The Italian Experience and Policy on Radioactive Contamination of Metal Scrap

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INTRODUCTION

Metal scrap is a widely used material in steel production, with international trade amounting to about 40 million tons a year. As Italy has no iron production worth mentioning from mines, the country is the first importer of metal scrap in the European Union. The Italian Association of traders of iron and steel, non-iron metals, iron scrap, iron-mongery and similar products (*ASSOFERMET*) includes 1100 firms, almost 600 of which are active in the field of iron and non-iron metal scrap. Collection, selection and preparation of scrap from the Italian market in 1997 consisted of 10.5 million tons. The Italian steel mills need 14.5 million tons each year. Therefore, each year 3.8 million tons need to be imported. 40% of the Italian scrap come from rejects from industrial processes and semifinished products, 20% from industrial demolition (machinery, chemical and oil plants, sheds etc.) and the rest from more heterogeneous material from the previously cited sectors, as well as from car bodies, metal shavings and cast-iron scrap (1).

For these reasons, possible radioactive contamination of metal scrap consignments is a problem that cannot be disregarded in Italy from a radiation protection point of view, as past experience has unfortunately demonstrated. Indeed, as early as in 1990 an anomalous Cs-137 contamination of the Po river below the city of Milan allowed for identification of some foundries located in the Lombardy region that had accidentally melted Cs-137 sources. A few years later, the Italian Ministry of Health was informed by an official report that contaminated scrap materials containing aluminium, copper and iron were circulating in Europe. These two facts were the starting point for the extensive experience developed in Italy on this issue, which for many years made quite heavy demands on the Ministry of Health, ANPA (National Agency for the Protection of the Environment), ISPESL (National Institute for Occupational Safety and Prevention), ISS (National Institute of Health), local health and border control authorities and many local laboratories for the control of environmental radioactivity.

Italian experience in the matter dates back about one decade. It features many different protagonists, who worked or are still working in the field and on elaborating regulations and setting up of experimental measurement procedures and protocols. It also includes broad debates in working groups, meetings and scientific seminars. It is, therefore, difficult to tell the complete story to make it known to the international scientific community, underlining the contributions of all, without overlooking facts, institutions or persons worthy of recognition. The authors apologise for possible oversights and would appreciate suggestions, proposals and criticism which could improve and complete the picture.

THE ITALIAN LEGISLATIVE APPROACH TO THE PROBLEM

As reported above, although a severe accident in a foundry had already occurred in 1990, only in July 1993, following reports by other European countries and the detection of some illegal sources in metal scrap cargoes at Italian borders, did the Ministry of Health issue a directive, complying with the law in force at that time, on the necessity of radioactive controls of metal scrap shipments at Italian borders. The directive followed a pronouncement by the *(National) Committee for the co-ordination of intervention for the radiation protection of workers and the population*, which, when consulted about the problem, suggested the procedures to be carried out, and a large debate with the Custom and Transportation Authorities and representative of the Regions directly involved in the matter. Some national institutions (ANPA and ISPESL) and all concerned regional authorities were involved in the radiometric control of imported metal scrap shipments. Moreover, to ensure the safety of the public, workers and the environment, the melting companies were charged to check on the presence of radiocontamination and/or radioactive sources in the different phases of the production cycle and to foresee, in their contracts, that in case of radioactive contamination of shipments judged non-acceptable by the Italian national and/or local authorities, the importers should take the shipments back. As a consequence of this directive, the Friuli Venezia Giulia Region and Piedmont Region (2) issued, respectively, a note and an ordinance with indications on how to perform controls in the companies.

In May 1994, a new directive of the Minister of Health invited the regional authorities to conform to the pronouncement of the *Consiglio Superiore di Sanità* (Superior Health Council). This consultative body of the Ministry of Health, on the basis of one year of experience of controls at borders and in companies, came to the conclusion that external measurements - the only ones possible at the border - of the metal scrap shipments did not guarantee the absence of radioactivity and that, therefore:

- a certificate, written by the sender, on the quality of the metal scrap to be recycled should be requested;
- a radiometric control on metal scrap should be carried out by the receiving company during unloading;

- normal surveillance activity should be performed by the concerned authorities.

Finally, enforcement of these measures would make continued controls at borders unnecessary.

The Veneto Region, following upon this last directive, issued another for concerned local authorities and organisations.

It became clear from the beginning, however, that many certificates coming from non-EU Member States were not reliable enough, hence border controls were continued up to the end of December 1995. Indeed in 1995, in the framework of the new Italian Radiation Protection Act - which implemented some Euratom directives on ionising radiation and became effective as of January 1st, 1996 - the monitoring of scrap metal was entrusted to metal scrap operators. The provisions concern industrial and trade operators and exclude those involved only in transportation. An *ad hoc* decree is foreseen to specify the application conditions. It should be issued by the Minister of Health, in agreement with the Ministers of Industry, Labour and Environment, once an ANPA pronouncement has been made. However, despite the fact that the work of experts was completed a couple of years ago and that the draft of the decree received the consulting agreement of ANPA and the *Committee for the co-ordination of interventions for the radiation protection of workers and population*, the decree has not yet been issued.

The National Institute of Health, involved by means of its experts who collaborated to the preparatory work, has always maintained the following points:

- in order to provide the maximum prevention of accidents due to possible radioactive contamination of metal scrap, or hidden sources in it, controls should be made at different stages of processing (external radiation measurements of the shipment, visual inspection and external radiation measurements of the unloaded scrap, gamma spectroscopy measurements of casting proof tests, radioactive control of flue dusts, etc.);
- all measurements should be carried out following suitable protocols, after adequate calibration of instrumentation and periodic intercomparisons;
- attention should also be paid to shipments coming from national territory because experience shows that sources or contaminated material can easily originate in the country;
- particular commitment should be dedicated to informing operators and workers of the possible risks and educating them in recognising possible sources.

In the absence of the decree, in June 1997, following the accident at the *Alfa Acciai* described below, the Lombardy Region issued an urgent ordinance (3), implementing the duties concerning radiometric surveillance, detailing the operative procedures aimed at guaranteeing the protection of the population, workers and the environment from the risk of accidental melting of radioactive material. The ordinance calls for the following control steps:

- radiation measurements outside each truck, train wagon or container used for transportation of metal scrap before unloading;
- visual inspection of scrap after unloading or before processing to identify possible shielded sources or holders. To succeed in this goal, personnel should be educated to recognise signs, labels, symbols and shapes of possible radioactive source holders;
- radioactive measurements - of adequate sensitivity - after melting on all casting test samples;
- radioactive measurements - of adequate sensitivity - of slag and dust originating from the fume settling system;
- continuous monitoring of environmental radioactivity, with alarms in the areas at highest risk of contamination or where the personnel occupancy factor is the highest.

Choice of the procedures of the different control steps was left up to the firms depending on their dimensions and the characteristics of their activity. However, controls carried out should be recorded and kept at the disposal of the surveillance authority (3).

Initially, the industrial firms involved were not completely in favour of the ordinance, which was quite costly both in terms of equipment and personnel, but it was shown that accidental melting of a source is much more expensive due to decontamination activities, activity shutdown, health controls on the possibly contaminated personnel, etc. Moreover, health authorities cannot neglect human and environmental costs, which are their primary concern (3).

It was of great satisfaction for the Italian experts involved in the various stages of finding solutions to the radiation protection problems posed by the possible contamination of metal scrap, to verify that their basic ideas were in optimum agreement with the opinions of US experts who, e.g., in a paper published in 1995 (4), wrote: "The authors recommend, as a basic principle, that users and suppliers of scrap consider adding terms to scrap supply contracts that specify that radiation monitoring of the scrap be done and that the scrap has no radiation levels above normal ambient background levels as determined by the suppliers' radiation monitoring

equipment… Although monitoring of outgoing product or by-product may not protect the plant or its workers once a smelting of a radioactive source has occurred, it will serve to alert personnel of a smelting and may serve as damage control, to ensure that the problem is discovered rapidly and that steps are taken promptly to assess the situation and to mitigate the consequences" (4).

Finally, it should be remembered that in 1996 the Italian government, due to the large quantities of metal scrap imported in Italy cited above, decided to install gate detectors at the borders to guarantee, as a first step, safe transportation of shipments on national territory. For this purpose, a sum equivalent to 2.5 million Euros was allocated and the Ministry of Industry charged with the choice and purchase of the detectors. After some difficulties of various origin, the contract was concluded and the installation of the gate detectors should now be undertaken.

EXPERIENCE OF THE CONTROL SYSTEM ON ITALIAN TERRITORY

As cited above, after the Health Ministry directive of 1993, systematic control of radioactivity of metal scrap shipments were conducted both on trucks and trains at the Italian border and internal customs areas. To guarantee the necessary personnel, several different local laboratories involved in environmental radioactive monitoring and two national institutes (ANPA and ISPESL) involved in radiation protection of workers were engaged.

First, attention was directed at non-EU shipments. Indeed, the fall of the Berlin wall had encouraged importation of large quantities of metal scrap of often unknown origin from Eastern countries. However, it soon became clear that shipments coming from non-EU countries were transformed into EU shipments before reaching the Italian border, thus avoiding the controls. Moreover, at the beginning of 1995, Austria became an EU Member State and the only borders with non-EU Member States remained those with Switzerland and Slovenia.

Estimates are given of the rejected shipments in many of the papers published in reference (5). The percentages declared range from 0.3 to 1.7 and in more than one paper it is stated that a clear reduction of this percentage was observed over time. Radioactive sources found among metal scrap were mainly Ra-226 (from instruments, quadrants of clocks and rev counters, lightning conductors, ionisation smoke detectors, radiotherapeutic devices, etc.), Am-241 (from ionisation smoke detectors), Co-60, Sr-90, U-238 in rods from nuclear plants, Th-232 from radioactive oculars. Moreover, contamination of Ti-44, Sc-44, Na-22, Co-60, Cs-137 and 134, and of natural radionuclides was found in several different types of metal scrap.

A complex situation to be dealt with was the control of metal scrap arriving by sea. It can arrive either in containers or loose in the ship’s hold (6). Shipments are large (thousands of tons) and geometries very particular and the control procedure is made difficult by the fact that the material can be monitored only superficially before authorising the unloading (7).

Most of the Italian melting activities are concentrated in the Lombardy Region and particularly the Brescia area, in plants of very different sizes. For this reason it is worth summarising the information available concerning this region and this area.

In the period 1990 - 1998 seven cases of radioactive contamination of working environments, connected with radioactivity in metal scrap, were registered in the Brescia area (8). They involved both iron and non-iron scrap and were of different degrees of severity.

- 1990 Cs-137 contamination of an aluminium refinery in two facilities and the relevant waste dump;
- 1991 Cs-137 contamination of an unauthorised dump of wastes from aluminium melting;
- 1991 Am-241 contamination of some copper alloy manufacturer and melting firms;
- 1993 Cs-137 contamination of a part of the Brescia and Monitirone goods yard;
- 1995 Cs-137 contamination of dust from settled fumes in a steel mill in the decommissioning phase;
- 1997 Cs-137 and Co-60 contamination of the *Alfa Acciai* steel mill;
- 1998 Cs-137 contamination of the soil of a scrap storage depot.

After the first case, the local health authorities began surveillance of the territory with monitoring and sampling surveys of final products, wastes and manufacture rejects in steel mills, aluminium melting firms, copper alloy melting and manufacture firms, metallurgic firms and metal storage depots. Subsequently, in 1993, the Health Ministry directive was promulgated.

As regards the accidents listed, the most severe one was the accident at the *Alfa Acciai*, which will be described briefly below. It is one case in which the preventive controls on scrap were not able to avoid contamination of part of the plant (8).

Other data are available about the Lombardy Region, referring to one year of application of its ordinance. 100 contaminated shipments were found, almost all in the Brescia administrative district. They were almost all national or EU transports, 80% on wheels and 20% by train; 84% iron scrap; 50% contained Ra-226 sources used in medical devices and industrial products, 20% other radionuclides of natural origin (U and Th families) and 20% artificial radionuclides (Co-60, Cs-137, Ir-192, Kr-85); activities ranged from around ten kBq to several score MBq (for lightning conductors) for each object; 55% was contaminated metallic material of

different shape, 17% radioactive sources, 18% instrument quadrants; moreover, in some cases they were lightning conductors and smoke detectors (3).

ONE ACCIDENT AVOIDED AND THE ACCIDENT AT THE *ALFA ACCIAI*

In February 1996, during routine controls at an internal customs area in the Veneto Region, a train wagon with iron scrap coming from the Czech Republic was stopped and investigated due to the very high dose rate measured outside it. Indeed, the maximum dose rate measured was 380 mGy/h at a distance of 0.2 m from one wall of the wagon. No external contamination of the wagon surface, the soil or the tracks was detected. The wagon was first isolated on a side track under strong surveillance with no access to the public, then returned to the Czech Republic. The activity of the unshielded source, Co-60, once localised and removed, was assessed at 1.6 TBq. It had probably been stolen from an irradiation facility used for sterilisation of food.

This event, known to the Italian experts, is summarised from the Czech point of view in reference (9). It is worth noting that the private company exporting scrap to Italy maintained that the wagon had been checked by simple dose rate meter at the premises of the company by an employee before departure to Italy and that no source of radiation has been found. Further enquiry at the company premises found no possible source of contamination (9).

In May 1997 the firm which collects the furnace dust of the *Alfa Acciai* for disposal rejected a shipment due to the measured Cs-137 radiation level in it. After this alarm, Co-60 was detected in the final product of the mill. The most contaminated products were still at the firm, whereas part of the rods from two successive castings had already left the plant. They were heading for several Italian localities, therefore exposing drivers, workers of other firms and possibly the population to irradiation risk. This material was brought back (16-20 May) and stored safely in an area of the plant, together with other more contaminated products. An accurate radiation protection survey of all workers, both of the plant and those possibly contaminated – with Whole Body Counter and radiotoxicological analyses - and of the external environment and population was carried out. Luckily, it was concluded that neither workers nor the population had been exposed to doses higher than those allowed by the Italian law. However, no dose assessment was made for drivers, due to the impossibility of making any hypotheses on the time period and transport procedures of the contaminated product.

Recovery of the plant took place from June the 3rd to July the 1st. After a partial and new start, under surveillance, on July the 11th, the plant returned to routine conditions on July the 22nd. At the end it was concluded that the source fusion probably took place in the period from May 6th to 13th and that the source of Co-60 was of the order of 7 GBq (assessed by means of steel contamination), whereas that of Cs-137 of the order of 150 GBq (assessed by means of dust contamination). It was not possible to determine in which way the sources arrived at the firm. Since no national radioactive waste deposit has ever been approved or set up in Italy, the contaminated mild steel rods, together with the wastes of the recovery of the plant (mainly Cs-137 contaminated dust), are still deposited in an area of the plant.

In conclusion, the consequences of the accident were rather limited. Indeed, part of the final product was contaminated by Co-60, but the system to settle fumes had been effective in avoiding release of radionuclides in the surrounding environment (8). Nevertheless, the total cost of the accident was much more than 10 billion liras (> 500 thousand Euros), including the recovery of the plant and the fixed expenses during plant shutdown (10).

SCIENTIFIC ACTIVITIES

The local experience with possible radioactive contamination in metal scrap gave origin to new collaboration between local health authorities, industrial associations and some universities. Worth noting are the collaboration between the Brescia industrial association (AIB) and the Milan Polytechnic, and that between the local health authority and the AIB. The former was devoted particularly to coping with some technical problems such as setting up protocols to choose the best gate monitoring systems, elaborating a Montecarlo software to map doses and building an experimental station for radiometrical measurements to simulate real situations of actual shipments (11, 12). As regards the latter, the international conference - already mentioned - organised in Brescia in 1998 was one of the results (13). It is interesting to note that the main conclusions of this conference were that most accidents originate in Italian or EU scrap and that the time is ripe for international legislation on this issue. The accidents in Chernobyl and Spain - see below - were cited (14) to support this opinion.

Moreover, among the scientific initiatives, the seminar held in 1995 by the Italian Radiation Protection Association should also be remembered (5), as should other papers given by Italian authors at national and international seminars or conferences (see e.g. 15, 16).

INTERNATIONAL ACTIVITIES

The Italian experience convinced Italian experts that an international effort should be made to cope with this type of risk. Indeed, in a meeting organised in 1996 "on radioactive contamination of imported metal scrap" by the EU Commission, Italian experts suggested that

- co-operation and common European legislation are needed to solve the problem, which cannot be solved separately by each Member State;
- scrap metal should be monitored at the border at least in those Member States which have a common border with East European countries;
- some kind of legal system should be established to force the parties to take action;
- the principle "what can be avoided should be avoided" should be followed.

In 1998, the accident at the ACERINOX plant in Algeciras (Spain), discovered when Cs-137 was detected in the air in many European countries, confirmed the right position of the experts.

In 1999, it seems that something began moving at the EU level, due to an increase in the awareness of the importance of the problem. Indeed, radiation protection authorities in all Member States have began to co-operate more intensively with other organisations, such as customs and operators. In a meeting held in Luxembourg in April 1999 some important conclusions were set down (17). As regards controls at external borders, they were considered useful and the EU Commission was asked to set up a working group on acceptability and desirability for a system of border controls, with the aim of fixing it in legislation. An equal radiation protection approach towards all scrap being imported from outside the EU was considered necessary. The EU Commission undertook to contribute to activities of Member States to inform - especially small - operators about the health consequences of radioactivity in scrap. Moreover, it was agreed that responsibility of detection should be pushed as far upstream as possible and industry requested for support of this from authorities. Finally, the EU Commission stated that it is searching for means to find lost sources in developing countries (17). The EU Commission seems to be paying continued attention to the problem, given that a second meeting on the matter was held last December.

It is worth recalling another international initiative. In 1998, the Dutch Inspectorate for the Environment initiated a project, supported also by the European Commission, named *European enforcement project "radioactivity in scrap metal"*, to which all the EU countries were invited to participate. The main objectives of the project are to

- contribute to the improvement and harmonisation of the working methods concerning enforcement activities;
- contribute to the improvement of compliance with legislation concerning radioactivity in scrap metal;
- use the results from practical experiences to give – if necessary – recommendations to the European Commission on the above fields;
- stimulate the equal treatment of the relevant companies in the EU Member States.

Two conferences were held, in Maastricht in 1998 and Salzburg in 1999, and a number of working groups have been organised to achieve the objectives of the project.

CONCLUSIONS

This review makes it clear that a number of initiatives have been undertaken in Italy to address the problem of possible contamination of metal scrap and strong efforts been made to enhance awareness of it. As regards the legislative approach, all the work concerning the technical bases for drafting a decree and a measurement protocol has been completed long ago, but, in the authors' opinion, what is probably missing is the political will to face the problem. However, it is worth noting that the attitude of industry towards controls has changed perceptibly over the years, going from open opposition to the introduction of new strict regulations to their advocation.

In short, the authors feel that it is extremely important that radioactive control be carried out in different steps with the aim of avoiding

- the entry of contaminated materials, or sources hidden in scrap, into plants;
- their introduction in the melting process;
- the possible contamination of the final product and dust.

In conclusion, the more scrap is monitored, the more one can feel confident that radioactivity will be detected and melting will be avoided. However, even the best surveillance systems cannot provide 100% protection because of the shielding provided by source containers and surrounding metal scrap (18).This is the reason why the third step is, in any case, necessary. It could be suggested that gamma spectrometry of casting test samples should rightly take its place among the qualification proofs of steel and other metals made in foundries (19). Moreover, the possible contamination of slag and dust from settled fumes should also be considered, not only because it is a sign of contamination of the plant, but also because dust is often utilised in

industry (e.g. in buildings).

Moreover, even if the authors are aware that radioactive material often comes from the national market, an EU or international legislative approach to the problem is considered unavoidable. Indeed, import of contaminated material is only one facet of the problem: when a source is melted, the final product can be traded internationally. Therefore, the problem of radioactive sources in recycled metal scrap requires attention world-wide (18).

Finally, in Italy a particular difficulty originates from the fact that the disposal of radioactive waste has not yet been solved because no national or regional waste disposal facility has been identified. As a result, sources, the contaminated material identified in scrap and the wastes of the recovered firms are still in the plant areas.

However, the authors agree with the statement of the US experts that the problem of radioactive contamination of recycled metals is only the most common and most visible manifestation of a larger problem: inadequate control, insufficient accountability, and improper disposal of radioactive materials (20). Possible reasons for such frequent findings of radioactive sources among scrap is the loss of records of their existence and the high cost of disposal (4). Therefore one way to solve the problem or to improve the situation could perhaps be to take additional regulatory measures to assure that licensed sources are properly controlled by licensees and that, when transferred or disposed of, this is done in an approved manner so that they cannot enter the scrap metal stream (18). This effort seems to have been undertaken in the US (18).

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