Decontamination Process of Internal Part of Pipes – 13442

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ABSTRACT

The MARCOULE Site, created in 1955 is one of the first nuclear sites in France. It combines the activities of the Research Centre of the French Atomic Energy Commission (CEA) and AREVA industrial operations. Today, a large part of the operations on this site consists of the cleaning and the dismantling of nuclear Installations, once the end of their life cycle has been reached. An example can be the reprocessing plant UP1. This unit, started in 1958 has been stopped in 1997 and its dismantling started quickly thereafter. Technical challenges of the UP1 dismantling are mainly linked to a very high risk of exposure due to a large variety of contaminated equipments and residuals of fission products, potential sources of irradiation. The dismantling of Hall 71 is a typical example of such challenge.

This paper will present a solution developed by AREVA Clean-Up business unit, in collaboration with COFIM Industry, to remove contamination incrusted inside the pipes before starting the cutting operations, thus reducing irradiation risk

INTRODUCTION

The dismantling process is quite challenging and spans over several years. Most of time, this process involves the implementation of a large number of technologies dedicated to decontamination operations but also to cutting operations.

These complex operations require the use of various types of skills and technologies, depending on the context and most particularly:

- the accessibility of rooms or cells,
- the equipments and pipes dimensions,
- the type and the level of contamination,
- the level of irradiation,
- the policy in terms of waste production and management,
- the cost.

Generally, the techniques used to achieve cutting operations are based on the use of mechanical tools such as disk sanders, etc... Despite proved results, these types of tools are not so efficient. As a consequence, cutting operations are much risked because of a too long time of exposure in contaminated and irradiating environments.

The Hall 71, situated in the “High Activity” part of the UP1 plant, was used for highly contaminated solutions reprocessing. Concentrated fission products, issued of irradiated nuclear fuels, were recovered by using evaporation process.

Connected with other industrial facilities at MARCOULE, it is constituted of four main units:

1. the Storage Unit
2. the Transfer Unit
3. the Evaporation Unit
4. the Distillates and Gas Unit

Concentrated fission products retrieved were evacuated to temporary storage plants before their final processing at the Vitrification Unit of MARCOULE.

When UP1 industrial activity stopped, several rinsing campaigns had been started. Equipments (chemical dissolvers, batteries, evaporators, tanks…), ventilation systems and process pipes used for contaminated liquids circulation were rinsed several times using acid solutions and other chemical products.

The major part of the dismantling works in Hall 71 consists of the removal of the previously cleaned equipments and pipes networks. This Hall 71 is nineteen meters high. As a consequence, a major part of the interventions has to be realized by using very high scaffolds, in a quite reduced space. Besides, some pipes are covered with thick layers of lead in order to minimize effects of radiation due to repetitive passages of contaminated liquids.

One way to remove these protected pipes is to take off the lead part before cutting the pipe. Before starting such operations, the risk of irradiation must be decreased. Thus, a part of the contamination incrusted inside the pipe has to be removed.

To provide a solution to this main issue and an improvement in terms of working conditions, operator dosimetry reduction and waste management, the Clean-Up business unit of AREVA, in collaboration with COFIM Industry, worked on the development of a new technology.

After a brief introduction to the principles and characteristics of this new technology, results obtained during an industrial trial stage will be presented. Some modifications realized on the tool will be described before assessing its improvements and gains in terms of security, handling, dosimetry and cost.

OVERVIEW OF THE TECHNOLOGY

Principle

As mentioned in the introduction, the dismantling project in Hall 71 of UP1 requires the use of a specific tool compatible with the recurrent nuclear issues. The goal of the collaborating project was to develop a tool which enables to mill an internal part of the contaminated pipe, to limit its radiation effects, before cutting it.

Characteristics

The developed tool is constituted of two independent parts which are the motorized part and the milling part.

- Motorized part description

According to the context (space availability, level and type of contamination…), the motorized part can be deported to be set-up at a certain distance of the intervention site if necessary, or to be fixed onto a support for example.

Figure 1: The motor part

Motor characteristics

- Weight of 30 Kg
- Power level of 2kW(50Hz, 230V, 12A)
- Rotation speed from 500 to 15 000 RPM
- Flexible length of 2 meters

- Milling part description

The milling part is constituted of several clipped extensions units which number and dimensions depend on the length of the contaminated pipes. Bronze rings BP25, fixed on the first unit called the “head boom” and on the others extension units, constitute the guidance system of the tool, once introduced into the pipe.

Before milling operations, the “head boom” with its milling cutter must be introduced and clipped into a Ø 12 mm adapter, directly linked to the flexible of the motor part. Then the extension units are plugged in function of the machining progress.

Nota: With the use of a unique key clamping system, the fixation of the adapter on the flexible is very easy.

Figure 2: Head boom and extension units

In that case, two types of “head boom” were developed to be compatible with the widest range of contaminated pipes:

- a “head boom” with a milling cutter adapted to DN32 pipes and with a capacity of machining such as to get a final internal diameter of 39mm,
- a “head boom” with a milling cutter adapted to DN40 pipes and with a capacity of machining such as to get a final internal diameter of 49mm.

Figure 3: The milling cutter (the boom nozzle)

Milling part characteristics:

- Weight of the DN32 head: 1.0 kg
- Weight of the DN42 head: 1.2 kg

Two types of extension units are available, depending on the size of the contaminated pipes.

Figure 4: An extension unit

Extension units characteristics:

- Weight of a 0.5m extension unit : 1.05 kg
- Weight of a 1m extension unit : 1.50 kg

Advantages

This two-parts system presents several advantages as explain below.

- Motorized part advantages

The quite heavy motorized part, totally independent from the milling part, can be deported to be set-up in the most convenient site. The rotation speed of the milling cutter controlled by a stepless speed governor allows a wide range of milling speeds from 500 to 15 000 RPM. This motor is fitted with a carrying handle and equipped with an emergency stop device in case of issue during the operation.

- Milling part advantages

The low weight of the milling part allows a quite easy handling. Its extension units clipped very easily and quickly, guaranty compactness to the initial system and a possibility of deployment according to the operation progress. The bronze rings make easier the introduction of the tool into the contaminated pipes and its guidance during the machining.

Figure 5: Bronze rings

TEST OF THE WHOLE SYSTEM

Goals of these tests

As mentioned in introduction, several trial stages were realized during the development of the tool in order to:

- adjust and determine the different “laboratory” parameters to get optimal results,
- assess its performances with the chosen parameters,
- fix the encountered problems.

These stages were done in “non active” conditions, in COFIM Industry facility situated in Voiron, close to Grenoble (France).

Materials and equipments used

The tests were carried out using a DN 32 stainless steel 316 L pipe, with a thickness of 4 mm:

- a temperature sensor was fixed on the external part of the pipe to measure temperature and to control any overheating,
- an electronic callipers was used to assess the machining efficiency by checking the evolution of the internal diameter of the pipe

Figure 6: Electronic caliper

Improvements

- Parameters

Some parameters were tuned during the trial stages to avoid any motor interruption and to get optimal results.

To realize a successful milling operation, it is recommended to have:

- a milling cutter rotation speed fixed at 1800 RPM ,
- a forward speed varying from 1.5 to 2 m/h.

To avoid any overheating and to keep a maximal temperature around 60 °C, it is better to have a 10 minutes break every 30 minutes machining.

- Complementary system

Several adjustments were realized to get a safety final tool, compatible with a recurrent nuclear issue which is the waste recovering.

An additional guidance and security system was developed to be fixed at the extremity of the pipe to decontaminate. This nozzle equipped with a detector makes easier the introduction of the tool into the pipe and allows the milling cutter rotation.

Figure 7: Additional guidance and security system

To avoid any external waste generation, the thin layer of contaminated material can be recovered by hovering. Machining trials highlighted the production of very thin metallic chips, easy to recover at the other extremity of the pipe (until a 10 meters length), using a vacuum cleaner type NILFISK.

Figure 8: Nilfisk vacuum system

FINAL RESULTS

Thanks to these different improvements, it is possible to get:

- a milling depth from 0.1 to 0.5 mm
- an homogenous and regulate internal state of the milled pipe

Figure 9: View of the internal part of a pipe, after milling

Finally, it is possible:

- to remove an internal part of a supposed contaminated pipe, before any intervention on it.
- to avoid some difficulties regarding the storage of decontaminated cut pipes.
- to recover the generated contaminated wastes into a nuclearised vacuum cleaner.

CONCLUSION

The developed tool is compatible with recurrent nuclear issues.

Preparation of the equipment

The deported motorized part makes easier the handling of the tool. Thanks to the extension units system, the initial compact tool can be introduced into reduced environments and deployed in function of the operation progress.

Figure 10: Use of the tool

Compatibility with recurrent pipes dimensions

The two types of "boom head" can cover a wide range of pipes for each of them (around 70% of pipes which have to be cut): from 29 to 39mm diameter for the first one and from 39 to 49 mm diameter for the other one.

Safety

The extension units allow interventions to a certain distance from the contaminated and irradiating pipes.

The detector of the guidance system and the emergency stop device of the motor, constitute complementary securities.

The possibility of restarting a milling operation without removing the tool of the tube highlights the management of degraded modes.

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