

Cleanup under Airlock of an Old Uranium Foundry – 13273

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ABSTRACT

Since 2004, AREVA's subsidiary SICN has been conducting the cleanup and dismantling of an old uranium foundry located in the town of Annecy (France).

The first operations consisted in the removal of the foundry's production equipment, producing more than 300 metric tons (MT) of waste.

The second step consisted in performing the radiological characterization of the 1,600 m² (17,200 ft²) building, including underground trenches and galleries. The building was precisely inventoried, based on operations records and direct measurements. All subsurfaces, which needed to be cleaned up were characterized, and a determination of the contamination migration was established, in particular with trenches and galleries. The wall thicknesses to be treated were empirically justified, knowing that the maximal migration depth inside concrete is 5 mm for a liquid transfer vector. All singularities such as cracks, anchoring points, etc. were spotted for a complete and systematic treatment. Building structures not laying directly on the soil, such as floor slabs, were not cleaned up but directly deconstructed and disposed of as waste.

The facility was located within the town of Annecy. Therefore, in order to avoid the risk of dusts dispersion and public exposure during the building deconstruction and the soil treatment, a third of the building's surface was confined in a sliding airlock built from a metal structure capable of resisting to wind and snow, which are frequent in this area.

This particular structure provided a static confinement over the half of the building which was covered and a dynamic confinement using a ventilation and high efficiency air filtration system, sized to provide 2.5 air changes per hour.

The enclosure and its metallic structure is 33 m long (108 feet), 25 m wide (82 feet), and 13 m high (42 feet), for a volume of 10,000 m³ (353,000 ft³). It was made up of a double skin envelope, allowing the recycling of its structure and outside envelope. After cleaning up and dismantling the first portion of the building, the enclosure was repositioned on the second and the last third of the building, by sliding it on support pads.

Almost 7,000 m² of concrete surface has been treated with no dust dispersion outside the enclosure.

After treatment, all the remaining surfaces were controlled by an independent entity to verify their acceptability with regards to residual contamination (less than 0.4 Bq/cm² (24 DPM) for alpha contamination and less than 1 Bq/g of total uranium). Approximately 1,900 MT of equipment and waste were generated in batches of 1m³, in order to be staged on site, and then characterized and packaged in 20 foot containers for shipment to the final ANDRA repository. The package certification included the verification of the physical and chemical characteristics and the radiological characteristics (mass activity, dose rate, and residual outside surface contamination).

Finally, after cleanup and dismantling of the foundry, a concrete slab was poured on the free surface as a clean base for implementation of new activities.

INTRODUCTION

History of the site

Originally consisting of two natural uranium fuel fabrication plants which operated from the 1960s to the early 2000s, the AREVA SICN sites have now been cleaned up and dismantled. Uranium metal and sintered UO₂ fuel were fabricated there for French gas graphite and fast neutron reactor systems.

In the 1980s, the plants also machined uranium metal for a variety of applications and for the production of tooling. In addition, they contributed to the development of processes for test reactor fuels.

This work concerns one of the two sites, located in the center of Annecy. The site conducted foundry operations for alloyed and unalloyed uranium metal in addition to metal forming (extrusion, rolling, heat treatment, etc.) for NUGG (Natural Uranium Gas Graphite) reactor fuels and civilian equipment such as radiological shielding.

Operations ceased permanently in 2002 and 2003.

Location of the site

The AREVA SICN plant in Annecy is right in the center of the city (see Fig. 1), next to apartment buildings and not far from a major commercial district. It occupies a surface area of 3.5 hectares (8.65 acres) and features some 15 buildings, including the old uranium foundry discussed in this article.

Due to this special location, numerous contacts with local governmental authorities were necessary throughout the project. Moreover, the environmental bias of local elected representatives prompted us to take special protective measures.

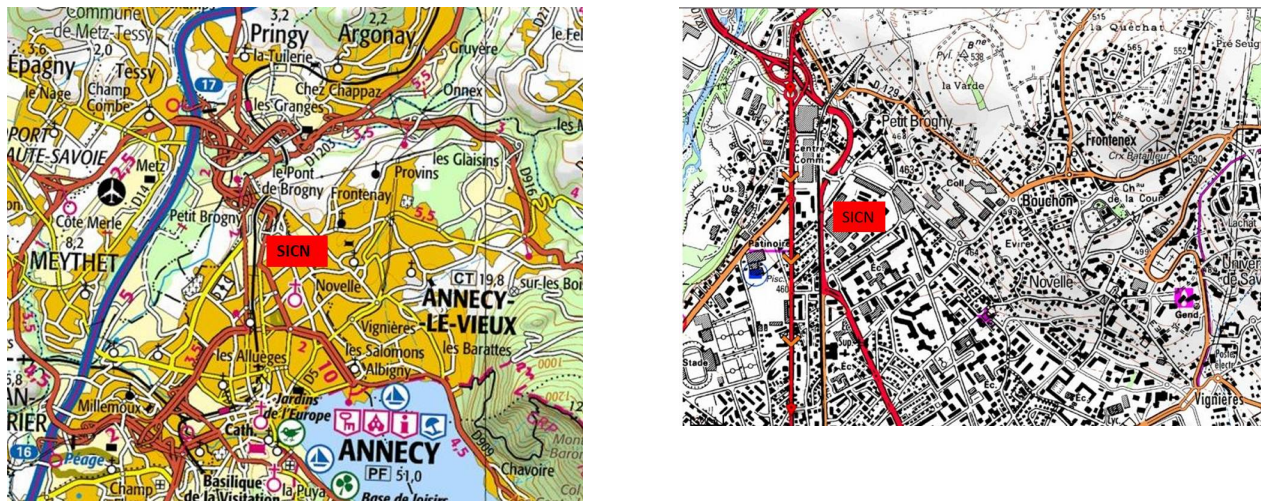


Fig. 1. Site location in the city of Annecy

DESCRIPTION

The project's main objective consisted of cleaning up a site in a downtown area in compliance with regulations and in the shortest possible time, without disturbing or endangering the surrounding population and without incident or accident involving cleanup personnel.

Another important objective was to reduce the quantities of waste produced. During the development of building or structural processing scenarios, the question was thus do we remove the contamination completely and send the waste to conventional disposal, or do we demolish the building and send the waste to a licensed very low-level activity waste disposal center?

Environmental conditions

Of the 15 buildings at the SICN Annecy site, special arrangements were adopted for the old uranium foundry's cleanup and dismantling. The contamination in this building, where natural uranium was smelted, was particularly high, requiring special radioactivity monitoring.

To prevent any dispersion of dust during building deconstruction and processing of soil and pipe galleries, it was "enveloped" in a movable airlock.

Regulatory aspects

Cleanup of the old uranium foundry at this city-center site in Annecy was a first in France due to the scenario selected: creation of a movable airlock covering one third of the building at a time, followed by cleanup, deconstruction and pouring of a clean concrete slab to allow for future re-industrialization.

The cleanup process was based on:

- Nuclear safety criteria used to define safety measures for the installations during all dismantling operations and to achieve the end-state, which were contained in several documents:
 - The nuclear safety report for final shutdown and dismantling operations,
 - General surveillance and maintenance rules to be followed (RGSE, Règles Générales de Surveillance et d'Entretien),
 - The justification for the proposed end-state,
 - An impact study for final shutdown and dismantling operations,
 - A waste study to ensure limited waste production and to identify and monitor waste streams, and
 - Several emergency response plans (PUI, Plan d'Urgence Interne and PUT, Plan d'Urgence Transport);
- The decommissioning procedure, whose purpose is to present cleanup principles deployed for purposes of facility decommissioning, with cleanup principles based on two successive and independent lines of defense:
 - Removal of a given thickness of material to achieve surface cleanup, obviating the need for systematic monitoring of all surfaces; and
 - Confirmation of the conventional nature of the remaining structures after cleanup.

The decommissioning acceptance criteria set by the authorities were:

- Surface activity: no more than 0.4 Bq/cm² alpha
- Specific activity: no more than 1 Bq/g in total uranium

Prefectural orders and regular interaction with governmental authorities govern these processes.

Approach

Initially, all equipment in the buildings was dismantled, leaving the floor and sides free for cleanup. This first phase generated more than 300 metric tons of waste.

During the second phase, research was conducted based on operating documentation of the facility, with its surface of 1,600 m², including buried pipe galleries and pits, to draw a precise picture of radiological conditions before cleanup and dismantling. So the contaminated areas were identified. Supplementary measurements were carried out on a 1 m² grid in areas estimated to be uncontaminated beforehand. If measurement indicated contamination, measurement operations were immediately stopped and the area was placed in the “contaminated area” category. Supplementary measurements were carried out on 100% of all uncontaminated estimated areas. These measurements were conducted with the use of CV28 or MIP10 type contamination monitors equipped with beta and gamma probes.

This phase, which we call the surface characterization phase, is fundamental because it distinguishes contaminated areas from those that are not.

Following radiological characterization, the migration of contamination had to be determined, especially in the concrete. It is important to note that migration depends on the type and porosity of the concrete, recognizing that some sections may be quite heterogeneous.

The depths to be processed were identified empirically. In our case, for a liquid transfer vector, and considering our radiological elements (natural uranium) the maximum migration depth in concrete observed was of 5 mm. Of course this depth depends on several factors, such as the type of concrete (its transport properties), the nature and concentration of the contaminant, the time span of the contamination period [1].

Contaminated surfaces were processed by removing a surface depth between 5 and 15 mm in the concrete. Indeed in order to be sure to have removed all the contamination a greater depth than 5 mm was removed (up to 15 mm). This supplementary depth is not constant. It depends on the type of surface to be treated (roughness, holes, bumps...).

A variety of tools and machinery (see example in Fig. 2 and 3) was used to remove contamination from the concrete walls, floor and buried pipe galleries in the contaminated areas, such as power shovels (necessary for containment enclosures), bush hammers, grinders, sanders and pneumatic drills.



Fig. 2. Operator using sander



Fig. 3. Concrete scabbling using a Nuclearized Brokk

All irregularities such as cracks and anchors were identified at the same time for complete and systematic processing. The irregularities were removed either by core-drilling or with a pneumatic drill. It is important to identify operations to process irregularities, because they can be hugely time-consuming if the required cleanup criteria are to be met.

Not all surfaces outside the floor were cleaned up, in particular the many sections of glass atrium, which were carefully deconstructed whenever they were less than 10 cm thick, panel by panel, and disposed of as waste.

In view of the plant's location in the downtown area of the city, and to prevent the dispersion of any dust during the processing of flooring and non-flooring surfaces as well as during the building's deconstruction, the building was enveloped in a rolling airlock with a metal framework capable of withstanding both wind and snow, both of which are frequent in this region. The building was more than 100 meters long, so it was decided not to procure an airlock to cover the entire edifice for reasons of cost and ventilation equipment design. A solution based on a rolling airlock that could cover one third of the building at a time was therefore chosen (see Fig. 4, 5 and 6).



Fig. 4. Three-dimensional sketch of the building and airlock



Fig. 5. Erection of the airlock



Fig. 6. Airlock in place over one third of the building

This special solution offered:

- Static containment by completely covering one third of the length of the building;
- Dynamic containment with ventilation designed to provide an hourly air exchange rate of 2.5 with very high efficiency filtration system.

Once the first third of the building had been deconstructed, the airlock was slid to the second and final thirds of the building on beams poured along the length of the edifice on both sides before work began.

At each phase of the project, measures were taken to protect the operators involved in cleanup, such as MAR 95 coveralls, TIVA protective suits, masks and dosimeters. No occupational incident was reported.

Taking into account the level of contamination, the difficulties and sometimes the impossibility of removing all the contamination, especially in the glass panels and metallic frameworks of the building, but also taking into account the cost differential between the working hours needed to reach the clean-up acceptance criteria and the cost of nuclear waste storage at the ANDRA's facility, it was decided to send the waste to the Very Low-Level waste disposal center (CSTFA, Centre de Stockage de déchets Très faiblement Actifs) managed by ANDRA. Before shipment, all packages underwent:

- Monitoring for their physico-chemical and radiological characteristics;
- Radiological monitoring to determine the specific activity of each package;
- Final monitoring of the container of several waste packages (dose rate and absence of external surface contamination).

Project data

The old uranium foundry building had the following characteristics:

- Industrial building with a surface area of 1,600 m² used to smelt natural uranium

- Several subsurface structures with traces of radiological activity: operating pits and two large pipe galleries running the length of the building
- Building structure: metal, concrete and concrete block, stone walls, glass panels

The metal frame of the airlock was 33 meters long, 25 meters wide and 13 meters high, giving a total volume of 10,000 m³. It had a double shell envelope, allowing the outer shell to be recovered for later use.

The project ran from mid-2006 to mid-2010, in several phases:

- Surface characterization: historical literature search and radiological mapping
- Determination of contamination migration
- Equipment removal
- Installation of the airlock and surface processing followed by building deconstruction, one third at a time, and placement of a clean concrete slab after verification of compliance with end-state criteria (0.4 Bq/cm² and 1 Bq/g)
- Waste removal as the project progressed

RESULTS

Fig. 7 and 8 presents the foundry before and after the clean-up and demolition work.

Nearly 7,000 m² of concrete surface was processed using the moveable airlock without any dust leaving the building. After cleanup, all interior surfaces were inspected by an independent organization to verify their acceptability in terms of the criteria set by the competent authority, i.e. no more than 0.4 Bq/cm² alpha of surface activity and no more than 1 Bq/g of specific activity in total uranium.

Building demolition under the moveable airlock generated approximately 1,900 metric tons of waste which was packaged in big bags, in screened baskets and as whole solid parts of varying volumes per ANDRA's primary waste package acceptance criteria and shipped in 20-foot containers per ADR (Accord européen relatif au transport international des marchandises Dangereuses par Route) regulations for the shipment of dangerous goods by road. Waste was shipped out twice a day in two 20-ton shipping containers.

The initial schedule was met, with cleanup and dismantling of the SICN foundry in Annecy taking nearly four years. The total cost of the project to clean up and dismantle the uranium foundry was more than 5 million euros; waste processing represented a little less than one third of the total. The budget and schedule were met, thanks in large measure to the substantial experience of AREVA's D&D business unit in cleanup and dismantling projects.

The AREVA group's commitment to re-industrialization of the site at the end of the work was widely applauded by all stakeholders, whether local government, elected representatives or members of the public.



Fig. 7. Inside the building before the project



Fig. 8. Under the airlock after the demolition work

Lessons learned

For buildings contaminated with natural uranium, the use of a double-shell airlock in a solid metal framework, whether movable or not, that envelopes the building is an innovative solution that facilitates cleanup and provides safe working conditions.

The cleanup and dismantling of buildings and structures with traces of radiological contamination requires detailed radiological mapping of the start-state. This type of inventory is fundamental and helps limit costs, particularly as concerns waste.

For the deconstruction of a building contaminated with natural uranium, it is important to define scenarios in advance, starting with an assessment of the need for deconstruction under an airlock, with large quantities of waste sent to a licensed radioactive waste facility, versus cleaning up to the requested criteria followed by deconstruction, with waste sent to a conventional disposal center.

CONCLUSION

The project demonstrated that, working in liaison with the regulatory authorities, even in an urban area, it is possible to clean up a large building without raising concerns among residents and elected representatives.

Local environmentalists agreed to the method adopted for the cleanup work.

Lastly, this project marked the first time in France that the method was applied in which surfaces were processed without systematic radiological monitoring of all surfaces.

REFERENCES

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