IL9806329

THE INTRODUCTION OF THE PERSONNEL DOSIMETRY INFORMATION SYSTEM IN GREECE DESIGNED AS A RELATIONAL DATABASE AND THE IMPROVEMENTS ACHIEVED

G.Drikos, J.Psaromiligos, G.Georgiou and V.Kamenopoulou

Introduction

Dose record keeping is the making and keeping of personnal dose records for radiation workers. It is an essential part of the process of monitoring the exposure of individuals to radiation and shares in the same objectives [1]. The dose record keeping is becoming more and more critical because of the importance of statistical analysis and epidemiological studies in radiation protection, and of the increasing cooperation and exchange of personnel between countries [2].

The GAEC's personnel dosimetry laboratory assures the personnel dosimetry all over the country and keeps the official central dose record. The personnel dosimetry information system had been established in an electronic form on 1989 in Cobol language. Since then appeared various arguments that imposed the change of the data base used. Some of them are:

1. There was no distinction between establishments and their laboratories.
2. The workers didn't have a unique code number, consequently, the total dose of a person working in more than one place couldn't be estimated. The workers were directly related to their workplace, so if somebody changed his working place he was treated as a new entry, resulting an overestimation of the number of monitored workers introducing an source of errors in the collective and average dose calculations.
3. With the increasing applications of the ionising radiations many types of dosemeters became indispensable e.g. for beta and gamma, for neutrons and for the extremities. Also, the new category of outside workers appeared requesting a special treatment. All these distinctions were not achievable with the previous sytem.
4. Last years appeared an increasing interesting in statistical analysis of the personal doses. A program written in Cobol doesn't offer many possibilities and has no flexibility for such analysis.

The new information system has been rebuilt under the design of a relational database with more possibilities and more flexibility.

General Structure of the System

Although current database technology has emerged user friendly tools suitable for the development of a Personnel Dosimetry Information System (PDIS), however, such a development is not trivial. If the PDIS is centralised and even more so if the system operates as a national PDIS, it must be carefully designed. Special consideration is needed to size, structure, accessibility, dissemination of information, organization and quality assurance procedures [2]. Additional difficulties arise when the PDIS is going to replace an earlier computer-aided system without loss of information. The system had to cope with the above difficulties and also be easily integrated with a Central Information System containing administrative, financial and technical information about establishments, laboratories and individuals using ionising radiation.

The most critical component of a PDIS is undoubtedly its database because it stores, manages and ensures the consistency of the data as well as it determines the degree of integration with the other administrative and financial procedures of a central information system. Today's most powerful database systems are the relational and the choice of such a system was an obligation [4]. These systems use a relational data model [3] which is a collection of two kinds of objects: tables and links among them. Each table models a real world entity (e.g. Establishment, Laboratory, Worker, ...) and it is characterised by a proper set of attributes that correspond to the columns of the table (e.g. Establishment ID, Establishment_Name, Establishment_Address, etc). A link models a specific relationship between two entities and it is represented by a proper set of attributes too. The links are characterised as one-to-one or one-to-many. One-to-one link between two tables means that each row of the second table is related to one row of the first, while one-to-many link means that there may be many rows of the second table related to one row of the first.

The system consists of three basic components: the database, the user interface and the interface with external resources. The user interface is the component that controls all the interaction of the PDIS with the users. The interface with external resources is the component that controls the interaction of the system with external programs when they need to pass data from external resources (e.g. the optical density of the film dosimeters from an analog to digital converter).

Each authorised user works on a PC where resides the respective user interface component under the operating system windows 95. For some users there is an on-line external resource that can pass data into the database through the analogous interface. Such resources are devices that pass on-line the value of the optical density of the film dosimeters into the proper software and then through the interface (using the appropriate protocol) into the database. The database resides in an Ingres RDBMS on an HP 9000 server under the Unix operating system. The programming language used is 4GL and C. There is a local area network connecting 25 PCs and the server. Some authorised users may have connections with the server from a portable computer through a telephone line in case of an emergency and not only. There are two levels of security against unauthorised access, the first level is provided by the Unix operating system while the second by the Ingres RDBMS.

The Relational Database

The relational structure of the dosimetry database is represented in figure 1.

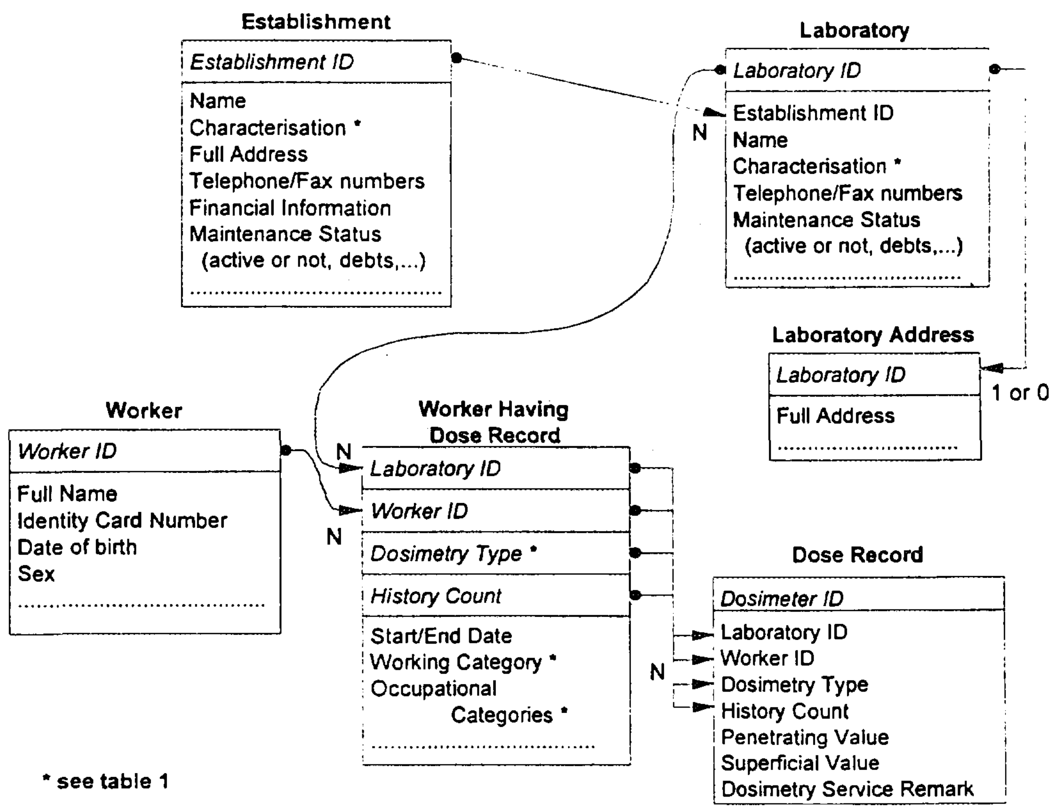

Figure 1. The relational structure of the Dosimetry Database.

Table 1: Classifications

OCCUPATIONAL CATEGORY	WORKING CATEGORY	DOSIMETRY TYPE	ESTABLISHMENT CHARACTERISATION	LABORATORY CHARACTERISATION
General diagnostic radiology	Radiation physicist	Wholebody	Hospitals	General diagnostic radiology
Cardiology	Auxiliary staff	Extremity	Dentists	Mammography
Mammography	Medical doctor	Outside Worker	Veterinary practitioner	CT
Surgical radiology	Nurses	Neutron	Private medical practitioner	Industrial radiography
Dental radiology	Scientist		Private clinics	Brachytherapy
Veterinary radiology	Technician		Universities, Research	Urinary
CT	Other		Nuclear Research Reactor	Nuclear medicine/biochemistry
Industrial radiography			General Industry	Non-destructive investigation
Brachytherapy			Governmental service	Teletherapy
Gastrenterology			Defence	Maintenance, repair
Orthopaedics			Other	....
Urinary				*many other characterisations including the above elements*
Nuclear medicine				
Biochemistry				
Non-destructive investigation				
Brachytherapy				
Teletherapy				
Maintenance, repair				
Nuclear Technology & Research				
Research reactor				
Radiation research				
Other				

For clarity purposes, a graphical representation is used for the description of the relational structure as well as some underlying clarifications. The graphical representation includes two kinds of shapes: rectangles and arrows. The rectangles represent tables while the arrows represent links between them. Each table may have one or more keys (denoted by italic fonts) that uniquely characterise each record of the table, while the direction of each arrow denotes the kind of relation between the two tables. At the end of each arrow there is the symbol N or 1 denoting the relationship as one-to-many or one-to-one correspondingly.

Each establishment/laboratory has a unique code number respresented by the attributes "Establishment ID" and "Laboratory ID" correspondingly which form the keys of the underlying tables (figure 1). The rest attributes represent the information needed for the dosimetry service as well as for financial purposes. Because an establishment may have one or more laboratories, the link between the two tables is one-to-many. For the shipment of dosemeters the address of each laboratory must be stored too. However, inserting the attribute "Full Address" in the table "Laboratory" would add redundant data in that table as most of the laboratories have the same address with the establishment that belong to. So, when the address of a laboratory is different from its corresponding establishment it is stored in the table "Laboratory Address", otherwise, it is used the address of the corresponding establishment. The link between the tables "Laboratory" and "Laboratory Address" is one-to-one.

Each worker has a unique code number represented by the attribute "Worker ID" which forms the key of the table "Worker". The other attributes of this table represent the constant characteristics of a worker. All the necessary information for dose record keeping is stored in the tables "Worker Having Dose Record" and "Dose Record". The attributes of the first table represent the general data of dosimetry while the attributes of the second represent the specific dose data.

More specific, the attributes: "Laboratory ID", "Worker ID", "Dosimetry Type" and "History Count" form the key of the table "Worker Having Dose Record". The first two attributes are the links of this table with the tables "Laboratory" and "Worker" correspondingly. Both links are one-to-many because a laboratory may have many workers as well as a worker may be in multiple laboratories. The attribute "Dosimetry Type" represents the kind of dosimetry performed on a specific worker, in a specific laboratory. The attribute "History Count" holds a natural number which is incremented by one each time the same worker restart his (her) job in the same laboratory with the same dosimetry type. The attributes "Working Category" and "Occupational Category" have the values shown in the table 1 according to the CEC technical recommendations [1]. Moreover, the attribute "Occupational Category" may hold more than one of their possible values.

The dose data are stored in the table "Dose Record". Each record of this table represents a specific dose. The attribute "Dosimeter ID" constitutes the key which is a unique code number formed by the specific month and year of dosimetry as well as the serial number of dosemeter. The next four attributes are used for the link with the previous table. The attribute "Dosimetry Service Remark" is used by the dosimetry service to characterise some situations when a dosemeter didn't return back, it is damaged etc. Finally, the attribute "Financial Record Flag" is used for payment purposes. The link is one-to-many because each worker may have many dose records depending on the time period he (she) works on a laboratory.

Conclusion

The introduction of the new information system brought more flexibility to the personnel dosimetry service because all the informations are structured and stored in one place and so they can be easily correlated. More specifically the improvements achieved are:

- establishments and laboratories are separate entities with different addresses when it is necessary
- information stored for establishments and laboratories covers both the radiation technical and administrative needs
- every person is characterised with a unique code number allowing us to maintain information concerning different workplaces simultaneously, being able to calculate the total dose received
- statistical analysis became more flexible with a lot of fields of choice
- improvement of the reporting system
- classification coding has been changed, following the EE's recommendations [1]. There will be no difficulty in joining a European data base for all monitored workers.
- access the database from different sources, like an analog to digital converter for entering the primary dosimeter data.

The database has already been extended and in the near future we would be able to handle information about the equipment and the isotopes used by the different laboratories.

References

[1] "Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation", European Commission, Report EUR 14852, 1994.

[2] H.W. Julius and F. Berman, "Dose Record Keeping: A Multipurpose Tool in Individual Monitoring", Radiation Protection Dosimetry, Vol.54, pp.321-326, 1994.

[3] C.J.Date, "An Introduction to Database Systems, Addison-Wesley, 1981.

[4] Ozkarahan, E. A., "Database Management: Concepts, Design and Practice, Prentice-Hall, 1990.