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(54) Title: TASK ALLOCATION METHOD AND APPARATUS

(57) Abstract: A method for generating data indicating a degree of change within an installation, the change being indicated by increased release of a contaminant. The method comprises receiving as input a plurality of dose data items, each dose data item indicating a dose of the contaminant to which an individual has been exposed while carrying out a predetermined task at a time specified by that dose data item, and processing said dose data items to generate output data indicative of a degree of change occurring within the installation between times specified by the dose data items.



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TASK ALLOCATION METHOD AND APPARATUS

The present invention relates to a method of selecting a resource to carry out a particular task. The invention also relates to a method for detecting change within an installation, a method for comparing performance of a plurality of individuals, and a method for monitoring performance within an industrial installation.

For safety reasons it is necessary to regulate access of individuals to various parts of a nuclear installation. It is also necessary to monitor radiation dosages to which individuals are exposed. Indeed, in the United Kingdom, the Ionising Radiation Regulations place a requirement on employers to satisfactorily maintain records of radiation to which employees have been exposed. In one prior art system this obligation is discharged by employees wearing film badges which detect radiation dosage. Periodically these film badges are processed to obtain an indication of the radiation to which each individual has been exposed. This data can then be manually entered into a database, so that a record is obtained of radiation to which each individual has been exposed over time.

In addition to the system described above which discharges the legal responsibility imposed by the Ionising Radiation Regulations, it is also known for individuals to wear Electronic Personnel Dosimeters (EPDs) which are pre-programmed with a particular alarm level. While a task is being carried out, the EPD detects the radiation to which the individual is being exposed, and if at any time this radiation exceeds the pre-programmed alarm level an alarm is sounded to indicate to the individual that it is not safe to continue work.

More recently, in some nuclear installations the EPDs described above have additionally been used to collect the legally required dosimetry data thereby obviating the need for the film badges described above. In such a system, a user is issued with an EPD when starting work. The EPD monitors the radiation dose to which the individual has been exposed and when the work is complete, data is read from the EPD into a dosimetry database.

In some prior art systems the use of EPDs as described above has been further enhanced to take into account predicted radiation dose for a particular task. Here, prior to issue of an EPD a check is made to determine whether a user has sufficient "dose credit" to tolerate the dose predicted for a particular task. If insufficient dose credit is available the user is not permitted to carry out the task.

Although the systems described above are useful in monitoring radiation to which a user is exposed and enforcing a particular safety system, the systems described above have not been used to provide any long term planning. For example, refusing an individual access to carry out a particular task if their dose credit is insufficient to provide the predicted dose credit implements a safety system, but does not allow long term planning to be carried out. Therefore, in use, the current system often allows individuals to use their dose credit relatively quickly thereby meaning that there is period of time during which the individual cannot do work in which they are subjected to exposure to radiation. That individual must therefore be allocated to other duties thereby reducing efficiency of the workforce. Thus, there remains a need for a system in which dosimetry data is used to improve monitoring and efficiency of the work force.

It is an object of some aspects of the present invention to obviate or mitigate at least some of the problems set out above.

According to the present invention, there is provided a computer implemented method for generating data identifying an individual to carry out a task. The method comprises storing first data indicating for each of a plurality of individuals, a dose of at least one contaminant to which each individual can be safely exposed, storing second data indicating a predicted dose of the at least one contaminant to which an individual will be exposed in carrying out the task, and processing said first data and said second data to generate output data indicating one of the plurality of individuals to carry out the task.

It is well known to monitor performance within an industrial installation. Performance is often quantified by reference to cost or schedule. Much work is currently being carried out to decommission nuclear power stations. Such work is very expensive, and typically spans a large number of years and is often labour intensive. Such work also typically incorporates high radiation dose burdens to individuals. In such circumstances known performance indices based upon cost or schedule fail to properly capture performance of resources.

It is an object of some aspects of the present invention to obviate or mitigate the problem set out above.

According to the present invention, there is provided a method of generating comparison data indicative of performance within an industrial installation in which a plurality of individuals are exposed to a contaminant. The method comprises receiving prediction data indicating a predicted quantity of the contaminant to which each individual will be exposed, receiving as input monitor data indicating the quantity of the contaminant to which each individual is exposed, and generating comparison data indicating a comparison between said prediction data and said monitor data.

Thus, the present inventors have surprisingly realised that performance can be more effectively captured using a metric based upon dose planning, instead of the schedule and cost metrics used previously.

Heretofore dosimetry data collected to satisfy statutory obligations has been used only for that purpose.

One aspect of the present invention provides a method for generating data indicating a degree of change within an installation, the change being indicated by changed release of a contaminant. The method comprises receiving as input a plurality of dose data items, each dose data item indicating a dose of the contaminant to which an individual

has been exposed while carrying out a predetermined task at a time specified by that dose data item. The dose data items are processed to generate output data indicative of a degree of change occurring within the installation between times specified by the dose data items.

The change within the installation may be indicative of a change in environmental conditions resulting in increased or decreased release of the contaminant, or deterioration in plant, causing increased release of the contaminant.

A further aspect of the present invention provides a method of comparing performance of a plurality of individuals carrying out a task. The method comprises receiving as input, first data indicative of exposure of a first individual to a contaminant while carrying out the task, receiving as input, second data indicating exposure of other individuals to the contaminant while carrying out the task; and processing said first data and said second data to generate output data indicative of performance of the first individual relative to said other individuals.

It will be appreciated that performance comparisons mentioned above may be concerned with identifying anomalies in working practices of various individuals, these anomalies contributing to a decrease in performance.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a network of computers used in an embodiment of the present invention;

Figure 2 is a schematic illustration showing a workstation of Figure 1 in further detail;

Figure 3 is a flow chart showing how the system of Figures 1 and 2 is used by a user to obtain an electronic personal dosimeter;

Figures 4a to 4c are illustrations of database tables storing dosimetry data;

Figure 5 is an illustration of a database table storing task data;

Figure 6 is a flow chart showing how the system of Figures 1 and 2 is used to return the electronic personal dosimeter after use;

Figure 7 is a schematic illustration showing how data is input to a planning system running on a planning server shown in Figure 1;

Figure 8 is a flow chart showing how dosimetry data and task data is read by the planning system of Figure 7;

Figure 9 is a flow chart providing an overview of operation of the planning system of Figure 7;

Figures 10 and 11 are screen shots of the planning system of Figure 7;

Figure 12 is a flow chart illustrating data processing to generate a performance index;

Figure 13 is a schematic illustration of data handling in accordance with the flow chart of Figure 12;

Figures 14 and 15 are graphs showing data analyses which may be carried out using embodiments of the present invention.

An embodiment of the present invention suitable for use in a nuclear installation is now described. Figure 1 schematically illustrates a network of computers used to put the invention into effect. The computer network is schematically illustrated 1 and a dosimetry server 2 is connected to the computer network 1 via a suitable network interface (not shown). The dosimetry server 2 includes a dosimetry database 3 storing information indicating radiation doses to which various individuals working within

the nuclear installation have been exposed. The computer network 1 is typically a local area network and in such embodiments the dosimetry server 2 is provided with a local area network interface of a type which will be readily known to one skilled in the art.

The system of Figure 1 further comprises a task server 4 which is again connected to the computer network 1 via a suitable network interface. The task server 4 includes a task database 5 indicating predicted radiation dosages for various tasks that are to be carried out within the nuclear installation. A planning server 6 is again connected to the computer network 1 via a suitable network interface, and is configured to read data from the dosimetry database 3 and the task database 5 in a manner described below.

The system schematically illustrated in Figure 1 further comprises three access control workstations 7, 8, 9 which are used by individuals before and after such individuals have carried out tasks within the nuclear installation. Figure 2 illustrates the access control workstation 7 in further detail. It will be appreciated that the access control workstations 8, 9 have a similar form, and that there may be any number of such workstations.

The access control workstation 7 comprises a memory 10, comprising a program memory 10a for storing instructions and a data memory 10b for storing data. The access control workstation 7 further comprises a processor 11 configured to read executable instructions from the program memory 10a and to execute these instructions. The processor 11 is also configured to read data from the data memory 10b. The workstation 7 also comprises a hard disk drive 12 for storing data and computer program code and a network interface 13 allowing the access control workstation 7 to send data to and receive data from the computer network 1. The access control workstation 7 also comprises an I/O interface 14 to which various input and output devices are connected. Specifically, a display device having the form of a flat screen monitor 15 and a keyboard 16 are connected to the I/O interface 14. It will be readily appreciated that other conventional input devices such as for example, mice

and combined display and input devices such as touch screens may be connected to the I/O interface 14 in a similar manner. The workstation 7 further comprises an electronic personal dosimeter (EPD) reader 17 configured to read data from and write data to an EPD inserted therein. Typically the EPD reader 17 is configured to transmit infrared signals to and receive infrared signals from the EPD. Finally, the I/O interface 14 is connected to a turnstile 18 which is activated in a manner described below so as to control access to various parts of the nuclear installation. The processor 11, memory 10, hard disk drive 12, network interface 13, and I/O interface 14 are all connected together by means of a central bus 19. It will be readily apparent to one of ordinary skill in the art that the components illustrated in Figure 2 may be connected together in a variety of different ways.

Figure 3 is a flow chart showing how the network of computers of Figure 1, and the access control workstation 7 illustrated in further detail in Figure 2 are used by an individual to obtain controlled access to part of a nuclear installation. At step S1 a user obtains a permit to carry out a particular task within the nuclear installation. Such a permit to work is typically obtained from a safe system of work controller and/or a radiological protection adviser. These individuals within an organisation are charged with the task of ensuring that safe working practices are followed. Having obtained such a permit to work, a user then retrieves an EPD from a rack and inserts this EPD into the EPD reader 17 at step S2. Having inserted the EPD, the access control workstation 7 prompts the user to input a unique identifier for the task that is to be carried out. This identifier is typically included in the permit to work obtained at step S1. This identifier is typically input using the keyboard 16 or another suitable input device such as a touch screen. At step S4, a user is prompted to enter a unique identifier which identifies themselves to the system. Such an identifier is allocated to each user when they begin work at the nuclear installation.

At step S5, the access control workstation 7 obtains dosimetry data for the user identified by the input identifier from the dosimetry server 2 via the computer network 1. This data is obtained by performing an appropriate query on the dosimetry database 3. Figures 4a to 4c illustrate tables of the dosimetry database 3. Figure 4a

illustrates a USER table. This table comprises a USERID field being the unique identifier for a particular user, a USERNAME field being the user's name a DOB field storing a user's date of birth field, and an NINUMBER field storing a user's national insurance number. A date on which the user last had a medical is stored in a LASTMEDICAL field. A DOSEIDS field identifying zero or more records in a DOSE table shown in Figure 4b, and a dose credit field indicating a single record in a DOSECREDIT table shown in Figure 4c are also included in the USER table.

The DOSE table illustrated in Figure 4b comprises a DOSEID field which is the primary key of the DOSE table. The DOSE table also includes a USERID field identifying the user to which the dose data relates. A record in the USER table of Figure 4a uniquely refers to a particular record in the dose table of Figure 4b by a particular DOSEID value stored in the DOSEIDs field. The dose table of Figure 4b comprises four fields which are used to store dosage data. These are a HARDGAMMA field, a SOFTGAMMA field, a FULLBETA field and a COMPRESSED BETA field. These fields together represent the radiation dose to which the user has been exposed. Additionally, the DOSE table includes a DATE field indicating a date on which the user was exposed to that dose. It will be appreciated that typically the DOSEIDS field of the user table of Figure 4a will typically identify a plurality of records in the dose table of Figure 4b each relating to a particular dose to which that user has been subjected.

The DOSECREDIT field of Figure 4a is used to uniquely locate a record in the DOSECREDIT table of Figure 4c which has as its primary key the user's ID. This table again comprises four fields indicating the user's available credit in terms of hard gamma radiation, soft gamma radiation, full beta radiation, and compressed beta radiation. It will be appreciated that the dosimetry server 2 can compute dose credit details from a set of dose records for a particular user and details of a total safe dose within a specified time period.

Referring back to Figure 3, at step S5 the data retrieved for a particular user will typically be dose credit information retrieved from the dose credit table of Figure 4c

using the input user ID. At step S6, the access control workstation 7 obtains predicted radiation data for the input task ID from the task database 5 connected to the task server 4.

Figure 5 illustrates a table stored in the task database 5. It can be seen that this table includes a TASKID field which is a unique identifier for a particular task, together with four fields respectively containing predicted hard gamma radiation, predicted soft gamma radiation, predicted full beta radiation, and predicted compressed beta radiation. The task database 5 also contains alarm level data used in a manner described below. This data is read by the access control workstation from the task database 5 at step S6. At step S7, the processor 11 of the access control workstation 7 executes computer program code to determine whether the user's dose credit details obtained at step S5 are sufficient to allow the predicted dose obtained from the task database at step S6. Assuming that the user does indeed have sufficient dose credit, processing passes to step S8 where a user's last medical date retrieved from the USER table of Figure 4a is compared with a current date to determine whether the user has had a medical sufficiently recently. Assuming that a user has indeed had a medical within an acceptable time frame processing then passes to step S9. It should be noted that if either step S7 or step S8 respectively determine that the user's dose credit is insufficient or that the user's medical is out of date processing ends at step S10. Assuming that the conditions of step S7 and S8 are satisfied, at step S9 alarm level data obtained from the task database at step S6 is written to the EPD via the EPD reader 17. This alarm level data is such that if that level of instantaneous or cumulative radiation is met the EPD will emit an alarm signal typically in the form of an audio alarm to warn the user that a dangerous dosage of radiation has been reached, and that the user should immediately leave the site at which work is being carried out. The access control workstation 7 obtains alarm level data from the task database 5.

Having programmed alarm data to the EPD at step S9, the EPD is removed from the EPD reader 17 at step S11. Additionally, in the illustrated embodiment the processor

11 causes the I/O interface 14 to control the turnstile 18 to allow the user into the controlled area at step S12.

Having carried out the procedure set out above, it can be seen that before being allowed through the turnstile 18, the user has properly been issued with an EPD programmed with the correct alarm level(s), and checks have also been made to ensure that the user's available dose credit is sufficient for the predicted radiation for the task to be carried out. Additionally while the task is being carried out the EPD will collect details of the actual radiation to which the user is being subjected, and this data is written to the dosimetry database 3 in a manner illustrated in Figure 6. At step S20, the user inserts his EPD into the EPD reader 17. At step S21, data indicating the radiation to which the user has been subjected is read from the EPD via the EPD reader 17. This data will typically initially be written to the data memory 10b, and thereafter written from the data memory 10b via the network interface 13 and the computer network 1 to the dosimetry server 2 for storage in the dosimetry database 3. Receipt of this data will cause the creation of a new record within the dose table illustrated in Figure 4b having a unique dose ID. This unique dose ID will be added to the list of dose ID's in the user's record in the USER table of Figure 4a. This writing of data is carried out at step S22. In order to write this data it will be appreciated that the access control workstation 7 must provide to the dosimetry server 2 details of the hard gamma, soft gamma, full beta, and the compressed beta radiation to which the user has been subjected, together with the user's ID. Having received this information, the dosimetry server 2 can then update the user's dose credit record in the DOSECREDIT table of Figure 4c.

At step S23 the EPD is removed from the EPD reader 17, and returned to the rack.

It will be appreciated that the database tables as illustrated in Figures 4a, 4b, 4c and Figure 5 are simply exemplary. It will be readily apparent to one skilled in the art that the data may be stored in database tables having different formats. In one embodiment of the invention tables such as those illustrated are used and are implemented using an Oracle™ relational database. However, it will be appreciated

that other relational databases can similarly be used as indeed can an object oriented database.

Figure 7 schematically illustrates how a planning application 20 can use dosimetry database 3 and the task database 5 for planning purposes. Here, the planning application 20 executes on the planning server 6, and accesses a planning system database 21. The planning database typically comprises tables comprising details of tasks to be planned, and resources which are used to carry out these tasks. The planning application 20 is provided with an application programmers' interface (API) 22 providing functions which can be called by external applications such that the external applications can work alongside the planning application. For ease of use, the planning application 20 is additionally provided with a graphical user interface (GUI) 23. A database interface application 24 is also executed on the planning server 6. This database interface application 24 is configured to query the dosimetry database 3 and the task database 5, and to pass obtained data to the planning application 20. Data is passed to the planning application 20 via the API 22. Having received data from the dosimetry database 3 and the task database 5 (via the database interface application 24), the received data can be used to improve the effectiveness of decisions taken via the planning system.

Figure 8 is a flow chart showing how data is passed to the planning application 20, to allow planning decisions to be taken on the basis of data stored in the dosimetry database 3 and the task database 5. At step S30 the planning application 20 and the database interface application 24 are launched. At step 31 the database interface application 24 reads dosimetry data from the dosimetry database 3. This typically involves the database interface application 24 (executing on the planning server 6) sending a request for data to the dosimetry server 2. The dosimetry server 2 will retrieve data from the dosimetry database 3 and return this to the planning server 6 for use by the database interface application 24. The data read in this way is then passed to the planning application 20 at step S32. This is conveniently realised by the database interface application 24 executing computer program code which call suitable functions provided by the API 22. At step S33 the planning application

receives data from the database interface application 24, and records in the planning database 21 relating to resources for which dosimetry data has been received are updated with the retrieved data.

At step S34, the predicted dose data for various tasks is read from the task database 5 by the database interface application 24. Here, the database interface application 24 requests data from the task server 4 and this data will in turn be retrieved from the task database 5. The retrieved data is then passed to the database interface application 24 executing on the planning server 6 via the computer network 1. This data is passed to the planning application 20 via suitable calls to functions provided by the API 22. On receipt of this predicted dose data by the planning application 20, records within the planning system database 21 relating to tasks for which predicted dose data has been received are updated (step S34). Having obtained this data planning operations can then be carried out in a manner described below, as indicated by step S35.

Figure 9 shows an overview of planning using the planning application 20. At step S36 tasks which are to be carried out within a plan are determined. This step is carried out by displaying a list of tasks and receiving user selections of tasks which are to be included within the plan. Having selected tasks, it is necessary to determine resources which are required to carry out the selected tasks (step S37). This is carried out either by reading data previously associated with the various tasks from the planning system database 21 or by receiving suitable user input. At step S38 available resources are displayed to the user, and at step S39 resource selection is carried out, whereby suitable resources are allocated to the various tasks within the plan. In some embodiments of the invention tasks are specified as requiring resources which fulfil a particular role, and resources fulfilling that role are then selected.

Planning operations described in overview with reference to Figure 9 are now described in further details, in connection with embodiments of the present invention described below are based upon Primavera P3e planning software available from Primavera Systems, Inc, of Three Bala Plaza West, Suite 700 Bala Cynwyd, PA

19004 USA. Figures 10 and 11 are screenshots taken from embodiments of the present invention based upon the Primavera P3e planning software.

Referring first to Figure 10, there is illustrated a window 25 displaying details of resources which are to be allocated to tasks within projects. The window 25 comprises a menu bar 26, a first area 27 and a second area 28. The first area 27 displays a hierarchically arranged list of resources, together with attributes of these resources. For example, it can be seen that a group of resources 29 are entitled "Sellafield zone ABCD", and this group comprises a sub-group 30 entitled "fitters". Three individual resources 31 are displayed which are classified as "fitters", that is, these resources can fulfil the role of "fitter" and can carry out tasks associated with that role. This hierarchical information is displayed in a "Resource ID" column 32 of the first area 27. It can be seen that the resource IDs are indented to varying degrees to signify hierarchical relationships. Where resources at a lower hierarchical level are not shown, a "+" icon is presented to allow the hierarchy to be expanded. When such lower level resources are shown, as in the cases of the group of resources 29, a "-" icon is presented to allow such resources to be hidden.

The first area 27 further comprises a "Resource Name" column 33 which provides a name for each resource. That is, for the sub-group 30 a name "FITTERS" is used, whilst individual resources 31 (representing individual employees) are indicated by their usual names. The first area 27 also comprises a "Dosage MTD" column 34 which indicates a dose of radiation to which the resource has been exposed to in the current month, a "Dosage YTD" column 35 indicating corresponding information within the current year, and a "Next Medical Date" column 36 which indicates when each of the fitters 31 is next due for a medical. That is, it can be seen from Figure 10 that dose information taken from the dosimetry database and read as described with reference to Figure 11 has been input to the planning software.

The second area 28 of the window 25 displays information relating to a resource selected in the first area 27. Specifically, the area 28 provides six tabs each displaying information relating to the selected resource. A roles tab 37 is shown in Figure 10 and

this displays information relating to the roles which the selected resource can take. Each role is identified by an identifier shown in a "RoleID" column 38, and a name displayed in a "Role Name" column 39. A resource's proficiency within a particular role is indicated in a "Proficiency" column 40 and a "Primary Role" column 41 allows specification of a particular role as a primary role. Thus, it can be seen that Willie Wallace (the resource selected in the first area 27) can take the role of expert fitter, or skilled nuclear operations. His primary role is that of fitter. The role data displayed in Figure 10 is stored in and read from the planning system database 21.

Referring now to Figure 11, an activities window 50 is shown. A first area 51 shows details of a plurality of tasks which are to be carried out in an industrial installation. These tasks are grouped together by areas within the installation in which they are to be carried out. Each activity has an identifier displayed in an "Activity ID" column 52 and a name or description in an "Activity Name" column 53. A second area 54 of the window 50 identifies resources required to carryout a task selected in the first area 51. The second area 54 again comprises a plurality of tabs of which a resources tab 55 is shown in Figure 11. This tab identifies the selected task by means of its identifier displayed in a field 56 and name displayed in a field 57. It also identifies a role which a resource must fulfil to carry of the task. This role is identified by a role name in a column 58. A resource ID column 59 identifies a resource when such a resource has been allocated. Again, it can be seen that dosimetry data has been included in the data shown in the window 50. Specifically, a "Budgetted Units" column 60 indicates a predicted dose associated with the task (determined from data read from the task database 2 in the manner described above). Additionally, an "Actual Units" column 61 is used to record a dose exposed to date in carrying out the task, and a "Remaining Units" column 62 indicates predicted dose to which the resource is yet to be exposed.

A window 64 shows details of resources which can be used to carry out the selected task, that is in this example resources having a role of fitter. Resources from the window 64 can be selected by a user to cause allocation which will then be reflected by insertion of the resource's identifier in the "ResourceIDName" column 59 of the second area 54 of the window 50.

It will be appreciated that in some embodiments of the present invention, the user may do no more than select a type of resource, and the planning software will then select a suitable resource to carry out the task. This automated selection may be carried out in such a way that resources having a relatively high dose credit are selected in preference to resources having a relatively low dose credit.

Thus either by presenting to a user details of dose credits for various resources, and allocating resources to tasks in response to user selection, or by implementing automatic allocation of the type described above, the present invention allows dose data to influence planning decisions. That is, resources can be allocated to tasks in such a way that dose credit information is taken into account, thereby allowing a more efficient use of the workforce.

The description set out above is concerned with how embodiments of the present invention can be used such that dose data is taken into account when allocating resources to tasks. The planning system of the present invention also has a variety of other uses, including the generation of performance indices for tasks or an entire installation, and monitoring of resource and installation performance.

Figure 12 is a flow chart illustrating how embodiments of the present invention are used to analyse data to generate performance indices. In particular a novel dose performance index (DPI) for a predetermined task is generated using the process of Figure 12 as is now described. At step S45 a task for which DPI is to be calculated is selected by a user. At step S46, the planning software 20 obtains data indicating doses of radiation to which one or more individuals have been exposed while carrying out the selected task. This data is obtained from the planning system database 21, and will have been provided to that database from by the database interface application 24. The database interface application obtains the data from the dosimetry database 2. At step S47, predicted dose data is read again from the planning system database 21, this data having been read from the task database 5 by the database interface application

21. At step S48 the monitored data obtained at step S46 is normalised. This can suitably be carried out by computing a mean of the monitored data so as to obtain data which is directly comparable with the predicted data read from the planning system database 21. At step S49 the normalised monitored data can be compared with the predicted data to generate the DPI. This comparison takes the form of a ratio, according to equation (1):

$$\text{DPI}(\text{task}) = \frac{\text{Norm}[\text{Monitored}(\text{task})]}{\text{Predicted}(\text{task})} \quad (1)$$

where:

Norm[Monitored(task)] is the normalised monitored dose data for the task selected at step S45;

Predicted(task) is the predicated data read at step S47; and

DPI(task) is the calculated DPI for the selected task.

The purpose of DPI is to measure performance in terms of dose planning accuracy. Thus, a DPI of marginally less than one will indicate that predications are accurate, with a small allowance margin to ensure safety. If DPI is more than one, it can be seen that predictions are too low, which will in due course result in resources reaching their dose credits earlier than planned, thereby reducing the operating efficiency of the installation. If DPI is considerably less than one, predictions are over estimated, and should be modified to improve operating efficiency.

In the description set out above, DPI was calculated for a particular task. However DPI can also be calculated for a particular project (comprising a plurality of tasks) within an installation, or on all projects within that installation. In such embodiments of the present invention, predicted dose data for a plurality of tasks is combined and monitored dose data for a plurality of tasks is combined. The combined data is then used in the manner described with reference to Figure 12 to generate DPI.

It will be appreciated that predicted dose data for each task may be generated using a model represented by suitable model data stored on a computer such as the planning server 6. Referring to Figure 13, model data 70 represents various tasks within an installation. Instantiation and execution of this model data generates predicted dose data 71 which is stored in the task database 5. The dosimetry database 2 stores monitored dose data as described above, and monitored dose data 72 can be read from the dosimetry database 2. The monitored dose data 72 and the predicted dose data 71 are processed in the manner described above to generate a DPI 73. As described above, the DPI is indicative of performance, based upon the predicted dose data 71. If DPI is sufficiently far from its ideal value of approximately one, the DPI is used to cause feedback 74 to the model data 70 so as to update the model to improve DPI.

The planning software 20 is also capable of carrying out various other data manipulations to generate useful information. For example, as described above, there is often a statutory obligation to monitor dose data of the type described above, and this data is available in the dosimetry database 2. Typically data in the dosimetry database 2 will indicate doses of radiation to which a plurality of individuals have been exposed while carrying out a particular task at various times. Thus, this data can be used to track radiation doses over time. Assuming that the work done is the same, the radiation to which an individual is exposed should remain substantially the same. Therefore, any substantial change must indicate a change in environmental conditions, for example plant deterioration. Figure 14 is a graph showing how data representing dose data obtainable on fourteen different dates for an identical task can be plotted to show a time-based trend. In the example data of Figure 14, it can be seen that there is a consistent increase in dose from August 2002 to February 2003, thereby indicating deterioration. Thus, the present invention allows already available information to be used for a different but very valuable purpose.

It may be desired to monitor performance of individual employees relative to performance of other employees. Again, dosimetry data from the dosimetry database 2 can be used by the planning software 20 to enable such monitoring. Here, if the dosimetry database contains dose data for a plurality of individuals carrying out the

same task, these data items can be compared graphically, as indicated in Figure 15. Here it can be seen that while resources A, B, C and E all received a substantially equal dose of radiation in carrying out a particular task, resource D received a far higher dose. This raises questions over resource D's working patterns. For example, it may be that resource D works to different practices or procedures thereby exposing himself/herself to a greater dose. Alternatively, it may be that resource D is purposely exposing his/her EPD to a high dose of radiation so as to more quickly use up dose credit and therefore be allocated to light duties.

It will be appreciated that although some embodiments of the present invention described above have been concerned with monitoring radiation doses, the present invention is not restricted to monitoring radiation doses, but is instead generally applicable to monitoring doses of any contaminant to which individuals are exposed. Such contaminants include various chemicals which are emitted during various industrial processes.

It will be appreciated that the database tables illustrated in Figures 4a to 4c are simply exemplary. Different tables may be used in some embodiments of the invention, and indeed field names within those tables may also differ. It will further be appreciated that the screen shots of Figures 10 and 11 are also exemplary, and different graphical user interfaces may be used in some embodiments of the present invention.

Specific embodiments of the present invention have been described above, however it will be appreciated that various modifications can be made to the embodiments described above, and any such modifications which fall within the spirit and scope of the present invention are covered by the appended claims.

CLAIMS

1. A method for generating data indicating a degree of change within an installation, the change being indicated by increased release of a contaminant, the method comprising:

receiving as input a plurality of dose data items, each dose data item indicating a dose of the contaminant to which an individual has been exposed while carrying out a predetermined task at a time specified by that dose data item; and

processing said dose data items to generate output data indicative of a degree of change occurring within the installation between times specified by the dose data items.

2. A method according to claim 1, wherein said output data is graphical data.

3. A method according to claim 2, wherein said graphical data indicates a relationship between dose and time as represented by said plurality of dose data items.

4. A method according to claim 1, wherein processing said dose data comprises computing a rate of change of dose.

5. A method according to claim 4, wherein processing said dose data further comprises computing a reciprocal of said rate of change of dose.

6. A method according to any preceding claim wherein processing said dose data comprises:

summing doses indicated by dose data items within a first time period to generate first dose data;

summing doses indicated by dose data items within a second time period to generate second dose data; and

processing said first dose data and said second dose data to generate said output.

7. A method according to claim 6, wherein processing said first dose data and said second dose data further comprises:

dividing said first dose data by the number of dose data items in said first time period to generate first mean dose data;

dividing said second dose data by the number of dose data items in said second time period to generate second mean dose data; and

processing said first mean dose data and said second mean dose data to generate said output data.

8. A method for generating data indicating a degree of deterioration within an installation, the deterioration being indicated by increased release of a contaminant, the method comprising:

receiving as input first data indicative of exposure of a first plurality of individuals to the contaminant while carrying out a predetermined task during a first time period;

receiving as input second data indicative of exposure of a second plurality of individuals to the contaminant while carrying out the predetermined task during a second later time period;

processing said first and second data to generate third data indicative of a degree of change between said first time and said second time.

9. A method according to claim 8, wherein said third data is graphical data.

10. A method according to claim 9, wherein said graphical data indicates a relationship between said first data and said second data over time.

11. A method according to claim 7, wherein said third data represents a rate of change of exposure between said first time period and said second time period.

12. A method according to any preceding claim, wherein said contaminant is radiation.

13. A method according to claim 12, wherein said contaminant is a plurality of different types of radiation.

14. A data carrier carrying computer readable instructions for controlling a computer to carry out the method of any preceding claim.

15. An apparatus for generating data indicating a degree of deterioration within an installation comprising:

a program memory containing processor readable instructions; and

a processor configured to read and execute instructions stored in said program memory wherein said processor readable instructions comprise instructions configured to cause the processor to carry out the method of any one of claims 1 to 13.

16. A computer implemented method for generating data identifying an individual to carry out a task comprising:

storing first data indicating for each of a plurality of individuals, a dose of at least one contaminant to which each individual can be safely exposed;

storing second data indicating a predicted dose of the at least one contaminant to which an individual will be exposed in carrying out the task; and

processing said first data and said second data to generate output data indicating one of the plurality of individuals to carry out the task.

17. A method according to claim 16, further comprising:

storing a plurality of dose data items, each dose data item indicating a dose of the at least one contaminant to which one of the plurality of individuals has been exposed together with an associated time of exposure.

18. A method according to claim 17, further comprising:

receiving said plurality of dose data items from a dosimetry database.

19. A method according to claim 17 or 18, further comprising storing for each individual of said plurality of individuals total dose data indicating a dose of the at least one contaminant to which a respective individual can be exposed within a specified time period.
20. A method according to claim 19, further comprising generating said first data from said dose data items and said total dose data.
21. A method according to any one of claims 16 to 20 wherein processing said first data and said second data to generate said output data comprises:
- presenting said first data to a user;
 - presenting said second data to a user;
 - receiving user input in respect to presentation of said first data and said second, and said user input identifying an individual; and
 - generating said output data is response to said user input.
22. A method according to claim 21, wherein presenting said first data to a user comprises:
- processing said first data to identify individuals who can safely be exposed to said predicted dose of the contaminant; and
 - presenting first data relating to the identified individuals to the user.
23. A method according to claim 21 or 22, further comprising validating said user input to determine whether said first data for said identified individual is greater than or equal to said second data; and
- if said first data for said identified individual is not greater than or equal to said second data:
 - presenting an error message; and
 - prompting a user for further input.
24. A method according to any one of claims 16 to 21, wherein processing said first data and said second data to generate said output data comprises:

processing said first data to identify individuals of said plurality of individuals who can be safely exposed to said predicted dose; and

selecting an individual from said identified individuals, said selected individual being indicated by said output data.

25. A method according to any one of claims 16 to 21, further comprising:
storing second data indicating a predicted doses of at least one contaminant to which an individual will be exposed in carrying out a plurality of different tasks.

26. A method according to claim 25, wherein said output data indicates a respective one of the plurality of individuals to carry out each of said plurality of different tasks.

27. A method according to any one of claims 16 to 26, wherein said contaminant is radiation.

28. A method according to claim 27, wherein said contaminant is a plurality of different types of radiation.

29. A data carrier carrying computer readable instructions for controlling a computer to carry out the method of any one of claims 16 to 28.

30. An apparatus for generating data indicating a degree of deterioration within an installation comprising:

a program memory containing processor readable instructions; and

a processor configured to read and execute instructions stored in said program memory wherein said processor readable instructions comprise instructions configured to cause the processor to carry out the method of any one of claims 16 to 28.

31. A project planning method, comprising:

retrieving from a dosimetry database at least one dose data item for each of a plurality of individuals, each dose data item indicating a dose of a contaminant to which a respective individual has been exposed;

storing safe dose data indicating a total dose of said contaminant to which each of a plurality of individuals can be safely exposed;

computing from said dose data items and said safe dose data dose credit data indicating a dose of said contaminant to which each of the plurality of individuals can be safely exposed;

retrieving from a task database task data indicating a predicted dose of the contaminant to which an individual will be exposed when carrying out a plurality of tasks;

receiving data indicating at least some of said plurality of tasks;

processing said task data for said at least some of said plurality of tasks and said dose credit data for said plurality of individuals to select one of said plurality of individuals to carry out each of said at least some of said plurality of tasks.

32. A method of comparing performance of a plurality of individuals carrying out a task comprising:

receiving as input, first data indicative of exposure of a first individual to a contaminant while carrying out the task;

receiving as input, second data indicating exposure of other individuals to the contaminant while carrying out the task; and

processing said first data and said second data to generate output data indicative of performance of the first individual relative to said other individuals.

33. A method according to claim 32, wherein said output data is graphical data.

34. A method according to claim 33, wherein said graphical data represents exposure of said first individual and each of said other individuals to the contaminant.

35. A method according to claim 32, wherein processing said first and second data comprises:

computing mean data indicating mean exposure of said other individuals to the contaminant while carrying out the task.

36. A method according to claim 36, wherein said output data comprises:

graphical data representing said first data; and

graphical data representing said mean data.

37. A data carrier carrying computer readable instructions for controlling a computer to carry out the method of any one of claims 32 to 36.

38. An apparatus for generating data indicating a degree of deterioration within an installation comprising:

a program memory containing processor readable instructions; and

a processor configured to read and execute instructions stored in said program memory wherein said processor readable instructions comprise instructions configured to cause the processor to carry out the method of any one of claims 32 to 36.

39. A method of generating comparison data indicative of performance within a industrial installation in which a plurality of individuals are exposed to a contaminant, comprising:

receiving as input prediction data indicating a predicted quantity of the contaminant to which each individual will be exposed;

receiving as input monitor data indicating the quantity of the contaminant to which each individual is exposed; and

generating comparison data indicating a comparison between said prediction data and said monitor data.

40. A method according to claim 39, wherein generating said comparison data comprises:

computing a ratio of said monitor data to said prediction data.

41. A method according to claim 39, wherein generating said comparison data comprises:

dividing said prediction data by said monitor data.

42. A method according to claim 41, further comprising analysing said performance data to generate a performance indicator.

43. A method according to claim 42, wherein optimal performance is indicated by comparison data approximately equal to one.

44. A method according to any one of claims 39 to 43, further comprising:
generating said prediction data from a model of said industrial installation.

45. A method according to claim 44, further comprising:
generating model data representing said model of the said industrial installation.

46. A method according to claim 45, further comprising:
comparing said comparison data with a predetermined criterion; and
generating modified model data in response to said comparison.

47. A data carrier carrying computer readable instructions for controlling a computer to carry out the method of any one of claims 39 to 46.

48. An apparatus for generating data indicating a degree of deterioration within an installation comprising:

a program memory containing processor readable instructions; and

a processor configured to read and execute instructions stored in said program memory wherein said processor readable instructions comprise instructions

configured to cause the processor to carry out the method of any one of claims 39 to 46.

49. A method of generating comparison data indicative of performance within a industrial installation in which a plurality of tasks expose individuals to a contaminant, the method comprising:

receiving as input a plurality of prediction data items, each predication data item indicating a predicted quantity of the contaminant to which an individual will be exposed when carrying out one of said plurality of tasks;

receiving as input a plurality of monitor data items, each monitor data item indicating a monitored quantity of the contaminant to which an individual has been exposed in carrying out a specified one of said plurality of tasks; and

generating comparison data indicating a comparison between prediction data items and monitor data items for at least one of said plurality of tasks.

50. A method according to claim 49, wherein generating said comparison data comprises:

computing a ratio of said monitor data items to said prediction data items for the at least one task.

51. A method according to claim 49 or 50, further comprising analysing said comparison data to generate a performance indicator.

52. A method according to claim 51, wherein optimal performance is indicated by comparison data approximately equal to one.

53. A method according to claim 51 or 52, wherein magnitude of the comparison data is inversely proportional to performance.

54. A method according to any one of claims 51 to 53, further comprising:
generating said prediction data from a model of said industrial installation.

55. A method according to claim 54, further comprising:
generating model data representing said model of the said industrial installation.
56. A method according to claim 55, further comprising:
comparing said comparison data with a predetermined criterion; and
generating modified model data in response to said comparison.
57. A data carrier carrying computer readable instructions for controlling a computer to carry out the method of any one of claims 49 to 56.
58. An apparatus for generating data indicating a degree of deterioration within an installation comprising:
a program memory containing processor readable instructions; and
a processor configured to read and execute instructions stored in said program memory wherein said processor readable instructions comprise instructions configured to cause the processor to carry out the method of any one of claims 50 to 56.

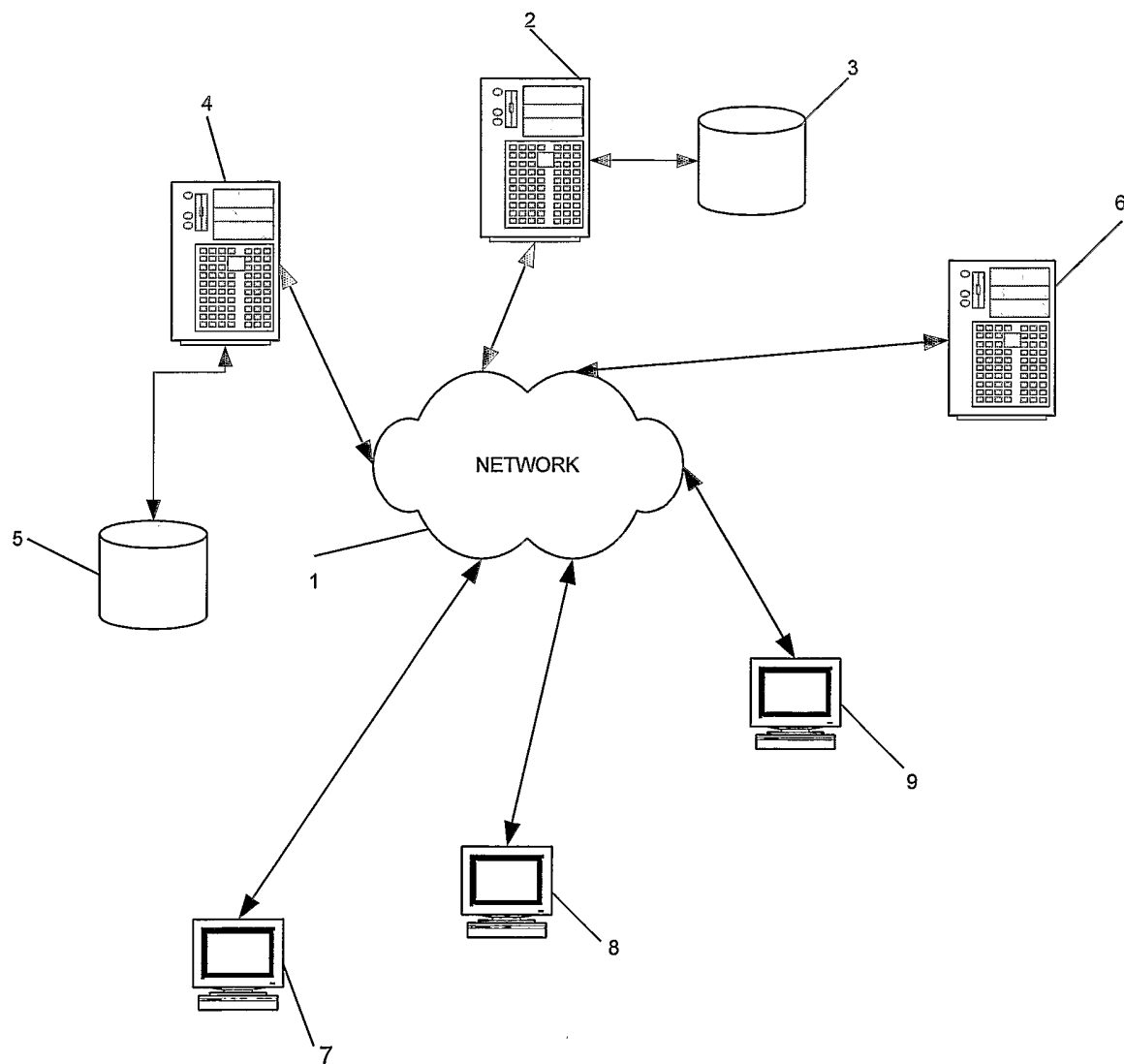


FIG 1

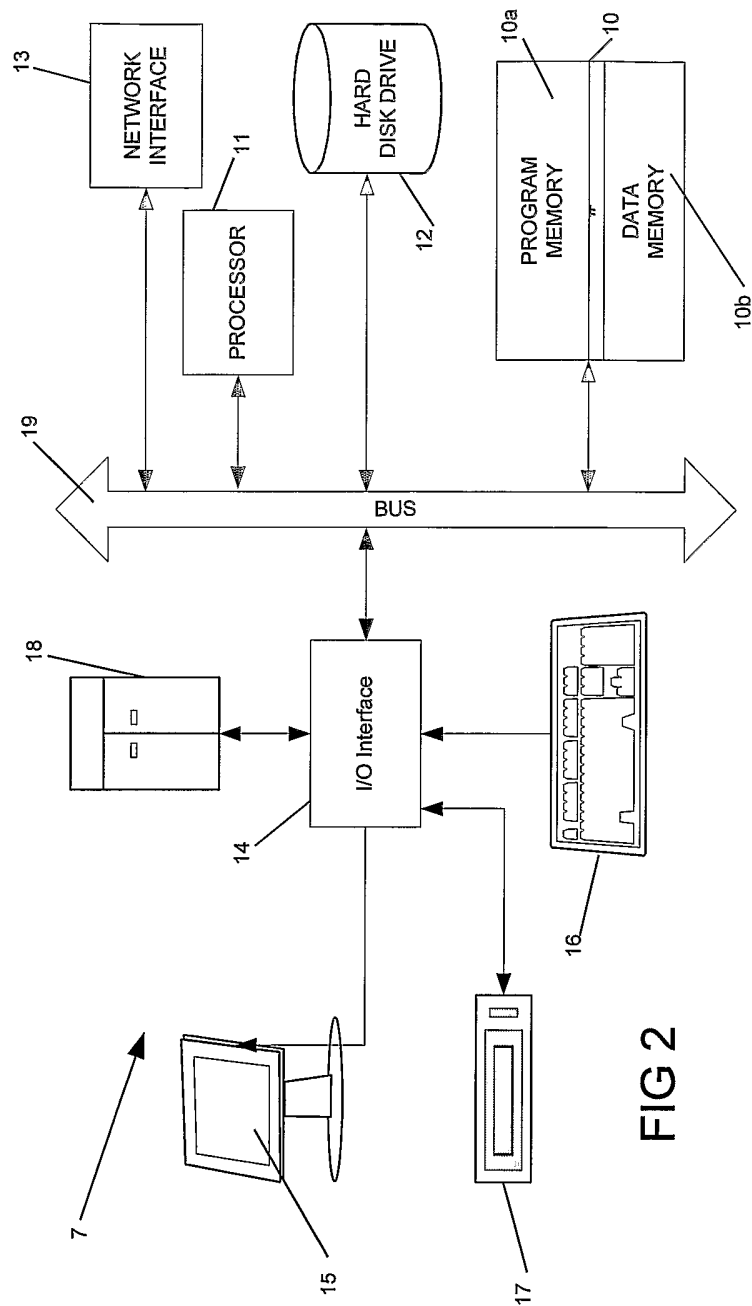


FIG 2

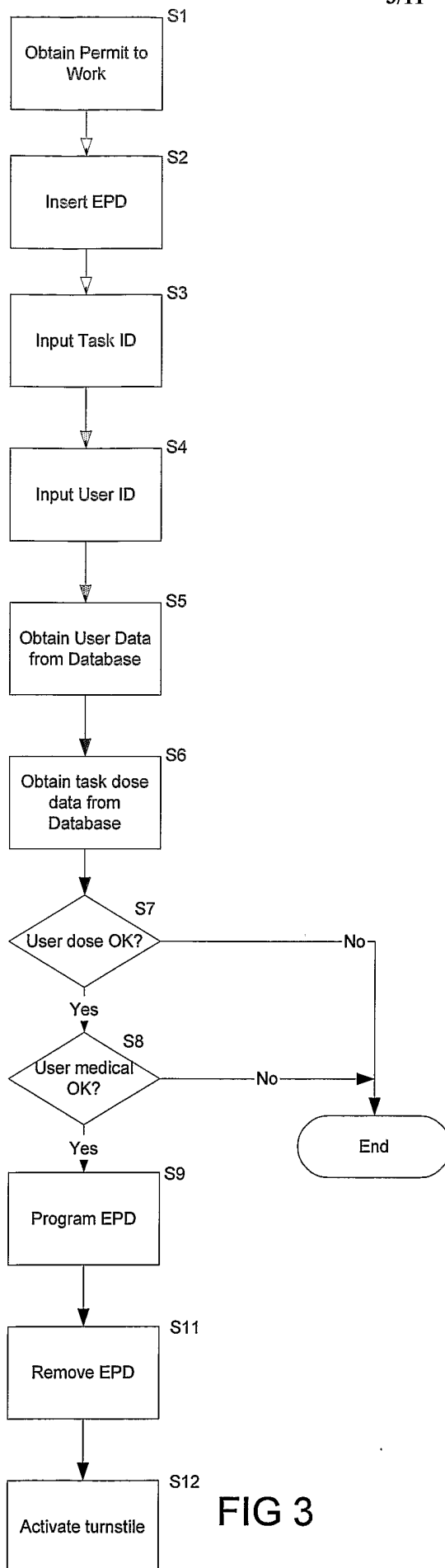


FIG 3

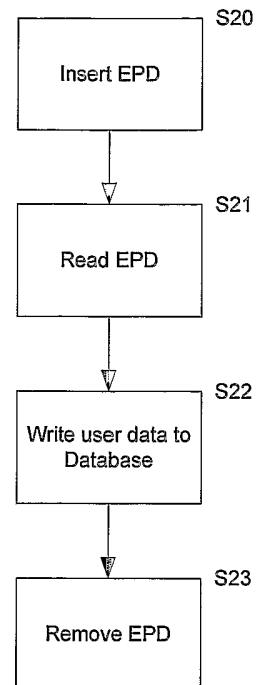


FIG 6

USER
USER ID USER NAME DOB NI NUMBER LASTMEDICAL DOSE IDS DOSE CREDIT

FIG 4A

DOSE
DOSE ID USER ID HARD GAMMA SOFT GAMMA FULL BETA COMPRESSED BETA

FIG 4B

DOSE CREDIT
USER ID HARD GAMMA SOFT GAMMA FULL BETA COMPRESSED BETA

FIG 4C

TASK
TASK ID PRED HARD GAMMA PRED SOFT GAMMA PRED FULL BETA PRED COMPRESSED BETA ALARMLEVEL

FIG 5

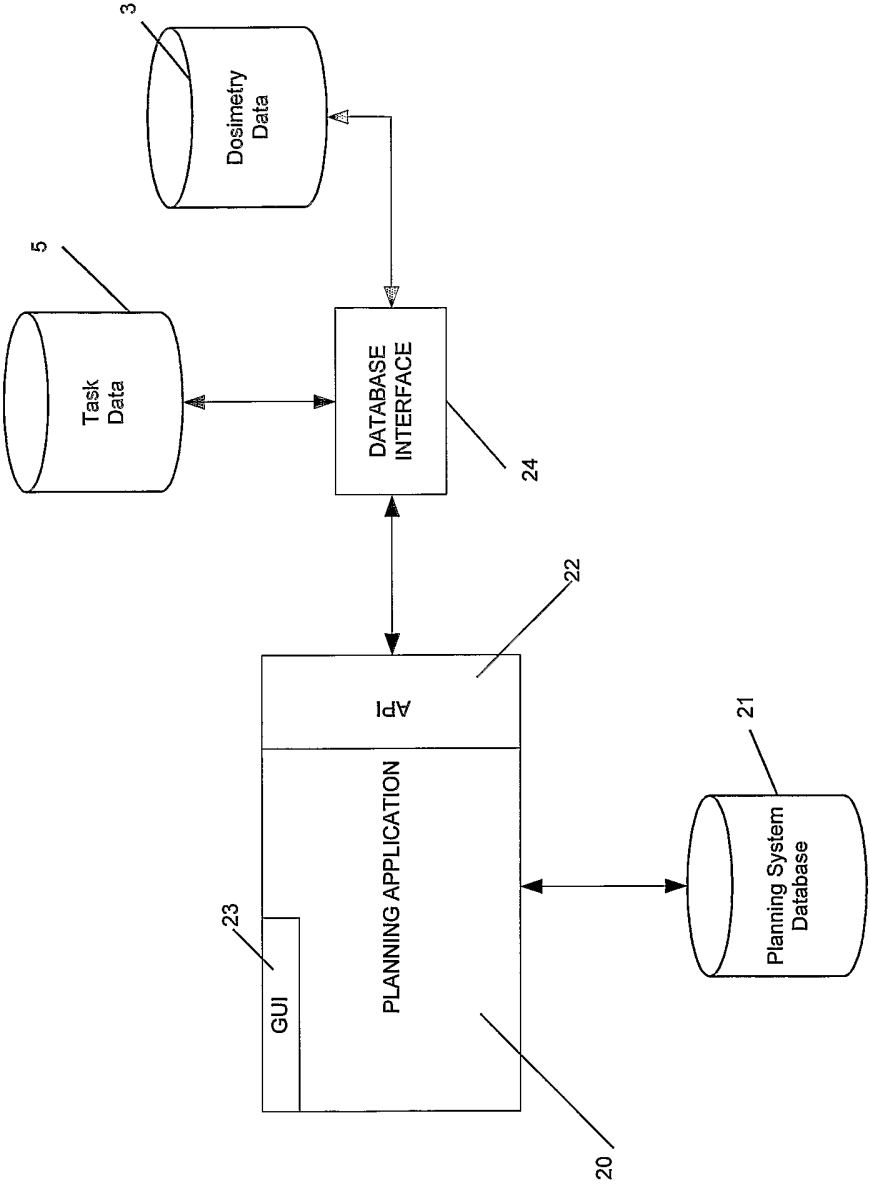


FIG 7

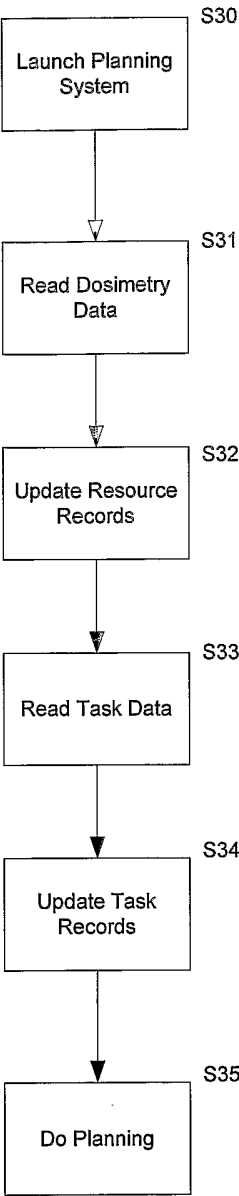


FIG 8

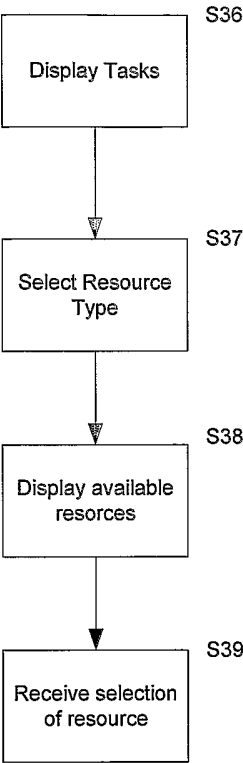


FIG 9

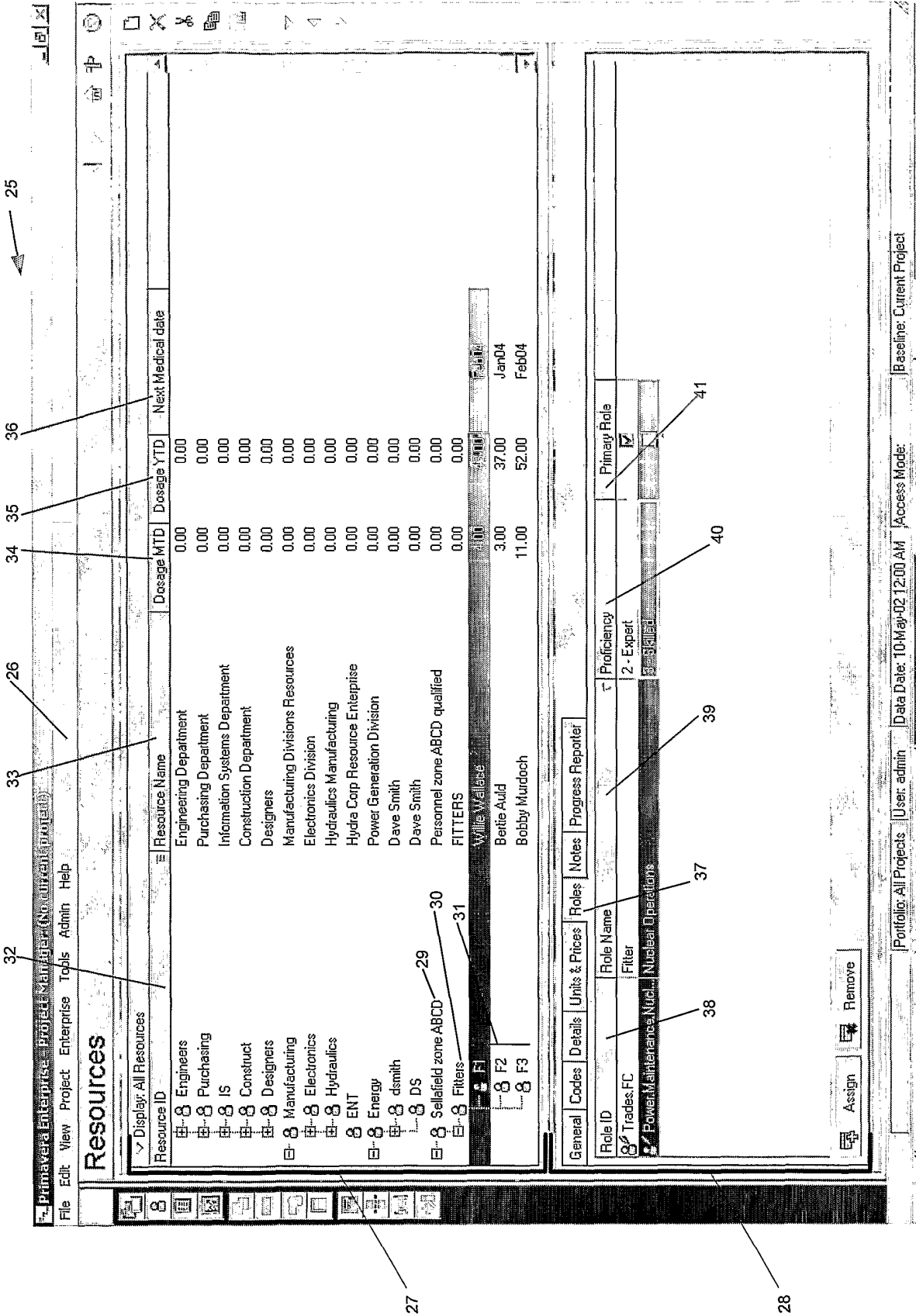


FIG 10

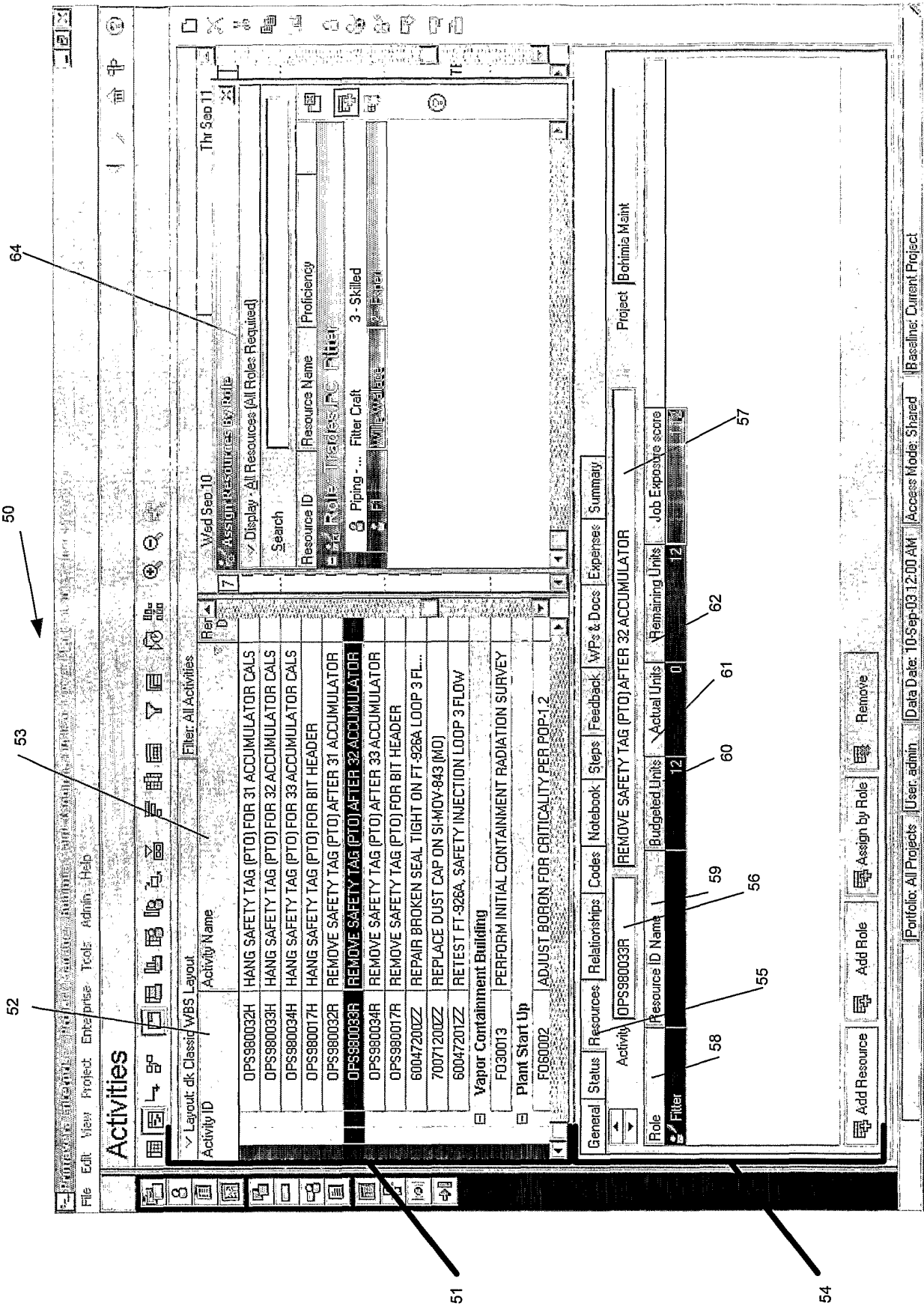


FIG 11

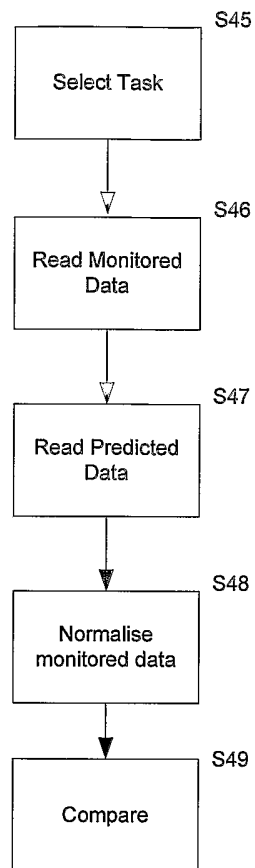


FIG 12

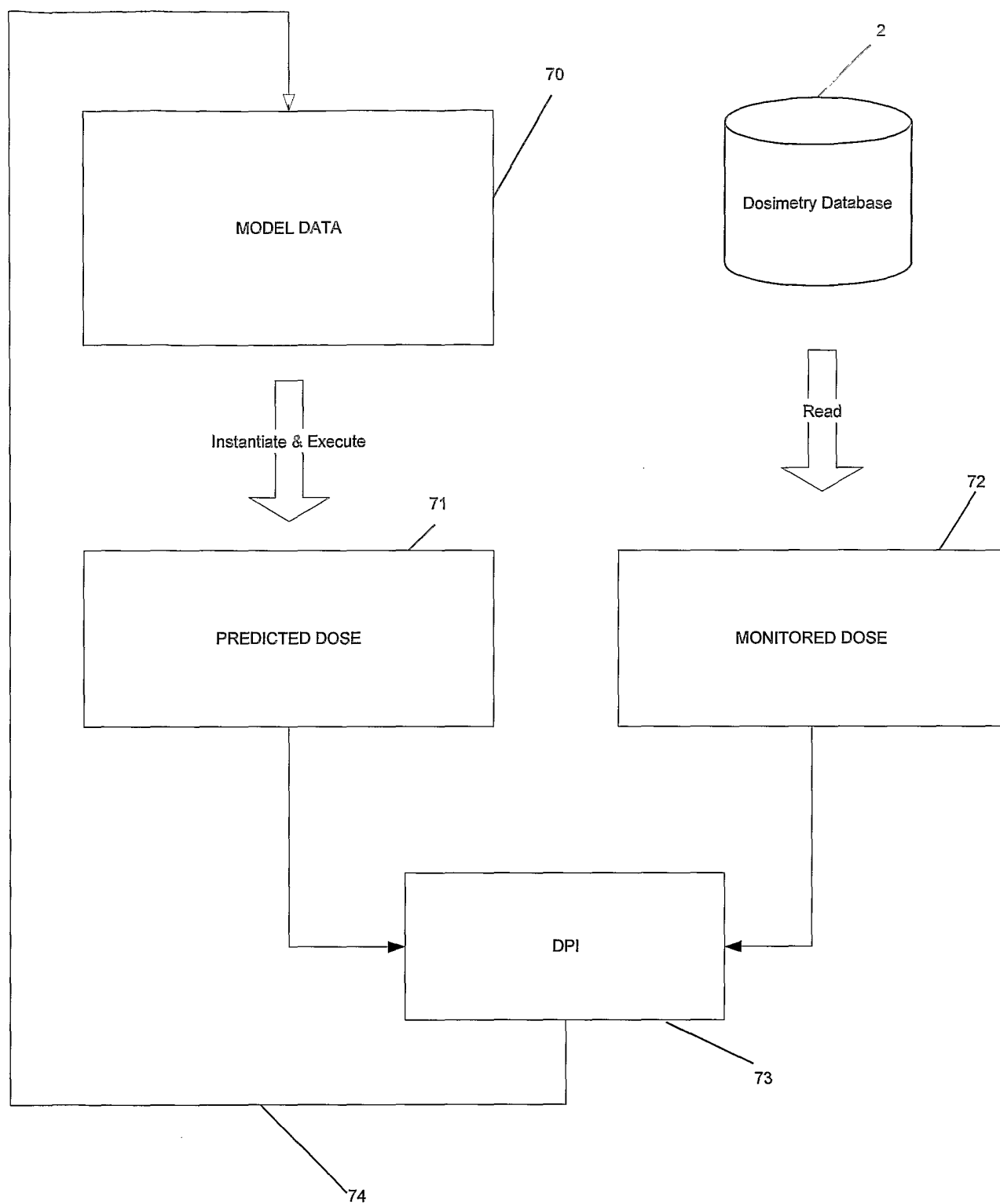


FIG 13

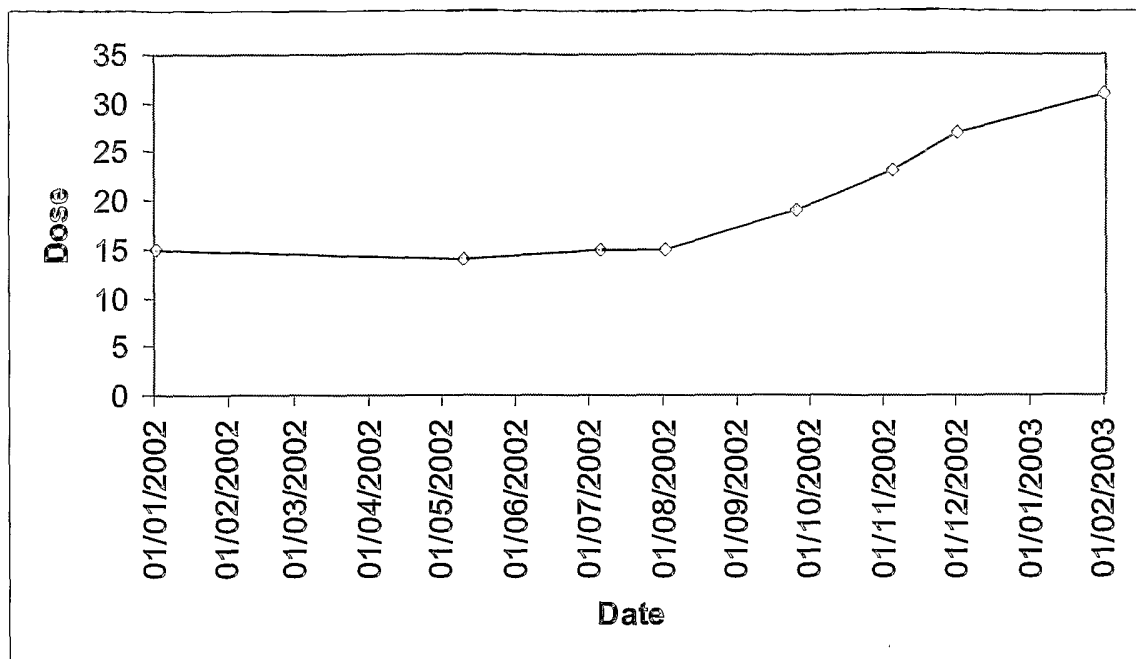


FIG 14

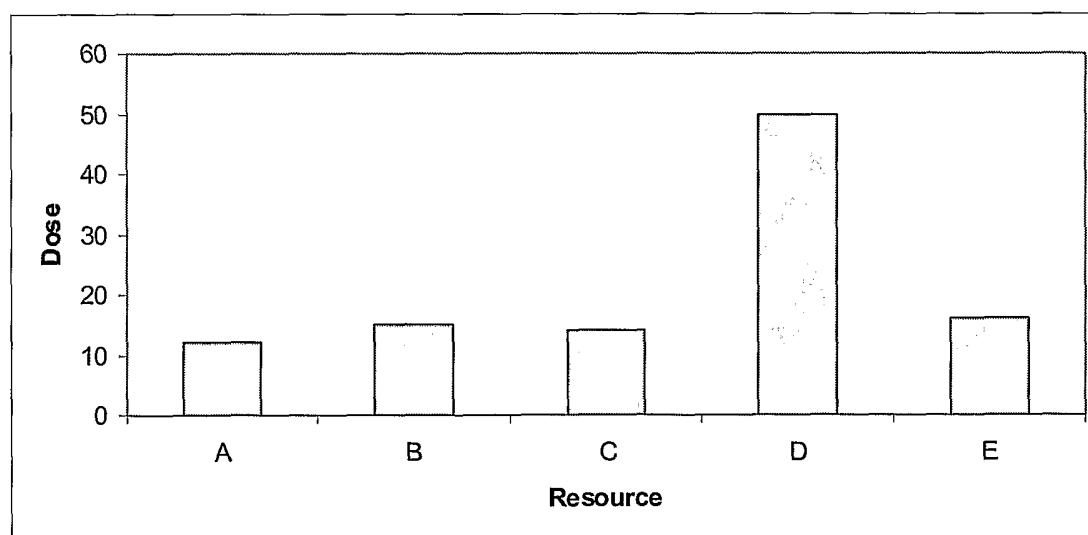


FIG 15