

Renovating a Medical Radiosotope Production Hot Cell - 11337

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ABSTRACT

In 1970 the Institute of Radio-Elements (IRE) located in Fleurus, Belgium, constructed a hot cell facility for Xenon and Molybdenum production. About 35 years later, despite on-going routine maintenance, it became necessary to perform a major renovation of the facility to ensure compliance with current regulations, upgrade safety systems for staff and public and position the facility for continued operation for several more decades. This paper will discuss the metrics of how IRE came to the decision to renovate, how the scope of work was defined and how IRE and ROBATEL Industries, the original facility constructor, jointly accomplished this strategic project. Emphasis is placed on project and task management including the incorporation of personnel dose control as a function of task development.

1. Background

In 1970 ROBATEL was contracted by IRE to design, manufacture and install their first hot cells for the production of Xe/Mo radioisotopes at the IRE facility in Fleurus, Belgium.

To design and manufacture its hot cells, IRE chose ROBATEL Industries. This choice was based on multiple technical reasons that included Robatel's technical staff relationships, Robatel's project management approach that involved working in close collaboration with the IRE Technical Manager to ensure the deliverables met and exceeded IRE's specifications, and requests. Robatel's uniquely engineered "self supporting" lead shielding slabs that allow large cells easily adaptable for various process equipment and project demands. IRE was also drawn to Robatel's engineering approach for rear cell access incorporating large sliding doors that permitted direct interior access eased decontamination and maintenance



Over the next ten years, Robatel engineered, manufactured and erected onsite 30 hot cells. These hot cells are installed in two parallel lines with rear access facing each creating a radiologically controlled zone.



Partial views of IRE production lines

IRE contracted ROBATEL in 2000 to perform maintenance and refurbish the original hot cells to support production of new radio-isotopes and improve existing production.

Following 24 months of planning and engineering, actual renovations began in 2002 on 3 production lines. They were

1. C12: A dual cell with a ventilated storage facility, and an alpha glovebox, [2002]
2. C7: two hot cells, C7A & C7B including a stainless steel enclosure for Sr/Y separation and a PVC enclosure for Y distribution [2009]
3. Xe/Mo-II: three hot cells, C27, C28 & C29.[2009-2010]

Additionally, a separate production line was installed consisting of three new cells designated: C40, C41 & C42.

2. Major Maintenance - Justification

IRE operates two Moly production hot cells in its main building. These cells are maintained on alternating schedules. Average time between scheduled maintenance is 5 to 7 years. The general condition of the Xe/Mo-II cell is good. It was used during the years 2000 to 2006 for production of Sr/Y and limited campaigns of iodine production. IRE management made a formal decision in 2008 for the renovations of the two cells to begin 2009. Renovations were completed in 2010.

Compliance with current leak-tight standards, along with the need to remotely operate and reduce the air inlet in the alpha box drove the decision to undertake this major refurbishment. Standard 10-648 criteria were utilized for post renovation leak testing as well as the goal of simplifying internal and external mechanical dependencies to reduce potential failure risks.

At the initiation of the project, it became apparent that electrical wiring, insulation and connectors had become radiation damaged and IRE elected to replace all cell wiring from the exterior junction box into the cell. IRE decided to contract with Robatel, the original supplier of the cells and equipment, to oversee the renovations.

It was also necessary, before starting the decontamination process, to let the hot cell "cool down". In order to allow continuation of the Sr / Y separation process that was being performed in the Xe/Mo-II hot cells, cell C7 was included in the renovation project.

3. TECHNICAL APPROACH

This paper focuses on the renovations of the C7 and Xe/Mo-II cells.

3.1. Cell C7

The objective of renovating Cell C7 was to partially dismantle and modify the lead shielding and to remove the stainless steel enclosure (in two parts). The stainless steel enclosure was then replaced with an engineered divider resulting in two separate smaller cells designated C7A & C7B and interconnected with a transfer tunnel and equipped with a shielded rotating airlock..



For technical reasons, one of the enclosures was fabricated using stainless steel while the other was manufactured with stainless steel lined with PVC. The transfer tunnel was fabricated with PVC



A Statement Of Work (SOW) was jointly prepared by IRE and ROBATEL Project Management to define the exact work scope to be performed and specifications for the new enclosures. After cold commissioning in ROBATEL's fabrication facility, the two enclosures were shipped to IRE for onsite installation and testing.

The following sequence for preparation and replacement of

the cell internals was implemented:

- Dismantle rear shielding wall,
- Decontaminate and remove existing enclosure (cell liner)
- Installation of the new internal liners creating two smaller cells
- Installation of new electrical wiring & control cabinets and connections to the enclosures,
- Connection to the existing ventilation system,
- Installation of the new rotating airlock, manipulators, and other accessories and equipment,
- Leak test of renovated cells,
- Functional testing,
- Final commissioning.

Since cell C7 was not used for 7 years, internal dose rates and smearable contamination were essentially non-existent requiring very limited decontamination.

Due to the minimal radiological hazards, all renovation operations were performed with limited radiological protection such as regular working clothes, paper filter mask and gloves.

No dose above IRE's operational limit of 10 mSv was recorded.

The project was finished within 7 months of contract award and required 8,700 man/hours of Robatel staff including Design Engineering, Project Management, Shop/Fabrication, on-site assembly and testing and site dismantlement/preparation.

IRE required about 1,000 man-hours to connect the renovated cell(s) to the ventilation off gas system, the liquid waste plumbing system and to perform the commissioning tests of the new equipment and systems (ventilation, electrical, scales, connections, lighting system, etc). An additional 1,000 man-hours was required to qualify and validate new in cell production equipment to IRE standards.



C7 Cell after renovation

By accurate planning, work scope definition and careful waste generation controls, the entire project generated only around 94 bags of burnable waste together with about 15 drums for other waste types.

3.2. Xe/Mo-II Cell Major Upgrade

The objectives of this project were to improve the integrity (tightness) of the enclosure and upgrade the electrical system and equipment to be compliant with the latest regulations and state of the art technology. This was achieved with 9 primary activities:

1. Replacement of primary components such as gaskets, electrical penetrations, fluid penetrations, etc.
2. Replacement of pneumatically operated components with mechanical ones. For example, the pneumatic jacks of some sliding doors were replaced by fail safe remotely handled counter-weights while other lighter doors were modified to be manipulated directly by the master-slave manipulators.
3. Replacement of the shielded liquid waste tanks.
4. Replacement of the viewing windows and their associated mounting hardware including gaskets.
5. Modification of the lighting system to enhance its maintenance and ease of lamp replacement.
6. Upgrade the electrical and control cabinets.
7. Installation of leak detection devices on the waste tanks and enclosures,
8. Replacement of flow meters, one-way valves, valves, pressure gauges, piping
9. Tightness test

The project was completed within 12 months.



access door with pneumatic actuator



upgrade underway



upgrade complete w/ manual door

Contrary to the 7-year hiatus of the C7 hot cells, the Xe/Mo-II cells were in active use prior to the start of renovation work. Consequently, smearable contamination, especially Beta, was a major challenge. It was extremely difficult to reduce contamination levels to effectively “none detectable”. Regulatory and operational conditions were significantly more restrictive resulting in limited stay times, close monitoring of dose and man-hours with an emphasis on work planning to maximize individual productivity per entry to offset reduced stay times.

As a result of the residual radiation levels, it became necessary to extend the original schedule by 6 months to accommodate the impacts of reduced stay time and employee availability. Daily monitoring was established as well as weekly meetings that included both the IRE and Robatel Project Managers. The meetings allowed for a review of work to date, prior day activities and planning of work activities for the coming week.

All operations inside the cells were performed with personnel wearing special “mururoa” suits – a positive pressure suit – with use of a temporary air lock to enter and exit the hot cells. Dose rates were continuously monitored by Health Physics (radiation protection). In the most critical steps, with greatest risk of excess dose, daily reading of electronic dosimeters as well as processing of TLD badges was performed. Additionally, urinalysis was performed on all radiation workers to monitor for internal strontium contamination.

These precautions and pre-job planning resulted in no exposures exceeding the operational dose limit of 10 mSv.

This project required 9,250 man/hours of Robatel resources consisting primarily of design engineering, project management shop/fabrication and on-site assembly and commission testing.

Following Robatel’s work, IRE required 3,500 man/hours over 4 months to reconnect the cells to the infrastructure (ventilation, waste, electricity, etc.), install production equipment and qualify and validate the facility.

Waste generated on this project amounted to:

- About 1,500 bags (or 30 m³) of burnable items,
- About 20 drums of other non-burnable waste

3.3. Onsite Organization

A collaborative project such as this was a first for both organizations. To minimize work place risks, harmonize corporate cultures, control employee exposure, resolve

issues and ensure an open flow of information, weekly on-site meetings were held between IRE and ROBATEL project staff.

Weekly meetings were attended by the Project Managers, design engineers and the On-Site Manager. In hindsight, it is clear that this methodology was the only way to ensure work was performed in a timely manner, with attention to all safety and quality concerns, and that problems were addressed immediately upon discovery. Participation and support from IRE and ROBATEL senior management was also essential to the success of the project.

As with the C7 cell renovation project, fabrication was initiated immediately on receipt of IRE design approval with the equipment manufactured, assembled and cold tested in Robatel's facility prior to delivery at the IRE site.

4. Dose Reduction

In addition to the more restrictive IRE policy and procedures, onsite worker radiation exposure was regulated by (Royal Decree) dated July 20, 2001 which is the Belgium law that provides for protection from ionizing radiation. Belgium law requires that personnel working in a radioactive controlled zone be limited to a dose of 20 mSv over a twelve month period. IRE's more restrictive internal administrative limit is 10mSv.

High priority was placed on radiological safety engineering during the work planning for the two projects to ensure IRE and ROBATEL personnel remained below the radiological control limit. Exposure controls included:

- advance scheduling to allow for natural decay of the short lived isotopes;
- real time continuous monitoring of dose rates;
- personal electronic dosimeters to augment TLD badges;
- stay time controls on individuals and teams.

While weekly meetings were used to establish week-to-week work schedules and scope, daily meetings between personnel, project managers and ES&H staff provided a forum to review activities for each day, concerns from prior day activities and to address any radiological issues associated with current day scheduled activities.

5. Conclusions and Lessons Learned

A major project involving active production hot cells must be approached as a multi function project with clearly defined User Requirements Specifications (URS). If significant changes are planned such as physical reconfiguration, electrical system upgrades, plumbing or ventilation, the participation of both the original design engineering and fabrication firm on the project team is a clear positive input. The work scope needs to be defined accurately and in as much detail as possible. Nevertheless, due to the nature of the work to be done, it is mandatory that a close interaction between the technical staff of all organizations (facility owner/operator and contractor) takes place from the beginning of the project.

The presence of Beta emitters in the working area is a clear complicating factor for the management of employee exposure and project scheduling. The number of hours worked by individuals is clearly restricted requiring great effort to continuously monitor dose in a real-time basis.