Official Dosimetry with Personal Electronic Dosemeters in Germany - Design and field-trial validation of a prototype meeting the requirements given

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Abstract:

EPD systems used for operational measurement are going to be applied for measuring the official personal dose. Now, an overall concept to guarantee nationwide harmonised procedures based on legal regulations was developed. The implementation of the concept will be tested with pilot studies in technical and medical enviroments to find appropriate methods and procedures with state-of-the-art techniques. The methodology of the tests, characteristic and common features as well with the specific technical solutions of the data management system have been introduced. After successful validation of the concept and its approval by state authorities the official use of EPD in Germany will be possible.

1 INTRODUCTION

Regulations in the Radiation protection ordinance (StrlSchV, [1]) and the X-ray ordinance (RöV, [2]) respectively, govern the estimation of effectice dose of radiation workers in Germany in the case of external exposure by measuring the personal dose with so-called official personal dosemeters. These dosemeters are subject to approval by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, BMU),the authorities of the States ("Länder"), and additionally - in case of application in photon radiation fields - to type approval by the Physikalisch-Technische Bundesanstalt, PTB. Only Monitoring services approved by legal authorities are allowed to deal with official personal dosemeters. Passive personal dosemeters like film, glass and TL dosemeters have been used succesfully to continuously supervise more than 300,000 persons for many decades. In combination with dedicated quality assurance arrangements these practices guarantee the high quality of the German personal dose measuring system.

Electronic personal dosemeters (EPD[1]) are used in several companies for workplace monitoring for operational dosimetry together with the official measurement based on passive dosemeters. Companies interest is to use their EPD as official personal dosimeters. The key difference compared to the current practice is the dose measurement and determination external of any monitoring service. Beside the legal requirements for official personal dosimetry in Germany [3-5] the analysis of official personal dosemeters external to the official monitoring services [4] demand the use of additional dosemeters with a potential longer monitoring period.

Since 2001 locally limited studies assessing the permanent use of EPD have been carried out successfully at isolated medicine facilities and nuclear power plants together with data transmissions to a monitoring service [6]. In 2004 a group consisting of interested partners from monitoring services, university based software developers and manufacturers have been started the development of technical components for networked-based data communication concerning EPD.

[1] The abbreviation EPD for electronic personal dosemeters is used irrespective of any special type of dosemeter and is not identical with dosemeters of Thermo Electron Corporation (former Siemens).

Besides the development of technical solutions in 2004 the German monitoring services published a concept paper by expressing their harmonized opinion towards a potential realization of official measurements using EPDs and eith the intention to widen their service to incorporate AEPD. Furthermore, since 1998 the introduction of EPD to official use was discussed in several professional panels like working groups of the German Fachverband für Strahlenschutz (FS) and Governmental bodies of federal and state authorities as well.

During an expert talk organised by the BMU in 2003 all these activities have been summarised and assessed by all interested parties from user side, monitoring services and legal authorities. As a major result nationwide and standard regulations have been recommended. This initiated a federal research project to introduce EPD as official dosemeter as an additional offer by monitoring services and an alternative to passive dosemeters. Conducting this research project in two parts, the first part resulted in a basic design concept for official personal dosimetry with EPD developed by the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (GRS concept, [7]), which shall fulfil the legal requirements to estimate the effective dose according to the relevant regulations for radiation protection in Germany (RöV, StrlSchV). The results will be presented in an associated workshop paper presented by Mr. Dr. Pfeffer.

In part two of the federal research project the implementation of an appropriate and generic system using EPD as official dosemeters will done and validated with reagrd to the requirements of the GRS concept. Therefore eight pilot studies will be carried out, which are representative for different scenarios and working fields in technical and medical environments. The contractors of the federal research project represent the three monitoring services[2], the SynOdys Group RADOS Hamburg as manufacturer, and the University of Applied Sciences Stralsund as software developer and the GRS as author of the concept for quality assurance. Started in autumn last year the work at the second part of the federal project is still in progress.

In the following, this paper describes the general approach of the project and gives an overview for the pilot studies with detailed characteristics and common features. Technical solutions of the data management system with state-of-the-art techniques allowing access to the dose readings at the workplace by the official monitoring services using a secured, encrypted channel via a communication network are presented. The design will take the different, vendor-specific EPD data representations and interfaces into account.

2 METHODS

The implementation and validation of the generic system to use EPD for official measurements will cover the full chain from the development of technical solutions to the field trial evaluation in accordance with the GRS concept. It will include the dose acquisition at the users' site, the data transfer according to legal regulations and the evaluation at the official monitoring services site.

- Measurement of the personal dose with an EPD system[3] including the assignment of a unique personal identification, e.g. a user-based Personal-ID and other relevant information related to the measurement.

- The non-reactive take-over of this data at this interface into the "area of responsibility" of the monitoring service without any interaction with an existing user-based dosimetry system if applicable.

- The secure and authenticated transmission of the relevant data to the monitoring service site using an official intermediate storage and including a vendor-specific data interpretation and logging at the customer site.

- The determination of the official dose for each person under surveillance by verification and summing up of individual doses as identified by the personal ID. Referencing the personal ID to a particular person is achieved by separately transmitted assignments person ID – person master data (like full personal,

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[3] An EPD system means an interety of (multiple) EPD and (multiple if applicable) Readers.

operational, institutional data, responsible supervising authority) and allows to determine the dose acquired so far.

- The resolution of potential conflicting cases transmitted erroneous data or presumable false personal doses identified by the verification process in co-operation with the radiation protection officer and with additionally data at user site

- The quality assurance of the whole EPD system at user site regarding (i) checking, registration and control of each EPD and reader and (ii) implementation of the obligatory calibration by the monitoring service itself and in some cases by the user with an approved quality assurance system in place.

- The information about the official final personal dose to the customer, i.e. the EPD user, the Radiation Protection Register and the competent supervisory authority if necessary.

The project's works are carried out nationwide with the help of representative pilot studies. To evaluate the GRS concept using available and new technical solutions two scenarios will be investiagted:

- In-situ studies will proceed with several dosimeter types in different fields of radiation use such as nuclear power plants, medicine, research and industry. Existing and new dosimetry systems will be investigated at different facilities with several dosimeter types, both with pool and personal assignments. These studies will involve a large number of EPDs.

- Tests for interoperability with do cross-over operation of different monitoring services and dosemeter types will prove the universal ability of application e.g. for service personnel of other companies.

In-situ studies are focused at three application areas. The medical use of ionising radiation will be analyzed in radiological and radiation therapy departments. Another main focus are nuclear power plants, which are different compared to the medical sectors, namely through well-defined entry and exit gates to the controlled areas together with well-regulated access control. Institutions using ionising radiation in industry and research for e.g. radiographic investigations and accelerator establishments complete the group of participants.

Furthermore the in-situ studies are classified regarding their constraints. Some institutions already use EPD systems for workplace monitoring. One part of this group uses well-established data bases, others use only the readout without any data acquisition, logging and analysis. Other participants need either a new implementation or a full reconstruction of an existing EPD system. That means, that results from both scenarios and comparisons relating e.g. to the acceptance for internal purposes in different phases of the implemantation of a official EPD system will be achieved.

For the in-situ studies a larger number of supervised persons and EPD equipments will be included. Issuing an EPD to a person follows either a permanent assignment or a pool-based approach, which allows a lower number of EPDs for a large number of persons under supervision.

Tests for interoperability are more limited in numbers both in supervised persons and EPD equipments. They will be carried out in existing or widely built-on systems to assure the generic nature of results from the project. That refers to integration and the parallel use of multiple manufacturer systems, secure data transfer and required non-interaction between operational and official data streams. Additionally, more than one monitoring service will be connected to the same supervised institution to map the handling of contracted personnel at different sites. Tests for interoperability should result in experiences relating to specific on-site situations, e.g. local, regional or nationwide allocated locations of one company to be supervised like bigger hospitals or satellite stations of power utilities.

Besides investigating EPD data handling the project requires the parallel use of official passive personal dosemeters to compare the single dose results of each person included for the same time interval to be supervised.

3 PILOT STUDIES

3.1 Overview and Characteristics

The results from the pilot projects allow generalisations to using official EPD because of their representative choice with different scenarios. The results obtained will be used for future application of official EPD. The choice of participated facilities covers typical application areas of ionizing radiation with generally numerous supervised persons.

Figure 1 shows the overview of the pilot studies: two nuclear power plants with altogether three reactor blocks, three large hospitals, two research institutions and one industrial enterprise taking part. All the participants are legally supervised by one of the monitoring services taking part in the project.

Scenarios and premises / Fields of investigations	In-situ studies - practical trial -			Tests for Inter-opera-bility	Scenario / Fields of investigations
	EPD system: available	*EPD system: new installing*			
Medicine	Klinikum Augsburg	Klinikum Rostock	*and*	Klinikum Großhadern	different manufacturer
Nuclear power plants	NPP Isar 1 and 2	NPP Grohnde		n/a	multiple participants and services
Industry and Research	Daimler Crysler	RWTH Aachen		Res.Center Rossendorf	specific requests

Figure 1 Overview of the pilot studies and functional scheme

The EPD systems taking part in these studies are representative for the mostly used modern equipment: DIS-1 from RADOS and DMC 2000 S and X respectively from MGP, both represented by the SynOdys Group as well as Mk2 from THERMO Corporation. The present EPD reader generations contain proprietary reader software functionality with a serial output (RADOS DBR-1 and DBR-2 respectively, THERMO ACT-5, MGP LDM 101/210/2000) or an optional a LAN adapter (DBR-1 and DBR-2 respectively). In this case the data extraction can be made by hardware modules conventionally. A short time ago entirely new EPD readers have been installed at workplaces taking part, which are PC-based with specific software application being executed to implement the reader functionality. For these PC-based systems the secure and reactionless data extraction for institutional and official will use certified software modules (see chapter 4).

Independent of a fixed or pool-based assignment of an EPD to a person each dose record should contain the unique person ID to allow later attribution of the dose to a particular person. This personal ID must have been transferred to the monitoring service together with the commonly used personal master data on a separate communication channel independent from the dose data stream. The assignment of person ID to a particular person has to be available at the monitoring service site at the time of receiving dose data from an EPD. From the description provided it is obvious, that the assignment procedure does not hinder official dosimetry using EPDs, however there is the requirement to keep track of each association of a person ID to a (temporarily) use of an EPD at the custormes site.

Institutions clearly differ in the way they provide access to the controlled areas. NPP and partly research institutions, e.g. in case of a accelerator facilities of the Research Center Rossendorf, have enclosed controlled areas, where the entry and exit is not possible without an obligatory read-out of a personally assigned EPD. In this case always a pair of data records of the type "in/out" will be registered with at least one time-stamp. Otherwise, medical and typical research areas with radiation sources allow admission without dedicated entry and exit gates and person-related control. Additionally, multiple sites at different location may be entered by the same staff. From the dose reading will care a time stamp but does not indicate whether the dose was obtained by entering or leaving a site.

The majority of the participating institutions already operates an operational personal dosimetry system and data base as well. Any kind of official dosimetry has to cooperate with this system without any influence to sensible operational procedures, e.g. access-related dosimetry in NNP. Here safety guidelines of the local data network take priority over the official data stream management especially in NPP.

In three other participating institutions an EPD system is not yet available, under construction or implementing new types of dosemeters. In two cases with no restricted access to the controlled areas optimized data and logistic structures for both operational and official data management have to be established. In the case of enclosed controlled area in a NPP experiences with the conversion to a new EPD system compared to an established operational dosimetry system can be obtained.

Official dosimetry for personnel hired from an outside company for work in a controlled area of an institution is a long-lasting problem, because this people need to mostly wear personal dosemeters from at least two sources, the outside company and the institution, for the same supervising period. Contracted personnel from outside companies wear both passive and electronic dosemeters as well; one of them has to be used for official measurements. Today (only) one passive dosemeter may be the official one; therefore confusions take place at any time everywhere. With the future use of official EPD expectations raise to solve this problem in general. However, the differentiation between own, contracted personnel and e.g. visitors can only be achieved using the person's master data and should not be an information passed with the EPD dose data. An indication for the different groups could be obtained from number circle used for the person ID.

A real advantage using official EPD for contracted personnel could be the real-time networking of different monitoring services to merge single dose records of one person wearing several EPDs at different locations during the same monitoring period. This requires a well-defined identification in the particular personal master data of each use case with a unique marking as official or additional use and last but not least an accurate time-stamp of the particular EPD leading to an exclusive use of EPD for official purposes independent of wearing a passive dosemeter in addition.

3.2 Common features

Besides the characteristics described in the previous paragraphs which cover nearly all potential scenarios a number of common features have to be taken into account. These features relate to all kinds of scenarios but may be solved differently.

The official use of EPD requires a hands-on check by visual inspection for both the EPDs and readers by the monitoring service at the institutional site at initial usage and repeatedly. The inspection is documented e.g. by labelling the equipment. In institutions with a certified quality management system (QMS) and numerous EPD the periodical check by the monitoring service could be limited to random samples with a complete inspection under the control by the user and an adequate documentation.

Basically the monitoring service is responsible to realise the obligatory calibration purposes for official EPD. The required official gauging and control measurements respectively are even carried out or organised by the monitoring service. Experiences from Switzerland confirm the practicability of such practice [8]. In institutions with a certified QMS an analogous method like in case of visual inspection is possible.

When wearing an official EPD the decision to use an additional passive dosimeters issued by the monitoring service is in the responsibility of the competent supervisory authority. During a transition period from using passive dosemeter to EPD it is recommended to allow for an additional use of passive dosimeters, potentially combined with a longer supervising period.

4 TECHNICAL SOLUTIONS OF THE DATA MANAGEMENT SYSTEM

The procedure for the determination of the official personal dose using EPDs necessitates acquiring the dose external to the official monitoring services. Starting from a specified interface of the EPD reader the dose data has to be acquired reactionless under the supervision of the official monitoring service. Accessing the data should not influence the institutional dosimetry systems, which usually communicate via the same interface. Furthermore, the data management system has to cope with distributed reader systems, like to be found in a hospital situation.

Based on a specification of the data items required for monitoring their acquisition has to possible for multiple vendor and/or reader systems, typically using a parser to analyse proprietory data formats. Further on, the transmission has to be accomplished using a secured and authenticated method and should allow for a transmission to any of the monitoring services by means of a unified data format and transmission protocol. Since communication services tend to be potentially unreliable from time to time an interim storage is to be foreseen at each institution to allow local buffering. Finally, the implementation of such a data management system needs to be validated against the above requirements.

Looking at the proposed system in more detail the following steps are envisaged: (i) conversion of the – primarily serial – data on the reader's interface onto an Ethernet based TCP/IP connection, (ii) transfer of the data using a secured and authenticated channel to the interim storage, (iii) parsing the dose data according to a vendor specific format within the intermediate storage, (iv) data reduction to those data items solely required for the official monitoring purpose and (v) generation of the unified format together with a secured transfer of the data to the official monitoring service. To allow traceability both the input and the output data are logged within the interim storage. Parallel to the generation of this official communication path, the institutional dosimetry receives its data by branching out from the input to the interim storage, which however does not require a particular secured communication channel.

Implementation of this data management concept has to rely on innovative approaches, in particular when accessing the data at the reader's interface parallel to the institutional routine operation. Readers differ not only in their interfaces provided (serial and TCP/IP) but also in their system design (proprietary reader with embedded control or PC-based). In particular, new PC-based readers like the MGP LDM 3000 may allow having a specific software module being executed on the reader's PC and thereby facilitating the branching of the data stream in an institutional and official stream. This approach can be envisaged similar to a typical proxy service known from network firewalls. To guarantee failsafe operation and protection against any potential fraud, the software module should be certified. Following the different reader system design the institutional stream can be branched out directly at the reader interface or using the above software module.

The interim storage system has to provide the functionality to parse and filter the data accordingly by means of scripts and or software. To provide extensive hardware reliability a hard disk raid, double power supply and an online UPS are foreseen. Transfer of the dose data received at the interim storage will use VPN via a dial-up line or Internet connection. For compatibility, both the communication protocol and the data representation will be standardized by all partners involved. Guidelines and procedures will be used to validate the data management system.

Within the scope of this research project two different data management systems will be evaluated as represented in Figure 2 and 3.

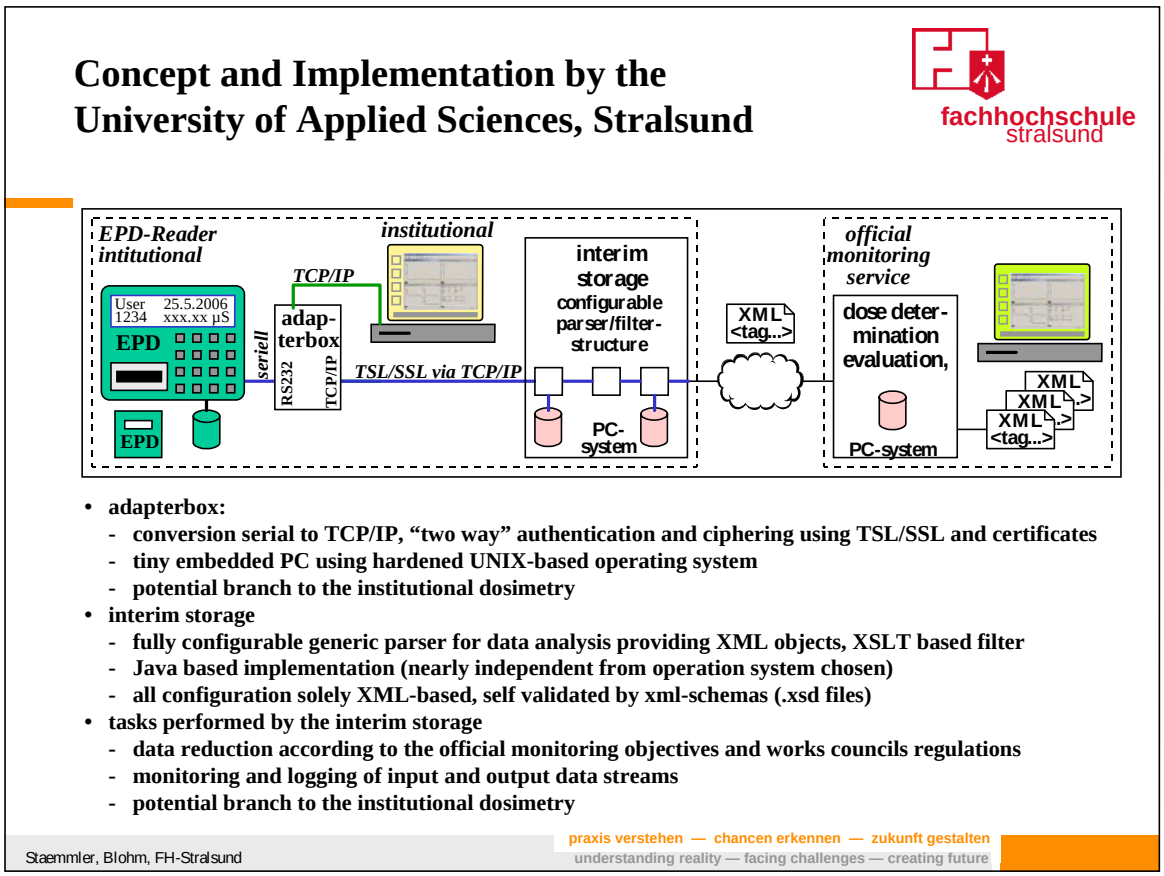

Figure 2 Concept and implementation by the University of Applied Sciences, Stralsund

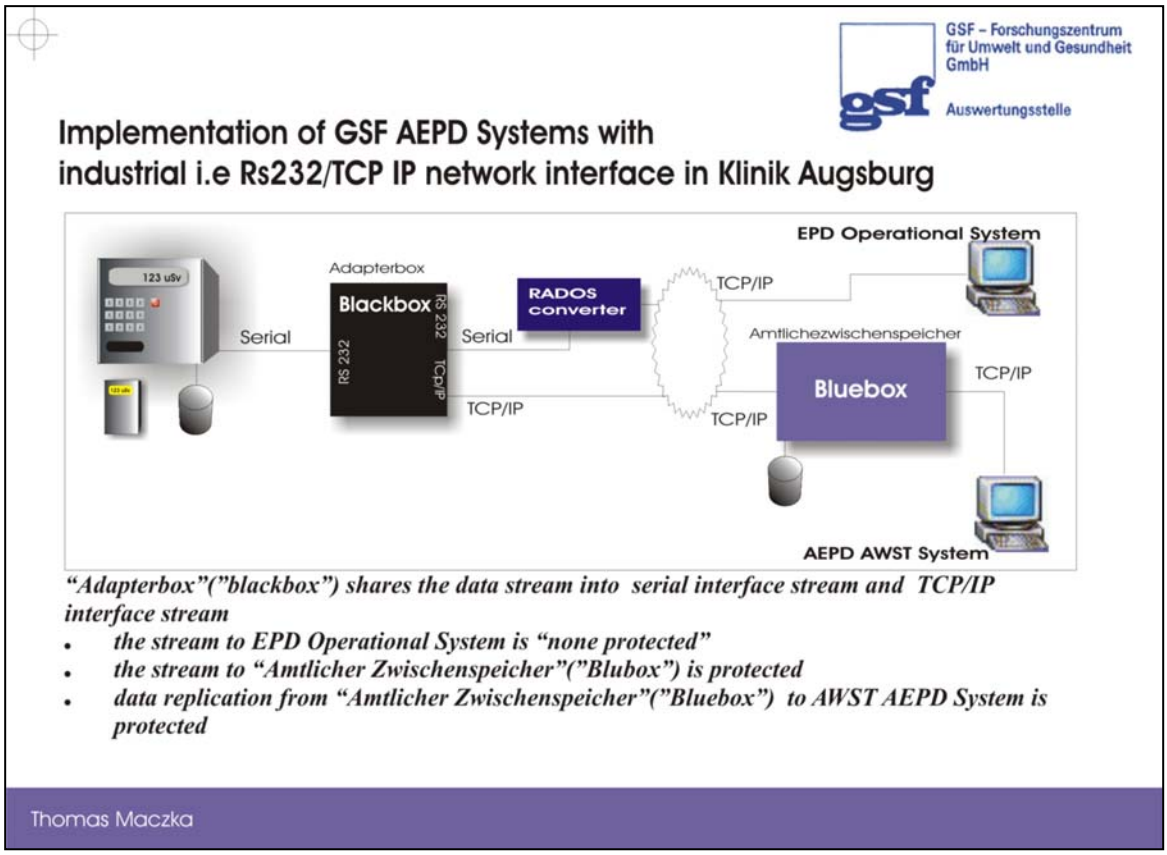

Figure 3 Concept and implementation by the GSF, Neuherberg

5 SUMMARY

EPD systems used for operational measurement should be applie to mesure the official personal dose according to both, the StrlSchV and the RöV. The usage of EPD as official personal dosemeter has been prepared both administratively and technically by monitoring services, users of EPD for workplace monitoring and other interested parties since several years. Now, an overall concept to guarantee nationwide harmonised procedures based on legal regulations has been developed for a federal research project. At present the implementation of the concept as an appropriate and generic system to use EPD as official dosemeters will be tested. Monitoring Services, manufacturer, software developer and the author of the concept will carry out an investigation using pilot trials in technological and medical environments. The methodology of the trials, the characteristics of the participating institution and technical solutions for the data management system have been introduced.

An essential requirement of a generic solution is its usability and independence from specific EPD manufactures and the participating monitoring services. Hard and software modules respectively take over the data at the reader interface into the responsibility of the monitoring service at customer site. Furthermore the quality assurance of the EPD systems by the monitoring service and an appropriate validation of the data management system associated with the conventional streams for personal master data and other processes guarantee the measurement as legal. After successful validation state authorities are able to start the release procedure for the official use of EPDs.

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