

PURPOSE

The purpose of this evaluation, conducted by Industrial Hygiene personnel, was to determine whether a potential radiation hazard existed during grinding and welding operations using thoriated tungsten electrodes.

INTRODUCTION

Thoriated tungsten electrodes are commonly used in arc welding due to ease of starting, less weld metal contamination and greater arc stability. These electrodes are typically used in the aircraft, petrochemical, construction and food processing equipment industries. The electrodes are ground to a fine tip using a grinding wheel. Grinding generally takes from about 30-90 seconds per electrode depending upon the technique and experience of the welder.

This evaluation was made to determine the airborne concentration of thorium containing particulates during grinding and whether this posed a potential hazard to the operator. The use of thoriated tungsten electrodes may contribute to internal exposure through the inhalation of thorium in particulates that may become airborne during grinding. The welding operation was also considered in this evaluation, since welding fumes may be another source for internal exposure.

In preparation for this evaluation a literature search was performed to gather information of similar studies. This literature search included the period 1957-to the present. During this time only three articles were published which addressed welding with thoriated tungsten electrodes. An article published by Breslin and Harris¹ in 1952 is the only one that presented the results from actual monitoring data. Subsequent articles made estimates of radiation exposure and dose.

"Use of Thoriated Tungsten Electrodes in Inert Gas Shielded Arc Welding-investigation of potential hazard" A.Breslin and W. Harris, U.S. Atomic Energy Commission, published in 1952." ¹

This paper reported the results of an investigation that gathered air sampling data during welding operations using thoriated tungsten electrodes. Breslin and Harris reported breathing zone and area air sampling results as well as the rate of consumption of the electrodes. The reported rate of release was found to be a direct function of electrode consumption.

Measurements of the amounts of thoriated material that become volatilized from welding fumes were taken. The results from air samples collected to measure total activity released in fumes were below the maximum allowable

concentration in the breathing zone of the operator. This report concluded that within the test limits no significant hazard to the operator was present from the use of inert gas welding using thoriated tungsten electrodes, nor was special ventilation or protective equipment needed. Another conclusion made was that the external radiation from the handling of these rods was also insignificant.

The welding operation included grinding and therefore additional measurements specifically during grinding were not taken.

"Estimated Radiation Doses from Thorium and daughters contained in thoriated welding electrodes" by L.M. McDowell-Boyer, 1979. This paper was prepared for the U.S. NRC Office of Standards Development by Oak Ridge National Laboratory." ²

This paper reported estimates of radiation doses. These estimates were based on data reported by Breslin and Harris and included a variety of assumptions developed from information gathered through interviews with welders, documentation on consumer distribution procedures and common disposal methods used in the United States. When uncertainties existed the estimates were made from supplementary data. These estimates showed that the maximum permissible concentration (MPC) for thorium in air will "seldom, if ever be exceeded in the immediate vicinity of a welder and will even less likely be exceeded in the welder's breathing zone."² This statement made a direct reference to the Breslin and Harris article of 1952.

The maximum estimated 50 year dose commitment reported in this paper for welders who work both in a shop and at home, 4 hours per day for a total of 1200 hours/year, was a maximum of 2.4-88 millirem whole body with the typical values between 0.07-2.7 millirem. Due to the uncertainties of these estimates a narrower range was not obtained according to the author.

This report did not estimate specific doses from particulates generated during the grinding operation. Grinding was considered part of welding. The doses reported were "individual and collective doses and dose ranges for whole body received during the use of thoriated tungsten welding electrodes (per one million electrodes used annually).

*"Doses from the use of Welding Electrodes Alloyed with Thorium oxide" by E.Stranden of the Statens Institute for Straalehygiene, Oslo Norway was published in the Government Reports Announcement and Index in 1981."*³

The abstract of this paper cites previously reported values (referring to Breslin and Harris) to calculate the radiation dose from inhalation and compared these to the ICRP 1979 value of the annual limit of intake for thorium oxide. The dose estimates were reported to be lower than the annual limit of the

ICRP. The conclusion drawn from this report was "there is no reason to forbid the use of thoriated alloyed welding electrodes at present, but that the matter should be followed up and the use of these electrodes limited as far as possible."³

*"Radiation exposure of the U.S. Population from Consumer Products and Miscellaneous Sources" issued December 1987 from the National Council on Radiation Protection and Measurements (NCRP) report number 95."*⁴

Chapter 3 of this report addresses natural radioactive elements. Section 3.2.8 specifically refers to thorium products. It estimates that 1,350-1500 kilograms of thorium dioxide are used annually to manufacture thoriated tungsten electrodes in the US for use in a variety of industries. Annual distribution as of 1980 was estimated at 5.2 million welding rods. The report cites the McDowell-Boyer² paper for dose estimation. Buckley et al.⁵ report that the typical 50 year whole body dose commitments due to internal exposures range from 0.4-14 millirem (4-140 μ Sv) for welders considered as heavy users. The external dose rates were estimated to be less than 1 millirem per year (10 μ Sv/yr).

The conclusions stated from the previously cited reports were essentially similar. The use of thoriated tungsten electrodes during welding did not pose a hazard to the operator. However, measurements and specific estimates from the grinding of electrodes containing thorium oxide were not taken or made. Therefore the primary goal of this evaluation was to assess the airborne concentration of thorium during grinding to determine whether a hazard to the operator was present.

MATERIALS AND METHODS

Eight air samples were collected from area locations and welder personal breathing zone while the welder ground tungsten electrodes containing thorium oxide to form an appropriate tip for tungsten inert gas welding.

An additional six air samples were collected from area locations near the welder during a welding procedure using a thoriated tungsten electrode. Two filter media discs were placed on horizontal surfaces surrounding the welding area to evaluate the potential for deposition of thorium from the welding procedures. Wipe test samples were also collected following grinding operations.

JOB DESCRIPTION

The welder job classification is responsible to grind thoriated tungsten electrodes for further use in inert gas shielded welding and complete set up of welding equipment depending on the type of metal to be welded and configuration of the metal fixture. Welding time is determined by the degree of difficulty to complete a quality weld. Welding parameters may vary through out the procedure and the welder may change positions frequently to complete a weld.

WELDING MACHINE AND ENVIRONMENTAL CONDITIONS

WELDING MACHINE (SET UP PARAMETERS)

The following are conditions used for inert gas shielded arc welding during this survey:

MANUFACTURER : MILLER

MODEL/POWER SOURCE: SYNCHRO - WAVE 250

OPERATING AMPERAGE: 75 DC

SET UP

START : HIGH FREQUENCY

SHIELD GAS: ARGON

POST FLOW: ON

ENVIRONMENTAL CONDITIONS

The Fabrication Shop is a single story building with ceiling heights of 60 feet and general ventilation fans exiting through the ceiling and local ventilation exiting through the side walls. Large doors are opened and closed through out the day generating natural air currents within the building. Welders flash screens are used to prevent inadvertent and unprotected eye viewing during welding operations. These screens also assist in preventing strong air currents from disturbing the shield gas flow during arc welding. Air temperature within the Fabrication Shop were between 65 and 75 degrees Fahrenheit.

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SELECTION OF AIR SAMPLING LOCATIONS

ELECTRODE GRINDING

Manual grinding of thoriated tungsten electrodes to a conical tip for welding purposes is required to facilitate quality welding of many heat sensitive metals. Current practices involve the use of ball bearing type bench grinder positioned on a grinding pedestal. Recently, the thoriated tungsten electrode tip grinding technique has been improved by the use of a motorized belt grinder on a pedestal.

Four air samples were collected during tasks at each grinder. One personal air sample collected total particulate from the breathing zone of the welder. One personal air sample collected respirable fraction of particulate using a Bendix BDX99R Respirable Dust Sampler, # 7010048 from the welder's breathing zone. The two personal breathing zone samples were collected while the welder ground the thoriated tungsten electrodes.

Since the position of the personal air sampling device is critical to represent the welder personal breathing zone, the personal samplers were positioned behind the protective face shield worn by the welder .

INERT GAS SHIELDED ARC WELDING

Two different welding operations were evaluated during this survey period. A single, short duration welding task involving the repair of a two inch zinc primed carbon steel pipeline located approximately thirty feet above ground level was evaluated while a welder installed a length of pipe. Only one area air sample was collected from a three feet by four feet by six feet enclosure used to shelter the welder from the effects of the weather. A longer welding operation was evaluated in the Michigan Division Fabrication Shop and involved several welding tasks over a six to seven hour period. -The locations of the air samples were selected to collect potential emission from the welding process.

Air samplers were moved occasionally during the sampling period to allow the welder to position the work pieces for optimum efficiency and quality of the welds.

SURFACE DEPOSITION OF WELDING FUME

Two DM-800 filter media discs(Gelman Scientific, Inc., Ann Arbor, MI) were placed at locations behind and to the left of the welder during welding using thoriated tungsten electrode. The purpose of the surface deposition

evaluation was to determine if welding fumes containing thorium were settling on surrounding surfaces.

WIPE TEST SAMPLES

Wipe test samples were collected in the area adjacent to the grinding operations to determine whether removable surface contamination was present.

SAMPLE COLLECTION : FILTER MEDIA AND AIR PUMPS

Air filter samples for area total particulate were collected on 47 millimeter diameter vinyl acetate membrane filters with a nominal pore size of 0.8 micrometers (Gelman DM-800, Gelman Scientific, Inc., Ann Arbor, MI). The filter media were placed with support pad in an open faced aluminum filter holder and to the holder connected to a high flow rate pump operated on 115 volt AC. Flow rates were set between 19 and 21 liters per minute using a calibrated rotometer and the rate was checked after the air sampling periods.

Breathing zone samples for total particulate were collected on 37 millimeter diameter vinyl acetate filters with a nominal pore size of 0.8 μ m (Gelman DM-800, Gelman Scientific, Inc., Ann Arbor, MI) placed in an open faced filter cassette. The filter cassette was then connected in line with a length of flexible tubing to a battery operated personal air sampling pump and calibrated to an airflow rate of 1.7 liters per minute using a Gillian bubble flow meter.

Breathing zone samples for respirable particulate were collected on 37 millimeter diameter vinyl acetate filter media with a nominal pore size of 0.8 μ m (Gelman DM-800) and placed in a Bendix BDX 99 nylon cyclone - filter holder assembly. The particle pre-selector excludes (with an efficiency of greater than 90 percent) particulate with an aerodynamic diameter greater than 10 microns.

SAMPLE COLLECTION : SAMPLING PERIOD

GRINDING THORIATED TUNGSTEN ELECTRODES

Area air samples for total particulate were collected during two different six minute tasks. The welder ground two different sizes of electrodes, of the four ground during each task two were 3/32 of an inch in diameter and two were 1/8 of an inch in diameter. It was not typical to grind four electrodes at one time for a duration of six minutes however the welder was requested to grind

for this time in order for sufficient collection of air. The concentrations were then compared to the U.S. Nuclear Regulatory Commission (USNRC) maximum permissible concentration for thorium in air.

INERT GAS SHIELD TUNGSTEN WELDING

Six area air samples were collected during the inert gas shielded arc welding while using thoriated electrodes. Thoriated tungsten electrodes with a diameter of 2.4 millimeter were used during arc welding. The duration of the sampling period was six to seven hours with actual welding time of approximately four hours, as determined by the welder.

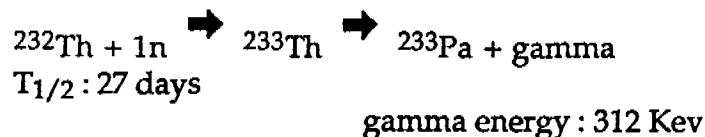
DETERMINATION OF AIRBORNE THORIUM CONCENTRATION

ANALYSIS OF FILTER MEDIA

Filtered air samples were submitted to Michigan Division Analytical Sciences Laboratory for determination of thorium.

The filters were removed from metal containers and placed in two dram polyethylene vials and sealed. A thorium standard was prepared from a stock solution of 1000 µg/ml by placing 10 µl into a two dram polyethylene vial and adding 5 ml of deionized water.

Filters and standards were placed in the rotating device (Lazy Susan) of the Dow TRIGA Mark I nuclear reactor and irradiated for 200 minutes at a power level of 240 kilowatts. After decay of 16 hours, samples and standards were removed from the reactor, the vials were washed to remove surface contamination, stored for spectra acquisition at a later time. Approximately 12 days after irradiation, the HPGe/MCA system was used to acquire data for thorium; data acquisition time was 20,000 seconds. The nuclear reaction used for thorium analysis and pertinent properties of the radioactive isotope are as follows:



The 12 day delay in data acquisition allows for decay of predominant isotopes produced during the neutron irradiation of filters. The predominate isotopes produced were bromine- 82 (half - life of 15 hours) and sodium - 24 (half - life 35.4 hours). Details of this analysis is reported in AL 93-060071 (W. L. Rigot).

EXPOSURE EVALUATION CRITERIA

United States Nuclear Regulatory Commission (USNRC) promulgates regulations regarding concentration limits in air and water from the use of radionuclides. These are found in Title 10 of the Code of Federal Regulations, Part 20 Standards for Protection Against Radiation, appendix B. The Maximum Permissible Concentrations (MPC) are concentrations for specific radionuclides that are used as protective measures for the prevention of excessive internal doses. The limits are set for individuals occupationally exposed so that based on the best data for uptake and retention in the body, the maximum annual doses to any organ in the body will not exceed 5 rem to the red bone marrow, head and trunks, gonads and lens of eyes and 15 rem to other single organs. For non-occupationally exposed individuals the doses must not exceed on tenth of the occupational value or 0.5 rem.

The NRC has also published regulatory guides describing limits for removable surface contamination for beta, gamma and alpha emitting radioisotopes.

The results of this evaluation were compared with the regulatory limits in microcuries (μCi) per milliliters of air for airborne radionuclides and μCi per square centimeter of surface area from Regulatory Guide number 8.21 for removable surface contamination. The following thorium(natural) concentrations were used as limits or guidelines for this evaluation:

<u>USNRC CRITERIA</u>	<u>SOURCE</u>	<u>REGULATION OR GUIDELINE</u>
Natural thorium in air Appendix B, Table 2, Col. 1	10 CFR Part 20	$2 \times 10^{-12} \mu\text{Ci/ml}$
Unrestricted area contamination	Reg. Guide 8.21	$1 \times 10^{-7} \mu\text{Ci/cm}^2$

RESULTS

1. Eight air filter samples were collected on November 18, 1992 to evaluate the potential exposure to thorium from grinding thoriated electrodes.
2. Two area air samples collected for total particulate during the grinding of thoriated tungsten electrodes on a ball bearing type grinder resulted in thorium concentrations of $1.5 \times 10^{-12} \mu\text{Ci/ml(air)}$ and $8 \times 10^{-12} \mu\text{Ci/ml}$ at positions lateral to the grinding wheel. A sample collected

from an area 13 inches to the left of the grinder exceeded the MPC for thorium but the area is not occupied by employees.

3. Two area air samples collected for total particulate during the grinding of thoriated tungsten electrodes using a motorized belt type grinder resulted in concentrations 4×10^{-13} $\mu\text{Ci}/\text{ml}(\text{air})$ at lateral positions to the grinding belt.
4. Personal air filter samples were collected concurrently with the area air samples for total particulate during grinding of thoriated tungsten electrodes. The results for thorium were 1.9×10^{-12} $\mu\text{Ci}/\text{ml}$ for the ball bearing grinding task and less than 4×10^{-13} micro curie per milliliter for the belt grinding task. The air sample result from the ball bearing grinder was less than the MPC for natural thorium.
5. Personal air filter samples were collected concurrently with the area air samples for respirable particulate potentially containing thorium during grinding of thoriated tungsten electrodes. Sample results for thorium were less than 5×10^{-13} $\mu\text{Ci}/\text{ml}$ for each grinding task.
6. Six area air filter samples were collected to evaluate thorium from inert gas shielded arc welding operations. One air sample collected on January 8, 1993 resulted in thorium at less than 8×10^{-15} $\mu\text{Ci}/\text{ml}$ for a 60 minute sampling period. Five air samples collected during arc welding process on February 3, 1993 resulted in thorium concentrations not detected at less than 6×10^{-15} $\mu\text{Ci}/\text{ml}$.
7. Two additional samples collected from level surfaces near the welding operations in the Fabrication Shop to evaluate airborne disposition of thorium resulted in less than 1.1×10^{-11} micro curies per square centimeter which is less than the current USNRC guideline for unrestricted areas.
8. The current United States Nuclear Regulatory Commission (USNRC) airborne limit for thorium in an unrestricted area is 2×10^{-12} $\mu\text{Ci}/\text{ml}$ (air). Only one air sample(February 3, 1993) result exceeded the current limit

DISCUSSION OF RESULTS

Table 1 is a summary of air monitoring results from grinding of thoriated electrodes using two different grinding devices. One was a standard ball bearing grinder with stone wheel and the second grinder was motorized belt impregnated with carborundum grinding particles. Figure 1 shows the location of the personal and area samplers at the ball bearing bench grinder.

Table 2 is a tabulation of personal air samples collected from the breathing zone of a welder as he ground thoriated tungsten electrode using both types of grinding devices. The employee wore gloves and a face shield in addition to normal work clothing while grinding four thoriated electrodes at each device. Personal air samples for total particulate and respirable fractions were collected from the breathing zone of the employee. Figure 2 shows the locations for personal and area samplers while grinding at the motorized belt grinder.

Table 3 presents the results from area samples collected during inert gas shielded arc welding. The air samples were collected during a short task at approximately thirty feet above ground level and during a series of arc welding procedures in the Michigan Division Fabrication Shop, 593 building. Four area air samples were collected while a welder, using a thoriated tungsten electrode arc welding technique, weld several stainless steel pipes and fixtures on a table designed for welding. Figure 3 represents the location of the welder in relation to the positions of the air samplers. One air sampler system was moved occasionally to facilitate the changing positions of the welder as required to efficiently finish the weld and not interfere with the normal welding techniques. The one sampler was maintained as consistent as possible between the welder and the work piece. The four other area samplers were placed in location that would be representative of the surrounding work place. The analytical results showed that thorium was less than $1.6 \times 10^{-15} \mu\text{Ci}/\text{ml}(\text{air})$. One area air sample was collected outside of the 593 building to evaluate normal background air concentration of thorium and the analytical results were less than $6 \times 10^{-15} \mu\text{Ci}/\text{ml}$.

Table 4 shows the results of two surface samples collected by placing filter media discs on a level surface near the welding operations in the Fabrication Shop. The surface samples were used to evaluate any deposition of thorium from airborne welding fumes during the welding process. The results showed that the thorium was less than 1.1×10^{-11} micro curie/ cm^2 which is less than the 1×10^{-7} micro curie/ cm^2 guideline for contamination in unrestricted area.

Table 5 shows the results of wipe test samples that were collected in areas adjacent to the ball bearing bench grinder and also the motorized belt grinder. All values were below the NRC guideline for removable surface contamination.

CONCLUSIONS

This survey evaluated the exposure potential to thorium from grinding and welding with thoriated tungsten electrodes. The results support the conclusion that there is no significant potential for employee exposure to

thorium from grinding or welding with thoriated tungsten electrodes under the conditions found in this study.

1. Grinding thoriated electrodes with a bench belt grinder resulted in less than the current USNRC limit of 2×10^{-12} $\mu\text{Ci/ml}$ (air) in an unrestricted area.
2. Inert gas shielded arc welding techniques used during this evaluation did not exceed the current USNRC airborne limit for thorium in an unrestricted area.
3. Deposition of thorium from welding fumes during this evaluation did not exceed the currently acceptable surface contamination guideline of 1×10^{-7} $\mu\text{Ci/cm}^2$.
4. Wipe test samples in areas around the two grinders were also below the surface contamination guideline of 1×10^{-7} $\mu\text{Ci/cm}^2$.

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Footnotes:

1. Breslin, A.J., and Harris, W.B., Use of Thoriated Tungsten Electrodes in Inert Gas Shielded Arc Welding-Investigation of Potential Hazard. Industrial Hygiene Branch, Health and Safety Division, New York Operations Office, U.S. Atomic Energy Commission, Industrial Hygiene Quarterly, December 1952.
2. McDowell-Boyer, L.M., Estimated Radiation Doses from Thorium and Daughters Contained in Thoriated Welding Electrodes. Oak Ridge National Laboratory for U.S., NRC Office of Standards Development, NUREG/CR-1039, December 1979.
3. Stranden, E., Doses from the Use of Welding Electrodes Alloyed with Thorium Oxide. Statens Institute for Straalehygiene, Oslo (Norway). Government Reports Announcements and Index (GRA & I) issue 19, 1981.
4. NCRP Report No. 95, Radiation Exposure of the US Population from Consumer Products and Miscellaneous Sources, December 1987.
5. Buckley, D.W., Belanger, R. Martin, P.E., Nicholow, K.M. and Swenson, J.B., (1980), Environmental Assessment of Consumer Products Containing Radioactive Material, NRC Report NUREG/CR-1775 (Nuclear Regulatory Commission, Washington, D.C.).

TABLE 1. RESULTS OF AREA AIR MONITORING FOR THORIUM DURING GRINDING OF THORIATED TUNGSTEN ELECTRODES USED FOR GAS SHIELDED ARC WELDING, 593 BLDG., MICHIGAN DIVISION NOVEMBER 18, 1992.

BALL BEARING BENCH GRINDER

<u>Sample ID</u>	<u>Sampling Time (min)</u>	<u>Total Volume (L)</u>	<u>Sample Description</u>	<u>Thorium Concentration ($\mu\text{Ci}/\text{ml}$)*</u>
593-1T	6	122	Eight inches left of grinding wheel; 4 electrodes, 2 @ 1/8" and 2 @ 3/32"	1.5×10^{-12}
593-2T	6	94.8	Thirteen inches right of grinding wheel; 4 electrodes, 2 @ 1/8" and 2 @ 3/32"	8.2×10^{-12}

BELT PEDESTAL GRINDER

<u>Sample ID</u>	<u>Sampling Time (min)</u>	<u>Total Volume (L)</u>	<u>Sample Description</u>	<u>Thorium Concentration ($\mu\text{Ci}/\text{ml}$)</u>
593-1T1	6	122.4	Six inches above top of grinding belt; 4 electrodes 2 @ 1/8" and 2 @ 3/32"	3.6×10^{-14}
593-2T1	6	118.0	Seventeen inches left of grinding belt; 4 electrodes 2 @ 1/8" and 2 @ 3/32"	3.6×10^{-13}

*10 CFR 20, Standards for Protection Against Radiation, Appendix B, Table 2, Col. 1, Maximum permissible concentration for Th (air) = $2 \times 10^{-12} \mu\text{Ci}/\text{mL}$

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TABLE 2. RESULTS OF PERSONAL AIR SAMPLES FOR THORIUM DURING GRINDING OF THORIATED TUNGSTEN ELECTRODES USED FOR GAS SHIELDING ARC WELDING 593 BLDG, MICHIGAN DIVISION, NOVEMBER 18, 1992.

TOTAL PARTICULATES COLLECTION TECHNIQUE

<u>Sample ID</u>	<u>Sampling time (min)</u>	<u>Total Volume (L)</u>	<u>Sample description</u>	<u>Thorium concentration ($\mu\text{Ci}/\text{ml}$)*.</u>
593-3T	6	15	Fabrication/ welding specialist MN064272 grinding thoriated Tungsten electrodes on ball bearing bench grinder	1.9×10^{-12}
593-4T	6	13	Fabrication/ welding specialist MN064272 grinding thoriated Tungsten electrodes using left grinder on pedestal	Not detected at 4×10^{-13}

RESPIRABLE PARTICULATE COLLECTION TECHNIQUE

<u>Sample ID</u>	<u>Sampling time (min)</u>	<u>Total Volume (L)</u>	<u>Sample description</u>	<u>Thorium concentration ($\mu\text{Ci}/\text{ml}$)</u>
593-5T	6	10.3	Fabrication/ welding specialist MN064272 grinding thoriated Tungsten electrodes on ball bearing bench grinder	Not detected at 4×10^{-13}
593-6T	6	10.3	Fabrication/ welding specialist MN064272 grinding thoriated Tungsten electrodes using left grinder on pedestal	Not detected at 4×10^{-13}

*10 CFR 20, Standards for Protection Against Radiation, Appendix B, Table 2, Col. 1, Maximum permissible concentration for Th (air) = $2 \times 10^{-12} \mu\text{Ci}/\text{mL}$

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TABLE 3. RESULTS FOR AREA AIRBORNE THORIUM DURING INERT GAS SHIELDED ARC WELDING 593 BUILDING, MICHIGAN DIVISION, JANUARY 8, AND FEBRUARY 3, 1993.

SINGLE TASK ARC WELDING (January 8, 1993)

<u>Sample ID</u>	<u>Sampling time (min)</u>	<u>Total Volume (L)</u>	<u>Sample description</u>	<u>Thorium Concentration ($\mu\text{Ci/ml}$)</u>
572-2	60	120.6	Inside a 3x4x6 ft enclosure ~ 30 ft above ground	Not detected at 8×10^{-15}

MULTIPLE ARC WELDING PROCEDURES (February 3, 1993)

<u>Sample ID</u>	<u>Sampling time (min)</u>	<u>Total Volume (L)</u>	<u>Sample Description</u>	<u>Thorium concentration ($\mu\text{Ci/ml}$)</u>
593-7T	387	1.018	7 inches from work piece between welder & table	Not detected at 1.1×10^{-15}
593-8T	385	9.47	7 ft. behind welder while welding stainless steel	Not detected at 1.2×10^{-15}
593-9T	393	9.39	38 inches in front of welder on welding table	Not detected at 1.2×10^{-15}
593-10T	330	7.06	8 ft behind and left of welder	Not detected at 1.6×10^{-15}
572-3	90	1.81	Background and outside of 593 Bldg.	Not detected at 6×10^{-15}

1) 10 CFR 20; Standards for Protection Against Radiation, Appendix B, Table II, Column I, Maximum Permissible Concentration for thorium in air = $2 \times 10^{-12} \mu\text{Ci/ml}$

TABLE 4. SUMMARY OF RESULTS FOR THORIUM FROM SURFACE SAMPLES COLLECTED IN THE MICHIGAN DIVISION FABRICATION SHOP, 593 BUILDING, FEBRUARY 3, 1993.

<u>SAMPLE ID</u>	<u>LOCATION DESCRIPTION</u>	<u>THORIUM ($\mu\text{Ci}/\text{cm}^2$)</u>
593-11T	8 feet behind welder/fabricator on level surface	Not detected at 1×10^{-10}
593-12T	12 feet from welder/fabricator on a level surface on flash screen	Not detected at 1×10^{-10}

NRC regulatory guide 8.21 for removable surface contamination = $1 \times 10^{-7} \mu\text{Ci}/\text{cm}^2$ which equals $1 \times 10^{-5} \mu\text{Ci}/100 \text{ cm}^2$

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TABLE 5. RESULTS FOR REMOVABLE SURFACE CONTAMINATION FROM THE USE OF THORIATED ELECTRODES IN THE AREA OF BENCH AND PEDESTAL GRINDERS, 593 BUILDING FABRICATION BUILDING, MICHIGAN DIVISION, MAY 26, 1993.

Wipe test results around Bench Grinder

<u>Sample Number</u>	<u>Location of Wipe Test</u>	<u>Calculated Results ($\mu\text{Ci}/100\text{ cm}^2$)</u>
1	At the center and top of grinder	1.9×10^{-8}
2	Left side and top of grinder	2.2×10^{-8}
3	Top of the rest below grinding wheel on left side	2.3×10^{-8}
4	Right side along cente	1.1×10^{-8}
5	Top of rest below grinding wheel to the right side	2.75×10^{-9}
6	At the back of grinding wheel left side	5.1×10^{-8}
7	At the back of the wheel right side	1.1×10^{-8}
8	Left side of wheel on the floor ~ 1 ft from the base	3.2×10^{-9}
9	Floor area in front and ~1 ft from base	6.2×10^{-9}
10	Right side of wheel on the floor and ~ 1 ft from base	3.3×10^{-9}

NRC regulatory guide 8.21 for removable surface contamination = $1 \times 10^{-7} \mu\text{Ci}/\text{cm}^2$ which equals $1 \times 10^{-5} \mu\text{Ci}/100\text{ cm}^2$

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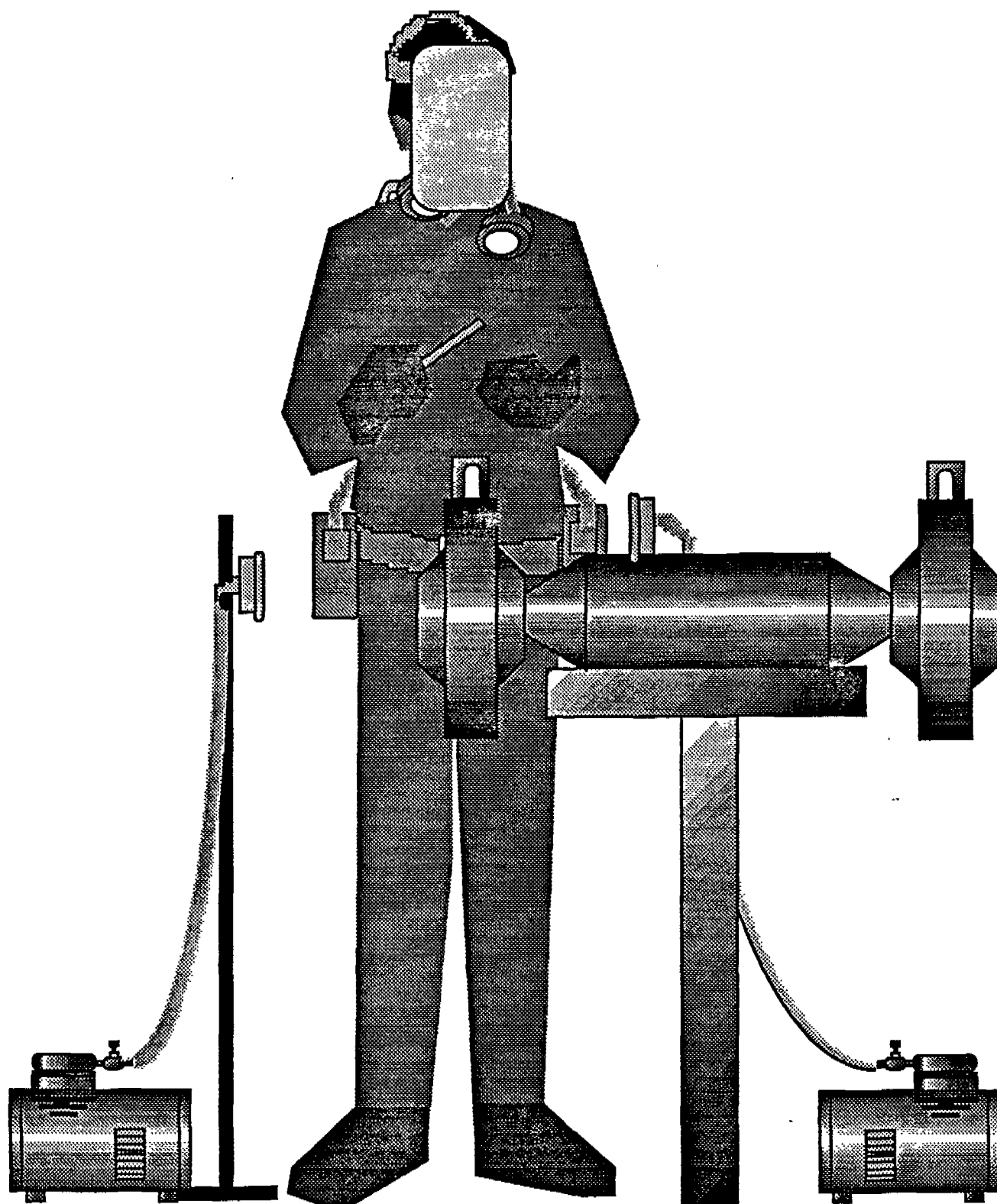
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TABLE 5. (cont'd) RESULTS FOR REMOVABLE SURFACE CONTAMINATION FROM THE USE OF THORIATED ELECTRODES IN THE AREA OF BENCH AND PEDESTAL GRINDERS, 593 BUILDING FABRICATION BUILDING, MICHIGAN DIVISION, MAY 26, 1993.

<u>Sample Number</u>	<u>Location of Wipe Test</u>	<u>Calculated Results ($\mu\text{Ci}/\text{cm}^2$)</u>
11	Top of metal guard over grinding wheel	2.2×10^{-9}
12	Top of wheel along center	7.7×10^{-10}
13	Rear on top of wheel	1.5×10^{-9}
14	Left of wheel along center beam	7.7×10^{-10}
15	Pedestal base at the center	1.0×10^{-8}
16	On the floor to the left of pedestal base	8.6×10^{-9}
17	Pedestal base in rear and right side	1.9×10^{-9}
18	Floor in front of pedestal ~ 2 ft from base	2.1×10^{-9}
19	Bottom shelf adjacent to pedestal base	3.2×10^{-9}
20	Floor on right side ~ 2 ft from base	1.6×10^{-9}
21-24	Background	1.1×10^{-10}

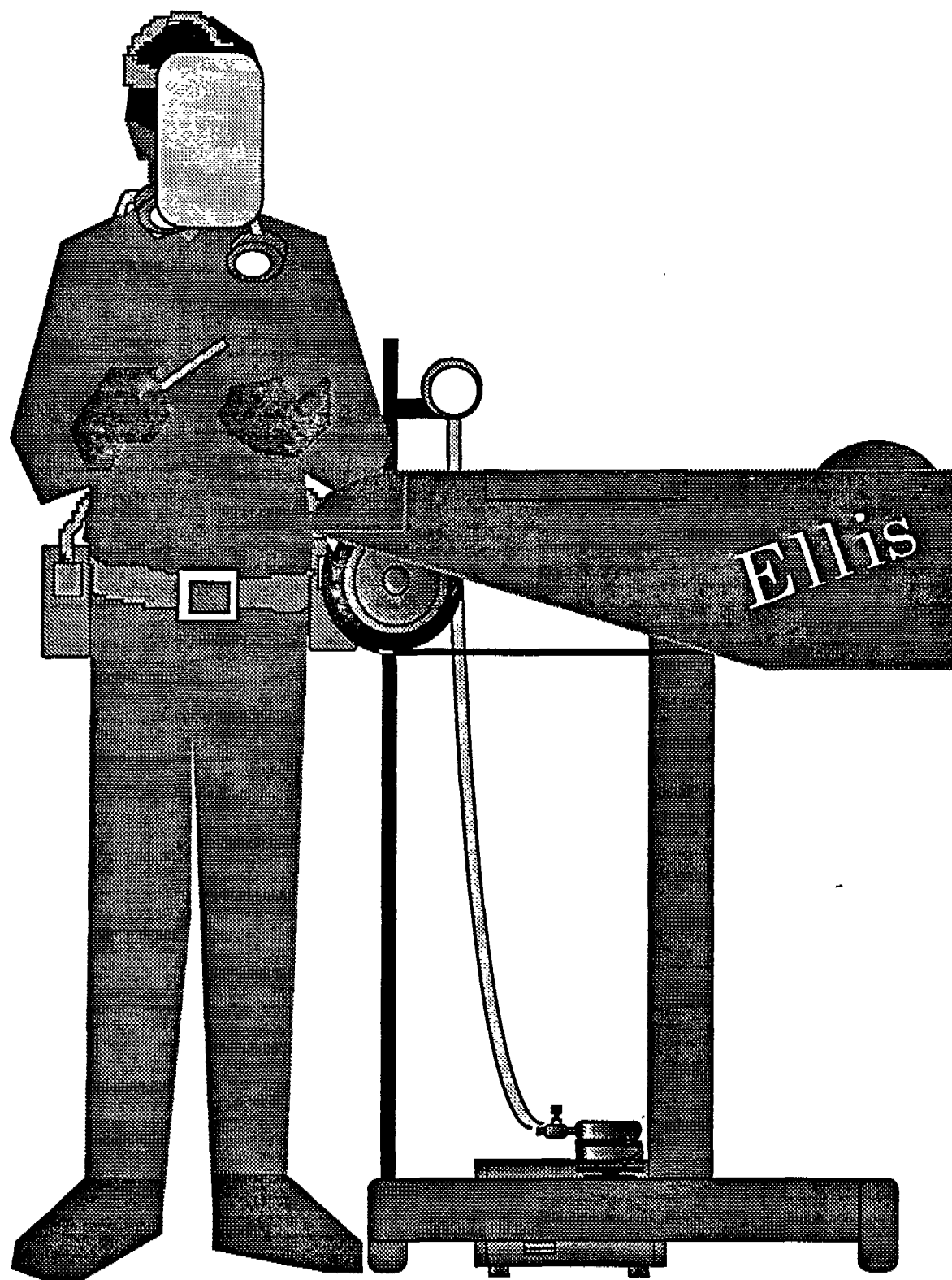
NRC regulatory guide 8.21 for removable surface contamination = $1 \times 10^{-7} \mu\text{Ci}/\text{cm}^2$ which equals $1 \times 10^{-5} \mu\text{Ci}/100 \text{ cm}^2$

FIGURE 1 LOCATION FOR PERSONAL AND AREA AIR SAMPLES WHILE GRINDING THORIATED TUNGSTEN ELECTRODES ON A BALL BEARING TYPE GRINDER



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FIGURE 2 LOCATION FOR PERSONAL AND AREA AIR SAMPLES WHILE GRINDING THORIATED TUNGSTEN ELECTRODES ON A MOTORIZED BELT TYPE GRINDER



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FIGURE 3. AREA AIR SAMPLING LOCATIONS FOR INERT GAS SHIELDED ARC WELDING IN THE FABRICATION SHOP, MICHIGAN DIVISION, 593 BUILDING.

