OPERATIONAL EXPERIENCE WITH A LEGAL ELECTRONIC DOSIMETRY SYSTEM

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ABSTRACT

The Thermo (Siemens) Electronic Dosemeter EPD-1.2D is the Approved dosimetry system for British Energy (BE). It has been in use for a number of years firstly as a control dosemeter and latterly as a legal dosemeter. This paper reviews its performance from a corporate perspective and considers issues such as maintenance strategy, sharing of dosemeters across a number of sites and common user problems encountered across sites.

1.0 INTRODUCTION

British Energy (BE) and BNFL/Magnox are using the Thermo Electronic Personal Dosemeters (EPD) as the legal dosemeter in a number of their stations. Initially the EPD was used as a control dosemeter. BE decided to embark in the transition from legal passive dosimetry to the legal EPD in 1998.

Approval for use of the EPD (Mk1) as a legal dosemeter was obtained in 2000. The first UK station to use the EPD as the legal dosemeter was the Magnox Station Oldbury in 2000. The first BE station was the Dungeness B AGR in February 2001. Currently six out of the eight BE power stations use the EPD as the legal dosemeter.

At present BE's Approved Dosimetry Service operated by BNFL has applied to the Health and Safety Executive (HSE) for approval of the EPD Mk 2 for use as a legal dosemeter. BE’s Hinkley Point B will be the first client of that service.

The purpose of this paper is to review the operational experience with the EPD from a corporate perspective.

2.0 THE EPD SYSTEM

The EPD systems implemented in the BE stations are based on the EPD hardware and software developed by the then Siemens Environmental Systems Ltd, currently part of the Thermo Electron Corporation (Thermo). The main components of the system and their purpose are:

- EPD: this is the dose measuring device (dosemeter) and is worn by the workers;
- EPD System: This is a computer based network consisting of the Server, the Access Control Terminals (ACT), and the user workstations,
- Software ‘Dose Control System’ (DCS).

The EPD system also interfaces with the Approved Dosimetry Service (ADS) and the station security system for access into the Radiological Controlled Area (RCA).

3.0 TRANSITION FROM PASSIVE TO ELECTRONIC DOSIMETRY

At the beginning of the process the stations used the film badge as the legal dosemeter and various electronic dosemeters as control dosemeters. These electronic dosemeters were in general issued and read manually.

The move to using the EPD, with its required hardware and software infrastructure, was a significant change to the workers customs and practices in place at the time. It also required a significant increase in the support to the dosimetry systems from the station Information

Technology (IT) departments. The increase in the complexity of the dosimetry system, which was to become effectively a computer system, also raised concerns with regards to its management and integrity.

A working group with representatives from all the company stations was set up to co-ordinate the transition phase. It was agreed that each station would proceed at its own pace to ensure that the system gained acceptance by the station workers and by the other departments. The working group would also agree standard approaches to be implemented at all stations as far as practicable.
The transition to the Thermo EPD as the legal dosemeter took place in three phased steps:

1) introduce the EPD as a control dosemeter on restricted issue; i.e. issued as required by the work permit.
2) use the EPD as a control dosemeter on general issue; i.e. issued to all that enter the RCA.
3) use the EPD as the legal dosemeter.

To assist each station through this transition, a standard Quality Plan was developed covering issues like:

- Procurement, installation, interfacing and testing of the EPD system
- Development of EPD system documentation: work instructions, procedures, disaster recovery plans
- Training of EPD users and dosimetry office staff
- Liaison with local Health & Safety committees & regulators
- System audits by the ADS and HSE

The transition phase progressed without any major problems. The main difficulties encountered were:

- gaining confidence with the EPD dosemeter due to its teething problems in particular battery problems and the ongoing RFI interference with the Mk1

- ensuring that the workers look after the EPD; initially there were too many EPDs damaged by being knocked off surfaces or dropped from pockets/belts.

- obtaining the necessary computing support from within the limited station resources; for example not all stations have Oracle expertise.

4.0 ORGANISATIONAL ARRANGEMENTS

The EPD system is a dosimetry system and as such comes under the control of the station Health Physics department. The driving force of the system at each station is the Dosimetry Officer and the day to day operator of the system is the dosimetry administrator.

4.1 Hardware Management

The hardware management covers the dosemeters and the EPD/computing hardware (ACT, servers, etc.).

<u>Dosemeters</u>

Each station is equipped with sufficient EPDs to support the day to day normal operation requirements. The stations operate a pool of additional EPDs to supplement their requirement during outages when there is a need for more EPDs.

The logistics of the EPD management to ensure that there is the right number of EPDs at each station whilst keeping the total number of EPDs low is very challenging. This has to consider not only the EPDs that are available for use, but the potential number of EPDs not available either because they are out for repair or have been sent for calibration. The distribution of EPDs in summer of 2002 with 2 outages taking place was:

EPD Mk1 Distribution in Summer 2002				
Station	**In Use**	**Emergency Packs**	**Off Site**	**Pool**
SXB	132	40		150
DNB	435 (outage)			
HYA	150	70	24	90
HYB	150	67		
HNB	300		13	
HRA	400 (outage)	50	41	
Total	**1567**	**227**	**78**	**240**

The total number of EPDs to support the six stations (5 AGR and 1 PWR) is about 2100.

The typical numbers of EPDs used at the stations are:

- Normal operation: 150
- Outages: AGR: 350-400 PWR: 450
- In Emergency Packs: 50-80

The EPD Mk 1 batteries cost about £15-£16 each. In order to limit the costs a lead station buys batteries in bulk at better rates and each station replenishes their stock from the lead station as and when required.

The ability to do basic EPD repairs varies from station to station. Typical repairs that a station may carry out are replacement of batteries, buttons and clips. Recently replacement of seals/RFI gaskets has been carried out at Heysham to improve the RFI performance of the EPD.

EPD Related Hardware

Each station has its own compliment of EPD hardware. At present there is no central holding of spares although it is being considered as part of the future deployment of the Mk 2. Each station has sufficient ACTs, desktop readers and Access Control Units (interface with security system) so that unavailability of one or two individual units is operationally acceptable. Typical numbers of equipment are:

- Access Control Terminals (ACT): 8-12
- Desktop Readers: 2
- Access Control Units (ACU): 4-6

The main critical component of the EPD system is the server, which operates the whole system. The initial approach considered was to have two spare servers at a central location that can be dispatched to where they are needed. Due to the different arrangements and types of servers at each station, in the end it was decided to have a spare server at each station.

As part of the approval for the EPD system there is a need to have detailed disaster recovery plans for the system. These cover the arrangements from a malfunction of a single issued EPD, to failure of the system server or network.

One of the major issues that was addressed is the possibility of server failure. Such a failure can result in the loss of the database. Therefore there is a data back up procedure in place that ensures the loss of data is minimised. Another important aspect of the system is the ability of the ACT to operate in a standalone mode for up to 48 hours. The ACT set up is such that, if the server is lost or communication fail, the ACTs continue to operate in local mode issuing and returning EPDs. This enables the work to continue whilst the system is being restored. Following restoration of the system, the data stored on the ACTs is uploaded to the server. There have been three instances of server failure and in all three the EPD system operated successfully.

4.2 System Support Arrangements

Until recently all support to the system was provided through a hardware maintenance and software support contract with the EPD supplier (Thermo). Recently (2004), first line IT system support is provided from the Company's IT department (see later).

Failed hardware is sent to Thermo for repairs and is then returned to the station. For software issues, Thermo operates a Helpdesk for reporting software problems and queries. Response to the calls depends on the severity of the problem.

These arrangements have been successful over the years and the service provided has been very good. In particular, the Thermo response in the few real station EPD emergencies was excellent.

EPD dosemeters are calibrated annually by a Calibration Laboratory with accreditation to ISO 17025.

5.0 OPERATIONAL EXPERIENCE

The introduction of the electronic dosemeter in such a large scale resulted in a number of issues being raised covering the end user, the dosemeter and the whole system.

5.1 End User Experience

The end user issues relate to the use of the EPD by the workers and health physics staff. They relate to the practices that are used in each station. Some of these became issues because of itinerant workers experiencing different practices at different stations. Typical issues are:

- Training: a generic training package was developed for use that had sections to incorporate local station practices. This resulted in itinerant workers receiving the training many times and having to adhere to the local way of using the EPD. Over the period we have continued the progress towards standardization to reduce these station differences.

- Method of wearing the EPD in relation to different types of overalls or personal protective equipment; this was important in order to reduce damage to the dosemeters. A 'pouch' was introduced to stop EPD dropping off from pockets.

- Changes in dosimetry work: Dosimetry work changed from being a 'hands on' job managing film badges to managing a software system. This required a change in the knowledge and expertise of the dosimetry staff. There was a certain degree of reluctance and trepidation towards the change. Networking between the station dosimetry staff helped the exchange of information and helped with any problems arising.

- User Confidence: The EPD Mk 1 had a number of 'teething' problems, mainly battery and Radio Frequency Interferance (RFI) problems. The EPD Mk1 is still susceptible to RFI. These have delayed acceptance of the EPD by the users.

Overall, there have been no significant issues associated with the end user except of those arisings whenever a change is implemented. The gradual transition process and the parallel use of EPD and film badge helped in the acceptance of the EPD by the end users. The acceptance of the EPD was likened to the introduction of wearing seatbelts in a car, it has now been accepted as the 'norm'.

5.2 EPD Dosemeter Experience

A number of different problems arose with the EPD dosemeter over the years. Some of them can be attributed to the user such as mishandling (vandalised, dropped, knocked) or not following instructions during issue / return of EPDs. Other faults are typical faults expected from such equipment like sounder,?? display and counter failures.

Numerous failures of EPDs resulting in loss of visit dose data have occurred due to the mishandling of the EPD, battery failure, RFI etc. In such an event, a dose assessment is carried out by the Health Physicist, and a record is entered in the database. This has resulted in additional Health Physics effort and resource being required to support the system.

Overall, there were three significant EPD Mk1 problems. These were:

- battery problems: early battery failures or battery/EPD circuit board connection failures; this has been addressed by improving the connections and the battery supply chain.

- RF interference (RFI): this is a persistent problem inherent in the Mk1; experience with the EPD Mk 2 at Hinkley Point B has shown that in 400,000 individual visits since August 2000 there has been only one spurious dose assessment (due to proximity to a welding set);

- Beta window failure: this failure is due to degradation of the seal between the EPD case and the beta window resulting in in-leakage of light which results in a false reading of high beta dose. Although the root cause of the problem has not been eliminated, the cause and effects are now known and they can at least be managed.

The RFI interference is generic to the Mk1 EPD design and is being managed procedurally at the stations. It still provides a significant workload to the Health Physicists in terms of dose investigations. The introduction of the EPD Mk2 will eliminate this problem.

Two generic problems were experienced with the EPD Mk2:

- Cracking of the lids: a manufacturing defect caused the EPD lids to crack at the corners; the manufacturing process was corrected and all the lids were replaced by the supplier;

- Flexi connector (power supply circuit board connection) failure: Environmental factors (temperature variations) could cause failure of the flexi connector and hence loss of circuit board power supply. The power supply connections were re-engineered and all the EPDs were repaired by the supplier.

5.3 EPD System (Hardware & Software) Experience

Although a number of hardware failures and software problems occurred, overall the EPD system has been remarkably robust both in terms of hardware and software. There are two issues worth highlighting.

<u>Resource Required for Computing Support</u>

At the beginning of the project there was a failure in ensuring computing support to the station Health Physics from the Company's central IT departments. The reasons for that were many and

varied. The consequence was that stations did not have sufficient expertise to support the EPD project. In addition the station computing infrastructure was different from station to station and this lead to the EPD system being implemented in different types of networks such as stand alone networks, virtual networks, and networks integrated with other station networks. This lead to a number of different problems experienced at different stations, such as network communication problems, data back up differences, and in user support.

In the case of Hinkley Point B, the installation of the EPD system was driven by a project team which included IT specialists from the central IT department. The system as installed has been exceptionally stable. It has also incorporated a 'Citrix' interface for providing access for numerous users without the need to install the necessary software on the user's own PC.

Over the last 18 months these problems have been overcome by putting in place a project to provide central computing support to all the stations. This includes standardising servers, data back-up arrangements, network configuration, Windows and Oracle support, security and others.

EPD Issue/Return Faults Affecting User's Perception

There have been a handful of occasions where due to errors in the EPD issue or return process the visit data was not properly recorded and the EPD remained issued to the user without the user realising. These resulted in visit data being lost and problems with subsequent user attempts to self-issue another EPD.

In terms of dosimetry, the impact of these faults was small requiring a dose assessment to be made for the specific worker visit. Compared with the loss or damage of a film badge the loss of data of a single EPD visit is insignificant.

However, these few events resulted in widespread concern about the integrity of the system as rumors spread between the stations. The concerns and rumors died out slowly with the good performance of the system.

6.0 SYSTEM HARDWARE AND SOFTWARE DEVELOPMENT

The EPD Mk1 was developed in the early 1990s. Sizewell B deployed the Mk1 as a control dosemeter from the beginning of its operation in 1994/5. The original system software, DCS, was developed to support the EPD application at Sizewell B.

6.1 Hardware Development

The EPD Mk1 hardware has remained virtually unchanged since its development. Thermo will be discontinuing the Mk1 support in 2004 due to obsolescence of components forcing them to withdraw the maintenance support of the system. However, the EPD Mk2 has been developed to replace the Mk1. The Mk2 incorporates significant improvements. From an end user's point of view the most significant are:

- It overcomes the RFI problem
- It is smaller, lighter and more robust
- It uses commercially available batteries (Mk1 requires specialist bespoke battery)
- It can provide more detailed dosimetric information for the investigation and assessment of doses. This requires a suitable upgrade of the dose control software.

The Mk1 to Mk 2 transition process has financial and logistical implications. The current plan is to phase in the Mk2 over a 3-4 year period in order to spread the cost and maximise the use of the Mk1.

One of the future developments that are being considered with the introduction of the Mk 2 is the move to a single server / database for all the stations. The advantages of this system are:
- the information for each worker needs to be entered once and it is then available to all stations
- the up-to-date total worker dose is available in real time especially for itinerant workers
- training and other compliance issues become easier to manage

The disadvantages of such a system are:
- the robustness and speed of the computing network to support such a system without undue delays especially at the EPD issue / return point
- constraints on the EPD and DCS3 software to support the way the EPD and other data is used.

6.2 Software Development

Software developments have been required for a variety of reasons. There have been user driven developments and there have been imposed developments.

As the users became more familiar with the system and the system capabilities became obvious to the users, there has been a demand for improvements in the user-system interface and for additional services. The user developments took the software through the following main versions:

- DCS2; 1998/9: add necessary functionality for legal system and to incorporate other dosimetry systems for millennium compliance (e.g. replace the film badge management software)
- DCS2-SP1; 1999/2000: interface with the ADS measurement; fix minor bugs; additional user services. this was the first software version to be used for the legal EPD at Dungeness.
- DCS3; 2000/02: additional user services

The latest software version is DCS3 V2.3 and is about to be deployed to the BE stations. In parallel with the BE/Magnox support, Thermo is developing DCS4 for another UK user. BE and Magnox have been kept involved in this development with the aim of making DCS4 the standard software used in the UK

The biggest driver for software development, however, are the operating software suppliers (Windows and Oracle). Decisions on whether to upgrade the operating software or to continue using previous versions are difficult. Based on our experience with the EPD software and its robustness we continue using the Windows NT and Oracle Version 7 software. However, this is becoming untenable and a BE corporate decision has been taken to move to Windows XP and Oracle 9i over the next three years.

There is a need to upgrade the software at the same time as changing from the Mk1 to the Mk2. BE is currently considering how best to achieve these targets.

7.0 CONCLUSIONS

The introduction of electronic dosemeters for legal use within BE has been successful. The Thermo EPD Mk1 is now used routinely and has gained a high level of acceptance by the workforce. The main issues that require attention with electronic dosimetry are:

- the reliability and ruggedness of the dosemeter,
- the arrangements for the computing support of the system, and
- obsolescence and updates of components and software