

## **The Radium Industry in France and the Remediation of Polluted Sites - 15256**

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### **ABSTRACT**

According to the French Law of 28th June 2006 relative to the management of radioactive materials and waste, Andra is in charge of a public service mission that involves the clean-up of orphan sites that have been polluted by radioactivity. Andra is currently working, or has worked in the past, on around thirty sites in mainland France.

The clean-up strategy is selected after a comparative analysis of the cost and the advantages of the different scenarios based on the ALARA principle. Whenever reasonable, Andra tries to achieve total clean-up, so that the site can be re-used without any constraint. However, for certain cases, it is opted for a less ambitious scenario, which means restricting the possibilities of use of the site after clean-up. In all cases, the chosen scenarios guarantee that there will be no radiological impact on the planned new use of the site. If the site is an orphan site, a National Advisory Committee for Public Funding in the field of Radioactivity (known as CNAR) decides which scenario presents the best cost-benefit profile and whether to provide public subsidies to fund the work. The multidisciplinary composition of the CNAR, with members from public administrations and organizations, politicians, qualified personalities and non-governmental organizations, guarantees a decision that has been carefully considered from all aspects.

### **INTRODUCTION**

According to the French Law of 28th of June 2006 related to the management of radioactive materials and waste, Andra is in charge of a public service mission that involves:

- The issue with a three years periodicity of a National Inventory of Radioactive Material and Waste. This inventory is a reference tool for the management of radioactive and waste; it provides data on the amounts and location of waste as on forecast arisings.
- The collection of old radioactive objects that some members of the public have been keeping. In most cases, Andra recovers objects containing radium, that had been sold by doctors or members of the public in the years 1920 – 1940 and that families had kept in their possession: medical and paramedical tools, luminescent objects, cosmetics, etc. Andra collects these free of charge.
- The remediation of sites that have been polluted by radioactivity, where the person responsible for the pollution has disappeared and where the principle “the polluter pays” cannot be enforced. Most of these sites were occupied by workshops that manufactured radium-based objects and plants that extracted radium from uranium ore during the inter-war period.

These missions are funded by a State subsidy with an amount of about 4 M€ per year (about 5 M\$). Most of it is used for the clean-up of polluted sites.

Remediation projects are carried on in three phases:

- A characterization phase in order to obtain all available information on the pollutions that are present on the site. This is a very important issue for studies, for the assessment of the cost and to prevent unexpected situation.
- A study phase

The purpose of all remediation work is to reduce the health hazard to an « acceptable » level taking into account the future planned use of the site. However different approaches are possible:

- to suppress or to reduce pollutions,
- to reduce the impact of the pollutions by implementing protection barriers, or by restricting the future use of the site.

The selection of the remediation solution is performed in accordance with the ALARA principle: the preferred target is to suppress the pollution source term as much as possible, however it should not need disproportionate means with respect to actual issues. The methodology follows a technical guide [1]. Therefore Andra has to study several scenarios, with a distribution from the most ambitious scenario (removal of the whole pollution) to the cheapest (to keep polluted materials on site and implement barriers, restrict uses and monitor the site and pollutions).

The cost of each scenario is assessed and its feasibility is checked, in particular with regard to the availability of waste management routes. At the end a balance of advantages and disadvantages is performed, which includes various aspects as safety issues (long term sustainability, robustness), political or ethical issues (consistency with already managed previous situations), social issues (preservation of the quality of life in the neighbourhood), economical (depreciation of the value in case of a non-complete clean up)...

Scenarios are assessed by a National Advisory Committee for Public Funding in the field of Radioactivity (known as CNAR) in order to select the scenario with the most interesting cost/benefit profile. Members of this committee are representative of the various components of civil society: administrations, NGOs, elected representatives, qualified people in the areas of radiation protection, of clean-up, of land management. This pluralistic composition is a guarantee that the decision will consider all aspects.

- A work phase to implement the selected option. Generally Andra acts as a delegate of the owner of the site; Andra specifies necessary works, negotiates and implements the contractual framework with specialized companies, supervises works with respect of cost and planning and performs the acceptance of the final state of the site. A special concern is related to the compliance with health, security, radiation protection and environmental protection requirements.

About 150 sites have been identified with a potential contamination have to be investigated. Andra is currently managing about 30 sites in France. The duration of works can significantly vary of several orders of magnitude, from a few days to more than ten years. Costs vary in the same range.

The following sections provide two significant examples of the approach that was undertaken by Andra.

### **The Remediation of a Suburban House in Paris Area (Gif sur Yvette)**

During the first half of the twentieth century, a facility has processed radium ore in a city south of Paris. This facility also included a research laboratory. It was one of the four facilities that processed radium ore in France; all were located in Paris suburb.

At the end of the fifties, the laboratory buildings were demolished and about hundred private houses were erected on the land that was made available, without any prior remediation. Later some depollution works were punctually performed, with some objectives that were considered as sufficient but that do not anymore comply now with present standards and presently available detection means.

Therefore in 2000 national authorities decided that a comprehensive radiological diagnostic should be performed in the whole area. In most of the residential sites, one or several patches of contamination were detected. However, as the contamination was very low, intervention was not justified. To prevent the possibility of a stronger pollution too deep to be detected, use restrictions were decided, so that any digging work, even in private area, had to be performed with the support a qualified company for radiation protection.

Nevertheless a few houses needed to be remediated, mainly because radon concentration was in the range of a few thousands Becquerels per cubic-meter, in comparison with the reference value of  $300 \text{ Bq/m}^3$  for building where the public is admitted. One of the houses has been built on a former storage of radium residues (see figure 1).



Figure 1: the situation of the radium facility site in 1936 and in 2000

More detailed measurements on cores from deeper drillings could show the location of polluted areas (see figure 2).

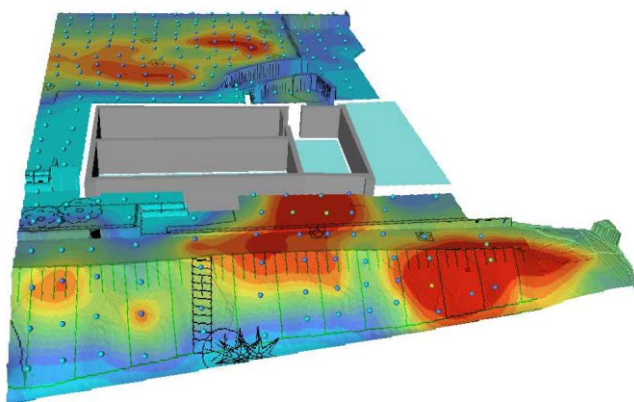


Figure 2: pollution area under a house in Gif sur Yvette

Studies quickly demonstrated that remediation solutions that would rely on generalized excavation under the polluted house were not realistic. Technically difficult, with a significant cost, these solutions could not bring a guarantee that after remediation the radon concentration inside the house would be reduced to acceptable values.

Therefore Andra selected to buy the house and its garden and to destroy the house. Soils were then cleaned up down to 5 Bq/g of Radium 226 and covered by a continuous layer of earth with a thickness between 0.5 and 2 meters. So remediated the field will be sold with a restricted use as a green space.

The total cost, including the purchase of the house, was 1M€(1.25 M\$).



Figure 3: remediation of the polluted site in Gif sur Yvette

### Remediation of a Factory of Lighters in the Marne Prefecture

The company ORFLAM-PLAST has been manufacturing lighters between 1931 and 1997 till its bankruptcy. The ore used (monazite) for the manufacture of flints was generating, after treatment, large amounts of waste with thorium, a naturally radioactive element. Wastes have been dispersed in different areas off site.

Areas around the factory site were remediated according case by case strategies: excavation of contaminated soil in some cases, recovery in other cases. These strategies were depending on technical, economic, but also social criteria.



Figure 4: the factory in operation

There were very few options for the remediation of the factory itself as there were significant amounts of waste to be managed. Furthermore disposal routes were not available and expected conditioning and disposal costs would not have been relevant with the safety issues to be dealt with. It was therefore decided to demolish the buildings and to confine rubbles on site, above the polluted soil.

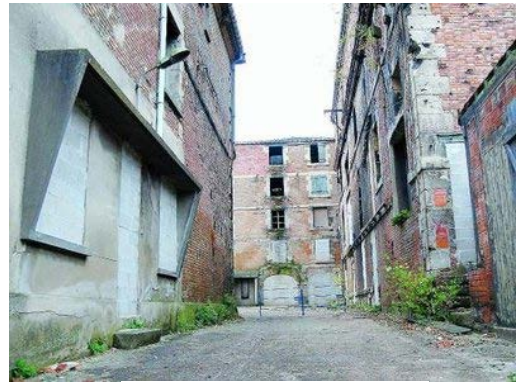


Figure 5: the factory site

Containment is provided by a capping made of clay. The clay is protected by a grid against animals that could dig it and is covered by a layer of topsoil. Grass, or thorny bushes at the bottom of the slope, can grow up on the topsoil. As a result of the thickness of the cover the dose rate is in the same range as the natural background. Land use restrictions are established: no construction on site, no excavation, vehicle.

When the remediation works will be completed, the site will be open to the public. Remediation will not only suppress hazards but also improve living conditions quality for the local community. Instead of an ugly hazardous disused factory they will have a rather pleasant green park.

This project started up in 1997. Remediation of the factory site and of external areas have lasted 17 years of studies and works with an overall cost of about 6 M€(7.5 M\$).



Figure 5: the site before remediation and just a few weeks before the completion of remediation

## CONCLUSION

With the Law of 28th of June 2006 that has established public interest missions of Andra and with public subsidy to fund them, France has created the framework and means to conduct a proactive policy of rehabilitation of sites polluted by radioactive materials, which, although in small numbers, represent an actual challenge.

## REFERENCES

[1] Management of sites potentially contaminated with radioactive materials- IRSN, French Nuclear Safety Authority, Ecology, Sustainable Development and Energy Ministry- December 2011 ([http://www.irsn.fr/FR/Actualites\\_presse/Actualites/Documents/IRSN\\_Gestion-sites-pollues\\_guide-122011.pdf](http://www.irsn.fr/FR/Actualites_presse/Actualites/Documents/IRSN_Gestion-sites-pollues_guide-122011.pdf))