

## FRENCH EXPERIENCE WITH ELECTROPOLISHING

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### ABSTRACT :

Following the results obtained in CHINON B1 comparing deposited activity observed on different surface finishes EDF decided to electropolish steam generator channel heads (S.G.C.H.) in order to reduce operator dose during plant maintenance. The qualification tests were performed on steam generator materials (Inconel 600 and S.S. 308 L) with the full on site operational equipment (i.e. a sealed sucker). In 1988 the 4 SGCH of NOGENT 2 were electropolished. In 1990 we observed a dose rate reduction of 45 % at NOGENT 2 compared to NOGENT 1.

Other French experience is electropolishing of 27 S.G.CH, since 1988

### 1. INTRODUCTION

French attention has also been focused on surface finishing and tests carried out at CHINON B1 NPP to evaluate the efficiency of mechanical polishing, electropolishing and combination of both [1].

The results after exposure of steam generators manway covers for up to three reactor cycles indicated a reduction factor of 3 in the radiation field following the use of electropolishing compared to the as received surface finish [2].

Based on these attractive results and also cost considerations it was decided by EDF to electropolish the S.G.C.H. bowl and partition plate.

Following this decision feasibility and qualification programmes were developed to exclude unacceptable behavior and detrimental effects (i.e. material degradation) [2, 3].

### 2. INDUSTRIAL APPLICATION

#### 2.1. FRAMATOME electropolishing experience

The French experience of S.G.C.H. electropolishing for SG channel head is summarized in table n° 1.

Table 1 : French experience of S.G.C.H electropolishing

Year	Month	Electropolishing % of total surface area	NPP	Number of S.G.
1988	February	60 %	NOGENT 2	4
1988	July	60 %	CATTENOM 3	4
1989	February	80 %	PENLY 1	4
1989	July	80 %	GOLFECH 1	4
1989	Oct.-Dec.	80 %	DAMPIERRE 1	3
1990	May	80 %	CATTENOM 4	4
1991	Jan.-Feb.	80 %	PENLY 2	4

## 2.2. Description of an electropolishing operation

A typical electropolishing operation takes approximately 5 Weeks for 8 channel heads, including all the initial and final inspections and quality controls :

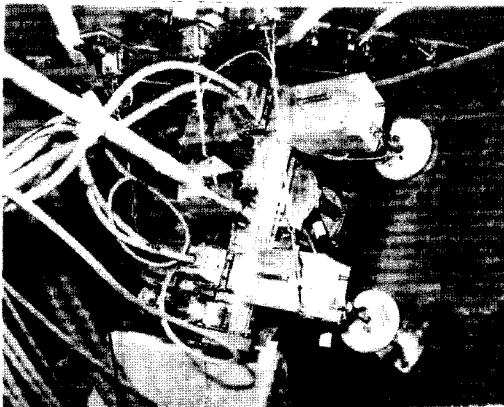
- surface pH, conductivity of the final rinsing water,
- microscopic examination on base surfaces and replicas to perform microscopic and SEM examinations,
- surface profilometry (roughness curves).

Metalurgical inspections also takes place during the electropolishing operation.

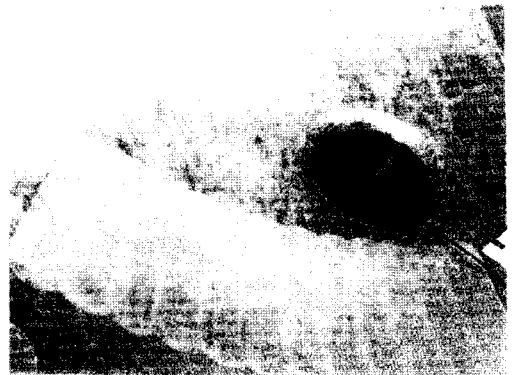
The electrolyte is composed of a mixture of sulfuric and phosphoric acids.

Electropolishing tools support the electropolishing sucker (STMI patent) which contains the cathode (S.S. disk) [3].

**Figure 1 : During "Mosquito" electropolishing**



**Figure 2 : Partial polished surface on the clad bowl (using "Mosquito" tool)**



## 3. METALURGICAL RESULTS

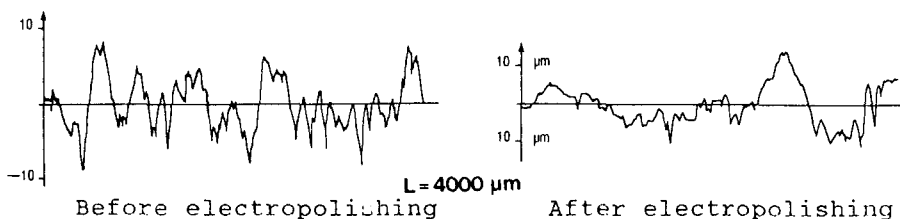
Two types of results are recorded as follows

### \* roughness results

- regular, uniform and extremely smooth surfaces are obtained.

Figure 3 shows examples of initial and final surface profilometry measurements. The micro-roughness has been eliminated after electropolishing.

**Figure 3 : Roughness curves on SS 308 L  
Profiles in X direction  $\mu\text{m}$  - from CATENOM 3**



The profilometry measurements are made directly on the S.G.C.H. base surfaces and are statistically analysed by STMI.

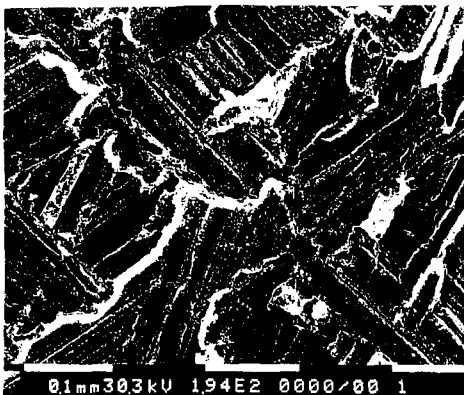
\* Metallographical results

- no pitting, no etching, or any other undesirable side effects of corrosion .
- only a slight intergranular grain boudary attach on Inconel 600 (i.e. the partition plate) and a very low selective dissolution of delta ferrite on SS 308 1 (the weld overlay).

All replica are immediately examined optically during the electropolishing operation by the metallurgical team, and then characterized at the UNIREC metallurgical laboratory by SEM examinations, occasionally with supplementary EDAX analyses.

Figure 4 provides examples of the initial and final surface finishes (obtained for SEM replicas).

Figure 4 : Microscopic examinations of initial and final surface made on replicas of In. 600) from DA 1 (remplacement S.G.)



Before electropolishing (x195)



After electropolishing (x503)

4. CONTAMINATION RESULTS : field results at NOGENT 2

In July 1990 during the first refueling outage after one operating cycle deposited activity and dose rates measurements were made.

The in situ deposited activity measurements were carried out by the CEA CADARACHE directly inside the steam generator with the Emecc equipment (measurements and studies of circuit's contamination). Gamma scanning spectra data were obtained on the hot leg of the S.G.C.H. n° 3. The results obtained after processing by a micro-computer are given on table 2 for Co<sup>58</sup> and Co<sup>60</sup>.

Table 2 : Deposited activity measurements at NOGENT 2 (GBq/m<sup>2</sup>)

Surface	State	Co <sup>58</sup>	Co <sup>60</sup>
clad bowl	non electropolished	10	0.9
	electropolished	2	0.4
partition plate	non electropolished	6	0.5
	electropolished	0.9	/

The electropolishing of the steam generator channel head clearly leads to a considerable reduction of activity specially that due to Co<sup>58</sup>.

The contributions from the partition plate and the bowl to the total dose rate have been calculated in case of a electropolished S.G.C.H. or a non electropolished S.G.C.H. Thus electropolishing leads to a reduction of 44 % of the total dose rate compare to a non-electropolished channel head.

This beneficial effect was confirmed by the dose rate measurements obtained during the latest refueling outage :

Total average : 21.8 mSV/hour

Taking into account the total average channel head dose rates at NOGENT 1 after one cycle (39.0 mSV/hour) at NOGENT 2 the approximate dose rate reduction should be about 45 %.

## 5. CONCLUSIONS

French electropolishing experience has been very satisfactory to date.

The improvement of the S.G.C.H. surface finish by electropolishing leads to a significant reduction of the dose rate level.

After one fuel cycle in one plant, a decrease of 45 % in the dose rate from the steam generator channel head was obtained.

These results have encouraged EDF to electropolish all new S.G.C.H. including steam generator replacements.

Electropolishing will also be realized on site and in FRAMATOME manufacturing facilities.

## 6. REFERENCES

- [1] Influence of electropolishing on corrosion product deposition. A. BRISSAUD - B. LANTES - P. SAURIN - P. BESLU - Berkeley 16-18/03/1988
- [2] French experience with electropolishing (1) P. SAURIN - C. WEBER - Berkeley 16-18/03/1988.
- [3] French experience with electropolishing (2) P. SAURIN - C. WEBER - A. BRISSAUD - G. GOUILLARDOU  
Bourmemout h 23-29/10/1989.