DataBase for Environmental Monitoring at Nuclear Facilities

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ABSTRACT

To ensure that an assessment could be made of the impact of nuclear facilities on the local environment, a program of environmental monitoring must be established well in advance of nuclear facilities operation. Enormous amount of data must be stored and correlated starting with: location, meteorology, type sample characterization from water to different kind of food, radioactivity measurement and isotopic measurement (e.g. for C-14 determination, C-13 isotopic correction it is a must).

Data modelling is a well known mechanism describing data structures at a high level of abstraction. Such models are often used to automatically create database structures, and to generate code structures used to access databases. This has the disadvantage of losing data constraints that might be specified in data models for data checking.

Embodiment of the system of the present application includes a computer-readable memory for storing a definitional data table for defining variable symbols representing respective measurable physical phenomena. The definitional data table uniquely defines the variable symbols by relating them to respective data domains for the respective phenomena represented by the symbols.

Well established rules of how the data should be stored and accessed, are given in the Relational Database Theory. The theory comprise of guidelines such as the avoidance of duplicating data using technique call normalization and how to identify the unique identifier for a database record.

1   INTRODUCTION

The combined global inventory of natural and human tritium emissions about 50 times greater than tritium levels from natural sources alone. There are several aspects related to the topic of tritium in the nuclear fuel cycle: e.g. its source, its behaviour when released to the environment, its management, conditioning, storage and disposal. Nuclear power plant and fuel reprocessing facilities are the major sources of tritium release to the environment, and with the continuing development of nuclear power, increasing attention will be given to improved treatment method for the tritium. The amount of tritium that will be produced and handled in future fusion reactors is several orders of magnitude greater than that produced during the generation of an equivalent amount of energy from fission reactors [1]. Much of the technology now being developed for handling tritium produced by fission reactions will be applicable to fusion installations.

The Cryogenic Pilot is an experimental project in the nuclear energy national research program, which has the aim of developing technologies for tritium and deuterium separation by cryogenic distillation. The process, used in this installation, is based on a combined

method for liquid-phase catalytic exchange (LPCE) and cryogenic distillation. In the liquid-phase catalytic exchange tritium transfer process the isotopic exchange reaction is carried out between liquid water and deuterium gas rather than water vapour. The use of a hydrophobic catalyst developed in the institute [2] enables the reaction to be carried out using liquid water, thus providing a counter-current process and avoiding the necessity of evaporation, superheating and condensation of the feed. The tritiated deuterium is purified by the removal of oxygen, nitrogen and other gaseous impurities and is then fed to the cryogenic distillation system using nitrogen and hydrogen like refrigeration agents. The detritiated deuterium gas from the first cryogenic distillation tower is recirculated to the LPCE front-end. Concentrated tritium is bled off periodically from the bottom of the last distillation tower and packaged for storage or disposal. In this process concentrated tritium is handled in its elemental state and the maximum tritiated water concentration handled is that of the heavy water feed. Total radioactive source, for normal working conditions, is contained in installation and it is equal with tritium inventory of process fluid. There are two ways that Cryogenic Pilot can interact with the environment: by atmospheric release and by sewage.

The site evaluation of a facility [3] demands various data specifically on: meteorological and hydro geological descriptions of a plant site; meteorological and hydrological data for surface water and groundwater; use of land and water in the region for dose assessment in the target population. Tritium is found in the environment in three principal forms – molecular tritium (T_2 or HT), tritiated water (HTO), and organically bound tritium (OBT) in which it is chemically bounded to organic molecules. Tritiated water is the most abundant chemical form of tritium in the environment. Until now, the simulation of the process described above was made with heavy water, but now we intend to full fill exigency of national regulations for nuclear facilities. This is the reason that we progressively established elements of an environmental monitoring program well in advance of tritium operation in order to determine baseline levels. The first step was the tritium level monitoring in environmental water and wastewater of industrial activity from neighbourhood.

Each location from the monitoring program must be characterized by geographic coordinates, meteorological data, and in situ parameters. Each sample from monitoring program must be recorded and it is necessary to have different parameters of sample starting with time and location, applied treatment, parameters for different applied methods, and at the end the measured radioactivity. To design a database for environmental monitoring for Experimental Cryogenic Pilot Plant must take account for all these demands, but in the same time it must full fill the final purpose of a ready mean radioactivity variation in time and space at this specific site.

2 ARCHITECTURE OF THE DATABASE FOR EXPERIMENTAL CRYOGENIC PILOT PLANT

In the architecture of the database we followed the following principles:
- It should allow conversion of all existing data into the electronic record under the principle one data-one record.
- It should allow easy future addition of data of any measurements or newly discovered historical data.
- It should allow easy selection of data by geographical location, date of measurement, type of measurements, type of monitoring, measured value, sample type, implementing laboratory etc.
- It must simplify fulfilment of our obligations regarding reporting to international systems of environmental radioactivity data like IAEA (International Atomic Energy Agency Vienna).

- The design must be simple and easy to maintain, used software support system should be robust, reliable and inexpensive.

The Cryogenic Database was developed as a relational database containing one record for each measured value. Each record is related to supporting tables of geographical locations, types of measurements, radionuclides and measuring units

The database is implemented using Relational Database System where relations that are part of the database are going to stand for abstract materials having a strong relation that connects them. One of the entities is 'MonitoringStation', this entity contains all relevant details stations can contain such as zone location, sources of emission, topography of the zone, latitude and etc. Therefore, an Entity Relationship Diagram (ERD) was created showing all distinguished entities along with their values as well as the relationships that interconnect them. From the diagram we can view the structure of the database or how data will be stored and manipulated when the system will be ready for use [4]. The Database Diagram is shown in the figure 1.
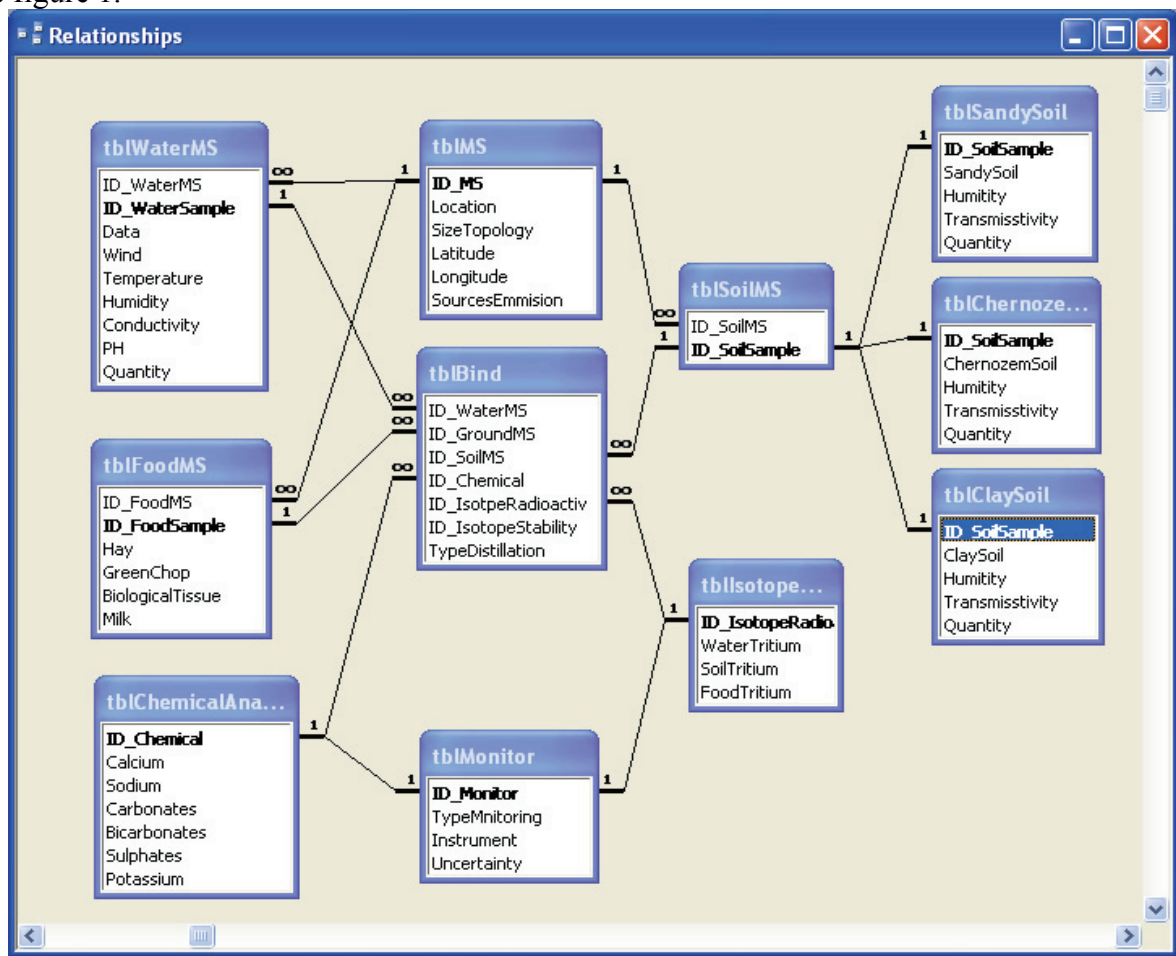

Figure 1: The database structure of cryogenic database system

The structure of the cryogenic monitoring system includes three general levels:
a. Data acquisition level
b. Data handling level
c. Management level

The data acquisition level of the cryogenic monitoring system is responsible for gaining general information about surfaces water, types food (hay, green chop, biological tissue and milk) and type soil (sandy, chernozem and clay).

Furthermore, the data handling level of the cryogenic monitoring system involves entering, updating and deleting of the above mentioned data into and from the created database. The system is divided in two parts, because the administrator part exists to handle the presentation data in the user part. The existing database was created following the standards of the IAEA and has several additional tables in order to suit the project needs for more specific cases.

The third level of the cryogenic monitor system is the management level. At this level the presentation data is analyzed by the system next it is distinguished, selected and ordered and finally it is presented by the user. Data can be managed only from system or managed by both the system and the user, in situations when the user gives the system qualification parameters in order to receive a result in the defined range. The data is managed by passing queries from the system to the database and retrieving answers from the database to the system and afterwards to the end users.

3   USER INTERFACE

The database has were designed to be user-friendly for the field observer in the first place arguing from the premise that it is more important that the field observer gets his data into the database correctly and efficiently than that the future user needs to make a bit more of an effort when interpreting the data. The latter will always find a way to manage the data, but if a field observer has difficulty entering his data, he may postpone entering data or give up all together and valuable data may not be recorded correctly or at all. We believe that the database is user-friendly for both field observers and data-users. After all, we hope that in many cases field observers also become data users who interpret the data of themselves and of others.

The Cryogenic Database allows multi-user access from any computer with a web browser and Internet access. The system has a transparent, scalable architecture in which one server is utilized to accept multiple requests and each request is handled individually. Since the system is completely thin client. The Cryogenic Database was developed in two parts, a client JAVA applet and a server application. The purpose of the client's JAVA applet is to provide a graphical user interface to the user. Through this interface the user can interact with the available data to view bar graphs, pie charts or maps. The server is a Microsoft Visual Basic application with two main functions to serve maps and return graphs. The server accepts requests from the clients and performs the required action and returns the desired graphical information.

On the other hand, the user part of the web site will be used for data sorting and presentation. The user will be able to generate reports by entering sorting parameters that will differ depending on which report is chosen. Moreover, other administrator-managed contents will be available for viewing.

The first thing we needed to do was to cover all the necessary security issues required from the users. Sensitive and confidential data need special attention and security coverage. That is why, according to the gathered user requirements we distinguished which the data that will available to all users and which data will be secured depending of the permission levels of the users. Authentication and authorization of users is the first security layer of the administrator part of the system. All authorized users will get username and password, except that they will have different access levels determined by the user administrator of the competent authority. Other security layers are managed in the proceeding code of the project and separate are those that are determined in the database itself [5] [6]. Therefore, the flow of web forms of the cryogenic monitoring system – Administrator part is the following:

• Login page – the users must provide the system with their username and password, otherwise if one of the inputs are not correct or it is not entered the user will not be able to enter the inner pages of the system.

• Default page – the users starting from here can select their further actions according to their needs. Of course, only those users who are authorized to enter certain pages can do so, otherwise they will be denied.

• Manage Users page – the administrator of users will view, enter, update and delete users for the current competent authority.

• StationMonitoring - authorized users will be able to enter, update or delete parameters the station of screen.

• WaterStation - authorized users will be able to enter, update or delete parameters the water of station.

• SoilStation - authorized users will be able to enter, update or delete parameters the soil of station.

• FoodStation - authorized users will be able to enter, update or delete parameters the food of station.

• WaterDataForm - authorized users will be able to enter, update or delete parameters physico-chemical for kind of waters.

• SoilDataForm - authorized users will be able to enter, update or delete parameters physico-chemical for kind of soils.

• FoodDataForm - authorized users will be able to enter, update or delete parameters physico-chemical for kind of foods.

The WaterDataForm is presented in figure 2.

Figure 2: An example of form related to monitoring of water for experimental in station Mihaiesti.

During year 2005 it was sampled monthly average precipitation (composite sample) near Experimental Cryogenic Pilot Plant. For the samples in this location was registered a mean value of 0.59 Bq/l for tritium specific activity. The maximum value for tritium was measured in May, 1.02 Bq/l and minimum value in February, 0.27 Bq/L (Figure 3).
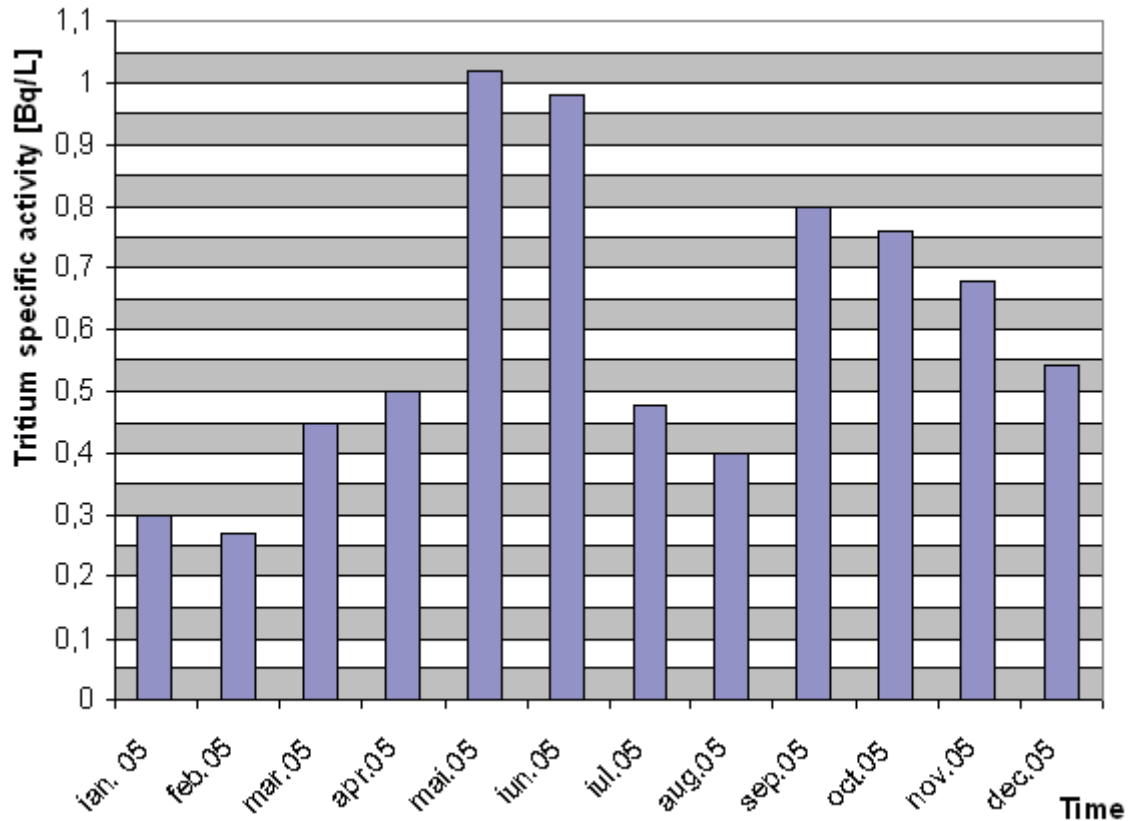
Figure 3: Tritium concentration in precipitation during the year 2005.

4 CONCLUSIONS

Database for environmental monitoring for Experimental Cryogenic Pilot Plant should be ensured that the data collected adequately represent local meteorological conditions, geographic coordinates, metrological data, in-situ parameters and the end measure radioactivity. Activities should be undertaken in accordance with accepted international standards. Data for at least one representative year should be presented. Information should be given to indicate the extent to which these data represent the long term meteorological characteristics of the site. This information may be obtained by comparing the local data with concurrent and long term data from synoptic meteorological stations in the surrounding area.

Object-relational databases are going to be increasingly used because they provide a better support than relational technology for complex data and relationships. Consequently, new methodologies for object-relational database design are emerging. In this paper we have summarized a methodology for object-relational database design, which is based on UML extended with the required stereotypes. We have focused on object-relational databases, although the UML proposed extensions could also be adapted for object database design.

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