REGION I Form 198-D
(July 82)

INDUSTRIAL - ACADEMIC

Docket
~~LICENSE~~ NO: 040-07344

DOCKET NO. (s) 040-07344

PAGE ____ OF ____

ATTACHED
- ☐ Appendix A
- ☐ Appendix B
- ☐ Appendix C
- ☐ Memo

INSPECTION REPORT NO. 86-01

General Electric
Space Systems Division
Philadelphia, Pa.

LICENSEE CONTACT: _____ Telephone No: _____

LICENSE NO: SUB-831 CATEGORY ____ PRIORITY: ____

CATEGORY ____ PRIORITY: ____

CATEGORY ____ PRIORITY: ____

INSPECTION DATE (s): August 1, 1986 TYPE OF INSPECTION:
- ☒ SPECIAL
- ☐ ROUTINE
- ☒ DAYSHIFT
- ☐ OTHER
- ~~☒~~ ANNOUNCED
- ☐ UNANNOUNCED

SUMMARY OF FINDINGS AND ACTION

- ☐ NO NONCOMPLIANCE, CLEAR 591 ISSUED
- ☐ NO NONCOMPLIANCE, LETTER
- ☒ NONCOMPLIANCE, APPENDIX A

RECOMMENDATIONS
SEE BASIS IN APPENDIX I

- ☐ CHANGE CATEGORY TO: _____
- ☐ NEXT INSPECTION DATE: _____

PERSONS CONTACTED

see next page

(215) 354-3129

THOMAS P. HANDLEY
MANAGER
INDUSTRIAL SECURITY, SAFETY,
AND ADMINISTRATIVE SERVICES

GENERAL ELECTRIC COMPANY
SPACE SYSTEMS DIVISION

P.O. BOX 8555
PHILADELPHIA, PA. 19101

354-
215-~~3~~-1085
DIAL COMM 8*747-1085

ALFRED W. KOBYLINSKI
SR. INDUSTRIAL HYGIENIST

GENERAL ELECTRIC COMPANY
SPACE SYSTEMS DIVISION

P.O. BOX 8555
PHILADELPHIA, PA. 19101

INSPECTOR: Laurence F. Friedman

APPROVED: John E. Glenn

D-164

Alfred W. Kobylinski, M.S., Sr. Industrial Hygienist, RSO
Charles Clifton, Mgr., Industrial Safety & Hygiene.
Tom Handley, Mgr., Industrial Security, Safety, + Administrative Practices
Gordon C. Clarke, Division Counsel

Mg Th alloy classified as pyrophoric by S.C.
Classification changed (per telecon from Chem Nuclear 7/31/86)

Encapsulation technique performed by Chem Nuclear, cleared with S.C. beforehand.

Drums filled layer by layer. Tapped for voids, drilled + inspected.

S.C. cut drums in half, drove rods through billets, found chip not completely coated ~~c~~ concrete in ~~center~~ body of billet. Liquid was droplets of cutting oils adhering to chips + displaced by concrete.

Material buried ~~by~~ after inspection.

No corrective action at K of P since no further shipments anticipated. Chem Nuclear has taken corrective action with regard to Evendale, OH plant, + permit there has been reinstated.

G.E. does not have copy of Barnwell License.

Shipped 2/26/86 32 drums 8.48 mCi Mg-Th turnings
LSA 84.76 lbs. source material.

GENERAL ELECTRIC

SPACE SYSTEMS DIVISION
GENERAL ELECTRIC COMPANY • VALLEY FORGE SPACE CENTER • P.O. BOX 8555 • PHILADELPHIA, PENNSYLVANIA 19101 • (215) 354-1000

August 6, 1986

Dr. L. Friedman
U.S. Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, PA 19406

Dear Dr. Friedman:

With reference to our discussion of 8/1/86, a thorough search of our files did not turn up a copy of Chem Nuclear Systems, Inc. radioactive material license for the Barnwell S.C. site. However, discussions with Chem Nuclear revealed that typically the requirements of 10 CFR 30.41 are satisfied by the Radioactive Waste Permit provisions paragraph of the State of South Carolina.

As you know, the state also administrates the Permit program for all generators of rad waste wishing to use the Barnwell site for disposal. The Permit application specifically requires that the generator identify the type, quantity, and form of all prospective wastes to be sent to Barnwell. When a Permit is granted by the state, it is in effect certification that the site can accept a particular type of waste under the terms of the Barnwell license.

For the above reasons, we believe that the application we sent to South Carolina, (Dept. of Health and Environmental Control) which clearly identified the Magnesium-Thoriam waste, along with the Permit issued to us for the disposal of this waste at Barnwell, clearly satisfies the intent of CFR 30.41.

If we can answer any further questions regarding this matter please don't hesitate to call.

Sincerely,

C B Chilton for AWK

A. W. Kobylinski
Senior Industrial Hygienist
Radiation Safety Officer

cc: C. B. Chilton
T. P. Handley
G. H. Clarke

AUG 0 8 1986

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
APPLICATION FOR RADIOACTIVE WASTE TRANSPORT PERMIT

Applicability: Pursuant to Section 13-7-140, 1976 S.C. Code of Laws (as amended) and Department Regulation 61-83, a Radioactive Waste Transport Permit is required to be obtained by all generators who transport or have radioactive waste transported into or within the State of South Carolina. Persons whose activities result in the generation of radioactive waste have the primary responsibility to obtain a permit.

Instructions: Complete Items 1 through 19. Submit original and one copy to Chief, Bureau of Radiological Health, S.C. Dept. of Health and Environmental Control, 2600 Bull Street, Columbia, S.C. 29201. All items must be completed, required certificate of insurance or bond attached, and signed and dated by an authorized person. If an item is not applicable, indicate "N/A". Incomplete forms and failure to provide an insurance certificate will result in delays or denial of the permit. Additional sheets may be used if necessary. Upon approval, the Department will return one copy with the transport permit. All permit fees shall be remitted and made payable to the S.C. Department of Health and Environmental Control, Bureau of Finance, 2600 Bull Street, Columbia, S.C. 29201. Please NOTE on remittance - "FOR RADIOACTIVE WASTE TRANSPORT PERMIT."

NOTE: Radioactive Waste Transport Permits may be purchased for more than one facility or location of a company, corporation, etc. However, an application shall be submitted for each facility to include the additional fee and the required certificate of insurance or bond.

1. Name and Address of Applicant (Shipper/Generator) General Electric Company Space Systems Division P.O. Box 8555 Philadelphia, PA 19101	2. Person responsible for Radioactive Waste Shipments: a) Name: Alfred W. Kobylinski b) Title: Sr. Industrial Hygienist c) Address: P.O. Box 8555, Phila, PA 19101 d) Telephone: (215)354-1085
3. Shipment Location(s): a) Philadelphia, PA b) King of Prussia, PA c)	4. NRC or Agreement State Radioactive Material License No. for each facility: a) NRC License #37-02006-05 b) NRC License #SUB 831 c)
5. Total Estimated Annual Cubic Footage: Approx.: 500 Cubic Feet	6. Type of Permit and Amount of Fee Remittal: Renewal [X] [X] [Y] [Z] New [ ] [X] [Y] [Z] ($ 500.00)
7. Complete Waste Descriptions: a) Magnesium Thorium Chips and Turnings b) c) d) e)	8. Physical & Chemical Form a) Solids b) c) d) e)
	9. Waste Class and Stability a) Class A b) c) d) e)
10. List Prominent Radionuclides: Thorium-232	11. Total Estimated Radioactivity (Curies): 0.007Ci
12. Does Waste Contain Any of the Following? [X] EPA Classified Hazardous Materials [ ] Chelating Agents [ ] Pyrophoric Materials [ ] None of the Above	13. If "Yes" to Item 12, Identify and Quantify. 98% Magnesium Chips and Turnings Flammable Solid, EPA Hazardous Waste #D001
14. Type Solidification Agents: [ ] Bitumen [X] Cement [ ] Vinyl Ester Styrene [ ] Other	15. Has Each Solidification Process Received NRC Topical Report Approval and Meet Stability Requirements? N/A [ ] Yes [ ] No

PAID
DEC 19 1986

DHEC-800 (Rev. 10/84) (Complete Reverse Side)

CHECK NO. 308896

RECEIPT NO. _____

Transport Permit Application continued

16. Name and Address of Broker, if used:	17. Name and Address of Carrier:
N/A	Chem-Nuclear Systems, Inc. P.O. Box 726 Barnwell, SC 29812

Information to Be Submitted as Attachment

18. A Certificate of Liability Insurance issued to the generator shall be submitted as evidence of financial ability to protect the State of South Carolina and the public at large from possible radiological injury or damage due to packaging, transportation, disposal, storage, or delivery of radioactive waste. For those applicants not maintaining liability insurance, they must deposit and maintain with the Department a cash or corporate surety bond in the amount of Five Hundred Thousand Dollars ($500,000.00). Failure to submit a current certificate or bond will result in processing delays.

CERTIFICATE

19. In compliance with Act No. 429 of 1980, the South Carolina Radioactive Waste Transportation and Disposal Act, and Department Regulation 61-83, I hereby certify on behalf of the named applicant (shipper/generator) to the South Carolina Department of Health and Environmental Control that: (A) the named applicant (shipper/generator) will comply fully with all applicable laws and administrative rules and regulations, both State and Federal, and any disposal facility radioactive material license requirements and criteria regarding the packaging, transportation, storage, disposal, and delivery of such wastes; (B) the named applicant (shipper/generator) will hold the State of South Carolina harmless for all claims, actions, proceedings in law or equity arising out of radiological injury or damages to persons or property occuring during the transportation of its radioactive waste into or within the State including all costs defending same; provided, however, that nothing contained herein shall be construed as a waiver of the State's sovereign immunity; (C) the named applicant (shipper/generator) has current copies of the Regulations for the Transportation of Radioactive Waste Into or Within the State of South Carolina, DOT Regulations 49 CFR Parts 171-179, and when applicable, the disposal site radioactive material license and the disposal site waste acceptance criteria; (D) the named applicant (shipper/generator) has prepared this application to conform with South Carolina Department of Health and Environmental Control's Regulations for Transportation of Radioactive Waste Into or Within South Carolina, and that all information contained herein, including any required supplements attached hereto, is true and correct to the best of my knowledge and belief.

Date February 13, 1986

Alfred W. Kobylinski
Signature

Alfred W. Kobylinski, Sr. Industrial Hygienist
Type Name and Title of Applicant's Authorized Representative

Form RHA-P
(10/80)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

SOUTH CAROLINA RADIOACTIVE WASTE TRANSPORT PERMIT

Pursuant to Act No. 429 of 1980, the South Carolina Radioactive Waste Transportation and Disposal Act, a Radioactive Waste Transport Permit is hereby issued to the below-named applicant (shipper). This Permit shall not, in itself, be construed as authorizing a shipper to dispose of radioactive waste within the State of South Carolina. This Permit shall not be transferred, assigned or in any manner disposed of, either voluntarily or involuntarily, directly, or indirectly, through transfer of control to any person, unless the Department shall, after securing full information, find the transfer is in accordance with the provisions of Act No. 429 and shall give written consent.

1. **Name and Address of Applicant (Shipper):** General Electric Company SPACE SYSTEMS DIVISION P.O. Box 8555 Philadelphia, Pennsylvania 19101	2. **Permit Number:** 0239-37-86-X 3. **Expiration Date:** December 31, 1986

1986

For the South Carolina Department of
Health and Environmental Control

February 20, 1986
Date of Issuance

By _____
Heyward G. Shealy, Chief
Bureau of Radiological Health

DHEC 801 (10/80)

South Carolina Department of Health and Environmental Control

2600 Bull Street
Columbia, S.C. 29201

Commissioner
Robert S. Jackson, M.D.

March 10, 986

CERTIFIED MAIL

Mr Alfred W. Kobylinski
Sr. Industrial Hygienist
General Electric Company
Space Systems Division
P.O. Box 8555
Philadelphia, Pennsylvania 19101

Dear Mr. Kobylinski:

An investigation conducted on March 4, 1986, by the S.C. Department of Health and Environmental Control revealed that shipments of radioactive waste received at Chem-Nuclear Systems, Inc. burial facility in Barnwell, South Carolina was in noncompliance with applicable state and federal regulations.

The violations are identified as follows:

Radioactive Waste Shipment Nos. 0286-291-A, classified as Radioactive Material, LSA, n.o.s., described as magnesium thorium alloy turnings solidified with cement, packaged in metal drums was found to contain turnings improperly encapsulated in cement and therefore not rendered non-pyrophoric. This is contrary to the requirements of Condition 51 of S.C. Radioactive Material License 097, Amendment 41, and 49 CFR 173.418(q)(4)(i). In addition, Drum No. B-3 contained liquid contrary to the requirements of 49 CFR 173.418(a)(3).

Each of these items constitute separate violations of Section 1.2, Department Regulation 61-83.

Please be informed that pursuant to Section 13-7-180, S.C. Code of Laws, 1976 (as amended) and Section 7.3 of the Department's Regulations for the Transportation of Radioactive Waste Into or Within South Carolina, you are hereby assessed a civil penalty of Two Thousand Dollars ($2,000.00).

CERTIFIED MAIL

In addition to the civil penalty, all shipments of magnesium thorium alloy from your facility to the burial facility in Barnwell, S.C. have been suspended until such time as you demonstrate to the Department that adequate measures have been implemented to ensure compliance with all applicable provisions of federal and state law.

If you do not wish to appeal this decision, payment of the civil penalty shall be submitted no later than March 31, 1986, and made payable to the "S.C. Department of Health and Environmental Control". Information concerning corrective measures and procedural modifications shall be submitted accordingly.

You are entitled to a full administrative hearing upon request and are allowed 20 days to make such application. However, should you wish to discuss this matter with us in an informal setting, representatives of this Bureau will be made available to meet with you at a mutually convenient time. Should you desire such a conference or wish to request a formal administrative hearing, please contact Mr. Virgil R. Autry of the Bureau of Radiological Health, (803) 758-5548.

Very truly yours,

Heyward G. Shealy

Heyward G. Shealy, Chief
Bureau of Radiological Health

HGS:VRA:kn

cc: Mr. R. Lewis Shaw, Deputy Comm.
DHEC Env. Quality Control

Samuel L. Finklea, III, Ph.D.
DHEC Legal Counsel

Mr. David Reid, Exec. Asst.
Office of the Governor

Mr. Robert Trojanowski
USNRC, Region II

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
Bureau of Radiological Health
Division of Radioactive Material Licensing and Compliance
Radioactive Shipment Inspection Report

86-02-07
Report No. 86-02-08

A. General Information:

1. Shipper Space Systems Division General Electric Company Address Philadelphia, PA
2. Carrier CNSI Tractor # 5262254 Trailer # 445099 Type Van
3. Type Package XXXX Drums XXXX Containing 63 steel drums

B. Shipping Documentation:

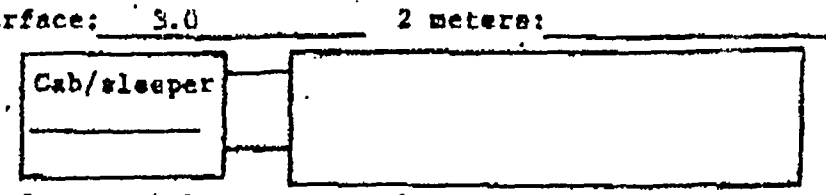
1. AS# 42578 Volume Allocation # 0286-291-A Permit # 0239-37-86-X
2. Shipping Name & Class: Radioactive Material, LSA, nos. HM Id.# UN 2912 (172.202(a))
3. Total Burial Vol.: 240 ft³ (172.202(c) Total Curies: 0.00848 (172.203(d))
4. Radionuclides: Thorium 232 (172.203(d))
5. Describe chem./phy. media: solidified oxides, magnesium thorium alloy chips (172.203(d))
6. Chelating Agents(%) None Shippers Certification: State DOT (172.204)
7. Exclusive Use Instructions (173.425(b)) Total T.I. NA (177.842(a))
8. Check for: Radiation Survey (173.441) Contamination Levels (173.443)
9. Compare: Radionuclides w/resin analysis NA Rad/Contamination Levels w/CNSI/BRH

C. Shipment Inspection Check List:

✓	Shipment Braced/Blocked (173.425(b)(6)	✓	Lids (Drum, box, cask) secure (173.425)(b)
✓	Visible Leakage (173.425(B)(1)	✓	Visible Damage (173.425)
✓	Package Labeling: W-I, Y-II, III (172.403) (b) & (c) or Radioactive LSA (173.425)	NA	Cask Defects/Missing Parts
		✓	Radiation Survey: Cab/sleeper, trailer/truck (173.441)
✓	Waste Class. Marked A-B-C Stable Unstable	✓	Contamination Levels (173.443)
✓	Gross Weight Marked (172.310) [LSA Exclusive Use Exempt]	✓	Vehicle Placards (173.425(c) (172.507)
NA	Type A/ Type B Package Marked (172.310)	NA	Tiedowns Secure/Adequate
✓	Trailer/Tractor Defects	X	Offloading Discrepancies
NA	Packages banded/reinforced/palletized		

D. Radiation/Contamination Survey: (transport vehicle or package)

(mR/hr) Surface: 3.0 2 meters:



Surface: 1.0 2 meters: 0.4

Highest contamination detected: Arrival 9 dpm/100cm² Release dpm/100cm²
9 dpm/100cm² dpm/100cm²

Results of Inspection: Summary of violations and discrepancies Upon Department inspection, it was determined that this shipment had not been properly solidified to render the contents non-pyrophoric. Drum #B38 was found to contain unsolidified turnings in the bottom of the drum. This is contrary to the requirements of Condition 51, S.C. Radioactive Material License 097, Amendment 41, and 49 CFR 173.418(A)(4)(1). In addition, Drum #B3 was found to contain liquid contrary to the requirements of 49 CFR 173.418(A)(3). Each of these items constitute separate violations of Section 1.2, Department Regulation 61-83.

Date: February 25, 1986 Inspector's Signature s/Richard S. Sappington

GENERAL ELECTRIC

SPACE SYSTEMS DIVISION
GENERAL ELECTRIC COMPANY • VALLEY FORGE SPACE CENTER • P.O. BOX 8555 • PHILADELPHIA, PENNSYLVANIA 19101 • (215) 354-1000

March 24,1986

Mr. Heyward G. Shealy, Chief
Bureau of Radiological Health
South Carolina Department of Health
and Environmental Control
2600 Ball Street
Columbia, SC 29201

Dear Mr. Shealy:

With regards to your March 10, 1986 letter of citation concerning our shipment of magnesium thorium waste to the Barnwell, South Carolina, disposal site, we are not in full agreeement with the alleged violations.

Before loading them onto the truck, each drum involved in this shipment was closely examined by both our broker and a member of my staff. Each billet was thoroughly tested for voids and when found a small hole was drilled through the drums to check for liquids. The lids on each drum were removed and the billets were checked for any loose material. At no time during our inspections was any drum in this group found to be in non-compliance. Any further destructive testing of these drums would have, in our opinion, rendered them unsafe for transportation.

It is our understanding, however, that all of the drums involved in this shipment have, at this time, been disposed of by burial at Barnwell. Therefore, we have chosen not to contest this citation or the civil penalty assessed.

Attached is a check for Two Thousand dollars ($2,000.00) to cover the penalty.

Sincerely,

Alfred W. Kobylinski
Senior Industrial Hygienist

AWK/ark
Encl.
cc: T.P. Handley
C.B. Chilton
S.J. Mucha, M.D.
W. Korn
G.H. Clarke
IRAG File
G.H. Webber

Enclosure 2

SEQUENCE OF REMEDIAL ACTIONS FOR 55-GALLON DRUMS CONTAINING MG-TH WASTES

1. Remove bottom and lid from drum.

2. Remove loose turnings from any voids which may be found. Place turnings into a 55-gallon drum to be mixed with sand.

3. Place the drum in a heated and ventilated area for at least three days to allow any water to evaporate.

4. Fill any void spaces in the drum with a mixture of sand and Mg-Th turnings. The weight ratio of the mixture will be sufficient to inert the mixture as determined by testing.

5. Place four inches of dry cement mix (five parts sand, one part Portland cement) in the bottom of an 85-gallon drum.

6. Place the 55-gallon drum in the 85-gallon drum. Use spacers to center the drum with approximately 1-3/4 inch annular space.

7. Fill the annulus with dry sand or cement mix. Discarded lids and bottoms may be placed above or below the 55-gallon drum.

8. Fill the 85-gallon drum to within two inches of the top with dry sand. Discarded lids and bottoms may be placed on the very top of the 55-gallon drum or bottom of the 85 gallon drum. Complete with lid, ring, and proper shipping information.

REMEDIAL ACTION

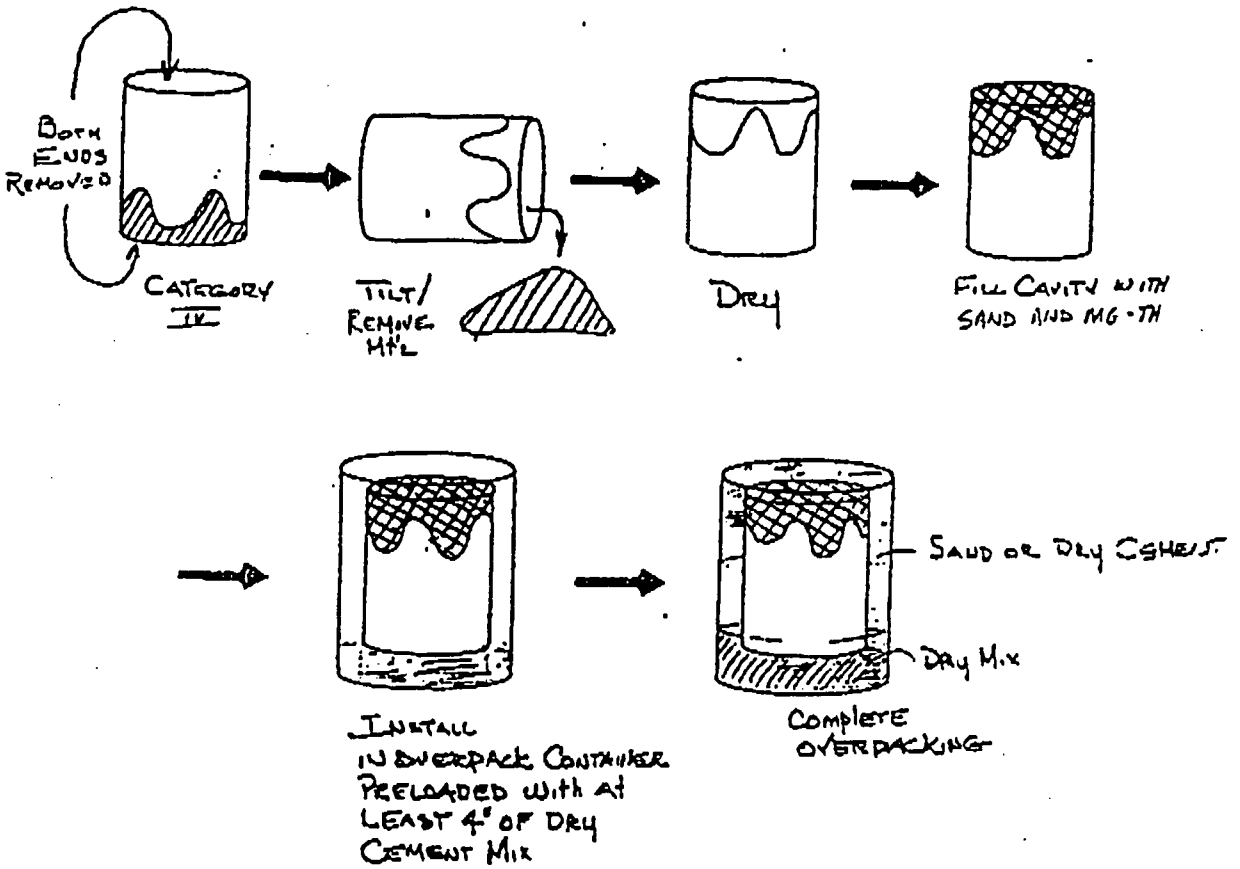
General Electric - AEBG through its contractor, Chem-Nuclear Systems, Inc., is instituting the following remedial actions to correct all packaging operations and to ensure future regulatory compliance:

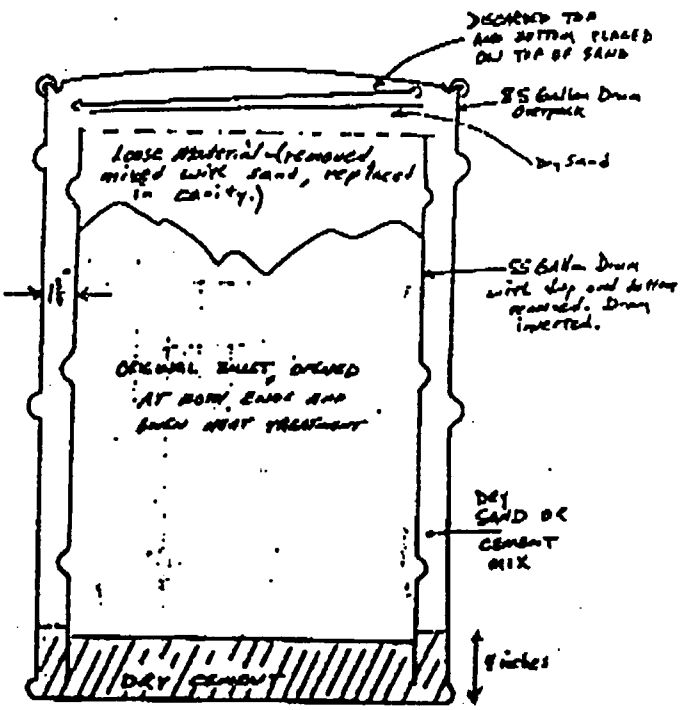
1. Chem-Nuclear has fully investigated the incident and has discussed its findings with GE - AEBG. Chem-Nuclear has taken personnel action, has performed testing, and has developed remedial action procedures to correct the remaining defective drums and to re-package them in accordance with all applicable regulations for shipment and disposal. GE - AEBG has performed an in-depth review of Chem-Nuclear's remedial action plan and procedures, and will closely monitor the corrective actions to be taken until all magnesium-thorium has been processed, transported and disposed of.

2. To ensure no free liquid, all remaining processed drums will be opened at top and bottom, any loose magnesium-thorium turnings removed, and the drums subjected to an elevated temperature in a protected area for at least three days to evaporate any residual free liquid. Drums thus dried will be placed in overpacks in accordance with the procedures outlined in Enclosure 2.

3. To ensure all magnesium-thorium turnings are rendered non-pyrophoric, the contents of all drums will be inspected for non-homogeneous areas and any loose magnesium-thorium turnings removed. The loose turnings will be mixed with dry sand at the appropriate weight ratio as verified by testing (most likely 10 parts sand to one part magnesium-thorium). Material thus mixed will be packed into the voids from which it was removed or packaged separately in either 55-gallon or 85-gallon drums. The drums will then be shipped to the Barnwell Waste Management Facility.

MG-TH WASTE DRUM RECOVERY SEQUENCE





MATERIAL SAFETY DATA SHEET

Dow Chemical U.S.A. Midland, MI 48674 Emergency Phone: 517-636-4400

PRODUCT NAME: SHEET/PLATE HM21A

Effective Date: 05/15/80 Date Printed: 10/16/85 Product Code: 61647

1. INGREDIENTS:

Thorium	2.0%
Manganese	0.8%
Magnesium	BAL.

2. PHYSICAL DATA:

BOILING POINT: Not applic.
VAP PRESS: Not applic.
VAP DENSITY: Not applic.
SOL. IN WATER: Not applicable
SP. GRAVITY: Approx. 1.77
MELTING POINT: Approximately 1121F, 605C
APPEARANCE: Silver solid.
ODOR: No odor.

3. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT: Not applic.
METHOD USED: Not applic.

FLAMMABLE LIMITS
LFL: Not applic.
UFL: Not applic.

EXTINGUISHING MEDIA: Melting flux, dry sand, metal extinguishing powders such as G1, met-l-x, etc.

FIRE & EXPLOSION HAZARDS: When heated in air to a temperature near their melting point magnesium-thorium alloys ignite and burn with a white flame. Use of water on molten magnesium-thorium alloys will produce hydrogen gas and may cause an explosion. Residues from burned magnesium-thorium alloys contain 10-20% thorium dioxide. Some radioactivity is detect-

(Continued on Page 2)

3. FIRE AND EXPLOSION HAZARD DATA: (CONTINUED)

able in the visible fume and at 15 feet from the burning alloy.

FIRE-FIGHTING EQUIPMENT: Wear positive pressure self-contained breathing apparatus.

4. REACTIVITY DATA:

STABILITY: (CONDITIONS TO AVOID) Stable under normal handling conditions. See incompatibility statement.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Acid, water. Reacts with acid to form hydrogen gas. In finely divided form, will react with water and acids to release hydrogen.

HAZARDOUS DECOMPOSITION PRODUCTS: See special fire fighting equipment and hazards section above.

HAZARDOUS POLYMERIZATION: Will not occur.

5. ENVIRONMENTAL AND DISPOSAL INFORMATION:

ACTION TO TAKE FOR SPILLS/LEAKS: Clean off and use.

DISPOSAL METHOD: Contact The Dow Chemical Company.

6. HEALTH HAZARD DATA:

EYE: Mechanical injury.

SKIN CONTACT: Mechanical injury; may cause slight irritation.

SKIN ABSORPTION: May be absorbed in toxic amounts upon gross exposure or repeated exposures.

INGESTION: Magnesium is moderately toxic to humans, but should not be a problem because of physical form, thorium is insoluble.

(Continued on Page 3)

6. HEALTH HAZARD DATA: (CONTINUED)

INHALATION: Fumes and dusts may be harmful.

SYSTEMIC & OTHER EFFECTS: Possible systemic injury.

7. FIRST AID:

EYES: Irrigation of the eye immediately with water for five minutes is good safety practice.

SKIN: Contact will probably cause no more than irritation. Wash off in flowing water or shower. Wash clothing before reuse.

INGESTION: If swallowed, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Call a physician.

INHALATION: Remove to fresh air if effects occur. Call physician and/or transport to medical facility.

NOTE TO PHYSICIAN:
Eyes: Mechanical injury only. Stain for evidence of corneal injury.
Skin: May cause mild irritation. If rash is present treat as any contact dermatitis. May be absorbed in acutely toxic amounts with chronic or gross exposure.
Respiratory: Chronic exposure may produce systemic injury.
Oral: Probably moderately toxic.
Systemic: Thorium has a long half life in the body. Consult standard literature. Target organs for thorium intoxication are hematopoetic system, nervous and reticulo endothalial systems, and damage to the lung and bone tissue. No Dow tox data.

(Continued on Page 4)

8. HANDLING PRECAUTIONS:

VENTILATION: Good ventilation, fume control and respiratory protection necessary during arc welding operations.

RESPIRATORY PROTECTION: None needed.

SKIN PROTECTION: Fire-resistant clothing and gloves desirable around melting or heat treat operations. Use gloves for handling metal.

EYE PROTECTION: Not normally necessary.

9. ADDITIONAL INFORMATION:

SPECIAL PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Practice reasonable care in handling magnesium and magnesium alloy product forms to avoid product damage and/or personal injury. Store product in dry location. Wet, moist or high humidity storage conditions will lead to corrosion of the product. Store away from other combustibles. See National Fire Protection Association bulletin NFPA 48, "Storage, Handling an Process of Magnesium" for detailed storage information.

MSDS STATUS: For additional information on safe handling of magnesium-thorium alloys, see "Magnesium-Thorium Alloys Industrial Health Experience in Fabrication and Production", bulletin 141-179 published by The Dow Chemical Company.

New MSDS.

DOW CHEMICAL U.S.A.

LLOYD F. LOCKWOOD
MAGNESIUM PRODUCTS

Texas Division
Freeport, Texas 77541
713-238-3408

MAGNESIUM-THORIUM ALLOYS

INDUSTRIAL HEALTH EXPERIENCE IN FABRICATION AND PRODUCTION

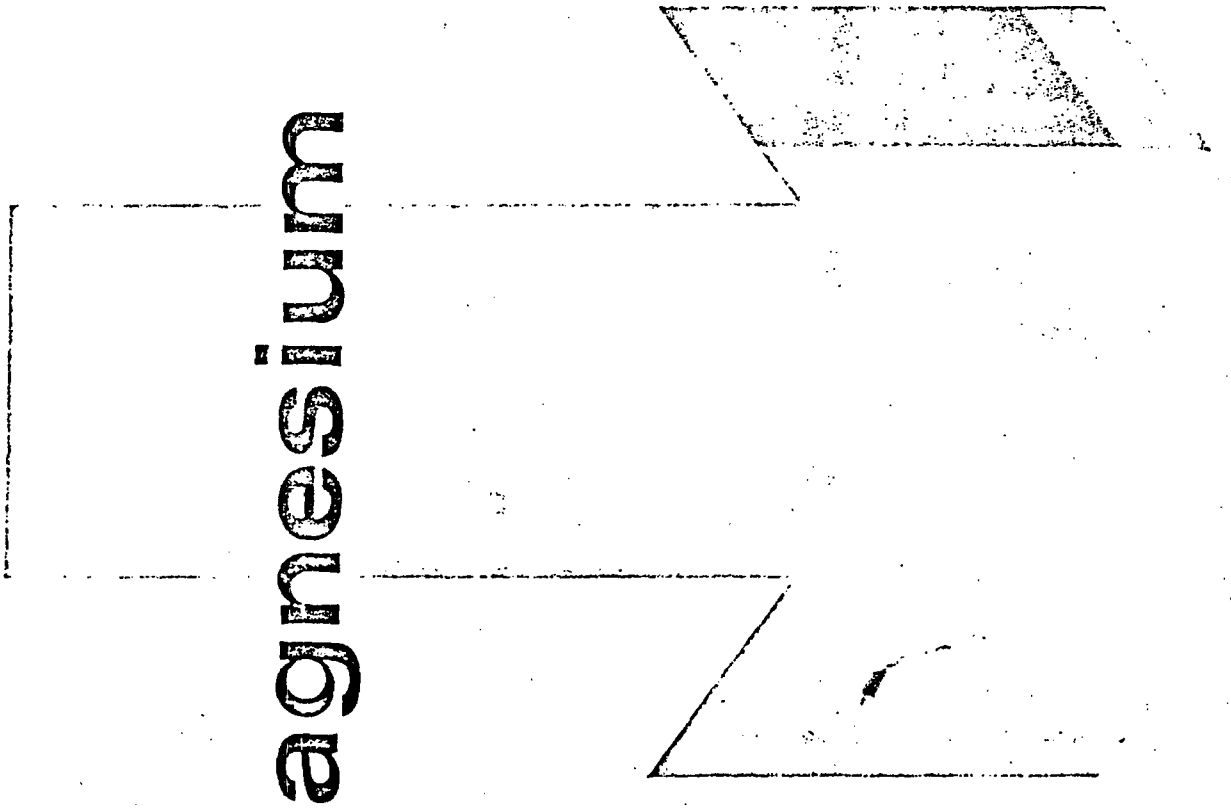


TABLE OF CONTENTS

Introduction

Magnesium alloys have been developed for elevated temperature service. Since these alloys contain thorium, a low level radioactive material, there has been some concern about safety precautions in their handling and fabrication. Thorium is a source material, the use and handling of which is regulated by the United States Atomic Energy Commission. This bulletin is based on past experience and recent studies related to thorium.

In general, the systemic (chemical) toxicity is low. Thorium is a metal which is not a chemical poison so the Industrial Hygiene Standard for continuous exposure to airborne thorium is based on its low level of radioactivity. The Standard for thorium is 270 micrograms per cubic meter of air. The Standard for heavy metals such as lead, chromium and mercury is in the range of 100 micrograms per cubic meter of air.

Since the radioactivity is comparatively low, it presents no unusual problem as the metal is currently used in magnesium alloys (3% nominal thorium or less). External radiation exposure from such alloys is so low that film badges and other monitoring devices are not necessary. Past safety practices employed in fabricating magnesium are satisfactory except that added protection will be required in welding, large scale melting, pickling and chemical milling operations to avoid internal radiation exposure resulting from inhalation of airborne thorium.

The information in this bulletin is based on data obtained in the laboratories of The Dow Chemical Company. In view of the many variables involved in Industrial Health problems, it is recommended that a preliminary survey by conducted at the start of large scale use of magnesium containing thorium.

Definition of Terms

Toxicity—property of a material defined as its ability to do damage to the body by other than mechanical means.

Hazard—the probability of a material doing damage under a specific set of conditions of exposure.

Radioactivity—the process in which certain elements spontaneously emit alpha, beta or gamma rays by the disintegration of the nuclei of the atoms.

Radiation—the energy emitted from the nuclei of atoms in the process of radioactive decay.

Disintegration—unit of radioactive decay.

Decay or radioactive decay—the process by which atoms are converted to other elements during the release of radiation.

Daughter—an element formed by the decay of the "parent" atom.

Curie—unit of radioactivity equal to 3.70×10^{10} disintegrations per second.

μCi—microcurie—(10^{-6} curies) unit of radioactivity equal to 3.70×10^{4} disintegrations per second.

Millicurie—(10^{-3} curies) unit of radioactivity equal to 3.70×10^{7} disintegrations per second.

Roentgen—unit of radiation exposure.

mr—milliroentgen—(10^{-3} roentgen) unit of radiation exposure.

mrem—millirem—unit of radiation exposure used in AEC and State regulations. It is equivalent to a milliroentgen of beta or gamma radiation as used in the regulations.

Radiation Unit—mr per hour at 1 meter from the source—to nearest whole number—used in identifying shipments subject to ICC control.

Half-life—time in which a given quantity of radioactive material loses one-half of its original activity. Each radioactive element has its own characteristic half-life.

Alpha Particle—weakly penetrating radiation consisting of helium ions.

Beta Particle—more penetrating than alpha particles—high speed electrons.

Gamma Ray—highly penetrating, high frequency electromagnetic radiation similar to X-rays.

Toxic Properties

Studies with both single and repeated oral administration of various thorium compounds to animals have revealed a very low toxicity.[4, 10] The principal action from single oral feeding of soluble salts was a local tissue injury and accompanying shock. As much as 4% in the diet of rats had no specific toxic effect in tests lasting two years. A depressed growth was due to decreased food intake.

Exposure of animals to heavy dust concentrations of thorium oxide and salts has revealed some thorium absorption and retention in the body with slight changes in blood and bone marrow.[9] These changes were attributable to internal radiation. This work with animals demonstrates a low physiological activity on the part of thorium; such activity as does exist is apparently due to radiation.

Human experience agrees with the experimental work upon animals. The manufacture and use of thorium salts over a period of many years has not revealed a particular health problem. An Industrial Hygiene survey of a thorium refinery revealed no industrial injury attributable to thorium among employees with up to 40 years working history. Levels of airborne thorium in excess of present permissible concentrations were found in certain areas of the plant.[15] The possibility of systemic injury exists in the medicinal use of Thorotrast (thorium dioxide) when large quantities are given intravenously.[1, 2, 11, 13, 14]

Magnesium the other constituent in magnesium thorium alloys is considered to be physiologically inert from the standpoint of skin exposure or hazard to health.

Radioactivity

Th^{232} has an extremely slow rate of disintegration (its half-life is 1.39×10^{10} years). Freshly separated thorium metal or compounds have a very low content of daughter products, the principal one being Th^{228}, which has a half-life of 1.9 years. The radioactivity of a thorium preparation varies over a period of years, reaching a minimal value after about 4 years, then slowly increasing to an equilibrium state. The total variation in radioactivity is by a factor of about 2.

INTERNAL RADIATION

Internal radiation exposure results from inhaling or ingesting radioactive materials. Normal practices of personal hygiene are sufficient to avoid ingesting hazardous amounts of thorium. The permissible body burden of thorium is 90 mg. which is contained in 3 g. of a 3% magnesium-thorium alloy.

Inhalation is the major route of entry into the body for most materials. Industrial Hygiene Standards have been set for many materials including thorium. This Standard is the airborne concentration of the material, below which no injury is expected to occur over a working lifetime if the workers are exposed continuously forty hours per week. Industrial Hygiene Standards are usually expressed in milligrams of material per cubic meter of air (mg/m^3), micrograms per cubic meter ($\mu g/m^3$) or in parts of material per million parts of air (ppm). Standards for radioactive materials are expressed as microcuries per milliliter of air ($\mu Ci/ml$).

In chemical milling, pickling or melting a separation of thorium from its radioactive daughters takes place. These daughters present two types of problem. The 6.7 year half-life Ra^{228} (mesothorium I) may be inhaled and deposited in the bone. The other daughters all have short half-lives, but may be inhaled and irradiate the lungs excessively if not

THORIUM DECAY SCHEME

Element (Synonym)	Atomic Weight	Atomic Number	Half-life	Radiation
Thorium	232	90	1.4×10^{10} yr	alpha
↓ Radium (Mesothorium I)	228	88	6.7 yr	beta
↓ Actinium (Mesothorium II)	228	89	6.13 hr	beta, gamma
↓ *Thorium (Radiothorium)	228	90	1.9 yr	alpha
↓ Radium (Thorium X)	224	88	3.64 days	alpha
↓ Thoron	220	86	54.5 sec	alpha
↓ Polonium (Thorium A)	216	84	0.14 sec	alpha
↓ Lead (Thorium B)	212	82	10.6 hrs	beta, gamma
↓ Bismuth (Thorium C) 66.3% β / 33.7% α	212	83	60.5 min	alpha, beta
Polonium (Thorium C')	212	84	10^{-6} sec	alpha
Thallium (Thorium C'')	208	81	3.1 min	beta, gamma†
Lead (Thorium D)	208	82	Stable	

*Contained in freshly separated thorium
† Major gamma radiation

controlled. Air samples counted for radioactivity have shown that there probably will be no hazard from mesothorium if short-lived radioactive products are controlled adequately by ventilation during melting, pickling and chemical milling. The present tolerance level for thoron daughter products is 10^{-8} μCi/ml.

In the case of the thorium refinery[15] where airborne thorium concentrations were in the range of present permissible levels, the lack of injuries attributable to thorium exposure indicates that the present levels are conservative enough to prevent any apparent radiation injury or industrial disease such as occurred in the radium dial industry. Although human experience and animal experiments seem to confirm present safe permissible limits for thorium, a reduction in permissible levels based on calculations of potential chronic radiation injury has recently been proposed.

PERMISSIBLE LEVELS IN AIR

Isotope	μCi/ml.	μg./m³	Authority
Thorium (natural)	3×10^{-11}	270*	AEC[17]
Radium[228] (mesothorium) soluble	7×10^{-11}		"
insoluble	4×10^{-11}		"
Radium[224] (Thorium X) soluble	5×10^{-9}		"
insoluble	7×10^{-10}		"
Thoron soluble	3×10^{-7}		"

* The AEC[17] states for the purpose of the regulations that one curie of natural thorium is equivalent to 19.850 pounds. This factor was used to convert the airborne activity to micrograms per cubic meter

EXTERNAL RADIATION

Direct radiation from handling alloys is not important. The permissible exposure to external radiation is 1500 mr/week for the hands and 100 mr/week for the whole body. HK31A (2000 lb. of sheet) containing 3.5% thorium was measured and found to produce a maximum of 4.2 mr/hour at its surface and 1.8 mr/hour one foot away. Assuming hand contact and the body one foot from the alloy for 40 hours weekly, exposures would be 168 mr/week to the hands and 72 mr/week to the whole body. These are within the permissible limits and represent maximum values which probably would not be approached in actual practice. Film badge measurements on workmen engaged in typical foundry operations showed a maximum of 30 mr/week on two out of 23 men involved. The other badges measured less than 10 mr/week.

COMMON RADIATION EXPOSURES

The exposure of persons to limited radiation such as from the magnesium-3% thorium alloys can be easily measured and is recorded in terms of milliroentgens per hour. Common radiation exposures listed here are compared with an HK31A measurement.

Type of Radiation	Total mr	Normal Exposure Time
HK31A (2000 lbs.) at 4 ft.	20 (0.5 per hr)	40 hours
Wrist watch—radium dial	1 to 5	1 hour (continuously)
Chest X-ray	300	2-3 seconds
Hand-arm X-ray	250-1000	8-9 seconds
Dental X-ray	1500-15,000	1-3 seconds
Shoe fitting X-ray	10,000-15,000	5 seconds

EXTERNAL RADIATION MEASUREMENTS

In order to verify the radiation from HK31A, measurements were made on production rolling ingots and on piles of the finished sheet prior to crating. In addition, similar readings were made on typical crates of HK31A ready for shipment.

Measurements were made with a RAYCHRONIX MODEL D-2A radiation survey meter. It was calibrated before test with a radium gamma reference source, and checked after test. No change in sensitivity was noted.

GAMMA MEASUREMENTS

Distance	Sheet Prior to Crating 40" x 50" x 7" Pile mr/hour	Crated Sheet, Typical Dow Package 50" x 50" x 7" Pile mr/hour	Rolling Ingot 10" x 26" x 76" 9'-0" high stack mr/hour
Surface	2.5*	2.5	2.2†
1 foot	1.8	1.5	1.7
2 feet	1.5	1.2	1.2
3 feet	0.5	1.0	1.1
4 feet	0.5	0.5	0.7
5 feet	0.1	0.0	0.6
6 feet			0.2
7 feet			0.0

* Beta – Gamma = 4.2 mr/hour
† Beta – Gamma = 3.2 to 5.1 mr/hour

Beta reading is given for surface of the metal only since beta radiation did not contribute to other measurements made at the various distances from the surface.

Gamma radiation only is measured outside of the crate as beta radiation is shielded by the wrapping paper or crate material.

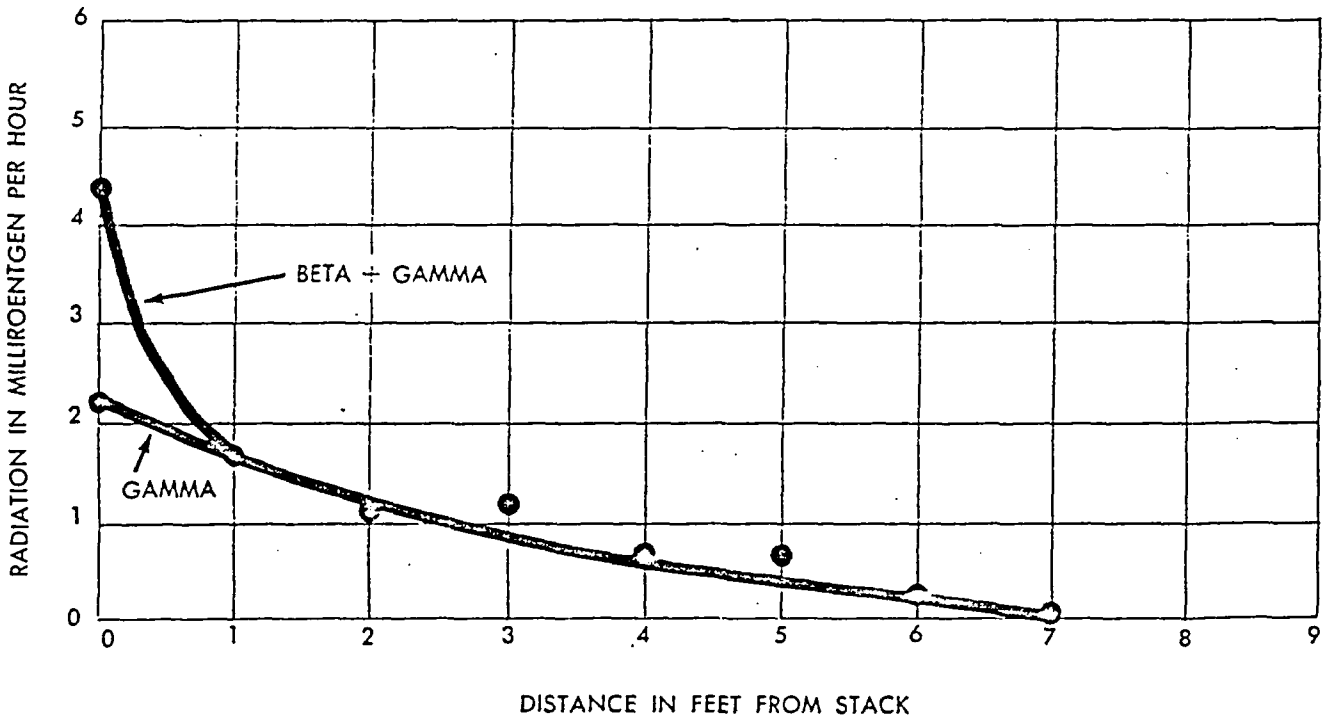
Thorium composition of one slab checked was 3.45%.

The variation in radiation due to changes in mass and thorium content is illustrated by the measurements in the following table. Very low values were obtained on thin section single sheets of alloy. Film badges attached to large slabs of magnesium-thorium alloys showed 150 mr for 168 days (0.89 mr/hr) for 2% thorium and 800 mr for 500 hours (1.6 mr/hr) for 3% thorium.

% Thorium	Alloy	Size or Weight	Distance	mr/hour $\beta + \gamma$
3	HK31A	⅛" x 18" x 36"	surface	0.5
3	HK31A	⅛" x 18" x 36"	1 foot	0.3
3	HK31A	⅛" x 12" x 12"	surface	0.5
3	HK31A	⅝" x 12" x 12"	surface	0.75
3	HK31A	7 billets 300#	surface	1.8
3	HK31A	7 billets 300#	within pile	3.5
3	HK31A	48" x 144" x 1850#	surface	1.6 *
3	HK31A	48" x 144" x 1850#	1 foot	1.3 *
3	HK31A	4 ft. dia. castings	within pile	3.0
2	HM21A	.071" x 12" x 12"	surface	0.25
2	HM21A	⅛" x 12" x 12"	surface	0.35
2	HM21A	1.5" x 5.5" x 8"	surface	0.6
25	hardener	500#	surface	35. *
100	pellets	100#	surface	100. *

* γ only

RADIATION FROM STACK OF HK31A SLABS



EXPOSURE OF PHOTOGRAPHIC FILM

Magnesium alloys containing certain minimum amounts of thorium may, with direct contact and continuous exposure, cause some autoradiographic darkening of photographic film over and above the background darkness of the film. This darkening will depend on the distance between the metal and film. Even a single piece of black paper separating the metal and film will reduce the exposure. The following values were obtained by densitometer readings of commercial X-ray film, Industrial Type K, after specific exposure.

While commercial shipments of photographic film are not likely to be handled by a carrier at the same time as shipments of magnesium alloys containing thorium, it is known that some exposure of the undeveloped film may take place over a period of time.

% Thorium	Exposure Condition*	Exposure Time In Hours		
		24	144	216
0.0	--	0.36†	0.36†	0.36†
0.07	A	0.36	0.36	0.36
0.6	A	0.36	0.45	0.50
3.1	A	0.55	0.94	1.20
10.0	A	0.66	1.30	1.73
0.07	B	0.36	0.36	0.36
0.6	B	0.36	0.36	0.43
3.1	B	0.42	0.62	0.82
10.0	B	0.57	1.06	1.50

* A = Metal in direct contact with film.
* B = Metal separated from film by one layer of black paper.
† = The background or zero reading of the densitometer is 0.36 for this test.
For exposure times of 216 hours some film darkening resulted at percentages of thorium above 0.5% both with and without the black paper.

The test described here was conducted to simulate actual shipping conditions with a longer than normal contact time between the alloy and the film. Except for the removal of individual film strips for use as control blanks, the film cartons were identical to standard shipping packages. This included black paper wrapping, film box, corrugated cardboard layer plus kraft paper outside wrapping.

Film Used	Panatomic X–2 boxes of 11 sheets each Kodak Medical X-ray Film–2 boxes of 23 strips each.		
Alloy	HK31A (3% thorium)		
Quantity of Alloy	1850 pound stack of 4 ft. x 12 ft. sheets set on edge with 500 pounds additional alloy 5 ft. beyond the stack on the side away from the film.		
Film Location	One box of each type taped to the stack of sheet. Second box of each type supported one foot away from the flat side of the stack.		
Exposure Time	500 hours		
Measured Radiation at Flat Surface of Stack	Survey meter	1.3 mr/hr	
	Film badge	800 mr/500 hr	
		1.6 mr/hr	
Measured Radiation at 1 Foot from Stack	Film badge	650 mr/500 hr	
		1.3 mr/hr	

OPTICAL DENSITY AFTER DEVELOPMENT

Film	Zero Reading	Control	Contact With Stack	One Foot Away
Panatomic X	0.02	0.10	1*–0.23	1*–0.16
			5 –0.18	5 –0.16
			11 –0.16	11 –0.16
Medical X-ray	0.04	0.20	1*–1.35	1*–0.67
			5 –1.20	5 –0.60
			10 –1.15	10 –0.58
			15 –1.12	15 –0.58
			20 –1.03	20 –0.57
			23 –1.00	23 –0.57

* Order of sheet in pile of film with number 1 nearest to the HK31A. Note the self shielding effect of film sheets in pile.

Practical Aspects of Processing Magnesium-Thorium Alloys

With the exception of welding, the common operations of fabricating magnesium do not contaminate work room air sufficiently to be of concern. The safe practices normally followed to collect grinding dust, the standard storage methods employed for raw materials and finished products and the proper ventilation used in pickling operations all adequately control air contamination.

MECHANICAL OPERATIONS

At the mechanical operations of grinding and filing acceptable levels of thorium were encountered, this work being done at exhausted dust collecting equipment commonly used to control the fire hazard. Sawing did not produce small particles capable of being suspended in the air. The spectrographic analytical results were as follows:

Operation	*μg. thorium/m³ air*
Grinding, filing, buffing (5.5 and 3.3% thorium)	35.3, 10.2, 5.5, 4.5, 0.8
Sawing (5.4 and 3.3% thorium)	<6.7

In mechanical operations there is no separation of thorium from its daughters, so the control figure of 76 μg/m³ is applicable.

The following chart shows the results of measurements made during a variety of mechanical operations. In this case the samples were taken with an Electrostatic Precipitator and analyzed spectrographically for thorium, with the results as shown. The chart includes grinding, both surface and open wheel, rotary filing, buffing, sawing, and the drumming of very fine HK31A powder. All were breathing zone samples and the operation took place on equipment that is designed for safe operation with magnesium, including local exhaust and water traps to collect the grinding fines. Samples eight and nine involve slabs of HK31A. Sample eight was an area sample taken near heat treat ovens and sample nine was taken during the rolling of the slabs. Very little oxide coating was noticed on the slabs during the heat treat and a small amount was observed during the rolling.

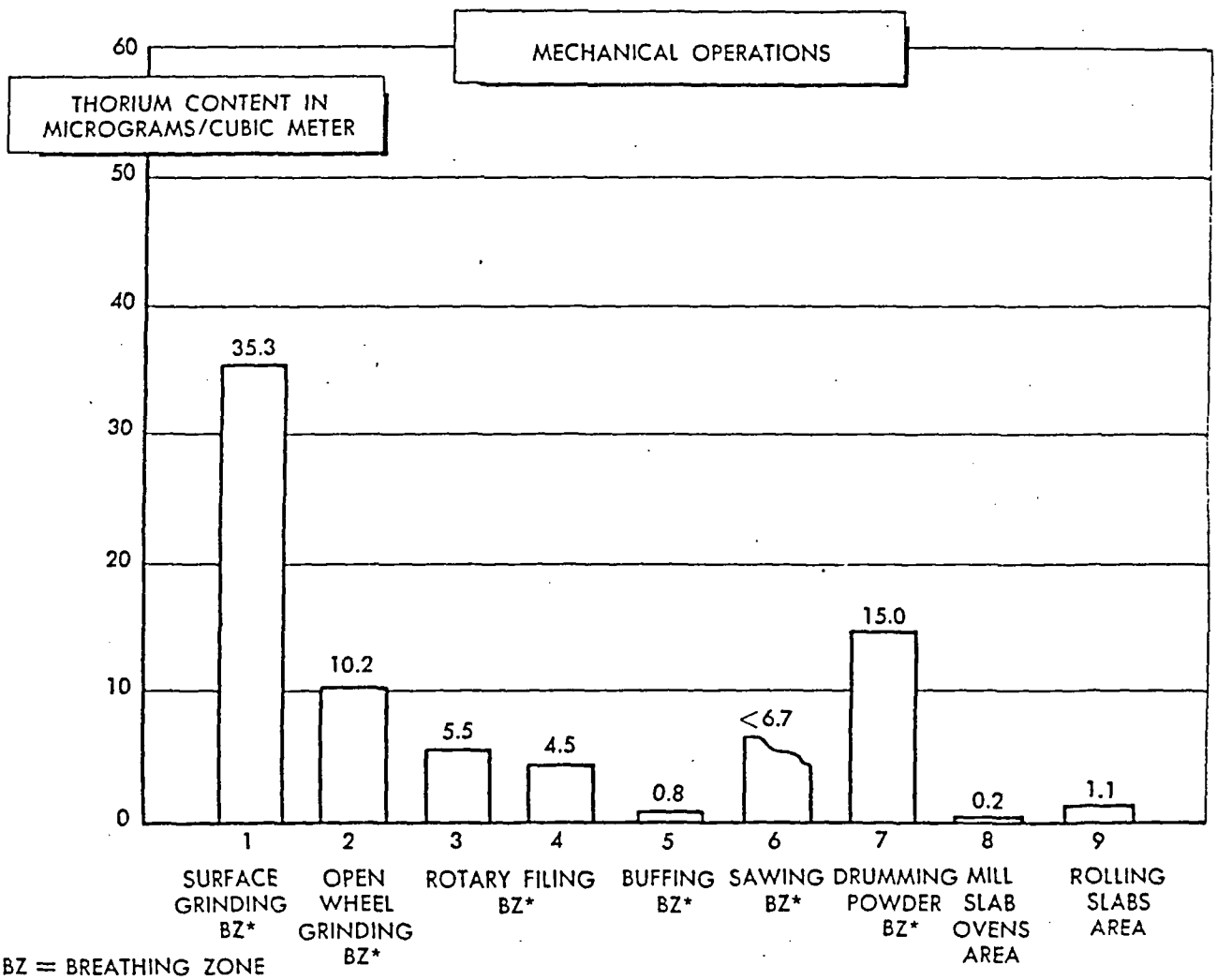
ARC WELDING

Arc welding of magnesium-thorium alloys is carried out with an argon or helium shielded arc as is normal for other magnesium alloys. Adequate ventilation is essential with either type of alloy. Recommended respiratory protection, ventilation and fume control measures are given in the Welding Handbook, Section 1[21] of the American Welding Society.

In many cases, air samples taken in the breathing zone of the operator have been well within the limits for airborne thorium, particularly where the shop has high ceilings and normal ventilation is good.

Where welding is done in an enclosed area or the visible fumes tend to envelop the operator's hood, a form of local exhaust may be necessary.

An air sampling survey should be conducted to determine the adequacy of ventilation under production conditions. Since permissible airborne limits are based on continuous exposure for 40 hours per week, the measured concentrations during shorter actual welding exposures should be time weighted over the work week to obtain the total average exposure.



* BZ = BREATHING ZONE

Magnesium Base Alloy % Thorium	Ceiling Height-Ft.	μg thorium/m^3 air (Spectrographic Analysis)	Remarks
3	20	100	
3	20	52	
3	20	29	
3	20	34	Automatic Welder
2	35	<2.3	
2	35	5.1	
3	40	59	
3	40	<17	Local exhaust
--	--	270	Permissible average level

PICKLING AND CHEMICAL MILLING

A very few measurements taken during acid pickling of HK31A indicated levels of radioactivity well below tolerance near the pickling tank. These readings were made with the lip-type ventilators drawing about 250 cfm/sq. ft. of tank area. Local exhaust ventilation should reduce concentrations at the worker's breathing zone to an acceptable level.

MEDICAL CONSIDERATIONS

There is no particular concern about direct handling and storing of commercial magnesium-thorium alloys (3% nominal thorium or less). The low concentrations of thorium prevent excessive direct radiation.

Any metal slivers penetrating the skin should be removed, as is the case with any foreign body.

If additional assurance of safe working conditions is desired, a yearly medical examination for general health can be conducted.

STORAGE CONDITIONS

Excessive amounts of radioactive emanations in storage should not be encountered if alloys are stored in accordance with recommendations for fire safety. The storage of magnesium base alloys containing thorium is maintained under the same simple conditions as outlined for other magnesium alloys in the National Fire Code, Volume II[19] published by the National Fire Protection Association. For indoor storage of sheet and plate, the size of storage stacks should be limited to 1250 cubic feet for plates and 1000 cubic feet for sheets. 4000 cubic foot piles are permissible if the building is sprinklered. Aisle widths should be not less than one-half the height of the piles; aisle widths equal to the height of piles are recommended. These storage conditions are safe from both the fire control and radiation viewpoints.

BURNING MAGNESIUM-THORIUM SCRAP

Since the disposal of magnesium-thorium alloy chips and scrap may at times be made by burning on a dump, tests have been conducted to determine the radioactivity of the fumes and smoke.

Three HK31A fires were checked, the last two, incidentally, because the results of the first were quite surprising. No thorium was found by spectroscopic analysis, X-ray diffraction or X-ray fluorescence, in either the visible fumes or a short distance from the fire. A second fire was checked and this time the residue was saved. Again, in the visible fumes and 5 feet from the fires, there was no thorium to be found. However, in the residue 10 to 20 percent thorium dioxide was discovered by X-ray diffraction. Apparently the thorium remains in the residue when a magnesium-thorium fire takes place. The third fire was sampled with analysis of samples being made by counting for radioactivity. In the visible fumes, the 3.6 day half-life of Ra^{224} was evident as was 10.6 hour half-life of Pb^{212}.

HK31A FIRES

	Thorium Found		
	X-ray diffraction	X-ray fluorescence	spec. analysis
#1: In visible fumes	0	0	0
BZ* 1 ft. from fire	0	0	0
#2: In visible fumes	0	0	
5 ft. from fire	0	0	
Residue	10-20% ThO_2		
	Ra^{224}	Pb^{212}	
#3: In visible fumes	2×10^{-9} μCi/ml	2.5×10^{-9} μCi/ml	
15 ft. from fire	8×10^{-12}	2×10^{-11}	
Permissible level (Insoluble)	7×10^{-10} "	2×10^{-8} "	

* BZ = Breathing Zone

Air-Analysis

Samples of fume and dust have been obtained with an Electrostatic Sampler Model F made by the Mine Safety Appliance Company, using aluminum tubes The metal or oxide is recovered by solution in 75-80 ml of 10% nitric acid. This solution is evaporated to dryness and the residue taken up in 1 ml of the nitric acid. A 0.03 ml aliquot is employed for spectrographic determination, using the thorium line at 4019Å. A Baird brand 3 meter Grating Spectrograph with Ennis type spark source has been used.

In recent work air samples were collected with an electrostatic precipitator and counted for alpha and beta activity in an NMC model PC-1 proportional counter. The counter efficiency for alpha was determined by counting a calibrated alpha source. Beta efficiency was assumed to be 50%, which is too low by an unknown backscattering factor. This error is on the safe side since reported beta counts are higher than actual counts.

Where a chemical or physical separation of thorium from its radioactive daughters is possible, air samples must be counted for radioactivity to determine the extent of hazard. In grinding, buffing, sawing and other mechanical operations spectrographic analysis for thorium may be used since the industrial hygiene standard of 270 $\mu g/m^3$ of air is calculated on the basis of thorium in equilibrium with its daughters.

Atomic Energy Commission Controls

LICENSES

The U.S. Atomic Energy Commission regulations have established procedures for the issuance of licenses to receive, possess and transfer thorium. The licensing conditions are described in the Code of Federal Regulations, Title 10—Atomic Energy Chapter I, Part 40—Licensing of Source Material[18].

A General License is effective without the filing of an application and provides for the use of not more than 15 pounds of thorium (500 pounds of HK31A) at any one time or a total of 150 pounds (5000 pounds of HK31A) in any calendar year. Specific licenses for which application must be made are granted for larger quantities of thorium. Specific license applications are obtained from and filed with:

United States Atomic Energy Commission
Washington, D.C. 20545
Attention: Director,
Division of Licensing and Regulation

Regulations covering Standards for Protection Against Radiation have been issued by the AEC as 10 CFR Part 20[17].

The Dow Chemical Company, is licensed to receive thorium for use in the preparation of magnesium alloys. Shipments of thorium-containing alloys can be made only to those companies having valid General or Specific licenses.

Companies who receive finished products containing no more than 4% thorium by weight magnesium alloy and do not chemically, physically, or metallurgically treat or process this product are exempt from any licensing requirements.

The AEC has recently provided through agreement with individual states for the licensing of thorium and other radioactive materials by the state. This replaces the application to and licensing by the AEC but is expected to be on the same general basis. This change is effective only in those states where individual AEC-State agreements have been arranged.

DISPOSITION OF THORIUM WASTE

No thorium waste is to be released to the public except to a firm specifically licensed by the AEC to receive such waste. This applies to clippings, solid scrap and chips as well as to non-reclaimable fines, sludge, etc.

Liquid wastes which contain thorium may be discharged into sanitary sewers providing:

1. Waste is readily soluble or dispersible in water; and
2. Dilution is at least 440 gallons of effluent per pound of thorium (or 13 gallons per pound of 3% MgTh alloy) based on both daily and monthly average quantity of water released; and
3. Does not exceed 10 pounds of thorium per day.
4. Local regulations permit discharge into sanitary sewers.

Solid or sludge type waste containing thorium may be buried in accordance with AEC approved procedures. The amount of thorium buried at any one time is limited to 1000 pounds.

Department of Transportation Requirements

SHIPPING LABELS

Thorium alloys are listed by name in CFR49 (Code of Federal Regulations) and classified as "Low Specific Activity Material".

Low specific activity material enjoys various exemptions from the Hazardous Materials Regulations. These exemptions permit, under certain conditions, use of non-specification packages, elimination of labels, and shipment of bulk, unpackaged materials. The conditions under which these exemptions apply are detailed in paragraph 173.392 of CFR49.

When exemptions are not relied upon, the proper label for this material is determined by the millirem reading on the surface of the package and at a distance of three feet.

(1) Radioactive	WHITE I LABEL	<0.5 mrem/hr at surface
(2) Radioactive	YELLOW II LABEL	<10 mrem/hr at surface or <0.5 mrem/hr at 3 ft
(3) Radioactive	YELLOW III	not applicable to magnesium-thorium alloys

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MATERIAL SAFETY DATA SHEET (MSDS)

COMTRA NO. SC-000-065 REV. 0 DATE 11/25/85 CODE 15-04
CONFORMS TO REQUIREMENTS OF OSHA STANDARD 1910.1200 "HAZARD COMMUNICATION" AND TO MINNESOTA STATUTES 1982 , 182.651 "EMPLOYEE RIGHT TO KNOW ACT OF 1983"

SECTION I PRODUCT IDENTIFICATION

This MSDS supplied for: MAGNESIUM/THORIUM ALLOY CASTINGS

ASTM NO.

HK-31-A
HZ-32-A
QH-21-A
ZH-62-A

VENDOR NAME AND ADDRESS: Hitchcock Industries Inc.
8701 Harriet Ave. South
Minneapolis, MN 55420

EMERGENCY PHONE NUMBER: 612-887-7800

FIRE HAZARD CLASS: HEALTH: 0 FLAMMABILITY: 1 REACTIVITY: 2
THE FOURTH DIAMOND: AVOID USE OF WATER

ANSI: WARNING: GRINDING OR MACHINING THIS CASTING WILL GENERATE DUST OR CHIPS WHICH WILL BURN OR MAY EXPLODE. THE DUST OR CHIPS ARE OF LOW LEVEL RADIOACTIVITY.

SECTION II - HAZARDOUS COMPONENTS

INGREDIENT	CAS NO.	PERCENT	TLV	PEL
Cerium	7440-45-1	0-1.5	N/E	N/E
Copper	7440-50-8	0.1.0	1.0 mg/cu.m as dust	1.0 mg/cu.m
			0.2 mg/cu.m as fume	0.1 mg/cu.m
Magnesium (as magnesium oxide fume)	1309-48-4	89.3-96.4	10 mg/cu.m	15 mg/cu.m
Nickel	7440-02-0	0.005-0.01	1 mg/cu.m	1 mg/cu.m
Thorium	7440-29-1	0.6-4.0 Max.	(1)	(1)

INGREDIENT	CAS NO.	PERCENT	TLV	PEL
Silver	7440-22-4	0-3.0	0.1 mg/cu.m	0.01 mg/cu.m
Zinc	~~1314~~-13-2 7440-66-6	0.2-6.2	10 mg/cu.m as dust	15 mg.cu.m
			5 mg/cu.m as fume	5 mg/cu.m
Zirconium	7440-67-7	0.40-1.0	5 mg/cu.m	5 mg/cu.m

(1) The U.S. Nuclear Regulatory Commission sets the maximum concentration of natural Thorium in air averaged over 40 hours per week for 13 weeks, at 6E-11 microcuries per milliliter of air. No TLV has been adopted by the American Conference of Governmental Industrial Hygienists (ACGIH) for Thorium. Radiation effects are more important than chemical toxicity.

Elements having a listed percentage greater than zero will be present in all grades. Those having a value of "0" may not be present in certain grades.

SECTION III - OVERVIEW

There are no chemical hazards from these castings in solid form.

Machining, grinding, flame cutting, or welding on the casting will put contaminants in the air. Since the casting contains mostly magnesium, most of the airborne contaminants will be magnesium dust or magnesium oxide fume.

Thorium is a naturally occuring radioactive element which in radioactive equilibrium, emits alpha, beta and gamma radiation. Since Thorium has a low specific activity and the maximum content in the castings is 4%, the level of radiation emitted from the castings is low. The major health effects are from the radioactive decay products of Thorium if they are inside the body. Therefore, special precautions must be employed to protect against breathing or eating the dust or metal shavings. Excessive intake of Thorium for a long time can cause lung cancer or bone cancer. Wherever Mag/Thoroium castings are machined, ground, and welded on, employees should be instructed on basic radiological health principles. Eating, drinking or smoking should be prohibited where ingestion of the dust or metal is possible. Good personal hygiene such as thoroughly washing hands and face before going on break should be followed.

Magnesium oxide fume has the same TLV as a nuisance dust. A nuisance dust has no health effect on the lungs or body. Magnesium dust and shavings are extremely flammable. When machining, grinding or welding class D fire extinguishing agents should be readily available for extinguishing metal powder or dust fires. Wet dust collectors are used for exhaust ventilation. However water should never be used for extinguishing magnesium fires.

Magnesium will react with water slowly to form hydrogen, a flammable gas. Normal ventilation is adequate to disperse hydrogen but it could accumulate in confined spaces.

Dedicated machining and grinding operations are required for magnesium castings to reduce the possibility of fire from sparks or hot metal chips from ferrous and other types of alloys. Adequate dust control ventilation should be provided for production operations. The dust and machining wastes are considered low level radioactive wastes and must be disposed of according to the NRC low level radioactive waste disposal regulations, so they should be collected separately.

Grinding on castings that have not been cleaned may generate significant amounts of dust containing free silica, which can cause silicosis.

The other metals in magnesium castings are present in small amounts compared to the magnesium. If airborne concentrations of magnesium are controlled to levels below its respective TLV and

PEL, these minor constituents would also be adequately controlled.

SECTION IV - PHYSICAL DATA

PHYSICAL DESCRIPTION: Silvery-white metal
MELTING POINT: 1200 F
BOILING POINT: 1994 F
VAPOR PRESSURE: N/A
VAPOR DENSITY: N/A
SOLUBILITY IN WATER: Reacts
SPECIFIC GRAVITY: about 1.7 (water=1)
PERCENT VOLATILE BY VOLUME: N/A
EVAPORATION RATE: N/A

SECTION V - FIRE AND EXPLOSION DATA

FLASH POINT(CLOSED CUP): N/A
EXPLOSIVE LIMITS: FOR THE MAGNESIUM DUST: LOWER: 0.03 grams/liter
(In the same units as the TLV, 30,000 mg/cu.m.)
AUTOIGNITION TEMP: N/A
FIRE POINT: N/A
EXTINGUISHING MEDIA: In case of a metal powder/dust fire, use a class "D" fire extinguishing agent (Lith-X, Dry Graphite, etc.) and isolate the fire.
HAZARDOUS DECOMPOSITION PRODUCTS: Water may react slowly with magnesium to liberate hydrogen gas, a flammable and explosive gas.
SPECIAL FIRE FIGHTING PROCEDURES: N/A
UNUSUAL FIRE & EXPLOSION HAZARDS: Like all combustible solids, dust from this product can form explosive mixtures in air. Explosive dust concentrations are usually very thick dust clouds, not often found in working areas, but can occur in process vessels, dust collectors or bulk loading operations. The bulk metal is not flammable.

SECTION VI - HEALTH HAZARD DATA

ACUTE HEALTH EFFECTS OF OVEREXPOSURE:

EYES: Irritation due to particles in the eye.
SKIN: Cuts from metal. Burns from molten metal. Radiologic damage from alpha radiation may occur if metal dust or particles enter the body through cuts in the skin.
BREATHING: Overexposure to magnesium oxide fume can cause a mild increase in body temperature followed by fever and an increase in white blood cell count. Recovery is complete. Excessive intake of Thorium for a long time can causse lung cancer or bone cancer.
SWALLOWING: Notify physician that metal dust or chips containing 0.5 to 4.0% Thorium was swallowed. Thorium is a radioactive element that emits alpha, beta and gamma radiation.
CHRONIC HEALTH EFFECTS OF OVEREXPOSURE:

EYES: Irritation
SKIN: Radiologic damage from alpha particles may occur if metal dust or particles enter the body through cuts in the skin.
BREATHING: Possible carcinogenic effects from overexposure to dust or fumes due to Thorium radioactivity. However if magnesium dust and fume levels are kept below their health limits, thorium levels will generally also be controlled.

FIRST AID

IF IN EYES: Flush with large amounts of water while holding eyelids open. Get medical attention if irritation persists.
IF ON SKIN: For burns: Run cold water over the effected area or dress with salve and cover with gauze. Call a physician.
Radiologic damage from alpha radiation may occur if metal dust or particles enter the body through cuts in the skin.
IF BREATHED: Remove to fresh air. If breathing is difficult, give oxygen; if breathing has stopped, give artificial respiration. Get medical attention.
IF SWALLOWED: Notify physician that metal dust or chips containing 0.5 to 4.0% Thorium was swallowed. Thorium is a radioactive element that emits alpha, beta and gamma radiation.

SECTION VII - REACTIVITY DATA

HAZARDOUS POLYMERIZATION: Will not occur.
STABILITY: Normally stable.
INCOMPATIBILITY: Magnesium (especially when powdered) undergoes violent or explosive reactions with oxidizing agents.

SECTION VIII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

FOR SPILLS: (Any Size) Allow molten alloy to cool. Then scrape up and dispose of according to NRC requirements.

WASTE DISPOSAL METHOD:

FOR SPILLS: Place in a tank with liquid ferric chloride and water. Hydrogen, a flammable gas, is given off by this reaction. Keep tank outside or maintain proper explosion proof ventilation. After reaction is completed in tank remove all moisture by air drying or adding approved NRC drying agents. Dispose in approved low level radioactive waste disposal site according to NRC regulations.

SECTION IX - PROTECTIVE EQUIPMENT TO BE USED

RESPIRATORY PROTECTION: Avoid breathing fume from this product. If fume control ventilation is not effective, wear a NIOSH approved respirator for fume and radionuclides.
VENTILATION: Provide local exhaust over grinding and welding operations to maintain concentrations below the TLV's and NRC Air Concentration limit.
PROTECTIVE GLOVES: Heat protective gloves are recommended when working with molten metal. Wash hands and face thoroughly before going on break.
EYE PROTECTION: Wear safety glasses with side shields or a face shield.
OTHER PROTECTIVE EQUIPMENT: Use a heat protective apron when working with molten metal.

SECTION X - SPECIAL PRECAUTIONS OR OTHER COMMENTS

Good housekeeping and personal hygiene are necessary when [illegible] or working magnesium, the dust and turnings are

INFORMATION PRESENTED HEREIN HAS BEEN COMPILED FROM SOURCES CONSIDERED TO BE RELIABLE AND IS ACCURATE AND RELIABLE TO THE BEST OF OUR KNOWLEDGE BELIEF BUT IS NOT GUARANTEED TO BE SO.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

APR 0 1 1986

General Electric Company
Aircraft Engine Group
Industrial Hygiene Department
ATTN: Mr. John D. Engel
Radiation Safety Officer
Mail Drop B-14
Cincinnati, OH 45215

License No. STB-53

Gentlemen:

This refers to the special inspections conducted by the State of South Carolina Department of Health and Environmental Control on February 25 and March 4, 1986 and to the telephone conversation between you and Mr. D. R. Gibbons of this office on March 24, 1986, regarding the shipments of radioactive waste shipped from your facility on February 22 and 26, 1986, and received at the Chem-Nuclear Systems, Incorporated, Barnwell, South Carolina disposal site on February 25 and March 4, 1986, and a review of documents pertaining to those shipments.

Based on the results of this review, certain of your activities appeared to be in violation of NRC requirements, as specified in the enclosed Notice of Violation. A written response is required.

The violation for which you have been cited has already been the subject of enforcement action by the State of South Carolina. On March 10, 1986, the State of South Carolina suspended your burial permit, and assessed a civil penalty of Two Thousand Dollars ($2,000.00).

In view of the circumstances surrounding this matter, we have exercised our discretion under the General Statement of Policy and Procedure for Enforcement Actions, 10 CFR Part 2, Appendix C, as revised, 49 FR 8483 (March 8, 1984), and have chosen to issue at this time the enclosed Notice of Violation. After reviewing your response to this Notice of Violation and your proposed corrective actions, the NRC will determine whether further NRC enforcement action is necessary in order to ensure compliance with NRC regulatory requirements.

We will gladly discuss any questions you have concerning this inspection.

Sincerely,

Jack A. Hind

Jack A. Hind, Director
Division of Radiation Safety
and Safeguards

Enclosures:
1. Notice of Violation
2. 3/10/86, ltr from Dept. of Health and Environmental Control, State of South Carolina

cc w/enclosures:
Mr. John D. Engel, Corporate
Radiation Safety Officer
DCS/RSB (RIDS)

cc w/o enclosure No. 2:
Heyward G. Shealy, Chief
Bureau of Radiological Health
State of South Carolina

NOTICE OF VIOLATION

General Electric Company License No. STB-53

As a result of the inspections conducted on February 25 and March 4, 1986, and in accordance with the "General Policy and Procedures for NRC Enforcement Actions," 10 CFR Part 2, Appendix C (1985), the following violation was identified:

10 CFR 71.5 prohibits delivery of licensed materials to a carrier for transport unless the licensee complies with applicable regulations of the Department of Transportation in 49 CFR Parts 170-189.

49 CFR 173.418(a)(3)(4)(i) requires that pyrophoric radioactive materials shipped in quantities not exceeding A_2 per package to be packaged in Type A packagings which are constructed of materials which will not react nor be decomposed by the contents. Contents must be free of water and any contaminants which would increase the reactivity of the material, and made inert to prevent self-ignition during transport by mixing with large volumes of inerting material such as graphite, or dry sand, or other inerting material, or blended into a matrix of hardened concrete.

Contrary to the above, the licensee failed to properly mix the contents of Drum No. 106 (listed on shipment 0286-292-A as solidified oxides of magnesium, thorium chips) to make the contents inert, and Drum No. 233 from shipment 0286-293-A and Drum No. 581 from shipment 0286-294-A contained a liquid contaminant that could have increased the reactivity of the material.

This is a Severity Level III violation (Supplement V).

Pursuant to the provisions of 10 CFR 2.201, you are required to submit to this office within thirty days of the date of this Notice a written statement or explanation in reply, including for each violation: (1) corrective action taken and the results achieved; (2) corrective action to be taken to avoid further violations; and (3) the date when full compliance will be achieved. Consideration may be given to extending your response time for good cause shown.

March 31, 1986
Dated

Jack A. Hind
Jack A. Hind, Director
Division of Radiation Safety
and Safeguards

South Carolina Department of Health and Environmental Control

2600 Bull Street
Columbia, S.C. 29201

Commissioner
Robert S. Jackson, M.D.

April 22, 1986

Mr. J.D. Engel
Radiation Safety Officer
General Electric Company
Aircraft Engine Business Group
1 Newman Way
Cincinnati, Ohio 45215-6301

Dear Mr. Engel:

This is to acknowledge receipt of your letter dated April 9, 1986, regarding your corrective action for shipments of radioactive waste to the Barnwell disposal facility found in noncompliance with applicable requirements. Further, we acknowledge payment of the assessed civil penalty.

We have reviewed the corrective procedures and find them acceptable to the Department. Accordingly, your S.C. Radioactive Waste Transport is hereby reinstated effective this date.

It is anticipated that all future shipments will conform to these procedural modifications and comply with all state and federal regulations and the burial facility's acceptance criteria.

We appreciate your continued cooperation in these matters; and if you have any questions, please do not hesitate to contact us.

Very truly yours,

Heyward G. Shealy, VRA

Heyward G. Shealy, Chief
Bureau of Radiological Health

HGS:VRA:kn

cc: Mr. Richard S. Sappington, DHEC Inspector
Mr. Lee Poppe, CNSI

Enclosure 1

GENERAL ELECTRIC - AEBG MAGNESIUM THORIUM DRUMS

DESCRIPTION OF TRANSPORT INCIDENT

Chem-Nuclear Systems, Inc., as a radioactive waste processing and disposal contractor for The General Electric Company - Aircraft Engine Business Group, Cincinnati, Ohio, made three shipments of solidified GE-AEBG-generated magnesium-thorium turnings on February 22 and 26, 1986. These shipments, containing a total of 187 55-gallon drums, were inspected by the South Carolina Department of Health and Environmental Control (SC DHEC) at the Barnwell Waste Management Facility and were found in some instances to contain measurable quantities of free-standing water and in other instances to contain loose magnesium-thorium turnings which had not been completely incorporated in the PMC cement matrix as required.

IDENTIFICATION OF PROBLEM

General Electric - AEBG, supported by Chem-Nuclear, has determined that the violations occurred due to the following reasons:

1. The PMC cement used to incorporate the magnesium-thorium turnings did not cure properly due to extremely cold weather during the initial curing period and subsequent storage. This caused damage to the cement's capillary spaces which later led to inability of the mix to incorporate and retain normal quantities of water. Additionally, the marginally freezing weather precluded complete hydration of the cement which also contributed to the surplus of water.

2. The processed drums were temporarily stored outside subjecting them to abnormally rainy and cold weather thus allowing water, in some cases, to overload the cement's capillary entrainment spaces. This, along with the damage caused by freezing, led to a supply of water which could slowly drain from the billet during shipping, notwithstanding that every drum had been punctured, drained of water if present, and resealed prior to shipment from the GE-AEBG facility.

3. Instances of procedural deviation (Procedure No. FS-OP-013), specifically with regard to mixing sequence steps 4.3, 4.4, and 4.5, resulted in some castings with relatively large bottom defects. These defects ranged from non-homogeneous areas of slightly abnormal ratios of PMC cement to magnesium-thorium turnings to those areas characterized by the presence of turnings without cement.

   Chem-Nuclear's project supervisors judged that reordering of the mixing steps met the intent of the magnesium-thorium/PMC cement mixing procedure. In no instance were there departures from cement chemistry specifications, compliance with which was considered to be critical to the solidification process.

4. A number of drums, which indicated non-homogeneous areas based on distinctive sounds produced by rapping with a steel bar, were opened and the solidified billet repaired and repackaged in new or reconditioned 55-gallon drums. To reinsert the repaired billet, it was necessary to reduce its diameter. The scaling of the billets to the required configuration allowed small pieces of cement and/or turnings to flake off during handling and shipping and fall to the bottom of the drums. This was another source of loose magnesium-thorium turnings which were found during inspection at the Barnwell Facility.

GENERAL ELECTRIC

AIRCRAFT ENGINE BUSINESS GROUP
GENERAL ELECTRIC COMPANY • 1 NEUMANN WAY • CINCINNATI, OHIO 45215-6301 • (513) 243-2000

April 28, 1986 NRC License STB-53

Mr. Jack A. Hind, Director
Division of Radiation Safety and Safeguards
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, Illinois, 60137

Subject: General Electric Co., Aircraft Engine Business Group
Corrective Action in Response to Transport Incident of
February 25 and March 4, 1986

Reference: Your NRC letter dated April 1, 1986

Dear Mr. Hind:

Enclosed is a description of the events that led to General Electric Aircraft Engine Business Group problem related to shipment of Magnesium-Thorium scrap chips as described in your referenced letter. The plan for corrective action is also enclosed.

Our corrective action plan has been approved by the South Carolina Department of Health and Environmental Control per enclosed letter dated April 22, 1986.

With reference to (1) the corrective action described will eliminate any free standing water by heating the original drums for three days and by placing about four inches of a sand and dry cement mixture in the bottom of a 85 gallon overpack drum. The mixing of loose Magnesium-thorium with ten parts of sand will inert the Magnesium.

With reference to (2) General Electric will use the enclosed corrective plan in the future to avoid the type of problem that occurred from using cement alone.

With reference to (3) we expect full compliance by May 30, 1986.

Sincerely yours,

J.D. Engel

J.D. Engel
Radiation Safety Officer
General Electric Co.
Maildrop N-123
Cincinnati,Ohio, 45215