RADIOACTIVE CONTAMINATION OF STEEL

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In 1986, we reported seven instances of accidental radioactive contamination of steel manufactured or imported into the United States as a result of smelting of sealed sources (Lu 86). Since then, two additional cases of accidental smelting of radioactive sources have been reported, both occurring in 1987. One is similar to earlier events in that 740 to 930 MBq of ^{137}Cs, probably from one or more gauges, was accidentally melted in a steel mill. The event was discovered when a truckload of flue dust from the mill caused a radiation monitor at the mill's weigh station to alarm when the truck passed. Contamination was confined to flue dust. The second event was unique in two respects, the radioisotope and the smelted metal. In this case, a radium source which came perhaps from a gauge or from a nuclear medicine program was mixed with aluminum metal scrap. Dross (slag) from the smelter was then transferred to a salvage yard where radiation monitoring of the incoming dross resulted in detection of the radioactivity. The contamination was confined to the dross. In both cases the contaminated smelting by-products - flue dust and dross - were collected for appropriate disposal. No cost estimates for these incidents are presently available.

In 1986, the U.S. Nuclear Regulatory Commission published a hazardous scrap warning poster and distributed it to U.S. ferrous metal scrap dealers and mills (NRC 86). The poster is intended for display at scrapyards and mills to inform workers of the possibility of radioactive material in scrap, how to identify warning labels, and who to contact for help. Following the aluminum contamination incident, additional distribution was made in 1987 to the non-ferrous metal industry. The U.S. Occupational Safety and Health Administration and the National Association of Recycling Industries assisted us by providing mailing lists.

In 1987, with the help of Professor John F. Elliott of the Massachusetts Institute of Technology, we made available a table showing the likely primary pathways of radioisotopes in steel-making furnaces (NU 87). The isotopes selected are those frequently used as sources in industry or medicine (Table 1).

The well publicized incidents of steel plants becoming contaminated by melted sealed radioactive sources have provided

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Table 1

Likely Primary Pathways of Selected Elements in Steelmaking Furnaces*

Element	Likely Pathway**
Co	Steel
Cs	Vaporizes***
Ra	Slag
Am	Slag
Ir	Steel
Pb	Vaporizes***
Po	Vaporizes***
Sr	Slag
Pu	Slag
U	Slag
Y	Slag
Th	Slag

*Typical temperatures of steel making furnaces: Basic Open Hearth, 2750 to 2950°F (1482 to 1610°C); Basic Oxygen (O_2 lance), 2750 to 3020°F (1482 to 1660°C); Electric Arc, 2750 to 3050°F (1482 to 1677°C).

**No consideration given to chemical form. In cases where slag or vaporization is the primary pathway, there may be low residual levels of the element in the metal bath. Persons using this table should consider it as guidance only and not as a definitive predictive statement of the ultimate disposition of radioisotopes in a specific case. Confirmatory measurements are recommended in all cases.

***Liable to be collected in pollution control equipment.

a powerful incentive to the steel industry to monitor incoming scrap for radioactivity. Installation of radiation monitors (usually costing a few thousand dollars) appears to be a wise investment even given some uncertainty of the detectors always finding such sources.

Scrap steel arrives in steel mills or scrap yards in trucks, railroad cars, or barges and since these routes of entry are controlled, the detectors are usually mounted at entry gates or at weigh scales. Typically, 5 x 5 cm NaI (Tl) detectors are mounted above or at the sides of the vehicles. Alarm points are frequently set at about 2X-3X background, which is high enough to avoid "false alarms" caused by fluctuations in background counting rates. Total reliance should not be placed on such systems to detect radioactive sources in scrap. Studies have shown that a large source in a well-shielded container in the center of a railroad gondola car or truck filled with scrap can go by undetected by such systems (La 86). These detection systems are, however, reliable, provide a degree of protection for scrap handlers that was not available before and have proven effective in identifying radioactive sources in scrap metal. Thus, the authors believe that use of the poster combined with a radiation detection system helps prevent unknowingly receiving sources in scrap shipments.

We do not have figures on the numbers of steel plants and scrap yards in the U.S. that have installed monitors but we can guess the numbers are increasing because of the increasing numbers of reports of another source of radioactive contamination of scrap-naturally occurring radioactive materials - NORM.

In the U.S., steel scrap contaminated with NORM comes from places as far apart as Alaska and Florida and has originated from oil and phosphate industries, from a kaolin clay plant, and from water softening equipment. In most cases the NORM was detected by stationary monitors and contact gamma radiation levels (for cases where we have data) ranged from 0.5 μSv/hr to 0.1 mSv/hr at contact.

An unusual case involved a cattle guard fabricated directly from recycled steel oil drilling pipe. Maximum radiation levels were 15 μSv/hr contact.

We are aware of only one case where such scrap, once found, was sent to a commercial low-level waste disposal site. In the other cases, the contaminated scrap was either off-loaded and stored on-site at the steel plant or yard or returned to the plant that generated the scrap. Obviously, these are neither permanent nor satisfactory solutions.

In the U.S. disposition of the scrap is made difficult by the absence of regulatory standards for handling NORM. Except for radium in uranium and thorium mill tailings, NORM is not covered by the U.S. Atomic Energy Act.

Whether the radioactivity in scrap metal is from sealed sources or from NORM the burden of this problem is presently being carried by the scrap dealers and mills. Radiation monitors cost several thousands of dollars and up. Trip and demurrage charges for rail cars transporting scrap can also run into the thousands of dollars. Special handling or hauling of identified radioactive scrap carries labor costs. Shouldn't the responsibility for preventing, controlling and monitoring for radioactivity in metal scrap be at the generator's end?

We have no conclusions per se. This report is an interim one on a problem that is in search of a solution. To reach a solution will require the cooperation of source generators, the metal industries, trade associations, governmental and voluntary standard setting agencies and the radiation protection community.

References

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