

PASSIVE DOSIMETERS BENCHMARKING

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French regulations originally required film to be used as a passive dosimeter. This ruling was changed with the publication of the decision dated 23rd March, "stipulating the rules concerning external dosimetry for workers assigned to tasks involving exposure to radiation". This decision lays down certain obligations in terms of results, but does not impose any particular technology. Moreover, technological advances have made the future of silver film uncertain, for both photographic and dosimetry purposes. Consequently, in early 2001 the Management at the EDF Group's Nuclear Generation Division (DPN) decided to undertake a study, looking at the feasibility and potential benefits of adopting a new passive dosimeter technology.

1) Definitions:

TLD: thermoluminescent dosimeter

OSL: optically stimulated luminescence dosimeter

RPL: radiophotoluminescent dosimeter

2) Study plan and conclusion:

- 2001:
State of the art of the various technologies available and experience feedback from foreign nuclear operators.
- 1st half of 2002:
Comparative study of the behaviour of the different technologies of Film, TLD, OSL and RPL, carried out under laboratory conditions and also in real situations in 3 EDF nuclear plants over a 3-month period. These 4 technologies were selected on the basis that they are used in industry throughout the world.
- Early 2003:
Survey of international nuclear operators conducted via the ISOE network. The operators surveyed were asked about the technologies they use, any changes they were considering or had already implemented, the reasons for these changes and their appraisal of the technologies concerned.
- 1st half of 2003:
The DPN Management decided to replace film with OSL in 2 pilot nuclear plants for the period July 2004 to December 2005. If the results of the pilot are positive, film will be replaced with OSL in all plants in 2006.
- September 2003:
European call for tender published for the period July 2004 to December 2005.

3) Comparative trials:

Around 250 badges including Film, TLD, OSL and RPL worn by a specific group of personnel, selected according to exposure conditions.

High exposure:

- Maintaining the reactor building (cleaning, decontamination),
- Installing and removing nozzle dam inside steam generators water box,
- Valve mechanics, insulation technicians and welders working on primary and connected circuits.

Low exposure:

- Chemists,
- Business managers and foremen,
- RPS (radiation protection service) technician,
- Fuel disposal,
- Sorting radioactive waste.

Identical badges were tested in extreme conditions:

- Exposure to 20 mGy for 1 minute using a gamma radiography projector,
- Exposure to 4.4 mGy for 11 minutes by a filter in the process of installation,
- Exposure through an X-ray detector machine,
- Poor thermal conditions with temperatures reaching 70°C.

The results are consistent, and the deviations observed are in line with standards. The technical performances of the OSL and RPL dosimeters are quite similar, and often superior to those of film and TLD.

4) Results of comparative study:

Characteristics		Film (KODAK)	TLD (HARSHAW)	OSL	RPL
Technical Aspects	Dose dynamic	-	=	+	+
	Dose linearity	-	=	+	++
	Energy response	-	=	+	++
	Repetition	-	=	+	+
	Batch uniformity	-	+	+	++
	Influence quantity	-	=	+	++
Regulatory Aspect	Dose storage	++	-	++	=
Economic Aspects	Number of suppliers	+	++	-	-
	Market - Carriers	=	+	+	-
	Operating cost	+	-	+	-
SUMMARY		-	=	++ homogeneous	+

- Acceptable

= Medium

+ Good

++ Very good

EDF chose to adopt OSL, since it combines the various benefits of film, TLD and RPL:

- Good sensitivity, as with TLD and RPL
- Good linearity with the dose, as with TLD and RPL
- Good energy response, as with TLD and RPL
- Monthly dose re-reading possible, as with Film
- Low cost, as with Film

5) Summary of the ISOE international survey:

Country	Plant	Current dosimeter	Change planned Y/N	Planned technology	Reasons
USA	Susquehanna	TLD	Y	OSL	OSL allows "provisional" reading whenever desired
	Calvert Cliffs	TLD	Y	OSL	OSL has good accuracy levels and economic benefits
	San Onofre	TLD	N		Any change would involve switching to an electronic dosimeter
	Commanche Peak	TLD	N		No change, given the investment made in TLD
CANADA	Gentilly	TLD	N		
UNITED KINGDOM	Sizewell	Film	Y	Electronic dosimeter	Legally recognised as dosimeter
SWEDEN	Oskarshamn	TLD	N		Film has been definitively rejected due to its problems and poor detection limit
	Ringhals	TLD	N		
GERMANY	Brokdorf	Film	N		Any change would involve switching to an electronic dosimeter
	Neckarwestheim	RPL	N		
BELGIUM	Doel + Thiangé	Film and TLD	N		
CZECH REPUBLIC	Dukovany	Film	N		Any change would involve switching to an electronic dosimeter
BULGARIA	Kozloduy	TLD	N		
SOUTH AFRICA	Koeberg	TLD	Y	OSL	OSL is cheap. Excellent directional response. Re-reading possible. Very good neutron response compared with TLD. Independent laboratory.
BRAZIL	Angra	Film	Y	TLD	Accuracy and cost. TLD is already used, and a certification procedure is under way to have TLD confirmed as legally recognised dosimeter.
JAPAN	Fukushima + Kashiwasaki	TLD	N		TLD replaced film in 2000. Disadvantages of TLD: no re-reading, regular calibrations required.
	Tomari + Onagawa + Shika + Takahama + Shimane + Ikata + Gonkai	RPL	N		RPL replaced film in 2001.
	Hamaoka +Tokai +Tsuraga	Electronic dosimeter	N		Replaced film or TLD.

6) References:

- State of the art of various technologies: study conducted by Mr Javaraly Fazileabasse of EDF Research and Development - Process Performance Optimisation Department (R&D - OPP).
- Comparative study conducted by Mr Javaraly Fazileabasse of EDF R&D - OPP. TLDs were loaned and interpreted by COGEMA and OSLs by the company LANDAUER. The CEA provided the RPLs. Trials were organised in real situations by Mr Charles Pauron of the Risk Prevention Group, which is part of the EDF - DPN Operational Installations Support Centre, (CAPE-GPR). Mr Pauron worked in conjunction with the Risk Prevention Services at the Gravelines, Penly and Tricastin nuclear plants. The trial protocol was submitted for approval by the French Institute for Nuclear Safety and Radiation protection (IRSN). A copy of the report was also sent to the institute. EDF – R&D – OPP will be issuing a publication.
- Survey via the ISOE network conducted by Mr Philippe Colson and Mr Charles Pauron of EDF – DPN – CAPE – GPR .