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ISOE INFORMATION SHEET

REACTOR VESSEL CLOSURE HEAD REPLACEMENTS (1994 - 1996)

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1. Introduction

On September 1991, at unit 3 of the Bugey NPP in France, the hydrotest of the main primary system performed during the 10-years in-service inspection revealed a leak at one adapter on the reactor vessel closure head (RVCH). After on-site inspections, which confirmed a generic problem and a need for immediate repairs, Electricité de France (EDF) has finally decided to order 23 RVCH replacements for its 900 MWe NPPs (34 units) and 10 more for its 1300 MWe NPPs (21 units). About three years after the problem was identified, one RVCH replacement has been performed in France, taking less than 25 days (removal of the old RVCH and installation of the new one). The operation was made following specific ALARA procedures coordinated by EDF operational services. This ISOE Information Sheet briefly describes the main evolutions - from 1994 to 1996 - in both the fields of radiological protection of workers and of ALARA organization. The collective dose predictions and results are also given for the PWR French RVCH replacements. Two other results of RVCH replacements, which have

been performed in other countries, are also given: Almaraz 1 (in Spain) from June 1996 and Ringhals 2 (in Sweden) from July 1996. Other six French RVCH replacements are planned in 1997.

2. Improvements in the Radiological Protection of Workers (1994-1996)

1994

During 1994, some qualifications of processes and methods were performed and the corresponding tr1 o0 -21.6 ucatio4was undertaken for :

- the automated machine to weld control rod drive mechanism (CRDM) hous0 -s to adapttio,
- specific tools for machining the CRDMs and adapttio,
- the autonomous handling machine to fit out the new RVCH,
- the automatic cutting machine which eliminates all human activity on the old RVCH…

Upon the completion of process and method qualification, the first four RVCH replacements were performed at Bugey 5 (01/94), Blayais 1 (01/94), Bugey 2 (04/94) and Gravelines 4 (04/94). At Blayais 1 and Gravelines 4 (second French 900 MWe PWRs generation called CPY), more than 20 % of the collective dose for the RVCH replacements was due to mishapo, unlike the earlier operation performed at Bugey 5 (first French 900 MWe PWRs generation called CP0) for which collective dose was quite close to the predicted values perhapo because, aftti two years of on -site inspections at Bugey,6 ucatio4knew much bettti the CP0 RVCH environment than that of the CPY. The automatic cutting and welding machines were only partially used for the first three RVCH replacements, and the first totally automated operation took place in Gravelines 4.

In conclus0on, 1994 was only the begino0 -21.6the application21.6specific ALARA procedures for RVCH replacements.

1995

The automatic cutting, welding and handling machines were at this point systematically used. From 1995, a specific effort was made to reduce doses during insulation, scaffolding, handling and packing.

- New tools allow to optimize time operation:
- a new rack for CRDMs equipped with a top-and-bottom guiding system,
- rack equipped with clip-on (instead of bolted) blocking-systems of the CRDMs,
- a specific upending device equipped with a remote control station.

- New specific biological shielding was used:
- steel biological shielding around the lathe,
- lead wall to protect workers during welding and liquid penetrant examinations.

- Equipment and tool packing was improved by mapping and planning, and by the use of a loading skid to reduce the number of handling tasks. As a result, a significant reduction in dose and work time was observed on these tasks.

- Improvements were also made in the follow-up of the operation from the radiation protection point of view: from that point, mishaps were better identified and quantified. Feedback experience analyses were also systematically written. Moreover, check-lists listing the immediate pre- and post-job actions were given to health physicists in order to help them in adapting their work to the 900 MWe or 1300 MWe environments.

- With training and improved worker competence, the number of exposed workers was reduced by a factor two for almost all activities.

1996

- The equipment and tool packing continues to improve (e.g. a size reduction of the racks),
- Ten custom-made portable shield walls have been developed,
- The loading procedure has been modified to avoid workers directly walking on the old and contaminated CRDMs.
- Many simple but useful ALARA measures have been implemented: indicators of shorter routes to works, personnel screening to avoid « visitors », use of roadsigns to indicate high and low dose rates areas (« no entry », « parking forbidden », « panoramic view »…), suggestion boxes…

In 1993, a goal of 350 man.mSv was established for every French 900 MWe RVCH replacements, and 340 man.mSv for every 1300 MWe RVCH replacements. Now, this dose goal is reconsidered for each plant to take into account the site-specific dose rates: dose rates at some measurement points are taken to establish a preliminary dose prediction (the main part of the collective dose is estimated from the assessment of the work time spent near CRDMs' welds, see Figure 2).

Tasks are then followed day-to-day and real-time compared with predictions. When half of RVCH replacement tasks are performed, a second prediction is made using a more complete set of dose rate measurements. This establishes the definitive goal in terms of collective dose. All job dose predictions and results during operation are kept in a structured database (DOSIANA® or EXCEL® Softwares for example) in order to help feedback experience analyses. Predictions and results for all RVCH replacements are given in Table 1 and Figure 1.

Table 1. French Reactor Vessel Cover Head Replacement Collective Doses (in man.mSv)

	1st prediction	2nd prediction « Goal »	Collective Dose Result	Mishaps	Result without mishaps
1994					
BUGEY 5[*]	389.0	*N/A*	**208.6**	21.0	184.6
BLAYAIS 1	458.5	*N/A*	**533.4**	172.3	361.1
GRAVELINES 4	323.0	*N/A*	**524.9**	109.0	415.9
BUGEY 2	571.0	*N/A*	**507.0**	21.0	486.0
BUGEY 3[*]	301.9	*N/A*	**266.1**	*N/A*	*N/A*
1995					
BLAYAIS 2	N/A	359.7	**437.8**	55.6	382.1
ST-ALBAN 1	377.1	421.3	**445.1**	46.8	398.3
GRAVELINES 3	397.6	413.0	**426.6**	29.3	397.3
FLAMANVILLE 1	382.6	456.1	**367.2**	27.6	339.6
BLAYAIS 3	402.8	443.6	**380.6**	38.6	342.0
TRICASTIN 1	326.7	359.3	**252.5**	15.2	237.2
1996					
TRICASTIN 4	385.4	406.9	**237.6**	8.6	229.0
PALUEL 4	202.0	218.6	**208.5**	9.5	199.0
ST-LAURENT B2[**]	592.2	564.2	**443.4**	31.7	411.7
BLAYAIS 4[**]	498.7	423.7	**474.6**	62.0	412.6
DAMPIERRE 1	381.2	372.4	**339.7**	14.7	325.0
FESSENHEIM 1	242.8	270.8	**335.6**	47.0	288.6

([*]) The good collective dose results at Bugey 3 and 5 can be also explained by very low dose rates in comparison with the other NPPs, in particular at Bugey 3 where a decontamination of the RVCH had been performed during the previous year's outage.

([**]) The high collective doses received at Saint-Laurent B2 and Blayais 4 in 1996 are partly explained by hot spots which particularly affect these two NPPs. Except for these plants, the percentage of « mishaps' dose » is now stabilized below 10 %.

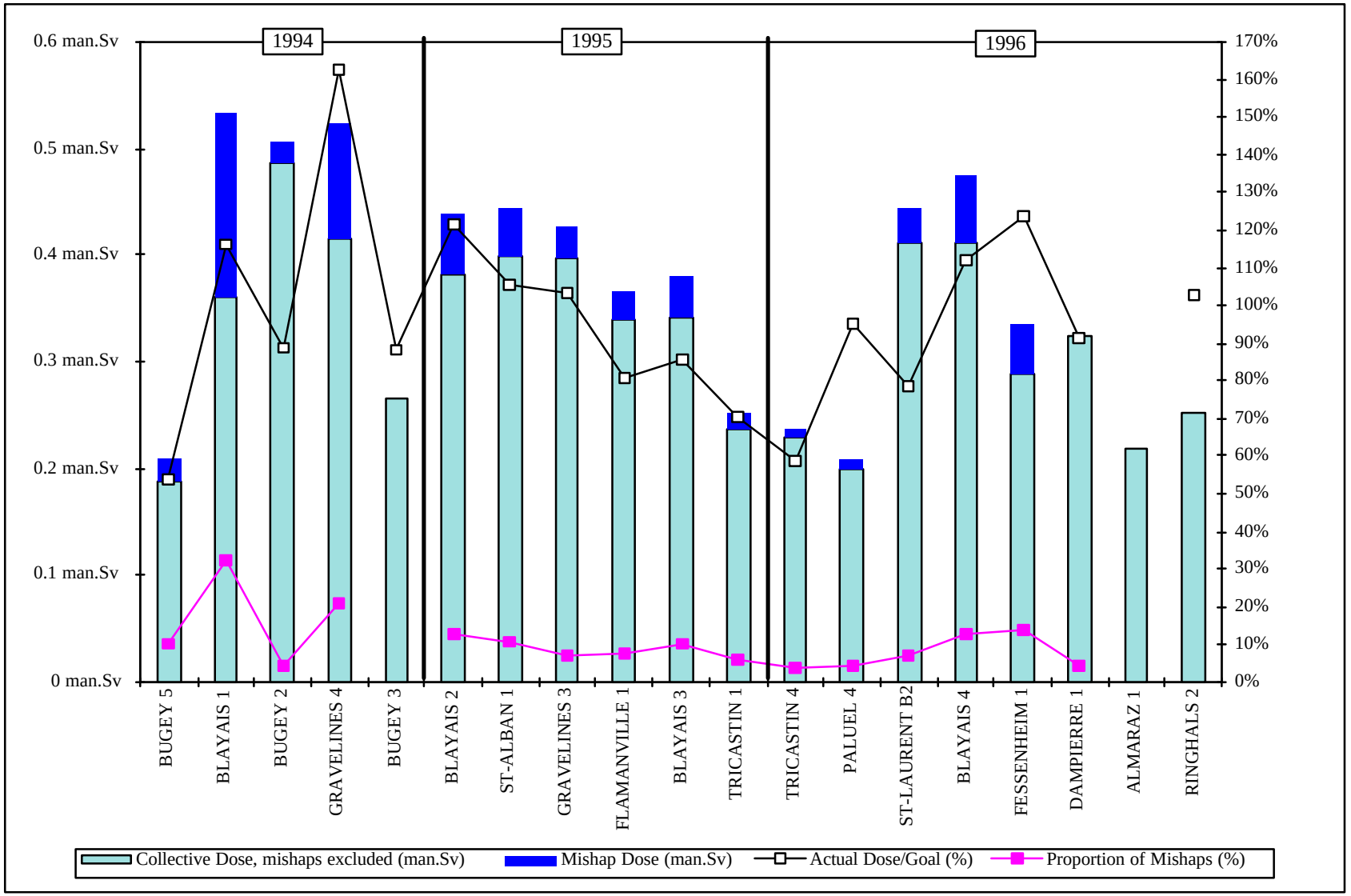

Figure 1. Chronological Evolution of Reactor Vessel Cover Head Replacement Collective Doses (1994-1996)

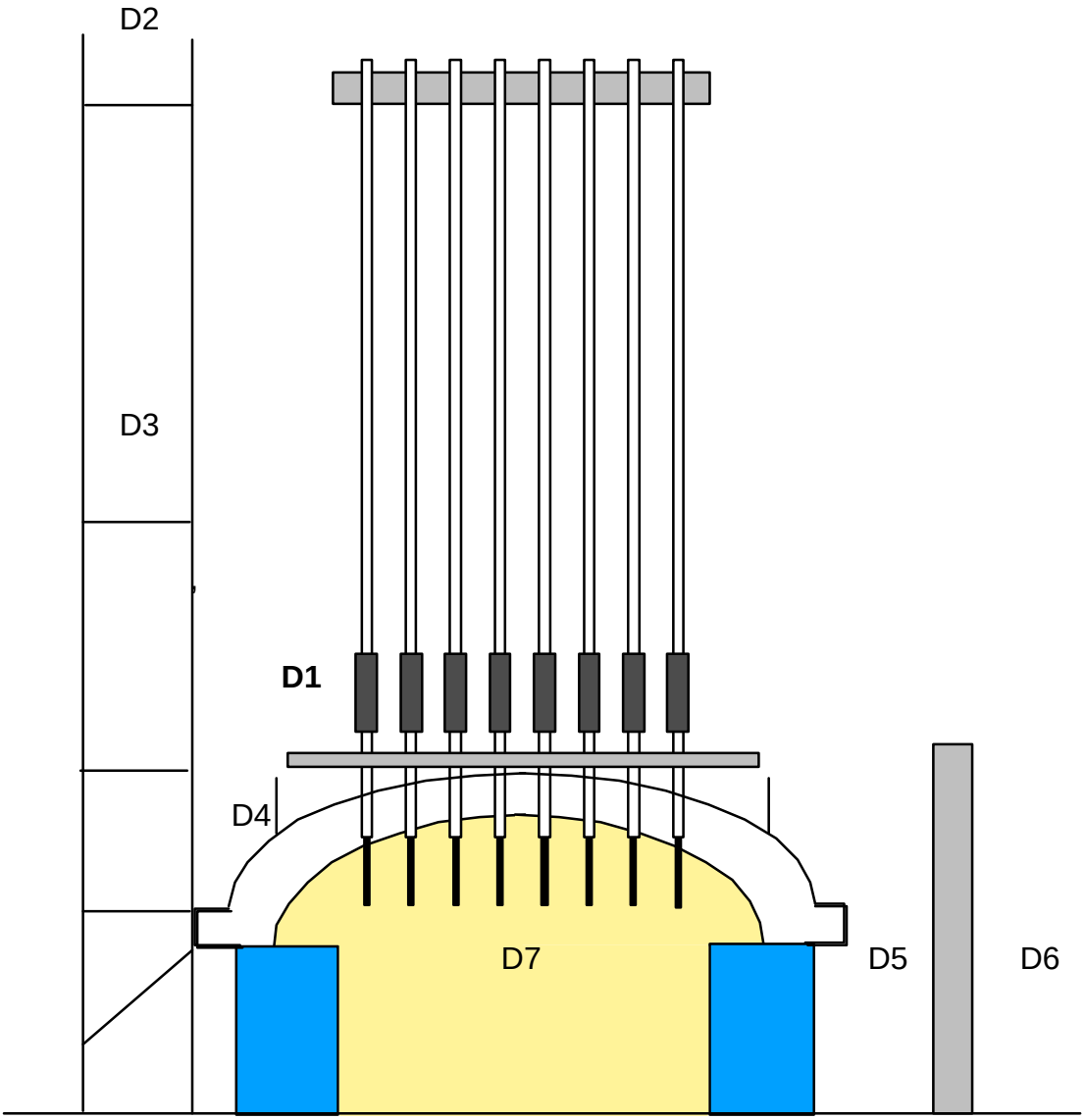

Figure 2. Dose rate mapping

Table 2. Range values of dose rates (mGy/h)

Dose Rate	Range values (mGy/h)	Description of the measurement point
D1	1 - 13*	latch housing / CRDM adapter (at 40 cm from the welding)
D2	0.02 - 0.10	cable bridge
D3	0.10 - 1	scaffolding (second level)
D4	0.30 - 2.50	RVCH lifting rig fasteners
D5	0.05 - 1	vessel mating surface (at 50 cm from the RVH)
D6	0 - 0.25	containment annulus
D7	20 - 70	under RVCH (middle point)

Measurements were taken RVCH on stand, insulation removed and all CRDMs still installed

* D1 = Main reference measurement used for the first dose assessment

As it is shown on Table 2, dose rates are very different from one plant to another and one has to be very careful to make comparison in terms of collective dose. Figure 3 compares for the eleven first replacements (1994-1995), the evolution[1] of what should have been the collective doses if all RVCH replacements had been performed under the same radiological conditions i.e. with the same dose rates around the RVCH.

This calculation allows to really appreciate the improvement of the work performed from one operation to the next ones (see in particular the progressive reduction of the normalized collective doses corresponding to RVCH replacements performed on the second generation of French 900 MWe PWRs).

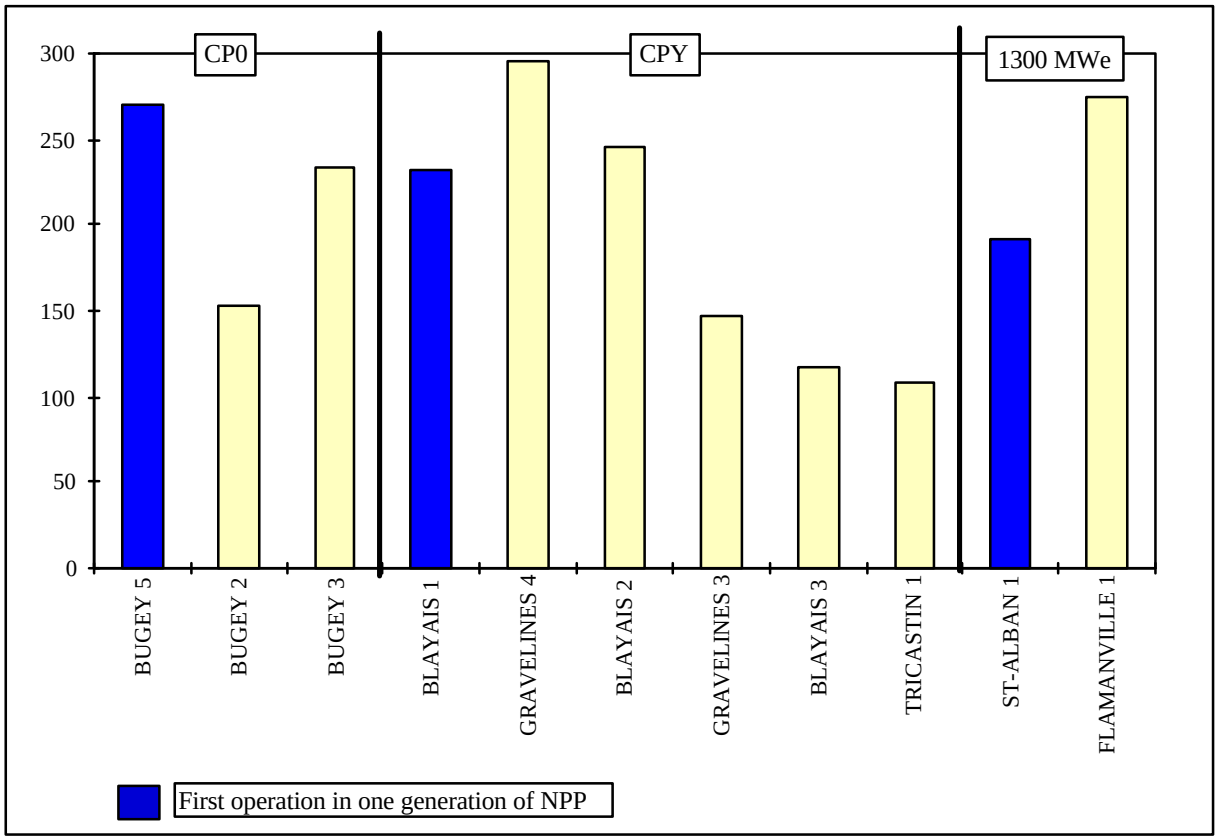

Figure 3. RVCH Replacements: Normalized Collective Doses (1994-1995)

1: One has to note that all the French RVCH replacements are performed by the same firms and the same staffs of workers.