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DUST AND RADIATION MONITORING AT ALGOMA STEEL CORPORATION LTD., SAULT STE. MARIE, ONT. MAY 2-3, 1961

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

Dust samples have been collected during the pouring of the first commercial heat of uranium-containing steel on May 2, 1961. Two samples from the pulpit and the pouring platform showed uranium concentrations of up up to half permissible concentrations. However, these levels were only of short duration, and over the regular 40 hour week period these concentrations work out considerably below permissible values. Radiation surveys indicated no excessive uranium concentrations anywhere. No difficulty was encountered, therefore, in meeting the conditions of the AECB licence.

A few billets were surveyed with a Geiger counter to map out uranium segregation.

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INTRODUCTION

Under the terms of the AECB permit No. 92/25/61, dated February 28, 1961, the Mines Branch was authorized to conduct test work on the use of uranium in steel both at its own laboratories and on other premises subject to certain conditions. These conditions included the monitoring of uranium concentrations in air and the determination of the radiation dose in operating and storage areas during and after tests. Subsequently the writer was made responsible for the conduct and coordination of monitoring activities carried out under the terms of this permit.

The first commercial heat of uranium-containing steel was planned to be made by Algoma Steel Corporation Ltd., Sault Ste. Marie, Ont. on May 2, 1961. The heat was made in a 100 ton oxygen converter. The writer, accompanied by Mr. Charles McMahon, travelled to Sault Ste. Marie on May 1 equipped with three Staplex air samplers, a Tracerlab radiation survey monitor and an Electronic Associates portable Geiger counter. On arrival a group was encountered representing the Ontario Government, consisting of Messrs. H.M. Nelson and M. Polny of the Department of Health and Mr. H.J. Bowman, factory inspector, of the Department of Labour. Mr. Nelson also had a number of similar air samplers, but used pleated paper filters, against our felt filters. While the two teams operated independently, a general

concerted programme of sampling was agreed on and it is planned to exchange survey results later. In addition, the Ontario group obtained a number of urine samples for analysis, both before and after the test work (see Appendix).

The uranium-steel test work was done under the supervision of Mr. R.C. Madden, chief metallurgist and Mr. T.W. Crosta, works metallurgist, Algoma Steel Corporation Ltd. The tests were also attended by Mr. D.R. Bell from the Physical Metallurgy Division, Mines Branch and Mr. E.B. Spice, Research and Development Division, Eldorado Mining and Refining Ltd. Mr. Bell will issue a separate report covering the metallurgical aspects of the test; the present report is concerned with the monitoring aspects only.

The melt consisted of a heat of 104 tons of steel. As a ladle addition, 215 lb of 50:50 ferro-uranium alloy was used, which was supplied by Eldorado, representing approximately 1 lb U per ton steel. The ferro-uranium was added as lumps sized 1 in. to 2 in., contained in 20 lb cans, which were thrown into the ladle successively during tapping of the furnace. The hot metal was then poured into sixteen ingots in hot top moulds. After soaking for about ten hours, the ingots were rolled first into 8 in. x 9 in. blooms, sampled, and then rolled further into 4 in. x 4 in. billets. The final steel was expected to contain about 0.015% U, 0.85% C, 0.38% Mn, 0.007% P, 0.16% Si, 0.027% S and 0.05% Al.

To establish uranium concentrations in air, it was decided to obtain dust samples at those locations which were most exposed to potential hot fumes or to high concentrations of metallic dust. In addition, radiation readings were obtained at all places where a high concentration of uranium could conceivably be encountered by a plant worker. Film badges were issued to the melter, Mr. A. Levesque, who added the uranium alloy to the heat, and to the rolling mill foreman, Mr. G. Lazure.

DUST SAMPLING

The following locations were chosen for dust sampling:

1. At the railing near the pulpit controlling the furnace operations, before, during and after tapping.
2. On the pouring platform, 10 ft from the last mould to be filled (No. 16), before, during and after pouring.
3. About 12 ft from the soaking pits while the uranium ingots were in the pits. Here, because of the long time involved, the filter became overloaded, choking off the air flow towards the end of the sampling period.

4. On the railing overlooking the 44 in. rolling mill.

5. Near the deseamer during machine scarfing operations (about two-thirds of the ingots were machine-scarfed for this purpose).

6. Six feet from the cooling beds during the early cooling period.

7. Close to operator during hand-scarfing of 4 in. x 4 in. billets.

A summary of these dust samples is presented in Table 1. The filters were counted on a beta counter on May 4, 5 and 8 to allow for the decay of atmospheric radon, which is known to lead to possible erroneous results. The only samples showing measureable activities are those obtained just after tapping and during pouring operations. It is seen that the total chemical assay of these samples gives uranium concentrations well below permissible levels (200 $\mu g\ U/m^3 \approx 5.6\ \mu g\ U/cu\ ft$ for steady 40 hour exposures). On the other hand, the momentary concentrations do not leave a very wide margin between the detected uranium levels and the permissible level, and in future tests further samples should be taken, especially on the pulpit, to check the rate of removal of uranium dust by the existing ventilation. It may also be advisable to check the dust and slag accumulated on the melting

TABLE 1

Analysis of Dust Samples (Heat A 2928)

Filter No.	Location	Sampling Time	Approx. Volume sampled (cu ft)	Net count rate after three days (c/m)	Total uranium (mg)	U concentration in air (μg/cu ft)
1	Pulpit, before tapping	11:47 am - 1:30 pm	4840	Backgd.	--	--
2	Pulpit, during tapping	2:03 - 2:12	450	Backgd.	--	--
3	Pulpit, after tapping	2:16 - 2:43	1350	87.8	2.68 (chem)	1.98
4	Pouring platform, before pouring	1:30 - 2:00 pm	1380	Backgd.	--	--
5	Pouring platform, during pouring	2:03 - 2:36	1550	83.2	2.52 (chem)	1.62
6	Pouring platform, after pouring	2:40 - 3:32	2470	Backgd.	--	--
7	Near soaking pits	5:40 pm - 1:15 am	~12700	Backgd.	--	--
8	Near 44 in. rolling mill	1:10 am - 2:17 am	3210	43	0.132 (calc)	0.04
9	At de-seamer	1:35 - 1:50 am	616	0.5	0.036 (chem)	0.058
10	Near cooling beds	2:07 - 4:30 am	4300	Backgd.	--	--
11	During hand-scarfing	3:42 - 3:52 pm	480	1.4	0.043 (calc)	0.09

Notes: Counter background was 12 - 14 c/m. Chemical determinations were obtained by fluorimeter by J.B. Zimmerman, Extraction Metallurgy Division.

floor after the furnace has been tapped. The dust level on the pouring platform may also need checking. In the present test the sampler was located at the end of the line of ingot moulds, about 10 ft from the last one to be filled. In future tests, one or more samplers may have to be set up closer to the centre of pouring operations. On the other hand, the dust sampling showed that the ventilation seems to be adequate to remove the existing airborne dust almost immediately from the pouring platform.

RADIATION SURVEYS

Radiation surveys were conducted at all locations where there were thought to be significant amounts of uranium. The first survey was made in the storage hut, where the ferro-uranium master alloy was stored. The alloy was contained in 10 cans, still packed in the shipping crate in which they had arrived. The total weight of metal was 215 lb; nine cans contained around 22 lb each, one can the remainder. The radiation level at the outside of the full crate, as measured with an ionization chamber instrument ("Cutie Pie") was 1.3 mr/hr. At the top and side of an individual can it was 0.3 mr/hr, at a location 1 inch above the centre of the cans in the crate it was 0.7 mr/hr. All these readings are well below the maximum permissible level.

The surface of a stack of 4 in. x 4 in. billets was surveyed with a portable Geiger counter (Electronics Associates

type EA 135 PS). The count rate was about double background, 240 c/m gross counts for a background of 90 c/m.

The slag in the ladle was also surveyed with the Geiger counter. The rough, slightly concave inner surface gave readings of 10,000 to 17,000 c/m, comparable to the reading from the luminous hands of the writer's wrist watch. After dumping, the smoother convex surface of the slag mass gave readings of the order of 3000-5000 c/m. The weight of the slag was estimated to be around 1500 lb and as it contained possibly 50 per cent of the added uranium this worked out to a uranium concentration of the order of 3.3%.

SURVEYS OF BILLETS

Geiger counter readings were taken on a number of billets as a check on the uniformity of distribution of the uranium in the metal and to indicate segregation effects. Some of the results are tabulated in Table 2. The readings indicate a higher uranium content in the first ingot than in the last ones. As the ladle was tapped from the bottom these results suggest that the uranium sank to the bottom of the ladle or was lost due to oxidation during the pouring period.

A number of 4 in. x 4 in. billets were also surveyed. Here the variations between billets from ingots 2, 8 and 16 seemed rather less marked. There were significant local variations,

frequently associated with visible surface scabs. The same was found for a bloom sample from the middle of the middle ingot (No. 8). It should be emphasized that such counter checks determine uranium content of the surface layer only, but they serve as a useful indication of major segregation effects.

TABLE 2

Geiger Counter Readings on Billets (8 in. x 9 in.)

Ingot 16 (last)	top, inside pipe	gross count 3000 c/m	Backgd. 80 c/m
	test area, middle	200	
	sheared end	80	
Ingot 8 (middle)	top, inside pipe	2200	
	test area, middle	650	
	sheared end	170	
Ingot 1	top, inside pipe	12000	
	test area, middle	1700	
	sheared end	100	

Scan along surface of No. 16 ingot, 3 inch steps (gross counts)

top surface	120	side	300
	130		
	130		
	100		
	120	side	400
	190		
	210		
(test area)	200		
	170		
	190		
	330	side	260
	130		
	120		
	120		
	220		
	210		
(shoulder of ingot)	230	side	450 (hollow)
	190		
	230		
	240		
	230		
	230		
shear end	130		

CONCLUSIONS

The tests have indicated that the uranium concentration in air during uranium-steel casting and treating has remained well below the maximum permissible level at all locations. However, one or two samples were relatively high and those conditions will have to be investigated in more detail in future tests. In view of the low recovery of uranium indicated in the metal by preliminary assays, slightly higher values of uranium content in dust may be anticipated in later tests and must be allowed for. So far it appears that present handling and ventilation conditions are adequate.

Superficial scanning of the billets with a Geiger counter has shown the existence of some segregation of the uranium.

No indication of undue radiation exposure was registered on the film badges when developed by the Department of National Health and Welfare.

APPENDIX

Ontario Department of Health Tests

To permit direct correlation of results, the following is a list of samples taken by Mr. Nelson during the same foundry operations:

Air Samples (pleated filters)

1. Near hopper on pulpit, before tapping
2. Near hopper on pulpit, during tapping
3. On mule train floor, during tapping
4. In crane cab over ladle, during tapping
5. On visitors' cat walk during ingot pouring
6. Near 44 in. rolling mill, during rolling
7. On cat walk ahead of mill, during rolling
8. On pulpit near deseamer, during deseaming

Urine Samples

10 samples before start of work

10 samples one day after

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GGE:DV