

RADIOACTIVITY IN SCRAP RECYCLING: MONITORING, DETECTING AND REGULATORY ISSUES

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Abstract

The results of 3 and a half years of metal scrap monitoring performed by more than 150 factories (steel mills, aluminium refineries, foundries and scrap-collecting factories) situated in the province of Brescia, are presented. Monitoring is carried out in compliance of Italian law and regional ordinance, although the latter is no longer valid. Actions following detection of radioactive material are also described. No radioactive source of high activity, which might have constituted a serious radiological and environmental hazard has been found, but the high number of sources and contaminated materials detected in metal scrap is evidence that many are not correctly disposed of and are out of control.

1. INTRODUCTION

The province of Brescia is the main important metallurgic hub in Italy. 7 million tons of metal scrap (steel, brass, copper, aluminium, etc.) are recycled every year in more than a hundred foundries and 13 steel mills. Approximately one third of the scrap used is imported. Unfortunately, in the recent past - since 1990 - numerous cases of contamination have occurred in Brescia, involving two steel-mills, one aluminium refinery and the associated facility, some plants producing copper alloys, one authorized and one unauthorized landfill, the goods-stations in Brescia and in a nearby town, and a scrap-collecting factory. None of the incidents caused significant exposure and/or contamination of the workers, but nevertheless they did cause concern among the population living close to the plants and among the foundry workers. The damage in terms of recovery costs, shutdown and market loss was significant.

2. REGULATORY ISSUES

2.1. National Law and Regional Regulation

Article 157 of the Italian Law on Radiation Protection [1], passed in 1995, made it mandatory for users and traders to monitor metal scrap and art. 142 of the same law established the penalty for non-compliance. Unfortunately the expected decree on specific applications and methods was not - and has still not been - issued, leading to a general lack of compliance. After the latest incident at a steel plant in Brescia, in May 1997, due to the melting of two different sources (^{60}Co and ^{137}Cs), the Lombardy Region issued an urgent ordinance [2] ordering smelting plants and scrap-collecting factories to check for the presence of contaminated materials in metal scrap prior to use. The Lombardy Region also defined a protocol for the monitoring of metal scrap from arrival at the factory to completion of the melting process.

The protocol required:

- (a) radiation measurements outside each truck, wagon or container with fixed detection systems positioned at the entrance gate or with portable detectors;
- (b) radiation measurements and visual inspection of the metal scrap after unloading;
- (c) gamma spectrometry of test castings, slag and furnace ash dust.

The protocol also specified the characteristics of the instruments to be used at each stage of the control process. In many cases the monitoring systems were sensitive enough to detect contaminated materials with very low activity and shielded radioactive sources.

The regional ordinance is no longer in force, but the steel firms and foundries that established control procedures still comply with it. Although a national protocol defines the procedures for controlling metal scrap transported by ships at seaports, the general decree mentioned above which allows full application of art. 157 has not yet been issued. So the level of compliance differs in Lombardy and other Regions. According to our sources, more than 150 plants in the Province of Brescia perform the required monitoring, the smallest of them using hand-held instruments, and also the visual inspection required by the regional ordinance. The industrial association, with the technical support of experts belonging to instrument manufacturers and universities, handled most of the training of the operators. Emphasis was placed on teaching workers to recognize labels, signs and shapes of sources. Pictures of the most commonly used and no longer used sources (smoke detectors, lightning rods, industrial source holders, etc) were distributed.

2.2 Actions following detection of radioactive material

According to Italian Law, any discovery of radioactive material must be reported to the Police and, according to the past regional ordinance, to the local Health Authority. When an alarm level has been exceeded, the firm, following the procedures and instructions given by a Qualified Expert in Radioprotection, unloads the truck or wagon and identifies the source or contaminated object (piece of metal, part of a pipe, luminescent dial, etc) which caused the alarm. The source or object is isolated and sequestered by the Judicial Authority, which delegates its categorization and the initial investigation to our office. In the presence of the sender the source is categorized and it is verified whether Italian law applies to that specific situation. Disposal of the source or object will be allowed at the end of the entire legal procedure. In only a few cases were the objects found to be below the activity and concentration limits established by Italian law. The consequences in both legal and financial term can be serious for the sender of the material.

3. CURRENT SITUATION

3.1 Local situation

As reported, more than 150 local firms (steel mills, foundries and scrap recyclers) comply with the law. Many of them perform checks at the different stages of the smelting process, not only on incoming loads. A firm in a nearby town, which recycles furnace ash dust, checks all incoming lorries for radioactive contamination and reports any abnormal cases to the local Authority. In 1995 these checks led to the discovery of ^{137}Cs contamination of dust in a steel mill, which ceased activity a few months later. In 1998 the checks performed at the gate of one of the biggest steel plants revealed ^{137}Cs contamination of soil from a scrap-collecting factory.

This latest incident probably occurred in the late 80s or early 90s, but the exact time and source of contamination are not known.

3.2 Results of scrap monitoring

Between June 1997 and December 2000 local firms reported 267 cases of detection of radioactive contamination, half of them reported by steel mills. Subsequent procedures led to the finding of 636 radioactive objects (Table I). In Table I the words “contaminated materials” indicate all types of contaminated object not specifically identified as a source.

Table I. Radioactive objects found in scrap loads between 28/5/97 and 31/12/2000

Radioactive objects (number)	Radioactive isotopes	Maximum estimated activity (MBq)	Total estimated activity (MBq)
Radioactive sources (29)	²²⁶ Ra	740	2239
	¹³⁷ Cs	516	
	⁸⁵ Kr	370	
	²⁴¹ Am	240	
	⁹⁰ Sr	166	
	⁶⁰ Co	55	
Lightning - rods (32)	²²⁶ Ra	40	448
	²⁴¹ Am	40	
Smoke detectors (28)	²⁴¹ Am	2	36
	²²⁶ Ra	1	
"Radium Trikkur" ¹ (10)	²²⁶ Ra	5	16
Luminescent dials (169)	²²⁶ Ra	1	22
Contaminated materials (368)	⁶⁰ Co	19	200
	¹³⁷ Cs	10	
	²²⁶ Ra	5	
	²³² Th	2	
Total number	636		≈3 GBq

About 50% of the radioactive materials found in metal scrap comes from Italy or, at least, the last trader is Italian. Only 6% comes directly from non-EU countries, including Switzerland, while France with 14% and Germany with 20 % are the main “suppliers” of contaminated items among EU countries.

According to the type of source, lightning-rods come mainly from France (18 out of 32) and “Radium Trikkur” from Germany (6 out of 10).

Depending on the type of production, 60% of the contaminated objects were found in iron scrap, 20% in brass scrap and 20% in aluminium scrap. In steel-mills contaminated materials are normally detected at the entrance gate before being unloaded, while in other smelting plants contaminated items are often found by monitoring systems installed on the conveyor-belts where the scrap is more spread out.

¹ for Radium water treatment

It is worth noting that the detected objects shown in Table I come from about half of the 13 steel mills operating (there were 24 in operation a few years ago) and from 1/6 of the foundries in the province. We have not received any reports of discovery of contaminated material by scrap recyclers.

It may also be interesting to compare the number of incidents with the tons of scrap used. Table II shows the number of radioactive objects detected, subdivided by year and referring to the quantities of scrap melted by three steel mills and one aluminium refinery. Approximately one contaminated object is expected to be found in every 70,000 tons of iron scrap and in every 3,000 tons of aluminium scrap.

Table II. Radioactive objects detected in three steel mills and one aluminium refinery.

Year	Iron scrap (tons)	Radioactive objects found (number)	Aluminium scrap (tons)	Radioactive objects found (number)
1997	2,455,000	39	-	-
1998	2,806,000	62	100,000	42
1999	2,655,000	44	130,000	65
2000	3,065,000	22	140,000	32
Total	10,981,000	167	370,000	139

4. FINAL CONSIDERATIONS

The monitoring of scrap before it enters the production cycle does not guarantee complete protection against accidental melting, but it certainly decreases the probability of such an event occurring. In our opinion it is a means for discouraging the incorrect disposal of old sources, but it needs to be extended to all countries interested in these activities, and it has to be performed systematically, using similar methods and instruments of comparable sensitivity. It is important to remember that although metal scrap imported into Italy from non-EU countries had official certification, some radioactive sources were found by the receivers.

Monitoring also prevents the contamination of slag and dust (mainly due to ¹³⁷Cs, ²²⁶Ra and ²⁴¹Am), by-products often used in other industries or disposed of in waste facilities. Although the checking of test castings and by-products cannot prevent contamination of the plant and machinery, it allows immediate detection of the incident and actions to control the spread of contamination. In the incident that occurred in 1997, which was detected a week later, it was possible to bring back the contaminated steel, which had already been sold, and to store the contaminated dust safely at the plant.

Although no highly radioactive sources constituting a serious radiological hazard were found, the high number of sources identified - small radioactive sources, scrap contaminated by NORM (Naturally Occurring Radioactive Material) and natural or depleted uranium - is proof that many are out of control and have not followed the correct disposal procedure out of ignorance or fraudulently.

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- [2] ORDINANZA DEL PRESIDENTE DELLA REGIONE LOMBARDIA 20 giugno 1997- N.57671- Ordinanza finalizzata alla definizione delle modalità temporanee di attuazione della sorveglianza radiometrica, prevista dal d.lgs 17 marzo 1995, n 230, su rottami o su altri materiali metallici di risulta destinati alla fusione. Bollettino Ufficiale della Regione Lombardia – Serie Ordinaria – N.29 – 14 luglio 1997 (1997).

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