

SEC Petition Evaluation Report Petition SEC-00079

Report Rev #: Addendum 1

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Subject Expert(s):	James Mahathy
Site Expert(s):	N/A

Petitioner Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00079	83.14	November 28, 2006	Dow Chemical Company (Madison Site)

Proposed Class Definition

All Atomic Weapons Employer employees who were monitored, or should have been monitored, for exposure to thorium radionuclides while working at the Dow Chemical Company site in Madison, Illinois, for a number of work days aggregating at least 250 work days from January 1, 1957 through December 31, 1960, or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
NONE			

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
SEC Petition Evaluation Report, SEC-00079	Dow (Madison Site)

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Peer Review Completed By:	<u>[Signature on file]</u> <i>S. Hinnefeld</i>	<u>08/06/2007</u> Date
SEC Petition Evaluation Reviewed By:	<u>[Signature on file]</u> <i>J. W. Neton</i>	<u>08/06/2007</u> Date
SEC Evaluation Approved By:	<u>[Signature on file]</u> <i>Larry Elliott</i>	<u>08/13/2007</u> Date

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Addendum to Dow Madison (SEC-00079) Special Exposure Cohort Evaluation Report

Shortly before NIOSH's presentation of the Special Exposure Cohort (SEC) Petition Evaluation Report (ER) for the Dow Madison site (SEC-00079) at the May 5, 2007 Advisory Board on Radiation and Worker Health (The Board) meeting, NIOSH received from Dow Chemical Company (Dow) an additional 72 digital file folders (676 pages) that were related to the operations at its former Madison site. Because of the short time period, NIOSH was not able to consider those documents in preparation of the ER. This supplement to the Dow Madison ER reviews the newly available documents and evaluates the impact of the information on the proposed class designation.

NIOSH has reviewed the additional documentation provided by Dow and concluded that the documentation does not provide sufficient additional information regarding potential internal thorium dose to workers at the Madison site during the covered period of the SEC, which would result in a change to the initial conclusion that it is not feasible to reconstruct those doses. The additional documentation does include sufficient information to provide a bounding reconstruction of external dose resulting from thorium.

Table 1 (attached) identifies the documents that were provided in the additional submittal from Dow. NIOSH has reviewed the list of documents to determine those that were not available for preparation of the ER. Each new document was reviewed to identify information relevant to dose reconstruction such as general radiation monitoring data, air sample information, personal monitoring data, types of activities, and time frames. Based on this review, it was determined if this new information allowed for the completion of dose reconstructions for individual members of the class with sufficient accuracy. Table 2 (attached) consolidates all the data from the various sampling and monitoring events reported in the documents.

Most of the newly provided documents are related to thorium processing at the Madison site and contain some additional dose rate and air sample data for thorium. The documents contain no new information regarding uranium.

Below are discussions of the impact of the newly available documents on the following sections of the ER. The particular source documents can be identified in Tables 1 and 2.

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NIOSH-Proposed Class Definition

NIOSH did not find any information in the newly provided documentation that would have any effect on the definition of the class or on any individual's qualification as a member of the class. This addendum will be provided to the Department of Labor (DOL) to assist it in implementing the current class definition.

Feasibility of Dose Reconstruction

The newly provided documentation does not contain any personnel bioassay monitoring results. The documents also do not contain any external personnel monitoring data for workers at the Madison site; however, they do include film badge results for a list of job titles related to magnesium-thorium alloy processing for workers at another Dow facility (Bay City, MI) during a 13-day period. Also included in the documents are a number of reports, papers, and memos presenting the results of several workplace sampling campaigns during operations at the Madison site, which included worker breathing zone samples, work area air samples, and external dose rate measurements. The breathing zone samples and work area air samples are essentially the same types of data that were initially available and which the SEC ER is based. Although these measurements provide a somewhat fuller understanding of the radiation environment to which the Dow Madison workers were exposed, NIOSH still lacks necessary information to complete reconstructions of the internal dose due to thorium for individual members of the class with sufficient accuracy. The additional direct radiation readings, coupled with film badge results from a facility performing the same operations, provide a much more complete understanding of potential exposures to external radiation from thorium.

4.1 Operations Description

The list of magnesium-thorium alloys which Dow Madison commercially produced should be revised from those listed in the ER (HK-31, HK-61, HM-21, and AZ-31). From the available documents the list of Mg-Th alloys would be: HK11(?), HK31*, HM21*, HM31*, HZ32A, ZH62A based on the following:

A 1/10/56 IH Sample Record (TDCC 000001) shows a surface radiation measurement for HK11, but there is no mention of it anywhere else. Per Dow magnesium product standard spec sheet A-I-2, July 1, 1968 (TDCC 000443, 536, 554) only three alloys (at that time) contained Th – they were HK31A, HM21A, and HM31A. Alloy AZ-31 is listed as not containing Th (HK-61 was not listed). Also, in a 6/19/57 paper by Dow scientist L. Silverstein (TDCC 000058) thorium-containing alloys were identified as HK31A, HM21XA, HZ32A, ZH62A, and HM31XA.

* Alloy designations sometimes have additional letter suffixes, e.g., HM31/HM31A/HM31XA.

The description of the alloying process should be revised. The addition of thorium to the molten magnesium involved (Per Affidavit No. 2) heating up a basket in the molten metal (Mg) first, then dumping thorium in the form of pellets into the basket, and then getting it under the surface of the molten Mg as quickly as possible so that it wouldn't ignite. The process did not involve pouring molten thorium into the basket as stated in the PER.

4.4 Site Locations Associated with Radiological Operations

Additional areas where thorium materials were handled were identified in the newly provided documents. Besides Bldg. 6, other buildings with Th activities included: thorium fluoride storage in Bldg. 376 and hardener casting in Bldg. 152.

4.5 Job Descriptions Affected by Radiological Operations

Among the newly provided documents is a report of 27 film badge readings (for a 13 day period) for 20 specific jobs (pour off, knockout, sandblast, band saw, chipper, machine trim, inspection, pickler,

rotary file, buffer, heat treat, Wheelabrator, touchup, X-ray, fixture, shipping, metal reclamation) associated with HK-31 casting production at Bay City, which was another facility operated by Dow (TDCC 000362). The list of jobs is fairly descriptive and specific, and probably similar to those which would have been performed during thorium operations at the Madison site, but it is not known how complete or how representative of the Madison site this list is, and therefore it is still not possible to use job descriptions to define the proposed class.

5.0 Summary of Available Monitoring Data for the Proposed Class

The newly provided documents contain data from a number of additional sampling events/campaigns not available for the ER. The following table summarizes data found in the newly provided documents that were not available for consideration in the original ER.

TYPE	NO. OF EVENTS*	NO. OF SAMPLES
Film Badge (Bay City)	1	27
BZ Air Samples	5	>30
Area Air Samples	>10	>97
Dose Rate Measurement/Surveys	5	>81

*Some sample dates precede the covered period, but cover the same types of operations

5.1 Internal Personnel Monitoring Data

The newly provided documents do not contain any personnel bioassay monitoring data for Dow Madison site employees. There are reports from five air sampling events where a total of over 30 worker breathing zone air samples were obtained during various Mg-Th alloy production operations.

5.2 External Personnel Monitoring Data

See 4.5 above. The film badge results for jobs at the Bay City site ranged from <10 mr to 75 mr for the 13 day monitoring period. It is not known how representative the list may be of jobs at the Madison site, nor is it known how similar the plant and equipment layout may have been at the two sites, and so it is not realistic to assume the results can be applied to workers at the Madison site.

5.3 Workplace Monitoring Data

The newly provided documents contain air monitoring results for thorium airborne contamination collected during at least ten sampling campaigns totaling almost 100 samples. These cover various operations and situations including mechanical operations, alloying operations, and alloy fires.

The documents also include results of several surveys of dose rate measurements in areas where thorium work was being conducted. Five surveys totaling over 80 readings were performed during the covered period or near that time.

5.4 Radiological Source Term Data

Several documents indicate different quantities of thorium which could have been received by Dow Madison. The ER cites an Atomic Energy Commission (AEC) inspection report that stated 80 English tons had been received through July 1, 1960. The amount cited (80 tons) = 160,000# total for approx. 4 years = 40,000# per year.

There are other indicators of what the potential source term may have been. Dow's 1956 application (and subsequent annual requests for renewal) for an AEC license covers 135,000# Th metal and 30,000# Th fluoride or oxide per year, however this covered multiple sites (Midland, MI; Bay City, MI; Madison, IL; and Freeport, TX) and it doesn't delineate how much might be handled at each site. Also, TDCC 000045 includes an estimate of external exposure based upon 2-3 casting runs per year of 100,000# of 3% alloy, which would equal 9000# of Th per year.

6.1 Feasibility of Estimating Internal Exposures

As stated in Section 5.1, no personnel bioassay monitoring results for thorium were included in the newly provided documents. A number of workplace and breathing zone thorium air monitoring results were found. Even with the addition of these data it is not feasible to reconstruct with sufficient accuracy the internal doses that may have resulted from potential exposure to thorium isotopes.

6.2 Feasibility of Estimating External Exposures

Based on the available dose rate measurements and survey results, a bounding reconstruction of external dose resulting from exposure to thorium is feasible.

7.0 Summary of Feasibility Findings for Petition SEC-00079

The newly provided documents contain no additional information or data that would change the conclusions of the ER in regard to reconstructing doses from uranium or from medical x-rays. Additional dose rate data is sufficient to support a bounding reconstruction of external thorium dose. No personnel bioassay data was included in the documents, and the additional breathing zone thorium air samples are not sufficient to support reconstruction of internal thorium exposures.

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TABLE 1 - REVIEW OF DOCUMENTS RECEIVED FROM DOW 5/17/07

Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
TDCC 000001	1/10/56 No author	Industrial Hygiene Sample Record for "Madison" Bldg.	Surface and up to 7' β and γ readings on slabs of HK-31 alloy metal, packaged sheets, HK11 and HM21 alloys 1/10/56 (Predates covered period).	Additional external radiation measurements for alloy metals.	No, but part of data were included in TDCC 000058
TDCC 000005	8/23/56 L. Silverstein (Dow Midland)	Paper: Determination of the Radioactivity Hazard Encountered in Alloying and Casting HM21 Alloy at the Madison Division	Surface readings on Th pellets and HM21 scrap; Workplace and BZ air samples during 35,000# HM-21 alloying campaign on 7/22- 23/56 (Predates covered period).	External rad readings for Th pellets and HM21 scrap at contact and normal working distance	No, but part of data were included in TDCC 000058
TDCC 000014	9/18/56 No author	Industrial Hygiene Sample Record	Area air samples during HM- 21 & HK-31 Alloying & Casting on 9/17-18/56 (Predates covered period).	Area air samples during alloying and casting	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
TDCC 000019	8/3/56 L. Silverstein (Dow Midland)	Paper: Health Hazards from Radioactive Decay Products from Th During Melting, Chemical Milling and Burning of Th Containing Mg Alloys	Workplace air samples during Mg-Th hardener production, melting, chemical milling (Bay City), ThF4 storage, and a fire involving 4# of HK31 shavings in the period 2/14/56 to 5/8/56 (Predates covered period).	Th air concentrations in Bldg. 152, 376, and Bay City, MI; Incident: Fire of 4# of HK-31 shavings in Bldg. 152 on 5/8/56	No
TDCC 000031	12/56 L. Silverstein (Dow Midland)	Paper: Industrial Health Experience in Fabrication & Production of Mg-Th Alloys	Rad levels on contact and 1 foot from HK-31A, and BZ air samples during grinding, filing, buffing, sawing, welding, and acid pickling (no date, but report predates covered period)	Welding air sample data (see TDCC 000058 and TDCC 000418)	No, but most of data were included in TDCC 000058
TDCC 000043	1/10/57 L. Silverstein (Dow Midland)	Letter to D. Levy (Dow)	Storage practices to meet lower annual exposure limit	No	No
TDCC 000044	2/26/57 D. Levy (Dow Madison)	Memo to W. Saunders (Dow Madison)	Memo to use Th pellets & hardener on 1 st in-1 st out basis	No	No
TDCC 000045	3/8/57 D. Levy (Dow Madison)	Letter to G. Ansel (Dow Madison)	Rad survey of Pot room on 2/27/57; Estimate of external exposures during Th pellet and hardener alloying based on 2-3 casting runs per year of 100,000# each (@ 3% Th =	Rad measurements and estimate of external exposure during alloying. Basis of estimate (2-3 casting runs per year of 100,000# each) gives indication of	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			3000# x 3 runs = 9000#/yr)	actual production levels at the time	
TDCC 000047	3/14/57 C. Mitchell (Dow Madison)	Memo to H. Hoyle (Dow) with lab results	BZ air samples during sanding of HK-31 on 3/14/57	Three BZ samples States "No dust respirators normally worn by personnel."	No
TDCC 000051	4/3/57 C. Moser (Dow Madison)	Meeting report: Dow with Mallinckrodt	Planning for upcoming U extrusion run and sampling by Mallinckrodt	This indicates that U extrusion at Dow Madison did not begin until after early April 1957.	No
TDCC 000055	4/10/57	Handwritten note that badges were sent for processing	Bay City list of job titles (names redacted) and badge nos.	Indicates that badges were being used sometimes (Note: this refers to Bay City)	No
TDCC 000057	4/12/57 D. Levy (Dow Madison)	Memo to G. Ansel (Dow Madison)	Correction to 3/8/57 memo (TDCC 000045)	Corrected hand and body exposure units in TDCC 000045	No
TDCC 000058	6/19/57 L. Silverstein (Dow Madison)	Paper: Industrial Health Experience with Mg-Th Alloys	Exterior rad rates for Th pellets and ThF ₄ , hardener, Mg-Th alloy metal, and sludges. Workplace and BZ air samples during 35,000# HM-21 alloying campaign on 7/22-23/56. Workplace and BZ air samples during grinding, filing, buffing, sawing, drumming, chemical milling, welding, melting, and 3 fires of HK31A)	5 BZ and 9 area samples during HM-21 alloy processing; 8 BZ and 2 area samples during HK-31 mechanical operations; 11 air samples during welding. Incidents: At least 3 Th fires occurred during HM-21 processing; 3 HK-31 fires were started in order to sample emissions. Lists Mg-Th alloys as HK-31A, HM-21XA, HZ-32A,	Yes, (Some of these data precede the covered period, but cover the same type operations.) Welding data not included in PER.

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			(HM-21 data same as in TDCC 000005)	ZH-62A, and HM-31XA.	
TDCC 000083	Duplicate copy of TDCC 000058	---	---	---	---
TDCC 000103	7/28/57 D. Levy (Dow)	Semi-annual IH Summary	Includes area air sampling for Th from 9/55 to 3/57 for pot room, slab oven, mill, wire brush machine, slab scalper, hand sanding	Th air concentrations from various operations (Most of these data precede the covered period, but cover the same type operations.)	No
TDCC 000108	7/31/57 L. Silverstein (Dow)	Memo to W. Saunders (Dow)	Personnel protection for fighting Mg-Th alloy fires	No	No
TDCC 000109	10/17-18/57 L. Silverstein (Dow)	Paper: Is Radiation Safety a Consideration in Working Mg-Th Alloys?	An addition to TDCC 000058, with basically the same data (a few discrepancies regarding which samples are BZ or area samples)	No	No, but most of data were included in TDCC 000058
TDCC 000149	10/17-18/57 L. Silverstein (Dow)	“(Part 2)”	Introduction says it is “Part 2” but it is a repeat of the same information.	No	See above
TDCC 000155	11/27/57 F. Mansfield (Dow)	Memo to L. Silverstein (Dow)	Protesting requirement for Radioactive Material labels for Th alloys; requested Silverstein to come talk with folks at Madison	No	No
TDCC 000157	11/26/57 L. Silverstein (Dow)	Memo to D. Levy (Dow)	Dow Madison now agreeable to labeling	No	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
TDCC 000158	12/20/57 H. Hoyle (Dow)	Memo to L. Treat (Dow)	Answers to questions about Th processing hazards	No	No
TDCC 000162	12/23/57 D. Levy (Dow)	Memo to F. Mansfield (Dow)	Assurance that HK-31 alloy processing will not result in exposures in excess of limits	No	No, but data were included in TDCC 000058
TDCC 000164	12/30/57 L. Silverstein (Dow)	Letter to C. Mitchell (Dow)	Alpha counts for air samples taken 12/2/57; will be submitted for spec analysis to determine Th (see TDCC 000166)	BZ sample data (see TDCC 000166)	No
TDCC 000166	12/2/57 C. Mitchell (Dow)	Letter to L. Silverstein (Dow)	Request to analyze 2 BZ samples from sanding HK-31 alloy on 12/2/57	BZ samples during sanding	No
TDCC 000167	J. Peloubet (Dow)	Mg-Th Alloys - Industrial Health Experience in Fabrication and Production	Compilation of previous reports by L. Silverstein (TDCC 000031 & TDCC 000058) plus densitometer readings of exposed X-ray film	See TDCC 000031 & TDCC 000058 Densitometer readings of exposed X-ray film	No, but some of data were included in TDCC 000058
TDCC 000191	4/16/58 L. Silverstein (Dow)	Letter to C. Mitchell	Spec analysis results for 3 BZ air samples from HK-31 alloy sanding on 3/24/58	BZ samples during alloy sanding	No
TDCC 000194	6/27/58 D. Levy (Dow)	Memo to G. Ansel (Dow) Annual Industrial Hygiene Summary	(no summary attached)	See TDCC 000103 and TDCC 000198	No
TDCC 000195	10/15/58 B. Milner	Lab results	Spectrophotometric measurement of particulates on	Spectrophotometric data (Would need conversion	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			air filter samples (8/29-30/58) for slab unit and billet unit	factor to Th concentration or activity)	
TDCC 000198	5/21/59 D. Levy (Dow)	Memo to J. Burns (Dow) Annual Industrial Hygiene Summary	Includes area air sampling for Th from 9/55 – 3/59 for pot room, slab oven mill wire brush machine, slab scalper, hand sanding	Th air concentrations from various operations (much of these data precede the covered period, but cover the same type operations.) Repeats data from TDCC 000103	No
TDCC 000207	3/19/59 D. Levy	Memo to “Harold”	Request for Th analysis of sample of oxides from surface of HK-31 coils; asks if respirators should be used by personnel handling coils	No	No
TDCC 000209	3/26/59	Note to D. Levy	(Partially illegible) “respirators are not necessary unless the man is exposed to an obviously dusty atmosphere” (no Th results)	No	No
TDCC 000210 (duplicate of 000418)	8/28/59 J. Peloubet (Dow)	Letter to L. Rogers (AEC)	See TDCC 000418	Data attachment is missing from TDCC 000210, but is included in TDCC 000418 (some of data also in TDCC 000031 and TDCC 000058)	Yes
TDCC 000212	12/15-16/59	Industrial Hygiene Sample Record	Area air sample results for Pot room and Sludge Recovery	Area air sample results for Pot room and Sludge Recovery	No
TDCC 000224	12/15/59	Air Sample	Sample # 3 from above	See TDCC 000212	See TDCC

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
		Radioactivity Counting Record			000212
TDCC 000228	12/16/59	Air Sample Radioactivity Counting Record	Samples # 4, 5, & 6 from above	See TDCC 000212	See TDCC 000212
TDCC 000233	8/4/60 W. Saunders (Dow)	Letter to E. McFall (AEC)	Response to questions from 8/3/60 visit; rad survey data from Mg-Th sludge dump and virgin Th storage cage	Additional survey data from the sludge dump area (7 locations - open & closed) and from the Th storage cage (2 locations - open & closed) These surveys were also reported in TDCC 000428 (which was cited in the PER) but these data were not included.	No, but some of data were included in TDCC 000428 see comment at left
TDCC 000236	4/15/57 (Agreement)	Memos, letter, and copy of agreement between Mallinckrodt and Dow	Agreement outlines scope of experimental extrusion work on uranium	No	Yes
TDCC 000250	1/23/58 – 11/4/65	Purchase Orders	Most are for Dow Madison to supply Mg alloy welding wire and rods, ignitor leads, heating coil wire, sheets, etc. to Weldon Spring; other products, Dow supplier sites, and Mallinckrodt sites are also included.	Some P.O.s are for Th- containing alloy which was commercially available product (eg., TDCC 000289)	No
TDCC 000290	7/2/57 – 1/16/61	Purchase Orders	See above comment	See above comment (eg.,	No but

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
				TDCC 000316). TDCC 000304 is P.O. for 2 campaigns for U rod straightening. Campaign #1 completed 12/21/59, campaign #2 completed 1/25/60	information on the U rod straightening campaigns was in FUSRAP documents cited in PER
TDCC 000330	1/12/51	Quit Claim Deed	Government conveys to Dow the Madison property for \$1.5 million	No	No
TDCC 000346	5/11/88 C. Young (DOE?)	Record of Contact with J. Carlson who had worked at Dow Madison	Carlson's statements about U extrusion operation; protective clothing was provided by Mallinckrodt	No	No
TDCC 000349	11/30/56 R. Young (Dow)	Letter to L. Johnson (AEC)	Request to purchase 20# of high purity Th metal under Dow AEC license	Commercial Th work	No
TDCC 000350	12/6/56	Dow application for AEC license	Covers 135,000# Th metal & 30,000# Th fluoride or oxide per year to be used to make Mg alloys for structural use. Sites covered include Midland, MI; Bay City, MI; Madison, IL; and Freeport, TX.	Commercial Th work - 135,000# Th metal & 30,000# Th fluoride or oxide per year (for 4 sites)	No
TDCC 000354	12/19/56 L. Johnson (AEC)	Letters to Dow	Granting of AEC license to receive/possess unlimited quantities of Th metal &/or compounds; permission to	Commercial Th work	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			procure 20# of Th (see TDCC 000210)		
TDCC 000357	1/21/57 O. Heath (Dow)	Letter to L. Johnson (AEC)	Submittal of Form AEC-8 covering unlimited purchase of sintered Th pellets	Commercial Th work	No
TDCC 000361	2/1/57 L. Johnson (AEC)	Letter to Dow	Authorization to receive sintered Th pellets	Commercial Th work	No
TDCC 000362	6/26/57 L. Silverstein (Dow Midland)	Letter to H. Price (AEC)	Request for exemption from posting and labeling requirements of 10CFR20 for areas and containers in which Mg alloys containing up to 4% Th are stored and fabricated; includes film badge data from HK-31 casting jobs	Personnel film badge data for 13 day period for 27 people (20 specific jobs) (Note: this list is from Bay City – it is the same as the list in TDCC 000055)	No
TDCC 000385	7/12/57 J. Delaney (AEC)	R. Borlik (AEC)	List of items pending, including Dow's request for exemption from posting and labeling requirements of 10CFR20; extensive discussion of potential impacts of exemption, and recommendation for exemption	No	No
TDCC 000393	8/8/57	Notice to file	Notice of addition of documents to docket in public document room files	No	No
TDCC 000395	11/20/57 O. Heath (Dow)	Letter to L. Johnson (AEC)	Submittal of Form AEC-2 application for renewal of	Commercial Th work - 135,000# Th metal &	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			license covering 135,000# Th metal & 30,000# Th fluoride or oxide per year to be used to make Mg alloys for structural use. Sites covered include Midland, MI; Bay City, MI; Madison, IL; and Freeport, TX.	30,000# Th fluoride or oxide per year (for 4 sites)	
TDCC 000404	1/1/58 J. Delaney (AEC)	Letter to Dow	Granting of AEC license to receive/possess unlimited quantities of Th metal &/or compounds	No	No
TDCC 000405	9/23/58 R. Barker (AEC)	File memo of phone call from J. Peloubet (Dow)	Request for extension of the exemption for fabricated Mg-Th alloy parts to cover also pieces of metal provided along with the fabricated part as repair material.	No	No
TDCC 000406	7/14/58 H. Price (AEC)	Memo to file	Determination that Dow license may be amended to allow exemption from posting and labeling	No	No
TDCC 000407	7/14/58 H. Price (AEC)	AEC license	Granting amendment of license exemption from posting and labeling requirements	No	No
TDCC 000408	7/14/58 H. Price (AEC)	Letter to Dow	Cover letter transmitting amended license	No	No
TDCC 000409	8/29/58 J. Peloubet (Dow)	Letter to L. Johnson (AEC)	Request for exemption of component parts and finished	No	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			products which contain Mg-based alloys with nominal 1% Th		
TDCC 000411	9/23/58 R. Barker (AEC)	File memo of phone call from J. Peloubet (Dow)	Request for extension of the exemption for fabricated Mg-Th alloy parts to cover also pieces of metal provided along with the fabricated part as repair material.	Same as TDCC 000405	No
TDCC 000412	12/5/58 O. Heath (Dow)	Letter to H. Price (AEC)	Submittal of Form AEC-2 application for renewal of license covering 135,000# Th metal & 30,000# Th fluoride or oxide per year to be used to make Mg alloys for structural use. Sites covered include Midland, MI; Bay City, MI; Madison, IL; and Freeport, TX.	Commercial Th work - 135,000# Th metal & 30,000# Th fluoride or oxide per year (for 4 sites)	No
TDCC 000417	1/1/59 J. Delaney (AEC)	Letter to Dow	Granting of AEC license to receive/possess unlimited quantities of Th metal &/or compounds	No	No
TDCC 000418	8/28/59 J. Peloubet (Dow)	Letter to L. Rogers (AEC)	Presents argument and data to justify not using local exhaust ventilation for welding Mg-Th alloys. Provides Th air sample data for welding Mg-Th metal	Th air sample data for welding Mg-Th metal (some of data also in TDCC 000031 and TDCC 000058)	Yes but the PER did not cite any of the air sampling data from welding
TDCC 000421	11/30/59	Letter to H. Price	Submittal of Form AEC-2	Commercial Th work -	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
	O. Heath (Dow)	(AEC)	application for renewal of license covering 135,000# Th metal & 2,000# Th fluoride or oxide per year to be used to make Mg alloys for structural use. Sites covered include Midland, MI; Bay City, MI; and Madison, IL.	135,000# Th metal & 2,000# Th fluoride or oxide per year (for 4 sites)	
TDCC 000426	1/1/60 J. Delaney (AEC)	Letter to W. Heath (Dow)	Granting of AEC license to receive/possess Th metal &/or compounds (quantity not specified)	No	No
TDCC 000427	1/1/60 J. Delaney (AEC)	Letter to W. Heath (Dow)	Amendment to license adding Sequoia Metalcraft Co., San Carlos, CA	No	No
TDCC 000428	11/30/60 R. Hageman (AEC)	Letter to H. Price (AEC) - Inspection Report	No noncompliances, but questioned whether burning Mg-Th scrap in the disposal area was covered under the incineration provisions of the Dow license. Includes rad survey data for the sludge dump and Th storage cage.	No	Yes
TDCC 000438	1/1/61 J. Delaney (AEC)	Letter to W. Heath (Dow)	Granting of AEC license to receive/possess unlimited quantities of Th metal &/or compounds	No	No
TDCC 000439	1/20/69	Dow product info sheet	Mg forging billet and ingot pricing and shipping info	No	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			(includes HM-21A which contains Th)		
TDCC 000443	1/2/69	Mg Tolling Agreement, Exhibit D	Table 1 shows chemical composition of Mg alloys – only 3 contain Th (HK31A, HM21A, and HM31A)	List of Th-containing alloys. Same as TDCC 000534	No
TDCC 000478	No date	Digest of Specifications for Mg Products	Lists various specifications (Military, ASTM, Federal, AMS) for Mg extrusions, sheets, plates, etc.	No	No
TDCC 000498	7/1/68	Digest of Specifications and Standards for Al Mill Products	Specs for Aluminum products	No	No
TDCC 000529		Dow ????(illegible) Exhibit B	List of plant equipment	No	No
TDCC 000534	1/2/69	List of Product Standards	Table 1 shows chemical composition of Mg alloys – only 3 contain Th (HK31A, HM21A, and HM31A)	List of Th-containing alloys. Same as TDCC 000443	
TDCC 000541	12/1/62	Key to General Layout of Entire Plant	ID numbers for rolling mill, extrusion, heavy press, alloy, and general plant equipment	No	No
TDCC 000554 (duplicate of 000534)	-----	-----	-----	-----	-----
TDCC 000589	5/31/57	Dow 1957 Annual Report	“Among promising new products are our new thorium-	No	No

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Document file # (Beginning Page)	Date/Author/Site	Document Type	Content	New or Differing Information from ER?	Doc. Was cited in ER?
			containing alloysThey are being used principally in missiles and high speed aircraft ...”		
TDCC 000617	5/31/58	Dow 1958 Annual Report	“Our new high-temperature thorium alloys are finding many applications in missiles and rockets.”	No	No
TDCC 000645	5/31/59	Dow 1959 Annual Report	“Military use still accounts for a large share of sales and the continued growth of the missile program has increased the demand for castings and mill products of the new thorium alloys...”	No	No

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TABLE 2 - RADIATION MEASURES/SAMPLES OF THORIUM ACTIVITIES IN NEW DOW DOCUMENTS

(Much of the data available for the Dow Madison site are used repeatedly in various reports, papers, and presentations, and variously summarized or presented in different combinations, formats, and units. In order to clarify what data are available, and to avoid double-counting data, this table presents the original measurement/sampling date, type and number of measures/samples, and the various documents in which the data are utilized. Note: Some data pre-date the covered period, but should generally be indicative of conditions during the covered period. Also, some data are for the Bay City, MI site, but Mg-Th alloy operations should be similar for the two sites, as indicated by a list of job titles from that site.)

Date ¹	Area/Activity	Type	Number of Samples/ Measurements	Measured	Source Doc.
Personnel Monitoring					
4/10/57	HK-31 pour off, knockout, sandblast, sawing, chipping, trim, pickling, filing, buffing, heat treat, etc.	Personnel film badges	27 (20 specific jobs) (Note: these are for Bay City – Madison would have had similar jobs)	<10 – 75 mr	TDCC 000362 TDCC 000055
Air Samples (BZ)					
7/22 - 23/56 ²	35,000# HM-21 alloying campaign	BZ air samples	5	Th, Ra228, short-lived	TDCC 000005 TDCC 000058 TDCC 000109
3/14/57	Hand sanding HK-31	BZ air samples	3	Th	TDCC 000047
12/2/57	Hand sanding HK-31	BZ air samples	2	Th	TDCC 000164 TDCC 000166
3/24/58	Hand sanding HK-31	BZ air samples	3	Th	TDCC 000191
No date	Grinding, filing, buffing, sawing, drumming	BZ air samples	8	Th	TDCC 000031 TDCC 000058 TDCC 000109 TDCC 000428

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Date ¹	Area/Activity	Type	Number of Samples/ Measurements	Measured	Source Doc.
Air Samples (BZ) (Continued)					
No date (first reported in 12/56) ²	Welding alloy (TDCC 000058 and TDCC 000418 were cited in PER but welding data were not used)	BZ air samples	22 (not all results reported in some documents) TDCC 000058 indicates this was HK-31 welding, but the Th % of several welds indicate that they would be HM-21 per specification	Th	TDCC 000031 TDCC 000058 TDCC 000109 TDCC 000418
No date	Acid pickling HK-31A	BZ air samples	“a very few”	Th	TDCC 000031
No date	HK-31A Fires	BZ air samples	1	Th	TDCC 000058 TDCC 000109
Air Samples (Work Area)					
9/55 – 3/57	Pot room, slab oven, mill, wire brush, slab scalper, hand sanding	Work area air samples	>13 (these are semi-annual summaries – data may be included in other documents)	Th	TDCC 000103 TDCC 000198
2/14/56 ²	ThF4 storage (Bldg. 376)	Work area air samples	2 (=2 locations x 1 sample)	Th, Ra228, short-lived	TDCC 000019
4/11 - 12/56 ²	Mg-Th Hardener Production (Bldg. 152)	Work area air samples	4 (=4 locations x 1 sample)	Th, Ra228, short-lived	TDCC 000019
4/10 – 5/8/56 ²	Hardener melting (Bldg. 152)	Work area air samples	7 (=7 locations x 1 sample)	Th, Ra228, short-lived	TDCC 000019
5/2/56 ²	Chemical Milling HK-31	Work area air samples	2 (6” above surface & 5’ from tank) This sampling in Bay City	Th, Ra228, short-lived	TDCC 000019
5/8/56 ²	Mg/Th fire (Bldg. 152)	Work area air samples	2 (=2 locations x 1 sample)	Th, Ra228, short-lived	TDCC 000019
7/22 - 23/56 ²	35,000# HM-21 alloying campaign	Work area air samples	9 (Note: some discrepancy in original reports regarding if these are BZ)	Th, Ra228, short-lived	TDCC 000005 TDCC 000058 TDCC 000109

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Date ¹	Area/Activity	Type	Number of Samples/ Measurements	Measured	Source Doc.
Air Samples (Work Area) (Continued)					
9/17 - 18/56 ²	HM-21 & HK-31 alloying & casting	Work area air samples	15	α and β	TDCC 000014
8/29 - 30/58	Slab and billet units	Work area - Air particulates - Automatic filter paper sampler ("Smoke sampler")	13 from slab unit 25 from billet unit	% transmission/ Coh units	TDCC 000195
12/15 - 16/59	Pot room and Sludge recovery HK-31	Work area air samples	13	Th	TDCC 000212 TDCC 000224 TDCC 000228
No date	Chemical Milling HK-31	Work area air samples	2 (4" above surface & 5' from tank)	Th (α and β)	TDCC 000058
No date	HK-31A Fires	Work area air samples	5	Th	TDCC 000058 TDCC 000109
No date	Rolling mill/ovens area	Work area air samples	2	Th	TDCC 000058 TDCC 000109 TDCC 000428
No date	Welding alloy TDCC 000058 and TDCC 000418 were cited in PER but welding data were not used	Work area air samples	1	Th	TDCC 000031 TDCC 000058 TDCC 000109 TDCC 000418
No date	Melting HK-31 at various ages since last melting	Work area air samples	8	Th	TDCC 000058

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Date ¹	Area/Activity	Type	Number of Samples/ Measurements	Measured	Source Doc.
External/Surface Radiation Surveys					
1/10/56 ²	Storage/Handling HK-31A alloy (max. 3.5% Th) Stacked Sheet, crated sheet, and slabs	Readings at surface and at distance intervals on HK31 sheets before and after coating and packaging. Surface radiation and 1 foot increments up to 7 feet of HK31 slabs stacked 9' tall. Also readings on HK11 and HM21.	About 60 readings total (not all results reported in some documents - only 13 reported in TDCC 000058)	β and γ	TDCC 000001 TDCC 000031 TDCC 000058 TDCC 000162 TDCC 000167
7/22-23/56 ²	Th pellets and HM21 scrap	External rad on contact and working distance	At least 4	mr/hr	TDCC 000005
2/27/57	Alloying of Th pellets and hardener	External rad survey	(Unstated)	β and γ	TDCC 000045
No date	Handling Th pellets, ThF4 powder, hardener	Surface radiation	(Unstated)	mr/hr	TDCC 000058
No date	Storage/Handling of non- and heat-treated HK-31	Direct counts; Swipes	4 7	α and β	TDCC 000362
No date	Alloys with Th content from 0.0 to 10.0 %	Photographic film exposure for 24, 144, 216 hrs.	8	Densitometer reading	TDCC 000167
No date	Sludges	Surface radiation	Maximum/average after 1 month	Mr/hr	TDCC 000058

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Date ¹	Area/Activity	Type	Number of Samples/ Measurements	Measured	Source Doc.
External/Surface Radiation Surveys (Continued)					
8/4/60 (date of inspection)	Mg-Th sludge dump; Virgin Th storage cage	External rad survey	11 locations (open & closed)(4 in TDCC 000428) 5 locations (open & closed)(3 in TDCC 000428) These reports cover the same surveys, but TDCC 000428 reported only part of the data. (Distance of reading above 7000# of master alloy scrap reported as 12' in TDCC 000233, but as 12 inches in TDCC 000428)	β and γ	TDCC 000233 TDCC 000428

¹ Date = actual date of measurement/sampling or date of earliest document reporting the data

² = predates covered period