DECONTAMINATION PROCESSES APPLIED DURING DA1 S.G.REPLACEMENT

Authors : Y.M. BEISSIERE - B. LANTES - EDF
P. SAURIN - C. BRUN - FRAMATOME
P. BESLU - CEA

ABSTRACT

In support of the ALARA concept, applied to the DA1 SGR operation, EDF decided to decontaminate at least the primary pipes and elbows of each primary loop. For the 1st and the 2nd loops an electrodecontamination process was applied after steam generator removal. For the 3rd loop a soft chemical decontamination was also performed in the channel head using the LOMI process.

INTRODUCTION

The steam generators replacement on the DAMPIERRE 1 (DA1) nuclear power plant in 1990 (900 MWe with 3 loops PWR) was the first such operation performed in FRANCE.

Decontamination had two purposes for DA1 (ALARA concept) :
- to lower the radiation level around the RCS elbows, thus to reduce overall radiation exposure,
- to remove contamination from the RCS elbows surfaces, to allow easier working conditions in SG cubicles.

In order to achieve these goals the minimum DF demanded was 8 and no free remaining contamination was allowed.

PREPARATIONS AND QUALIFICATION OF THE PROCESSES

Preparative studies were carried out over three years before 1990 operation. Several processes were evaluated ; various soft chemical decontamination processes, electro-decontamination and sand blasting. Two processes were retained, the LOMI process as soft chemical decontamination and electrodecontamination method using phosphoric acid.

LOMI chemical decontamination

As shown on fig. 1, chemical decontamination was simultaneously applied in channel head and primary pipes. In order to avoid introducing chemicals into the reactor vessel, inflatable stoppers were developed to withstand the conditions required by the process. The LOMI process, for which FRAMATOME acquired the license in 1987, was finally chosen because, it was proved to be efficient, non-corrosive, compatible with the inflatable stoppers and less risky in terms of temperature and pressure required.

Electrodecontamination process

The preparation work consisted in the complete design of :

- The electrodecontamination process, mainly the selection of the electrolyte, and operation parameters such as time, temperature, current density, suckers velocity ...

- and, simultaneously, the tools required to apply the decontamination process on primary pipes ends (cast elbows and stainless steel primary pipes).

Electrodecontamination basic principle was derived from well mastered electropolishing of SG channel head, with suction cups as shown in fig. 2.

Figure 1 : Implementation of chemicals and stopper

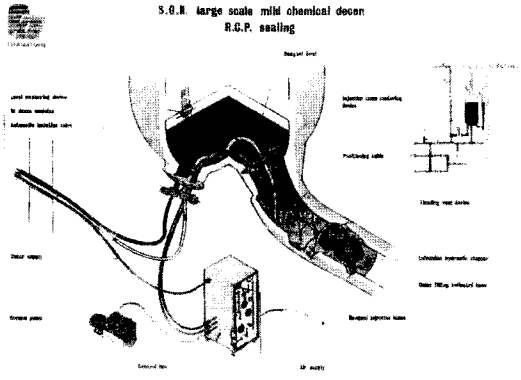
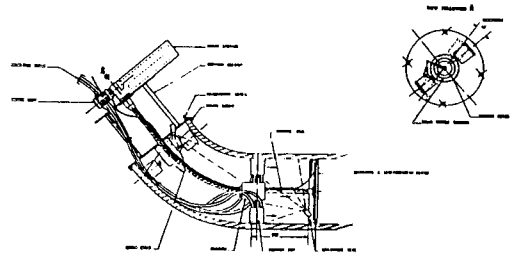


Figure 2 : Tooling for electrodecontamination (Barras/ Provence/STMI patended)



Tooling

Electrodecontamination of the pipe ends is applied after the steam generator has been removed. A specially designed carrier is mounted on the free end of primary pipes. It runs along a central rail fixed on the pipe end and is centered by a plug equipped with an inflatable ring located inside the primary pipe. This carrier suports a set of two leaktight suction cups applied on the RCS pipe walls and arranged symetrically to decrease the force on the carrier.

The carrier drives both the continous forward motion and rotation for the suction cups. Nominal displacement of the suckers comprised 2 passes (go and return) and rotation was achieved by a pitch equal to the diameter of cups. 15 stripes were planned to be performed by each cup.

DAMPIERRE 1 DECONTAMINATION OPERATIONS

The soft chemical decontamination was the first main steam generator replacement step. It started on march 8, 1990 on steam generator n° 3. Electrodecontamination started on march 26 for primary loop n° 1 since steam generators had to be first removed from their cubicles.

LOMI decontamination on SG n° 3

The main characteristics of the process used in DAMPIERRE were :

- 4 main steps O.R.O.R.
- Temperature 90° C

- Main steps duration O = 10 h - R = 8 h
- The oxidizing solution was stored temporarily in a buffer tank ready for reuse.
- 1st reducing step "decontaminated" by passing through cationic resins.
- Liquid effluents transported by trucks out of the plant for solidification.

Circulation and heating of solutions, resin treatment, chemical injection ... were performed by modular skid installed in the adjacent fuel building ; the reagents were routed through flexible hoses between the reactor building and fuel building. The tooling package consisted in two compact modules, two temporary storage tanks, and a laboratory skid.

The decontamination team was composed of 18 operators and 4 chemists for process control. The operation lasted the 8 days (3 shifts a day) scheduled. Total man-sievert dose to the deconteam was 0.055 man-sievert. Approximately 110 G.Bq were removed. Initial dose rates observed on DA1 RCS were very low (table 1) due to careful plant shut down and to purification of primary coolant.

Table 1 : Dose rates (arithmetic mean) m sievert/h
External contact of pipes

	INITIAL DOSE RATES (8 pts)	FINAL DOSE RATES (8 pts)	DRRF
Cold leg	0.413	0.027	15
Hot leg	0.253	0.022	11.2

The main results obtained were :

- Average dose rate reduction factor : 13.3 for 8 guaranteed.
- Decontamination factor (as ratio between initial surfacic contamination and final surfacic contamination measured by external γ probe collimated) :
  Hot leg : DF = 30
  Cold leg : DF = 70

- The average dose rate inside the cubicle was 0.05 m.sievert/h after steam generator removal.

Electrodecontamination on loops n° 1 and n° 2

The electrodecontamination tooling i.e, the carrier and its suction cups, the I and C cabinet and the electrolyte vats formed a self-contained unit installed in the reactor building at 4.6 m level for the vats, at 8 m level for the control cabinet in the containment annulus and at ground level for effluents storage. The electrodecontamination team was composed of 5 FRAMATOME supervisors and 27 operators and inspectors for STMI who operated the decontamination.

The decontamination operation lasted 100 h for loop n° 1 compared to 50 h scheduled and 70 h in the loop n° 2 for 50 h scheduled.

The decontamination team integrated dose after the decontamination of the two loops was 90 mSV (9 man-rem).

The average (arithmetic) dose reduction factors are shown in table 2 and 3 (m sievert/h)

Table 2 : DRRF before chamfer machining

Loop n° 1	Initial dose rate	Final dose rate	DRRF
Cold leg	0.457	0.030	
Hot leg	0.265	0.025	
Arithmetic mean	0.361	0.0275	13.1

Table 3 : DRRF after machining

Loop n° 1	Initial dose rate	Final dose rate	DRRF
Cold leg	0.457	0.027	
Hot leg	0.265	0.017	
Arithmetic mean	0.361	0.022	16.1

Loop n° 2	Initial dose rate	Final dose rate	DRRF
Cold leg	0.432	0.052	
Hot leg	0.252	0.020	
Arithmetic mean	0.342	0.036	9.5

4. CONCLUSION

Both decontamination processes were used in DAMPIERRE 1, because the first SGR operation was considered as a "bench test" for future similar operations.

- the goal was completely reached with soft chemical decontamination (dose rate reduction, working conditions in SG cubicles, experience)
- the goal was partially reached with electro-decontamination (dose rate reduction, experience) and improvement are already engaged to obtain clean working conditions.

The DRRF were similar (approx 13 in both cases) and this result was considered as successful, especially taking into account the low initial doses rates. The total man-SV saved by decontamination was estimated to be 0.5 man-sievert (50 man-rem) (i.e., 25 % of total integrated dose).