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ENGELHARD INDUSTRIES, INC.
D. E. MAKEPEACE DIVISION
Nuclear Materials Department
Plainville, Mass.

Report of Apparent Radiation Overexposure
During the Period From 6/13/60 - 6/25/60

Reference: Special Nuclear Materials License 185

Prepared by Norton M. Weiss
Norton M. Weiss
Health & Safety Manager
August 5, 1960

Approved by C. A. Carnham
C. A. Carnham
Plant Manager

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DISTRIBUTION

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Report of Apparent Radiation Overexposure at Engelhard Industries, Inc., D. E. Makepeace Division in the Period from June 13 to June 25, 1960.

On July 7, 1960, Engelhard Industries, Inc., D. E. Makepeace Division was informed via telephone by Nucleonics Corporation of America, its regular film badge processor, that film badge readings of two (2) employees in the Nuclear Department showed exposures of 15 rems and 23 rems of beta radiation, respectively. The Atomic Energy Commission, New York Operations Office, was informed of this event on July 8, 1960 by telephone and telegram, in accordance with regulations.

The two employees involved in the overexposure incident were classified as melters in the Nuclear Department, one of whom (b)(6) worked on the (b)(6) and the other (b)(6) on the (b)(6) Each of these melters normally has a helper who works very closely with him and is normally expected to receive approximately the same dosage of radiation exposure, if not slightly more so. The helpers' exposures were as follows:

EX 6

(b)(6) received an exposure for the same two week period of 80 millirems of beta and (b)(6) received 130 millirems of beta.

Previous cumulative exposures for the year 1960 are as follows:

(b)(6) - 1,845 millirems beta-gamma
- 4,035 millirems beta-gamma

(b)(6) 3905 millirems beta-gamma
5565 millirems beta-gamma

1 x 6

The melting schedule for this two week period during which the overexposure occurred has been broken down by shifts and a complete breakdown is attached as a supplement to this report. (Exhibit A). The total number of melts during this period is as follows:

First shift - 11 melts
Second shift - 18 melts
Third shift - 7 melts

This represents a somewhat above average melting schedule for a two week period but seems insufficiently increased to account for exposures of this magnitude. A complete melting breakdown for the two month period beginning April 18th is attached. (Exhibit B).

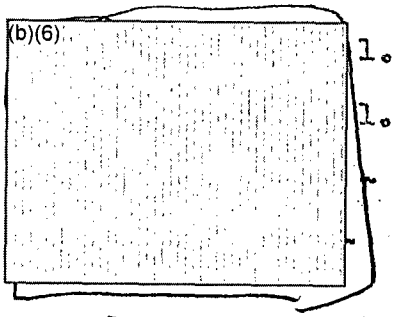
Our melting operations are carried out in either of two furnaces, one, a vacuum induction type furnace and the other, an air induction furnace. In the case of the former, it is sometimes necessary for the melters and helpers to enter the vacuum furnace shell for certain periods of time in order to facilitate the removal of crucibles and molds, or for certain cleaning operations. Normally, this time which is spent inside the vacuum furnace is held to a minimum, due to the fact that fairly high levels of radiation are found in the furnace chamber after a melt. A weekly furnace cleaning program has been in operation for a number of months in order that the amount of removable contamination inside the furnace be held to a minimum. This cleaning is not done by either the melters or helpers but by other personnel employed in the Nuclear Department on a rotating basis. We have not to date found excessive exposures to any of the personnel involved in the furnace cleaning operations.

From the attached supplement, Exhibit A, it is evident that the majority

furnace which is not large enough for anyone to enter, and therefore, offers much less chance for exposures of any magnitude. All of the melts which were made in the air furnace in this period were enriched uranium aluminum alloys, the largest charge being 20,000 grams and the highest alloy being 25% uranium.

Upon the receipt of the film badge report from our processor, the two men involved were immediately removed from the melting area and transferred to jobs which would not expose them to radiation. The men and their helpers were questioned at length in an effort to determine whether any unusual circumstances took place in that period, which might account for the high exposure on film badges. The results of the questioning were negative. A urine sample was taken from the two exposed men and submitted for analysis. In addition, blood tests and physical examinations were also done. The results from these tests are attached. (Exhibit C).

On June 28th, as a part of our regular urinanalysis program, a number of urine samples had been sent to our supplier, Controls For Radiation, Inc. in Cambridge, Massachusetts, including the two melters' and their helpers'. This was done without knowledge of the exposure which these men are assumed to have had. The results of this analysis are as follows:



1.6×10^{-3} micrograms per milliliter of total uranium.
1.2×10^{-3} micrograms per milliliter of total uranium.
1.6×10^{-3} micrograms per milliliter of total uranium
1.4×10^{-3} micrograms per milliliter of total uranium

These values represent quantities of uranium that are well below maximum tolerance levels. It is obvious, therefore, that if any exposure did occur, it was not accompanied by internal deposition of uranium.

In an effort to determine the cause of the radiation exposure, succeeding melts were monitored by Health Physics personnel. The results of these monitoring operations showed very low radiation levels (less than 5 mr. per hour). These surveys were made of air melts since the vacuum furnace was not used during this period. However, the vacuum furnace was also surveyed and found to have no readings in excess of 2 mr. per hour.

In order to determine the amount of exposure to which films would be subjected by either dropping or resting on pieces of uranium metal for long periods of time, two new film badges were deliberately exposed to pieces of uranium for periods of 8 and 24 hours, respectively. These films were then sent to our processor, Nucleonics Incorporation of America, where they showed exposures of 3 rems and 10 rems, respectively.

In attempting to determine the possibility which existed for the accidental or deliberate exposure of the film badges, the film badge handling procedures were reviewed. At the time of the apparent exposure, film badges were kept in an open rack by the guard's station at the entrance to the Nuclear Department. The badges were picked up by the workers in the morning and deposited on the rack when leaving either at lunch time or at the end of the day. Normally, there is a security guard present from 7 a.m. to 5 p.m. After 5 p.m., the night guards make hourly rounds and, therefore, the rack containing the film badges is available to any one within the Nuclear Department. At the end of each two week period, badges are collected by Health Physics personnel who then insert fresh film within the holders. The holders are replaced on the rack and the old films sent to the processor, via our shipping department in our Attleboro Plant.

We have received word from Nucleonics that they are in the process of recalibrating the two exposed films and hope to have revised results very shortly. These will be forwarded to the Atomic Energy Commission, New York Operations Office. They also indicated by phone that the two films were exposed from the back, indicating that the holders had been reversed from the normal position. This is consistent with what we would expect since the melters were in the habit of wearing their badges on the inside of their shirt pockets in order to prevent any contamination of the badges.

As a result of the incident and our investigation, we have arrived at several courses of action to prevent a reoccurrence at some future date. We are in the process of procuring additional survey instruments and also personnel to use them. It is our intention to increase our number of radiation surveys, especially with regard to areas where high levels might be expected, such as the furnace area. These will be recorded for permanent record and to aid in reducing exposure limits before they become excessive.

Our film badge control will be reviewed so that badges remain in a locked cabinet and will be handed to the workers by the guards. In this way, we will be able to account for all of our badges and at the same time, prevent the possibility of any misuse by unauthorized persons.

CONCLUSIONS:

The only two possibilities which exist to explain this occurrence would seem to be that either the men were exposed to extremely high radiation levels or the badges were exposed to these high levels in some manner. The pertinent factor in relation to the incident seems to lie in the fact that while the two melters showed high exposures, to radiation, each

xperience in the past that due to the almost equal amount of time spent in and around the furnace by both melter and helper, their exposures should be of a similar magnitude with the helper's usually being greater than that of the melter. It, therefore, seems quite inconsistent with prior data that this was a true exposure to the melter and not to the helper on each of two different shifts. In addition the badges of the melter and helper on the (b)(6) (b)(6) during this two week period showed no exposure whatsoever, indicating that if a true exposure did occur, it was restricted to the (b)(6) Results from urinalyses, blood tests, and physical examinations show no abnormalities to be found insofar as the physical condition of the two men is concerned.

We propose, therefore, to discount this reported exposure from the cumulative records of the two men since we feel that this was not a true exposure. Further, we intend to restore these men to their jobs on the melting furnace (b)(6) as of September 12th, and (b)(6) as of September 26th, unless we are advised otherwise by the Licensing Division. These dates will mark the end of a two month and three month period of non radiation exposure work for (b)(6) respectively. We feel that the further precautions which will be taken regarding radiation surveys and film badge control will prevent repetition of any similar occurrence in the future.

EX 6

Withhold All

EX 6

EXHIBIT A

(b)(6)

6/13 - 6/25

MELT	DATE	CHARGE WT.	U WT.	ENRICHMENT	FURNACE
Mg-Al	6/13				Air
Mg-Al	6/13				Air
Mg-Al	6/14				Air
Mg-Al	6/14				Air
U-Al	6/16	20,000 gms.	2600 gms.	93%	Air
U-Al	6/17	20,000 gms.	2600 gms.	93%	Air
U-Al	6/17	20,000 gms.	2600 gms.	93%	Air
U-Mo	6/22	350 lbs.	340 lbs.	Depl.	Vacuum
U-Al	6/23	20,000 gms.	2600 gms.	93%	Air
U-Al	6/23	20,000 gms.	2600 gms.	93%	Air
U-Al	6/23	7566 gms.	1850 gms.	93%	Air

(b)(6)

6/13 - 6/25

MELT	DATE	CHARGE WT.	U WT.	ENRICHMENT	FURNACE
Mg-Al	6/13				Air
Mg-Al	6/13				Air
Mg-Al	6/13				Air
Mg-Al	6/13				Air
U-Mo	6/14	60,000 gms.	54,000 gms.	25.6%	Vacuum
U-Mo	6/15	60,000 gms.	54,000 gms.	25.6%	Vacuum
U-Al	6/15	11,000 gms.	1820 gms.	93%	Air
U-Mo	6/16	60,000 gms.	54,000 gms.	25.6%	Vacuum
U-Al	6/17	20,000 gms.	2600 gms.	93%	Air
U-Al	6/20	10,000 gms.	600 gms.	93%	Air
U-Al	6/20	20,000 gms.	2600 gms.	93%	Air
U-Al	6/20	20,000 gms.	2600 gms.	93%	Air
U-Al	6/20	20,000 gms.	2600 gms.	93%	Air
U-Al	6/21	20,000 gms.	2600 gms.	93%	Air
U-Al	6/22	5,000 gms.	580 gms.	93%	Vacuum
U-Al	6/23	5,000 gms.	580 gms.	93%	Vacuum
U-Al	6/24	11,000 gms.	1820 gms.	93%	Air
U-Mo	6/24	60,000 gms.	54,000 gms.	25.6%	Vacuum

~~Withhold Att~~ - EX 6

EXHIBIT A

cont'd

(b)(6) redacted 6/13 - 6/25

MELT	DATE	CHARGE WT.	U WT.	ENRICHMENT	FURNACE
U-Al	6/14	12,000 gms.	2900 gms.	93%	Air
U-Al	6/15	5,000 gms.	550 gms.	93%	Vacuum
U-Mo	6/17	60,000 gms.	54,000gms.	25.6%	Vacuum
U-Al	6/20	10,000 gms.	600 gms.	93%	Air
U-Mo	6/21	350 lbs.	340 lbs.	Depl.	Vacuum
U-Al	6/22	10,000 gms.	600 gms.	93%	Air
U-Mo	6/23	350 lbs.	340 lbs.	Depl.	Vacuum

Pages 11 through 18 redacted for the following reasons:

(b)(4) and (b)(6)

~~Withhold All~~ Ex 6, portions

EXHIBIT "C"

controls for radiation

ANALYSIS DATA REPORT

P.O. No. A-1217 Lot No. 1

Subscriber: Bluebird Inc. Inc. D. T. Makepiece Div. Purple Isl Plainville, Massachusetts	Type of Analysis: RADIOMETRIC

Samples taken 7/19/60

Sample	Activity In c/m/ml	Date of Anal. d/h	Vol. ml
1. (b)(6)	2×10^{-3}	7/20/60	20
2.	1.6×10^{-5}		20
3.	2.3×10^{-3}		20
4.	1.0×10^{-3}		20

Remarks:

Submitted by:

A. S. Levine, Dept. Head

Date: [illegible] 1960

~~Withhold All~~ EX 6 portions

EXHIBIT "C"

controls for radiation
INC.
130 ALEWIFE BROOK PARKWAY · CAMBRIDGE 40 · MASSACHUSETTS
UNIVERSITY 4-8280

URINALYSIS DATA REPORT

P.O.No. A-12455 Lot No.2

Subscriber: Engelhard Ind. Inc. D.E.Makepeace Div, Route 152 Plainville, Mass.Attn: Mr.N.Weiss	Type of Analysis: FLUORCMETRIC

Samples taken 6/28/60

	Sample	Result In ug/ml	Date of Analysis	Vol. ml
1.	(b)(6)	$<1.0\times10^{-3}$	7/18/60	20
2.		$<1.0\times10^{-3}$	7/18/60	20
3.		1.6×10^{-3}	7/18/60	20
4.		$<1.0\times10^{-3}$	7/18/60	20
5.		$<1.0\times10^{-3}$	7/18/60	20
6.		1.4×10^{-3}	7/18/60	20
7.		1.4×10^{-3}	7/18/60	20
8.		1.2×10^{-3}	7/18/60	20
9.		1.2×10^{-3}	7/18/60	20
10.		1.6×10^{-3}	7/18/60	20
11.		1.4×10^{-3}	7/18/60	20
12.		1.4×10^{-3}	7/18/60	20
13.		$<1.0\times10^{-3}$	7/18/60	20
14.		$<1.0\times10^{-3}$	7/18/60	20
15.		1.6×10^{-3}	7/18/60	20
16.		1.2×10^{-3}	7/18/60	20
17.		1.4×10^{-3}	7/18/60	20
18.		$<1.0\times10^{-3}$	7/18/60	20
19.		1.4×10^{-3}	7/18/60	20
20.		1.2×10^{-3}	7/18/60	20
21.		3.5×10^{-3}	7/18/60	20
22.		1.4×10^{-3}	7/18/60	20
23.		1.2×10^{-3}	7/18/60	20

Remarks: Nos. 3, 10, 17 & 20
results called in to Miss Johnson

Submitted by: A. S. Levine
A.S.Levine, Dept.Head

EXHIBIT B

IN YOUR REPLY
REFER TO FILE

60.126

The Commonwealth of Massachusetts
Department of Labor and Industries
Division of Occupational Hygiene
286 Congress Street, Boston 10

August 4, 1960

Mr. J. A. Canham, Manager
Englehard Industries, Inc.
D. J. Makepeace Division
Plainville
Massachusetts

Dear Mr. Canham:

Enclosed is a report by our industrial hygienist, Mr. L. M. Comproni, on a visit made to your plant on July 19, 1960, with Mr. Nelson of the Atomic Energy Commission.

The problem of unexplainable, high film-badge-readings has been encountered occasionally in other plants, and we have no satisfactory answer to this problem. In connection with your cases I have noted a report from another plant in which workers, engaged in similar operations, who wear film badges on their wrists showed high levels, indicating a possible high exposure if in close contact with the crucibles used for melting uranium. Whether or not this finding would have any bearing on your cases is not clear.

Very truly yours,

Harvey A. Elkins
Director

HAE os
Enc.

B

EXIBIT B

60.126

Ex 6

July 27, 1960

TO: Dr. Elkins
FROM: Mr. Comproni
SUBJECT: Englehard Industries, Inc., D. E. Makepeace Division, Plainville
PERSONS INTERVIEWED: Mr. C. A. Canham, Manager
Mr. Norton Weiss, Radiation Safety Officer
DATE OF VISIT: July 19, 1960

Accompanied by Inspector Paul Nelson of the Atomic Energy Commission, a visit was made to this plant to investigate a high film-badge-exposure incident.

During the visit it was learned that two film badges showed excessively high doses of beta radiation on the date of July 7. The (b)(6) film-badge showed an exposure of twenty-three rem of beta radiation. The (b)(6) film-badge showed an exposure of fifteen rem of beta radiation. This exposure is now in the process of being investigated by the company.

On July 7, 1960, the film-badge supplier notified Mr. Weiss, by telephone, that the badge for the (b)(6) and the badge for the (b)(6) showed a 23- and 15-rem exposure, respectively. Since this was at the end of the working day, on July 7, Mr. Weiss waited until the next day, July 8 (Friday), to check the area. Mr. Canham was on vacation at this time, and (b)(6) was taken off the job on Friday, the following day. Subsequently, (b)(6) went on vacation for one week. Urine samples were taken on June 28 for the uranium analysis, which is done at 3-month intervals.

Mr. Weiss surveyed the furnaces, tables, crucibles, and molds on Friday morning, and the highest beta-radiation-rate obtainable was 20 mr/hr. By calculation, the company determined that the highest-possible radiation-rate in the center of the furnace is 400 mr/hr. The Atomic Energy Commission was notified on Friday, July 8, and the workers were questioned, to determine whether any unusual incident had occurred during the previous two weeks. The company could not determine that any unusual incident had occurred, and no excessive radiation-rates could be found upon monitoring the area subsequently. The film badges are processed on a two-week basis, so that the high exposure to these badges could have occurred any time during the previous two weeks. All film badge readings of employee exposures prior to this date, from January 1, 1960, were well below the maximum allowable. In fact, the melter's helper usually has a slightly-higher film-badge result than the melter himself. This is explained by the fact that the helpers load the furnace and are in more close contact with the uranium.

The results of the urinalyses of the melters were telephoned to the company in advance of the regular results and are as follows:

EX6

- 2 -

(b)(6)

URANIUM Milligrams per liter

1.6×10^{-3}
1.6×10^{-3}
1.4×10^{-3}
$1.2 \times$

The melting is done in one of two furnaces. One is a regular open-air furnace, and the second is a vacuum furnace operated inside a vacuum chamber. This unit is called a Kinney melting unit. Most of the metal is handled in the open-air furnace.

Three shifts are employed. However the third shift does not perform as much of the melting work as the other two shifts. All employees, working on these units, are required to wear film badges. However they are worn by clipping them inside the shirt pocket. In this position, the badge faces the man, thus the radiation must pass through the pocket cloth as well as the back portion of the film-badge holder. According to the supplier, this can reduce the true reading by a factor of approximately twenty-five percent.

Since depleted uranium gives a high beta-dose rate, the company exposed a badge for eight hours to depleted uranium and a badge for twenty-four hours to depleted uranium. The details of this exposure were not discussed; however, the result for the 8-hour exposure was 3R beta and the 24-hour exposure, 10R beta.

The medical program of control for this company includes a pre-employment and terminal blood test, annual physicals, and quarterly urinalyses for uranium. All radiation workers must wear film badges at all times when in the hot area.

(b)(4)

The time required to load the furnace is now two minutes, whereas it formerly required ten minutes. The operator must enter the vacuum furnace for this period of time and guide the uranium into the crucible as it is lowered by chain-fall into this unit. Formerly it was carried in by the operators by the piece and required a somewhat-longer loading time, thus extending the exposure time.

The crucibles are cleaned in a hood which is exhaust-ventilated, and a Plexiglass shield has been provided to reduce the beta-radiation exposure. This is

done whenever necessary, usually on a weekly or monthly basis. The vacuum chamber is cleaned weekly by washing the interior walls.

A monthly supply of film badges is received at the plant and changed biweekly under the supervision of Hazel Johnson, technician. They are placed on a rack on the guard's desk at the entrance to the hot area. Every two weeks they are brought to the Attleboro-plant shipping department and from there returned to the supplier. Miss Johnson notes any damage to the badges or visible contamination. Each worker picks up a badge upon reporting for work and leaves the badge with the guard upon leaving the area. Under the present system, it is possible for the worker to keep his badge overnight, and during the guard's absence the badges are left unguarded.

One-hundred-fifty badges are used on a biweekly basis, and the company will provide a locked cabinet at the guard's desk, and the handling of the badges will be supervised more closely. The badges will be worn outside the garment in the future.

It is generally felt, by all parties concerned at this investigation, that there is a strong possibility of the misuse of the film badges, resulting in these high-exposure readings. As a result the company plans to maintain a new, stringent program of control over the badges, and to acquire an ionization-type instrument to make beta measurements inside the furnace, to positively determine the levels of radiation within this unit.

EMC os