THE RADIOACTIVE INCIDENT OF ACINEROX IN SPAIN

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❑ Introduction

At the end of May of 1998 a caesium-137 source was melted accidentally in one of the stainless steel production plant furnaces of the company ACERINOX in Cadiz (Spain).

Once the presence of radioactive contamination was detected, a number of organisations provided assistance. These included LAINSA, an expert company in decontamination and dismantling of radioactive and nuclear facilities with experience in radioactive emergencies, the regulatory body, CSN, and the waste management utility, ENRESA. They have evaluated the situation and implemented first radiological protection measures:

- Evaluation of the contamination in the plant;
- Control of the access of people, vehicles and materials to the contaminated zones;
- Delineation and signing of all areas where radioactivity was detected;
- Control of radiation in the gases extracted by the smoke clearing system.

The recovery operation for the affected facilities began immediately: even before the formal approval from CSN of a Performance Plan, to decontaminate the affected facilities.

Decontamination took 5 months, and 50.000 man.hours were necessary to perform the whole work (20 % corresponding to radiological protection activities). The total collective dose was about 60 man.mSv.

❑ Objectives

The objectives established in the Performance Plan, previously mentioned, were:

- To avoid contamination outside of the Plant;
- To guarantee the radiological protection of the professionally exposed workers, the personnel of ACERINOX and the public in general;
- To control the decontamination activities according to the Radiological Protection standards;
- To ensure that the generated radioactive wastes remained in safe conditions as far as their manipulation, storage and transport are concerned.

❑ Affected facilities

Since the very beginning the contamination had affected the smoke dust that circulates through the conduits of the gas extraction system of the electrical arc furnace nº 1 and to the shared clearing system for furnaces n° 1 and n° 2 (Figure 1).

Table 1 summarises the detected values of radiation in the affected systems. The measured activities in samples taken in the smoke dust, before the beginning of the operations of decontamination were in the range 800 to 2000 Bq/g.

Table 1. Levels of initial radiation in the main areas

System	Average Dose Rate (mSv/h)	Maximum Dose Rate (mSv/h)
Electrical arc furnace n° 1 and gas ducts extractions	0.5	1.8
Natural cooler and stark arrester	0.02	0.05
Bag filter n° 1	0.05	0.1
Bag filter n° 2	0.02	0.03
Silos A and B	0.03	0.1

❑ Radiological Criteria

According to the Performance Plan approved by the CSN the final state of the facilities would be such that:

- The maximum permissible dose in any zone of the factory did not exceed the value 1 mSv in an annual period;
- The derived values from surface contamination were such that they did not exceed 4 Bq/cm^2, in those areas where their measurement was possible.

Due to the dimensions of the facility and the great number of affected zones it was not easy to establish a strict and unique access control. Thus, in the first phase those zones with higher dose rates and requiring greater movements of people were identified. The measures adopted were based on two general approaches:

- Immediate Intervention: action to remove radioactive material, decontaminating the zone, remove systems, equipment… or;
- Isolation of these areas, by establishing alternative access and routes.

❑ Works development

The objective established for the final state of the facilities had to fulfil two requirements; the production of the Steel Works had to continue and it was necessary to cope with the radiological protection principles.

Therefore, in the first phase decontamination was limited to clearing line n° 1, allowing normal production to continue on the other clearing line. In that phase most of the very low activity contaminated wastes were generated.

Next decontamination of the electrical furnace nº1 was undertaken, followed by the bag filter nº 2 and silos. In these phases, less smoke dust wastes were extracted but metallic wastes, refractory bricks of the furnace… were generated. Dry decontamination techniques (vacuum cleaning, grinding…) were used to avoid the generation of liquid wastes that would have been difficult to treat in that facility.

❑ Radiological control

The main activities of LAINSA were as follow:

Control of effluents

Isokinetic samples were taken from the gas evacuation systems. The results show that the values, prior to dispersion and diffusion in the atmosphere, were less than the lower limit of detection: 0.6 mBq/L. This monitoring was continuous until the decontamination of the smoke clearing systems was completed.

Radiological control of decontamination work

The criteria for radiological protection control of the programme are summarised in the Table 2.

The radiological state of area, equipment or systems were described in the corresponding Radiation Work Permit, where a dose estimation was also made.

Table 2. Radiological protection criteria

Individual dose constraints
0.3 mSv per day; 1 mSv per week; 3 mSv per month
ALARA studies
If anticipated collective dose is higher than 10 man.mSv
Use of electronic dosimeters
Works with dose rate greater than 30 µSv/h
Control of exposed time
If an ambient dose rate higher than 150 µSv/h
Control of environmental contamination
Before and during the execution of the works with risk of producing dust.
With values between 3.75 % and 37.5 % of the LDCA, face mask will be used.
With values greater than 37,5 % of the LDCA air-fed equipment will be worn, the ventilation conditions will be improved.
Control of surface contamination
Surface contamination limit in zones in which the measurement is feasible < 4 Bq/cm^2

❑ Controls of access

RP technicians from the UTPR – a specialised radiation protection company authorised to perform radiation protection tasks and provide specific activities such as decontamination – monitored the entrance and exit of personnel, materials and wastes, and controlled the accesses to the work zones. The controlled zones in thee work places and the waste storage areas were periodically monitored, to assure that the established radiological conditions were fulfilled.

❑ Occupational exposure

All the personnel involved in decontamination operations in ACERINOX were classified as Professionally Exposed Personnel to ionizing radiation and used TLDs. The total collective dose was 60 man.mSv. For the 5 months period, the average individual dose was 0.6 mSv and the maximum individual dose was 3.5 mSv.

Table 3 shows the results of the operational dose (electronic dosimeters) for the critical tasks. 40 % of the total collective dose was associated to the operations of decontamination of the electrical arc furnace nº 1 and of the gas ducts, where doses rates were the highest. The next critical group consists of the individual dedicated to the wastes segregation and preparation (23 % of total collective dose). In this case, the number of people and the time used were more significant than the dose rates. As far as the internal dosimetry was concerned, two programs of monitoring were set up (whole body monitoring), the first a few days after the start of works, to verify the suitability of the adopted protection measures. The second at the end of the work to confirm the absence of contamination. In all the cases, the results were less than the recording level, 0.5 mSv.

Table 3. Operational dose for critical tasks

Task	Doses (man.mSv)
Electrical arc furnace n° 1 and gas ducts extractions	16.1
Natural coolers	3.1
Bag filter n° 1	5.3
Bag filter n° 2	2.3
Scaffolding installation and stripping	3.4
Silos	0.5
Wastes handling	9.7
Total	**40.4**

❑ Waste management

The wastes produced were put into two types of containers. The smoke dust was put into 1 m^3 big-bags, whereas metallic, plastic wastes, paper… were put into 220 litres drums. Each waste was identified, labelled and measured. The parameters registered for each container were the content, weight, size, origin, specific activity... These wastes were stored within the facility in a place with the suitable radiological and physical security conditions. A significant percentage of the waste was checked with spectrometrical measures to determine the specific activity and to evaluate the decontamination process.

❑ Conclusions

The incident in ACERINOX in May 1998 did not involved illegal risks of exposure to ionizing radiation for the workers, or for the public, nor for the environment. The adopted radiological protection measures in the decontamination work were effective (no internal contamination). Also, the external doses remained at very low levels, thanks to the strict application of the established criteria of radiological protection from the beginning of the works.

Finally we would like to note that the immediate intervention made in ACERINOX, has demonstrated the capacity of response and co-ordination between companies and institutions in an incident without precedent in Spain.

Approximately 2000 tons of low level activity wastes were produced in the decontamination operation at ACERINOX (smoke dust: 91 %, fibre cement panel: 4 %, refractory bricks 2 %, compressible waste 2 %, metallic waste 1 %).

Figure 1. Contaminated facilities