signature)

eberline
Eberline Instrument Corporation
P.O. Box 3874
Albuquerque, New Mexico 87110

TMA
Thermo Analytical Inc.

TMA/Eberline Albuquerque Laboratory
7021 Pan American Hwy. NE
Albuquerque, NM 87109
(505) 345-3461 • FAX # (505) 761-5416

[redacted]

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O. # S-02209
P.O. # 1028

Description of Standard:

Model No. DNS-11 Serial No. 2222/90 Isotope Thorium-230

Electroplated on polished stainless steel disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

Radioactive material permanently fixed to the disc by heat treatment, without any covering over the active surface.

Measurement Method:

The 2π alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below and at the operating voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source SN 11478.

Measurement Result:

The total number of alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was

1,600 ± 160

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was

3,190 ± 319 (0.00144 uCi)

The uncertainty of the measurement is 10 % which is the sum of random counting error at the 99% confidence level and the estimated upper limit of systematic error in this measurement.

Calibrated by: Kathryn J. Hicks Reviewed by: Donald L. Taylor

Kathryn J. Hicks
Calibration Technician

Donald L. Taylor QC
Q.A. Representative

Calibration Date: 12/31/90 Reviewed Date: 01-02-91

HILBERT ASSOCIATES, INC.
RADIOLOGICAL ENGINEERS

WORK PLAN FOR SURVEY AND SAMPLING OF FeV SLAG AT THE SHIELDALLOY CORPORATION

ENCLOSURE 7.2

HILBERT ASSOCIATES, INC.
RADIOLOGICAL ENGINEERS AND CONSULTANTS

WORK PLAN

SURVEY AND SAMPLING PROTOCOL FOR FeV SLAG AT THE SHIELDALLOY CORPORATION NEWFIELD, NEW JERSEY

PREPARED FOR

SHIELDALLOY METALLURGICAL CORPORATION
WEST BOULEVARD
NEWFIELD, NEW JERSEY 08344

PREPARED BY

HILBERT ASSOCIATES, INC.
640 MAPLE AVENUE
SARATOGA SPRINGS, NEW YORK 12866

OCTOBER 1991

TABLE OF CONTENTS

SECTION 1.0 INTRODUCTION

1.1 Background

The Shieldalloy Metallurgical Corporation (SMC) of Newfield, New Jersey manufactures a variety of specialty ferro alloys from ore materials. The process methods for two of the manufactured products each produces a byproduct from the operation; FeCb (ferrocolumbium) and FeV (ferrovanadium) slag. The FeCb slag is unique in that the ore contains naturally elevated concentrations of thorium and uranium. The thorium and uranium in the FeCb slag typically exceed 0.05% by weight and are subject to and controlled by the USNRC Source Material License held by SMC. The other FeV slag does not contain licensable quantities of radioactive material and SMC plans to sell this product to other manufacturers. Both types of slag are stockpiled in segregated areas located at the eastern end of the SMC property. This area is refered to as the Source Material Storage Yard (SMSY).

SMC has formatted a radiological, direct-reading screening and sampling protocol in order to assure the FeV slag product does not exceed the regulatory limits for radioactive source material and is not appreciably contaminated with other materials having higher concentrations of radioactivity than the FeV slag. This plan describes the radiological methodology designed to screen the FeV slag.

1.2 SMC Site Work Area Description

The general work area is the eastern end of the SMSY extending from the western limit of the FeV slag stockpile(s) to the site security fence. The work area is adjacent to the radiologically controlled area (RCA) associated with the FeCb source material slag piles.

Work activities in this area can be summarized as follows:

1.2.1 Removal of FeV slag from existing stockpile(s) and initial gamma radiation screening surveys of material directly upon removal.

1.2.2 Transfer of FeV slag to an intermediate laydown area for a detailed gamma radiation screening survey. If FeCb source material is found during the above gamma screening surveys are to be removed and later returned to the original FeCb

storage piles. This intermediate laydown area will be established east of the existing FeV slag piles in the open area of the east end of the SMSY. A schematic representation of the work area is shown as Enclosure E.

1.2.3 The subcontractor will draw screened material from the intermediate laydown area for crushing operations. Several product piles will be created and fully identified for later disposition. Sampling and gamma spectroscopy analysis for Th232 and U238 will be performed for each of the product piles as described in this plan.

The work area established in this plan has been previously characterized by others (ORAU 88) and has elevated gamma radiation levels contributed from shine by the two primary FeCb slag piles in the RCA.

The source material FeCb slag can be described as discrete rock-like material with no significant transferable contamination hazard, although small particle fines and other isolated areas of FeCb non-slag materials have been evidenced in the RCA.

For the purpose of this plan, the entire work area will be established and regarded as an RCA. The work area is shown as Enclosure A to this plan.

1.3 Scope and Purpose

The scope of this plan integrates the radiological survey, sampling and health and safety program with the subcontractors crushing operation. The purpose of this work activity as implemented in this plan is to assure that:

1.3.1 work is performed in a safe and efficient manner in accordance with SMC contractual requirements and USNRC regulatory requirements.

1.3.2 a creditable radiological survey and sampling program is maintained to ensure the FeV product material meets the permissible radioactivity concentration limits and that no appreciable contamination with source material or other licensed material is contained within.

The final confirmatory sampling of the FeV product material will provide the analytical basis for characterization of the product material as non-source material and that no appreciable contamination with source material or other licensed material is contained

within. 'Source material' means: (i) Uranium or thorium, or any combination thereof, in any physical or chemical form; or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of (a) uranium (b) thorium or (c) any combination thereof. (10CFR20)

The gamma spectroscopy quantatative measurements described in this plan will measure the Thorium and Uranium radioactivity concentrations in the product material for direct comparison to the source material weight percent limits and confirmation of the non-radiological status of the product material.

SECTION 2.0 HEALTH AND SAFETY REQUIREMENTS

2.1 Radiological Health and Safety

2.1.1 Radiological Training

Federal law (10CFR19) requires licensees to provide instruction to workers involved with handling radioactive materials in restricted areas. The instruction is intended to inform personnel of the potential hazards and their individual responsibility, and that of the licensee, for implementation of the radiation safety program.

All project personnel shall receive this training and familiarization prior to the start of operations. Documentation of this training shall be signature verified on Enclosure B to this plan.

2.1.2 Personnel Radiation Exposure Monitoring

All personnel engaged in segregation and crushing operations shall wear a radiation exposure monitoring device called a Thermolumniscent Dosimeter (TLD). The TLD will be worn on the front portion of the trunk of the body and issued and returned on a daily basis. Upon project completion, the TLD's will be returned to an accredited dosimetric laboratory for analysis of integrated radiation exposure for each individual. Each worker may request and receive a copy of the TLD exposure report for this project for their personal and/or employer records.

The general gamma radiation level extant in the work area varies approximately from 20 uR/hr to 40 uR/hr. Although the work will be planned to take advantage of naturally shielded areas and selection of areas with lower radiation levels for stationary work, a potential exists for an individual to receive a detectable (mRem) gamma radiation exposure. However, detectable exposures are expected to be extremely small and well within allowable unrestricted area limits.

2.1.3 Bioassay Monitoring

Personnel will be monitored for the potential ingestion and inhalation of radioactive materials by urinalysis bioassay. Two one-liter urine samples shall be collected from personnel, one each at the start and termination of project operations and collected over a 24 hour period. An accredited vendor laboratory will perform radiochemical analysis for U238 and Th232 on each set of individual samples. No uptake of radioactive material is expected due to the physical form of the radioactive material (FeCb) and the limited handling of the FeCb slag. Results of bioassay monitoring can be requested by individuals.

2.1.4 Respiratory Protection and Personal Protective Equipment

Respiratory protection for airborne radionuclides will not be required for these work activities. No abrasive handling of radioactive material will be performed and work activities will be performed in areas well distanced from the FeCb slag piles. Air sampling will be performed on a periodic basis as discussed in 2.1.6.

Personal protective equipment and clothing for anti-contamination concerns will not be required for this work. Occupational health and safety PPE will be required as described in 2.2. Manual handling of manageable fragments of FeCb slag will be done using work gloves for hand protection. No removable contamination is expected from handling of FeCb material, however, nominal contamination control practices will be performed to verify contamination conditions as discussed in 2.1.5.

Eating and drinking will not be allowed in the

work area except in a break area approved by the licensee.

2.1.5 Contamination Controls

A program for contamination controls will be implemented for personnel and equipment to verify contamination status as follows:

2.1.5.1 periodic surveys of work gloves and other high contact items for beta-gamma contamination in allowable low background areas in the work area.

2.1.5.2 whole body beta-gamma surveys of personnel and equipment surveys after leaving the controlled area in the closest allowable low background area outside the controlled area.

Results of routine contamination surveys will be used to adjust contamination control program requirements.

2.1.6 Radiation Detection Instrumentation

Calibrated radiation detection instrumentation of the following types and applicability will be utilized on the project:

2.1.6.1 Portable ratemeters/scalers with 2" x 2" NaI gamma scintillation detectors for survey and segregation of slag material, e.g., Ludlum M.2221 with M.44-10 detector.

2.1.6.2 Portable ratemeters/scalers with gas flow proportional detectors for general beta-gamma surveys, e.g., Ludlum M.2221 with M.43-68 detector.

2.1.6.3 Portable ratemeters with alpha scintillation detectors, e.g., Ludlum M.3 with M.43-65.

2.1.6.4 Portable gamma scintillation detector for general gamma exposure rate surveys in uR per hour, e.g., Ludlum M.19.

2.1.6.5 Low volume (1 to 3 cfm) air samplers, e.g., Eberline RAS-1. Periodic air samples will be taken downwind of

handling and crushing areas during the duration of the project. Air samples will be analyzed to show compliance with the Th232 allowable air concentration limit of 1.0E-12 uCi/cc for unrestricted areas.

2.2 OCCUPATIONAL HEALTH AND SAFETY

2.2.1 Personal Protective Equipment and Training

All personnel shall wear hard hats, safety glasses, and safety (steel toe) shoes for this work as required by the SMC safety program for on-site work. All subcontractor personnel shall review and comply with all provisions of the SMC safety program while working at the SMC site.

2.2.2 Noise Monitoring and Abatement

SMC will provide noise monitoring during heavy equipment operations. Noise abatement methods and/or hearing protection will be provided by the subcontractor as required by SMC compliance requirements.

2.2.3 Dust Abatement

The contractor crushing mill shall not generate any visible dusts during operations. The contractor shall ensure that installed dust mitigation systems, e.g., water mist or ventilation containment, are operable and effective. SMC will monitor crushing operations for dust abatement integrity and compliance requirements.

2.2.4 Lifting and Handling

Personnel shall not lift or handle slag which require more than a nominal effort by one person. Large slag pieces destined for segregation shall be handled and transferred by front end loader or equivalent equipment.

Personnel shall not climb slag piles for access to survey. Surveys and handling of slag shall be done from a firm level surface.

SECTION 3.0 WORK PROCEDURE

Enclosure C presents a process flowchart of the work methodology.

3.1 Initial Radiation Survey

The FeV slag pile will be accessed on the south side for slag debris removal with a front end loader. Radiological control technicians (RCT) personnel will perform initial gamma radiation scan surveys of the slag material using 2" x 2" NaI detectors. Due to the variability in background gamma radiation and the discrete 'point source' radiation intensity of the FeCb slag, any indication of radiation which exceeds twice the background radiation shall be indicative of potential FeCb slag radiation contributions.

3.1.1 Large FeCb slag pieces shall be spray painted with a durable and highly visible mark for later removal with power equipment. Small pieces may be manually removed and set aside in a controllable area for later disposition.

3.1.2 The RCT will continue gamma suveys on accessible pieces of slag in the loading area and front end loader as work continues. Personnel shall stand well back from the slag pile during loading operations to avoid being struck by sliding material.

NOTE: The initial survey at the loading area will not be able to access all slag in the front end loader. The purpose of this survey point is to mark individual slag pieces on top of the load as well as to prevent large quantities of FeCb slag being added in the FeV pile.

3.2 Transfer and Detailed Radiation Survey

The front end loader will transfer the load to an intermediate laydown area, the extent of which has been initially surveyed with the NaI detector to determine the magnitude of the background radiation at the surface of the area. The FeV slag will be discharged and spread in rows as operations continue. The exposed slag will be surveyed to the

same criteria of 3.1. If radiation contributions which exceed twice background are detected, the immediate area of the slag will be investigated in a detailed manner with the NaI detector to identify radiation sources. The planar distribution of slag will allow for physical access and a detailed survey of the material.

The front end loader may then transfer FeV slag material to a predetermined area positioned for the subcontractors crushing machinery after any identified FeCb slag has been removed. The discharge and removal of slag from the intermediate laydown area should be sequenced such that surveys and heavy equipment operations can continue in an uninterrupted manner. RCT personnel shall be responsible to ensure that suspect marked slag is removed and controlled prior to transfer of FeV slag to the crushing machinery location.

Continue sequence of operations until sufficient FeV slag has been transferred to the crushing machinery location. Operations may be interrupted to remove large pieces of FeCb slag and transfer to an approved area.

3.3 FeV Product Sampling

Representative samples of the FeV product material will be taken during the crushing operations. Samples of small particle fines will be collected and transferred to 500 cc Marinelli geometry containers for gamma spectroscopy analysis. Four samples will be collected for each of the individually identified product piles created as a result of crushing operations. The product piles and samples will be uniquely marked and labeled for identification.

Enclosure D describes the analytical methods and criteria for confirmatory sampling of product material.

3.4 Equipment Release Surveys

All materials and equipment removed from the RCA shall be surveyed for fixed and removable contamination in accordance with the criteria of reference USNRC87:

3.4.1 1000 dpm per 100 cm2 for alpha and beta-gamma radioactivity averaged over an area not greater than 1 square meter.

3.4.2 A maximum of 3000 dpm per 100 cm2 for alpha and beta-gamma radioactivity within a 1 square meter area.

3.4.3 A maximum of 200 dpm per 100 cm2 of removable contamination for alpha and beta-gamma radioactivity.

The above contamination limits are to be independently applied for alpha and beta-gamma measurements.

SECTION 4.0 DOCUMENTATION

A final report of work task activities will be completed for transmittal to SMC which will include the following information:

- Work Plan
- Dosimetry results
- Bioassay results
- Instrumentation calibration certification sheets
- Gamma spectroscopy results
- Summary of project activities
- Applicable radiation and contamination survey forms
- Air sampling results

ENCLOSURES

Enclosure A	Site Work Area Location
Enclosure B	Radiation Safety & Familiarization Training
Enclosure C	Process Flowchart
Enclosure D	Analytical Methods and Criteria
Enclosure E	Work Area Operations Schematic

REFERENCES

10CFR19 Code of Federal Regulations, Title 10, Part 19, 'Notices, Instructions, and Reports to Workers; Inspections', 1989.

10CFR20 Code of Federal Regulations, Title 10, Part 20, 'Standards for Protection Against Radiation',

1989.

ORAU 88 'Radiological Survey of the Shieldalloy Corporation, Newfield, NJ', Final Report, July 1988, ORAU 88/G-79.

USNRC87 'Guidelines for Decontamination of Facilities and Equipment Prior to Release For Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material' USNRC Division of Industrial and Medical Nuclear Safety, August 1987.

RCP800A Hilbert Associates, Inc., Procedure RCP-800A, 'HpGe Gamma Spectroscopy Analysis'.

RCP200 Hilbert Associates, Inc., Procedure RCP-200, 'Radiation Detection Instrumentation'.

RCP225 Hilbert Associates, Inc., Procedure RCP-225, 'Radiation Surveys'.

RCP500 Hilbert Associates, Inc., Procedure RCP-500, 'Contamination Controls'.

GENERAL WORK AREA DESCRIPTION

SHIELDALLOY METALLURGICAL CORPORATION, NEWFIELD, NJ

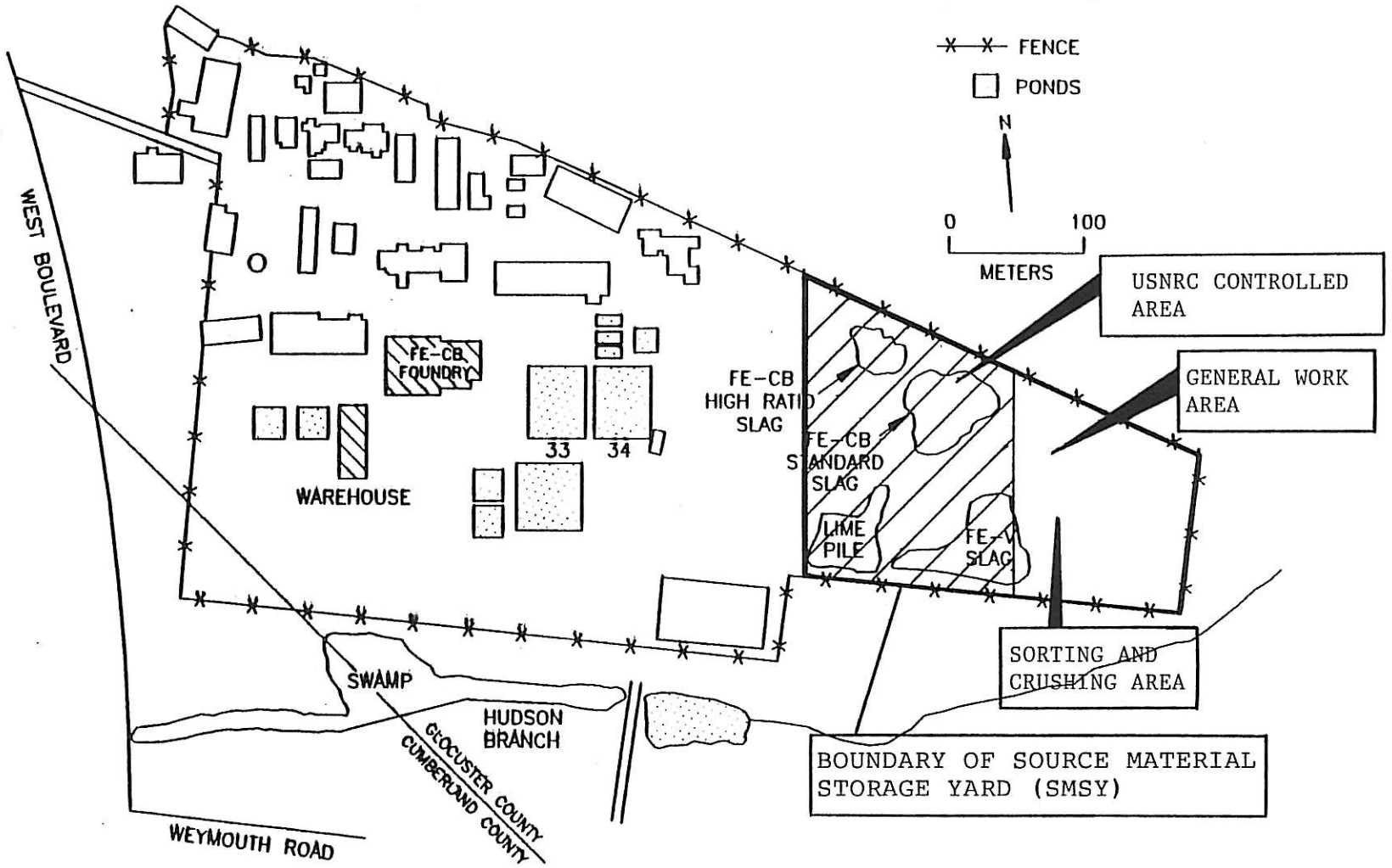


FIGURE 2: Layout of the Shieldalloy Plant in Newfield, New Jersey

NOTE: DRAWING ADOPTED FROM REFERENCE ORAU 1988

ENCLOSURE A

HILBERT ASSOCIATES, INC.
for SHIELDALLOY METALLURGICAL CORPORATION

RADIATION SAFETY & FAMILIARIZATION TRAINING

The purpose of this training program is to instruct and inform supervision and technicians involved in work at the SMC site of the existing radiological conditions and of the radiation safety program requirements. Elements of this program to be reviewed include the following:

- Review and discussion of the known low level radioactive contaminants at the site.
- Radiation and contamination controls incorporated into the site Work Plan for excavation and crushing operations.
- Personnel monitoring for radiation exposure; dosimetry and bioassay requirements.
- Radiological posting of site areas, if required.
- 10CFR19 requirements for Instruction to Workers.

I have attended the above seminar/discussion and received instruction on the radiological safety program at the SMC site and understand the following:

- Exposure to whole body radiation shall be monitored by personal TLD dosimeter. All radiation exposure and controls will conform to the legal requirements of 10CFR20.
- I will be additionally monitored for uptake of radioactive materials by urinalysis bioassay.
- I can request and receive the results of radiation exposure monitoring and bioassay monitoring upon completion.
- I am aware of my individual responsibility for the implementation of the radiation safety program for this project.

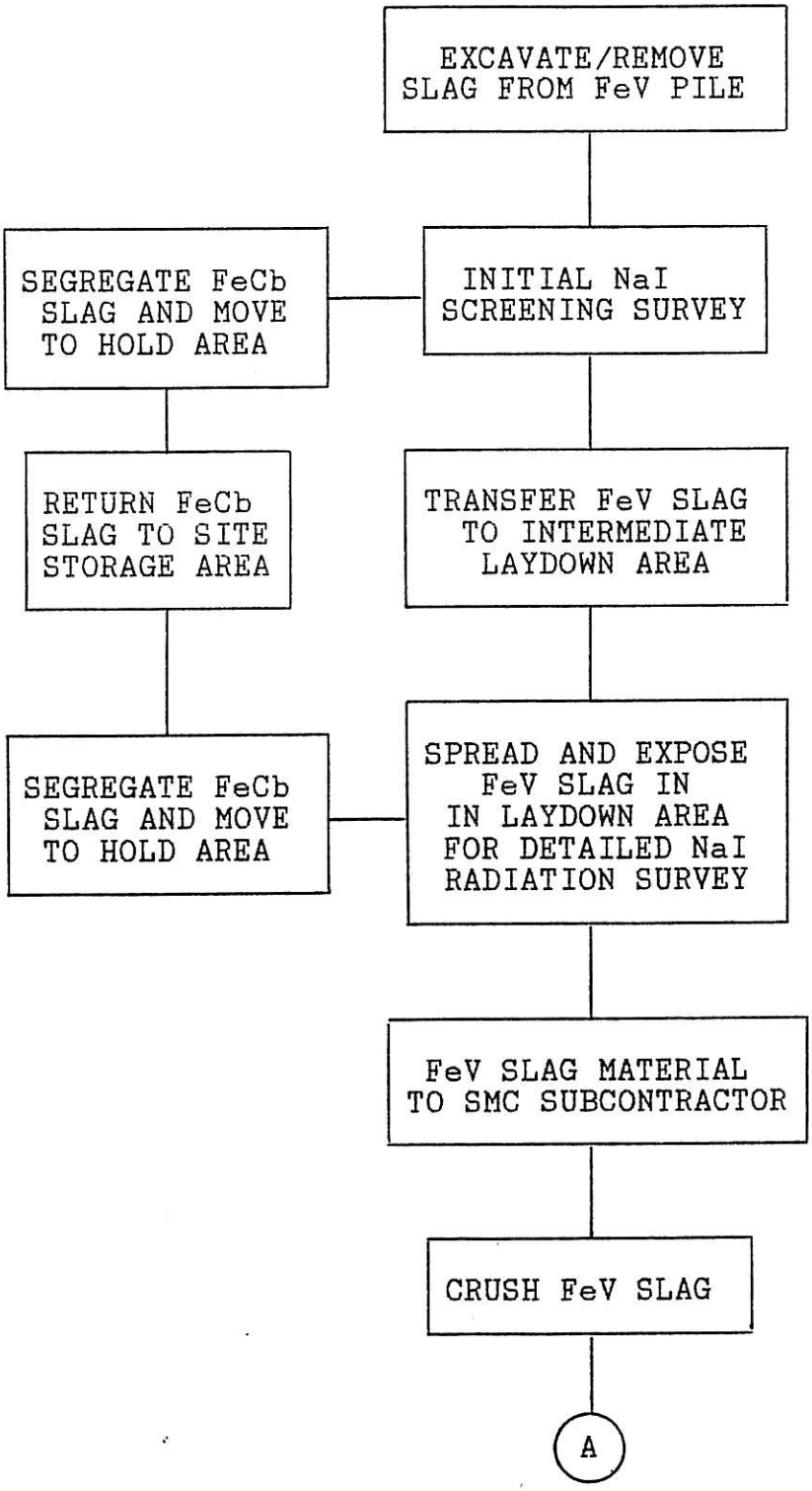
SIGNATURE_____DATE_____

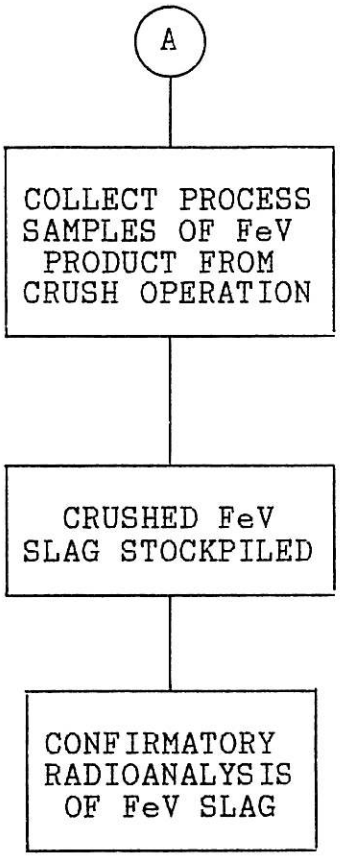
ENCLOSURE B

HILBERT ASSOCIATES, INC.

PROCESS FLOWCHART

SURVEY AND SEGREGATION OF FeCb SLAG
FROM FeV SLAG AT THE SMC SITE
NEWFIELD, NJ




A
COLLECT PROCESS SAMPLES OF FeV PRODUCT FROM CRUSH OPERATION
CRUSHED FeV SLAG STOCKPILED
CONFIRMATORY RADIOANALYSIS OF FeV SLAG

HILBERT ASSOCIATES, INC.
SHIELDALLOY METALLURGICAL

GAMMA SPECTROSCOPY ANALYSIS

HpGe gamma spectroscopy analysis for product sample material will be performed for quantatative determination of the following primary radionuclide photopeaks at a 90% confidence level:

Th234	at	0.093 MeV
Ra226	at	0.186 MeV
Ac228	at	0.911 MeV

Th234 and Ra226 are daughter radionuclides in the naturally occuring Uranium (U238) decay series. The Th234 photopeak analysis result will be used to infer the U238 radioactivity concentration based upon secular equilibrium conditions.

Ac228 is a daughter radionuclide in the naturally occuring Thorium (Th232) decay series. The Ac228 photopeak analysis will be used to infer the Th232 radioactivity concentration based upon secular equilibrium conditions.

Other secondary photopeaks, including Actinium (U235) decay series radionuclides, may be analyzed and reported as confirmatory radionuclides.

SOURCE MATERIAL RELEASE CRITERIA

The results of product confirmatory sample analysis are required to confirm the non-source material status of the FeV product material. The legal definition of source material (Natural Thorium and Natural Uranium) typically expressed as 0.05% by weight of Thorium and/or Uranium can be alternately expressed as radioactivity concentration (pCi per gram of material) for direct comparison to HpGe radioanalysis results as follows:

Th232: 0.0005 x 1.09E+05 pCi/gram = 54 pCi/gram

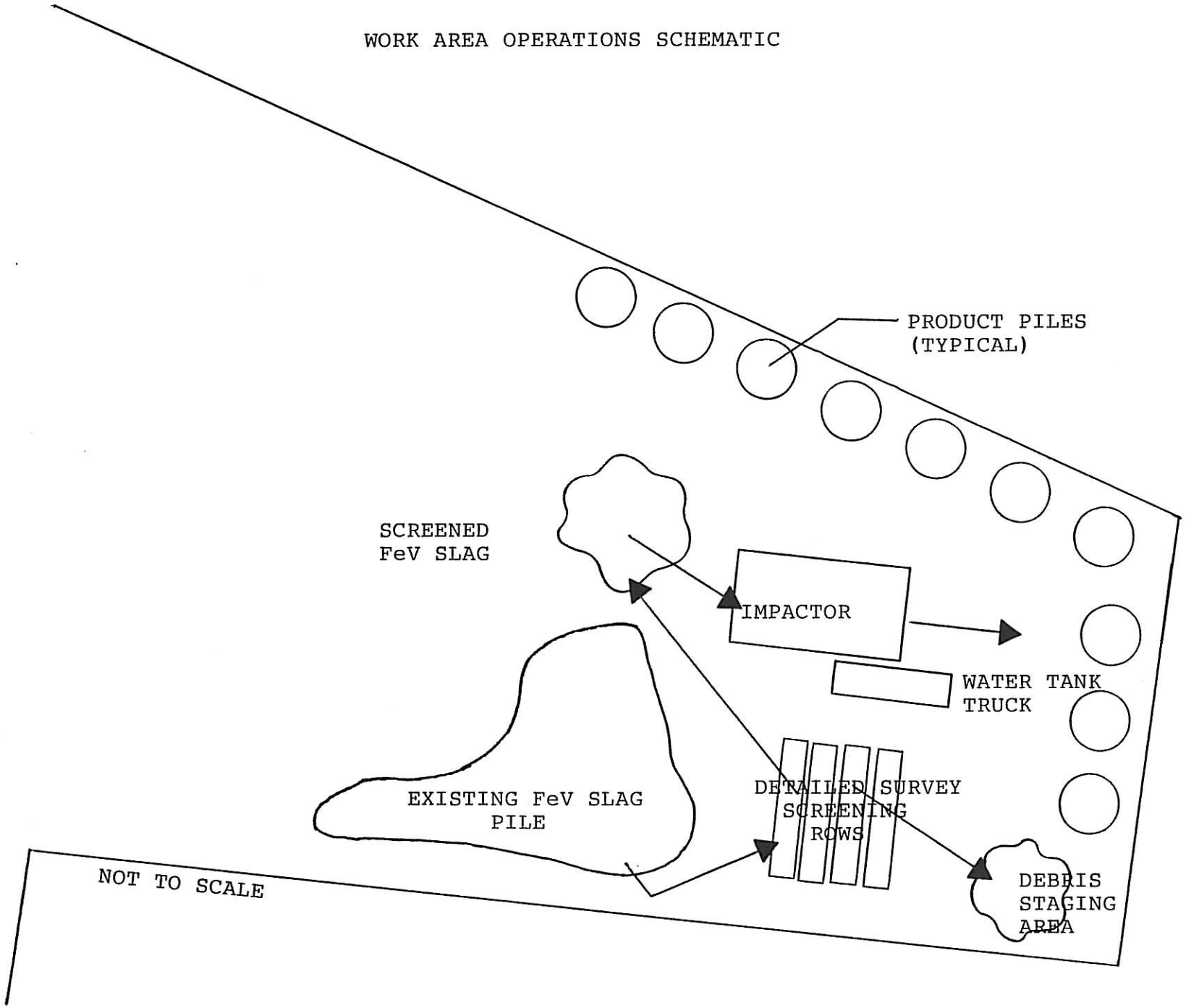
This equivalent radioactivity concentration for Th232 will be limiting for combinatory Thorium and Uranium mixture in this material. The actual results of sampling are expected to be well within this concentration and at or near the natural(1) radioactivity concentrations for U238 and Th232 in the FeV material:

Th232: Average background concentration is 7 pCi/gram
U238: Average background concentration is 8 pCi/gram

(1) From prior radiochemistry analysis of FeV slag by TMA Eberline for SMC, 01/90.

ENCLOSURE D

WORK AREA OPERATIONS SCHEMATIC



ENCLOSURE E