OECD Nuclear Energy Agency
International Atomic Energy Agency

ISOE

European Technical Centre

General Distribution

December 1998

ISOE INFORMATION SHEET

OCCUPATIONAL EXPOSURE AND STEAM GENERATOR REPLACEMENTS UPDATE

ISOE European Technical Centre - CEPN Information Sheet No. 17

In May 1994, the ISOE European Regional Technical Centre issued one Information Sheet on occupational exposure and steam generator replacements (SGR). An update has been performed on the request from the ISOE Bureau and is presented in this Information Sheet.

44 Steam Generator Replacements, whose data are available, have been performed by the end of 1997 (instead of 17 in 1994).

1. SGR Collective Exposures

Table 1 presents the collective exposures corresponding to these 44 SGRs and Figure 1 shows the evolution of steam generator replacement collective doses since 1990. Since 1994, the SGR collective exposure is still decreasing, reaching less than 0.4 manSv per steam generator, several times during the last years.

Table 1. Steam Generator Replacements from 1979 to 1997

Country	Plant unit	Replacement year	No. of SG replaced	SGR Duration (days)	Total Collective Dose (manSv)	Collective Dose per SG (manSv)
USA	Surry 2	1979	3	303	21.41	7.14
USA	Surry 1	1980	3	209	17.59	5.86
USA	Turkey Point 3	1981	3	210	21.51	7.17
USA	Turkey Point 4	1982	3	183	13.05	4.35
Germany	Obrigheim	1983	2	74	6.90	3.45
USA	Point beach 1	1983	2	117	5.90	2.95
USA	H.B. Robinson 2	1984	3	180	12.06	4.02
USA	D.C. Cook 2	1988	4	202	5.61	1.40
USA	Indian Point 3	1989	4	105	5.41	1.35
Sweden	Ringhals 2	1989	3	72	2.90	0.97
France	Dampierre 1	1990	3	70	2.13	0.71
USA	Palisades	1990	2	121	4.87	2.44
USA	Millstone 2	1992	2	185	6.70	3.35
USA	North Anna 1	1993	3	51	2.40	0.80
Switzerland	Beznau 1	1993	2	44	1.10	0.55
Belgium	Doel 3	1993	3	44	1.96	0.65
France	Bugey 5	1993	3	70	1.55	0.52
France	Gravelines 1	1994	3	37	1.45	0.48
Japan	Takahama 2	1994	3	105	1.49	0.50
Japan	Mihama 2	1994	2	359	1.46	0.73
USA	V.C. Summer	1994	3	38	2.24	0.75
Japan	Ohi 1	1994-95	4		2.93	0.73
Japan	Mihama 1	1994-96	2	519	1.11	0.55
Sweden	Ringhals 3	1995	3	69	1.33	0.44
USA	North Anna 2	1995	3	55	1.42	0.47
France	Saint-Laurent B1	1995	3	34	0.91	0.30
France	Dampierre 3	1995	3	39	1.25	0.42
Spain	Asco 1	1995	3	60	2.44	0.81
Belgium	Tihange 1	1995	3	38	1.64	0.55
Spain	Asco 2	1996	3	53	1.68	0.56
USA	Ginna	1996	2		1.04	0.52
Belgium	Doel 4	1996	3	37	0.63	0.21
France	Gravelines 2	1996	3	33	1.38	0.46
Spain	Almaraz 1	1996	3	55	1.58	0.53
Japan	Takahama 1	1996	3		1.17	0.39
USA	Catawba 1	1996	4	74	1.68	0.42
USA	Salem 1	1996	4		2.30	0.58
Japan	Mihama 3	1996-97	3		1.27	0.42
Spain	Almaraz 2	1997	3	42	1.20	0.40
Japan	Ohi 2	1997	4		1.98	0.49
France	Tricastin 2	1997	3		0.85	0.28
USA	Point Beach 1	1997	2	75	1.87	0.94
USA	McGuire 1	1997	4	56	1.43	0.36
USA	McGuire 2	1997	4	59	1.11	0.28

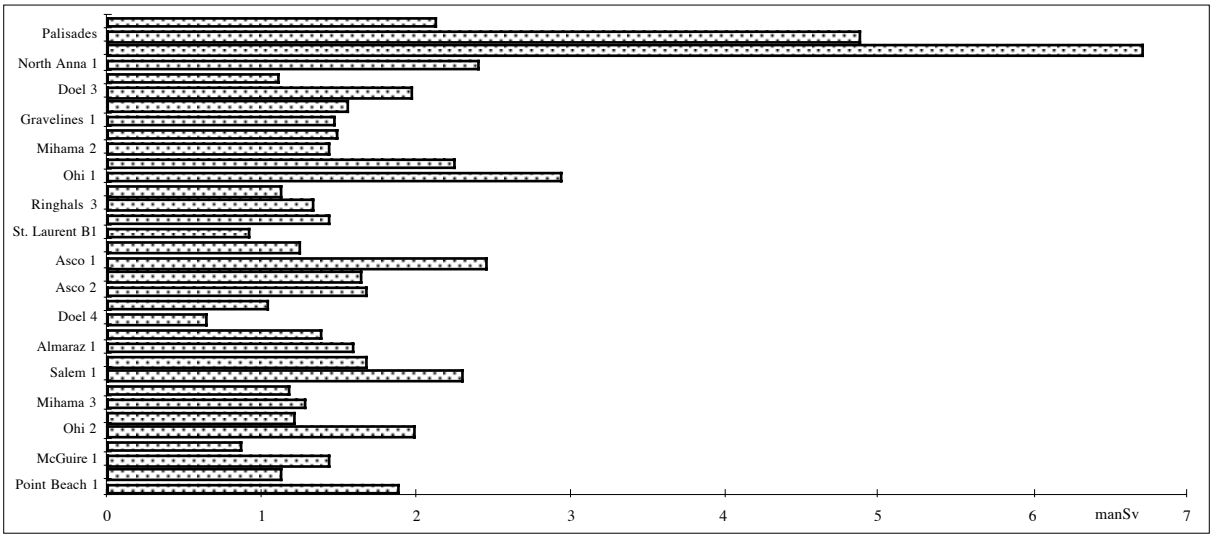

Figure 1. Evolution of steam generator replacement collective doses since 1990

2. Impact of SGR on Post SGR annual exposure

The method used is recalled here after.

METHOD FOR THE ANALYSIS

Recent steam generators replacements (performed in 1997) have not been taken into account in establishing Figures 2 and 3 presented in this ISOE Information Sheet, because annual collective doses concerning the post-SGR years are not available. Moreover, only the reactors for which the total annual collective exposure is given per reactor (not total exposure for the site) are kept for the analysis.

The analysis method is the following : in order to determinate if steam generator replacement has had an impact on the evolution of post-SGR annual collective exposure of a reactor, only the years with refueling outages have been considered. The reference period is composed of the last three refueling outage years before the steam generator's replacement. The average dose over these three years then represents the collective exposure received by the workers before the steam generator's replacement. For comparison with other reactors, this average collective exposure is normalised to 100. Collective exposures of the steam generator's replacement year and of the years, with refueling outages, following the SGR are also similarly normalised.

It should be noted that for some American reactors (Indian Point 3 and Palisades), only the two years before the SGR have been taken into account as the third year includes a refuelling outage of approximately one year, which is four times longer than the normal duration. Furthermore, the lower exposure level observed at Palisades during the SGR year can be partly explained by the fact that the SGR took place during two calendar years and by the fact that the considered year counted only 74% of the collective exposure due to the SGR.

Based on this method, twenty one reactors are used in the study, instead of six in the previous study. It is very impressive to see that the results observed five years ago have been totally confirmed:
- on average, collective dose during the steam generators' replacement year is 60% higher (70% in the previous study) than the average collective dose during the three prior years with refuelling outages.
- the collective dose following replacement falls to approximately 50% (as in the previous study) of the pre-replacement collective dose, or even slightly less during the 8 post SGR years with a refueling outage.

Figure 2 presents this average evolution assuming a normalised average collective dose, prior to SGR, of 100 and, Figure 3 the standard deviation associated to the average collective dose.

Of course, one may assumed that 8 to 10 years after the SGR, the outage exposure decrease is not only the "mechanical" result from the SGR. A lot of other factors may also have had an important impact such as ALARA Policies, chemistry modifications… Nevertheless, the correlation between that exposure decrease and performance of a SGR is quite obvious.

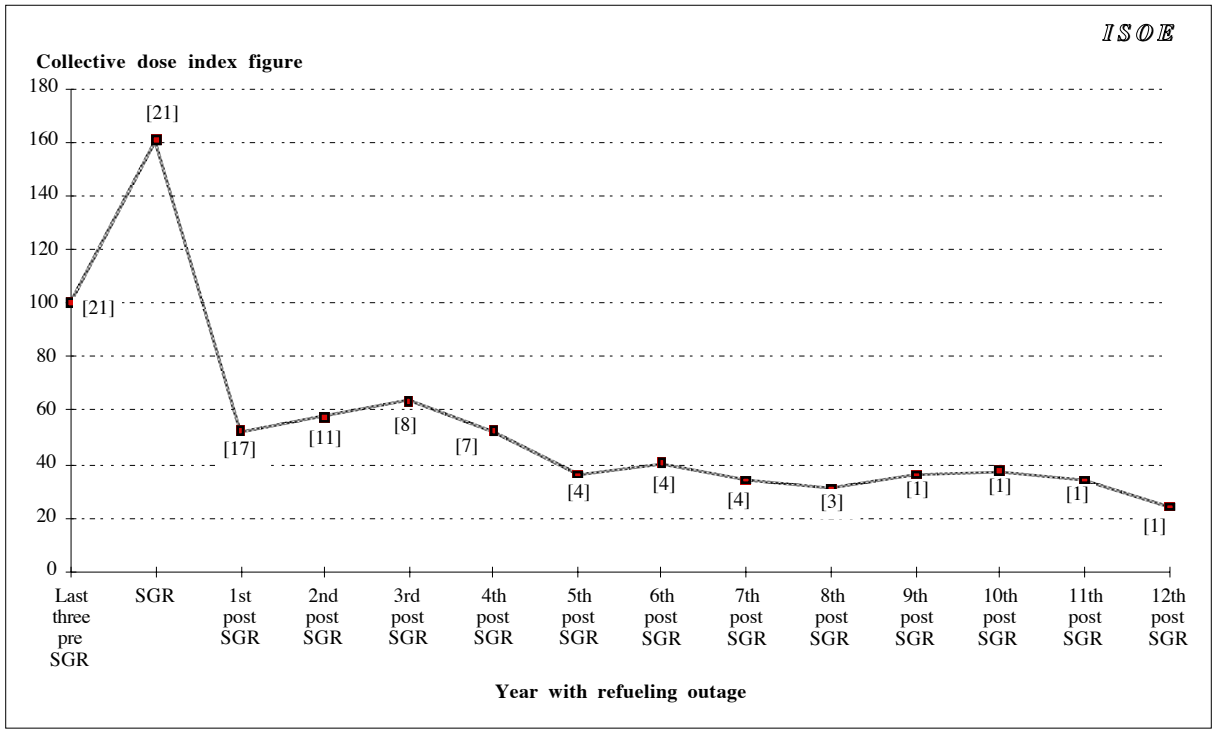

Figure 2. Average impact of a SGR on the evolution of the reactor annual collective dose [number of data considered for the average calculation]

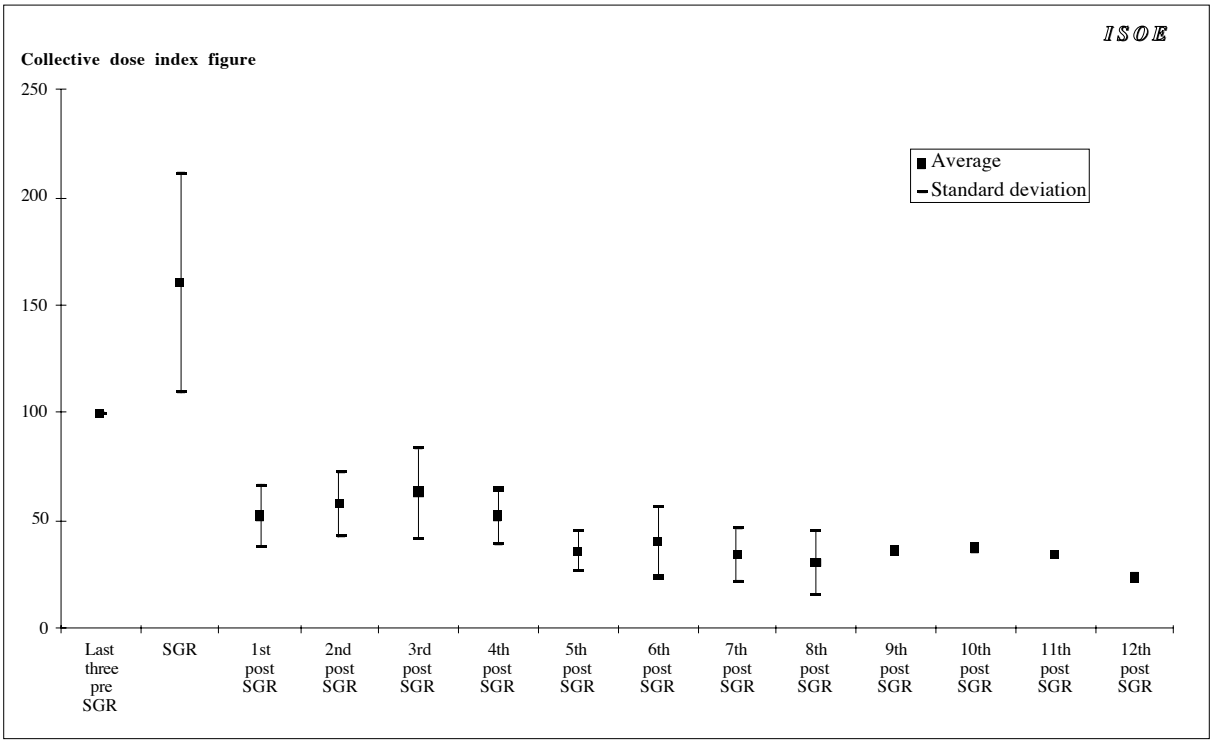

Figure 3. Impact of a SGR on the evolution of the reactor annual collective dose: standard deviation and average