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**A DATABASE STRUCTURE FOR
RADIOLOGICAL OPTIMIZATION ANALYSES
OF DECOMMISSIONING OPERATIONS**

Theo Zeevaert, Bartel Van de Walle

SCK•CEN

Radiation Protection Research Unit

B-2400 Mol (Belgium)

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Introduction

Radiological optimization is a major radiation protection principle in practices and interventions, involving radiological protection factors, economical costs, social factors etc. In the domain of decommissioning of NPP (nuclear power plants) an important lack of knowledge exists with respect to these factors, due to the low number of decommissioning operations already performed and enhanced by the fact that decommissioning happens only once for each installation.

Tasks, techniques and procedures are mostly rather specific, limiting the use of past experiences in the radiological optimization analyses of new decommissioning operations. Therefore it is important that relevant data or information be acquired from decommissioning experiences and stored in a database in a way that they can be used efficiently in ALARA analyses of future decommissioning activities.

At the radiation protection research unit of the SCK•CEN, a structure for such a database has been elaborated and is described in this report.

Principles

The aim of the SCK•CEN database DECOM is to store data from past decommissioning experiences, enabling the quantification of relevant attributes (radiological protection factors) in ALARA analyses of comparable decommissioning operations. Relevant attributes in this respect are:

- radiological attributes such as:
 - collective doses
 - individual dose distributions
 - radiological waste risks
- economical attributes such as:
 - labour costs
 - equipment costs (investment)
 - consumable costs
 - waste costs.

The values of the elements determining the attributes will not only depend on the operation or task considered but also on the conditions under which the operation is executed. Consequently they have to be specified in terms of conditions they are related to, which may enable the determination of normalised values (with relation to reference units), facilitating the derivation of values for other conditions (see also section "Application").

The elements and association conditions are to be arranged in fields or cels of a database system with a view to the application in multi-criteria analyses.

The major requirements concerning the structure of the database are therefore:

simplicity

transparency

easy access to all data

a logical relational structure, enabling the data to be stored at only one place in the database.

In order to meet these requirements, the database has been developed in MS-ACCESS (version 2.0), a relational database system under Windows. The data are grouped in several tables in a logical way. The tables are interrelated in such a way that duplication of data is avoided. Each record of a table is unambiguously identified by a unique combination of so-called primary key values (identification fields). Links (or joins) between the tables are created by using the same primary keys in tables that are to be related.

Description

Following tables were determined (see also Table 1):

- the table *Tasks*, which is the principal table, containing specifications of the tasks performed and the techniques applied. In this table, following Task Types may be considered: Decommissioning, Dismantling, Decontamination, Waste Management and Site Restoration (Evacuation, Demolition of Buildings). This table also contains reference values in order to normalize data determining radiological protection factors. It is linked with the table *Objects* through the identification number of the objects (Object ID);
- the table *Objects*, containing information concerning the objects on which, and the workplaces where the tasks are performed. This table also contains characteristics (of the objects) against which values of elements determining radiological protection factors may

be normalized. It is linked with the table *Installation* through the identification number of the installations (Installation ID);

- the table *Installation*, identifying the installation (type, name, address) where tasks are performed or to which the object belongs;
- the table *Labour/Dose*, storing the labour times (per qualification group of workers) and the doses of the individual workers having executed the tasks. Distinction is made between variable labour times and doses on one hand and fixed labour times and doses on the other hand, referring to labour times and doses that are either proportional to the work volume or independent on it. This table is linked with the table *Tasks* through the identification number of the task (Task ID) and with the table *Personnel* through the identification number of the individual workers or group of workers (Individual ID);
- the table *Personnel*, identifying the individual workers or group of workers and linked with the table *Qualification* through the identification number of the qualification of the workers (Qualification ID);
- the table *Qualification*, specifying the qualification and wages (unit costs) of the workers;
- the table *Suppl_Coll_Dose*, collecting doses respectively labour times which could not be assigned to a specific individual worker respectively group of individual workers with the same qualification, and that are to be taken into account for calculating collective doses and total labour times. For that purpose the doses and labour times in this table are to be associated with arbitrary individual workers. This table is linked with the table *Tasks* through the identification number of the task (Task ID) and with the table *Personnel* through the identification number of the individual workers or group of workers (Individual ID);
- the tables *Equipment*, *Consumables*, and *Wastes*, containing characteristics and unit costs of equipment, consumables and waste types (secondary or tertiary);
- the tables *Equipm_in_Tasks*, *Cons_in_Tasks* and *Waste_in_Tasks*, containing the amount of equipment, consumables and waste types used or produced in each task. The tables are linked with the tables *Equipment*, *Consumables* and *Waste* through the identification number of the equipment (Equipment ID), the consumables (Consumable ID) and waste types (Waste ID) and with the table *Task* through the identification number of the task (Task ID).

In a first approach, fields were determined and data introduced, based on dismantling operations carried out at BR3 (SCK•CEN). In a second phase the possibility of importing data from other databases has been investigated. A database in the EC Decommissioning Programme (Working Group C in DG XII), DB-COST appeared to be very valuable for our purposes. This database has been developed and implemented by NIS (Hanau, Germany), assisted by CEA (Marcoule, France) and BNFL (Sellafield, UK). It is a very comprehensive database, containing valuable information including specific values on costs and wastes related to reference values. DB-COST is developed in the relational ORACLE database management system. In order to import data from DB-COST into our database DECOM, the former has been converted into a MS-ACCESS version and the fields with data or information relevant for our purposes were selected and appended to fields in DECOM.

Precedingly field formats and records had to be adapted and additional fields to be created in both databases in order to adapt data in DB-COST to conditions and units in DECOM and vice versa.

As a result the final version of database (structure) DECOM was realized as shown in Table 1.

The essential properties (characteristics) of the fields are listed in Table 2. The fields may be of different *types*: Text, Number (Integer: 2 bytes / Single: 4 bytes ...), Logical, Dates, Memo, Currency, Counter, OLE object. The *size* of the fields is indicated in bytes for Numbers and in characters for Text. The *source table* refers to the table the data are originating from (in this database: always the table, the data are in). The *description* gives the definition of the data field. The *format*, which is specified for a number data type in this database, has been given following settings:

- General Number, which displays the number as entered;
- Standard, which uses thousand separator and 2 decimal places;
- Scientific, which applies standard scientific notation.

Application

From the data in the tables, values of attributes for radiological optimization analysis of comparable decommissioning operations may be derived through the use of proper queries. When deriving values of attributes for a specific operation from those for a similar operation on a comparable object, normalized values of the attributes must be considered, i.e. values per unit of measure of the characteristic(s) on which the comparison is based. For a cutting operation, for instance, such a reference characteristic may be the surface area of the cuts. Normalized values of the attributes are then expressed per unit cutting surface area.

As an example the cutting of the thermal shield of the BR3 reactor at SCK•CEN is considered, for which three different techniques have been applied. The purpose of this application is to determine the most suitable cutting technique with respect to the attributes indicated in the "Principles" section above. Since the techniques were applied to different parts of the operation, normalized values (per unit of surface area cut) must be calculated. Fixed and variable values of doses and costs must be considered separately. Indeed, fixed values are associated with the whole operation, while variable values only result from the part of the operation performed by the technique considered. Hence, the reference value for the fixed doses and labour costs and for the equipment (investment) costs is the whole cutting surface area of the thermal shield, whilst the reference values for the variable doses and labour costs and for the consumables and secondary waste costs are the technique-related cutting surface areas. These reference values are calculated in the *Global_Surface* and *Total_Surface_Technique* select queries. The normalized attributes values are calculated per technique type in crosstab queries, the design of which is shown in Table 3. The tables and select queries involved and the joins between them are shown as well as the equations of the calculations. Outer (directional) joins are used in the *Total_Coll_Dose* query (collective doses) in order to include all dose values (from the *Labour/Dose* and *Suppl_Coll_Dose* tables) and each value only once.

Table 1: Tables and Fields of the database DECOM (final version)

Tasks	Labour/Dose	Equipment
Task ID*	Task ID	Equipment ID*
Task Type*	Individual ID	Equipment Name*
Technique Type*	Fixed Dose	Kerf width
Technique Specification*	Variable Dose	Cutting step
Object ID	Fixed Labour Time	Execution speed
Job Period	Variable Labour Time	Equipment Cost*
Refvalki*(1)		Totalnac*(1)
Reference Value*		
Refeunit*(1)		
Number of elementary tasks		Equipm_in_Tasks
Task Description*		Task ID*
		Equipment ID*
		Number of equipment*
Objects	Suppl_Coll_Dose	
Object ID	Task ID*	
Object Name	Fixed Coll. Dose*	
Installation ID	Variable Coll. Dose	Consumables
Ambient Dose Rate	Fixed Labour Time*	Consumable ID*
Air Contamination	Variable Labour Time	Consumable Name*
Object Type	Individual ID*	Composition
Activity Type		Application
Activity Concentration		Diameter Cons
Material Type		Thickness Cons
Object shape/form	Personnel	Length/Height Cons
Object mass	Individual ID*	Volume Cons
Object volume	Qualification ID*	Unit Cons Cost*
Object thickness	Persnumb*(1)	Tconsnac*(1)
Object diameter	(Firm)	
Object height/length	(Name)	
	Qualifications	Cons_in_Tasks
	Qualification ID*	Task ID*
	Qualification Description*	Consumable ID*
	Qualification Unit Cost	Amount Cons*
Installation		
Installation ID		Waste
Installation Type		Waste ID*
Installation Name*		Waste Type*
Installation Part		Package Form*
Institution Name		Caskvolu*(1)
City		Unit Waste Cost*
Country*		Currency*(1)
		Waste_in_Tasks
		Task ID*
		Consumable ID*
		Waste ID*
		Amount Waste*
		Swamount*(1)
		Swamunit*(1)
		Material Collected
		Activity

(1) Fields imported from DB-COST.

* Fields in which data or information were appended from DB-COST.

Table 2: Field properties of the tables of the database DECOM

Table 2.1	Tasks
Table 2.2	Objects
Table 2.3	Installation
Table 2.4	Dose/labour
Table 2.5	Personnel
Table 2.6	Qualifications
Table 2.7	Equipment
Table 2.8	Consumables
Table 2.9	Waste
Table 2.10	Equipm_In_Tasks
Table 2.11	Cons_In_Tasks
Table 2.12	Waste_In_Tasks
Table 2.13	Suppl_Coll_Dose

Table 2.1

<hr/> Tasks <hr/>		
<i>Name</i>	<i>Type</i>	<i>Size</i>
TASK ID	Number (Integer)	2
Source Table: Tasks		
Description: Task Identification		
Format: General Number		
TASK TYPE	Text	80
Source Table: Tasks		
Description: Working Package		
TECHNIQUE TYPE	Text	50
Source Table: Tasks		
Description: Type of technique		
TECHNIQUE SPECIFICATION	Text	50
Source Table: Tasks		
Description: Specific technique		
OBJECT ID	Number (Integer)	2
Source Table: Tasks		
Description: Object Identification		
Format: General Number		
JOB PERIOD	Number (Integer)	2
Source Table: Tasks		
Description: Year of job		
Format: General Number		

REFVALKI Text 40

Source Table : Tasks

Description : Name of reference value

REFERENCE VALUE Number(Single) 4

Source Table: Tasks

Description : Reference Value

Format : General Number

REFEUNIT Text 10

Source Table : Tasks

Description : Unit of reference value

NUMBER OF ELEMENTARY TASKS Number (Single) 4

Source Table: Tasks

Description: Number of elementary tasks per task identified

Format: General Number

TASK DESCRIPTION Memo

Source Table: Tasks

Description: Description of the task

Table 2.2

<hr/> Objects <hr/>		
<i>Name</i>	<i>Type</i>	<i>Size</i>
OBJECT ID	Number (Integer)	2
Source Table: Objects		
Description: Object identification		
Format: General Number		
OBJECT NAME	Text	50
Source Table: Objects		
Description: Name of the object		
INSTALLATION ID	Number(Integer)	2
Source Table: Objects		
Description: Installation identification		
Format: General Number		
AMBIENT DOSE RATE	Number (Single)	4
Source Table: Objects		
Description: Ambient dose rate (microSv/h)		
Format: Standard		
AIR CONTAMINATION	Number (Single)	4
Source Table: Objects		
Description: Air contamination (Bq/cubic dm)		
Format: Standard		

OBJECT TYPE Text 50

Source Table: Objects

Description: Single Component; Assembly; Structure; System

ACTIVITY TYPE Text 50

Source Table: Objects

Description: Activation; Not Removable Contamination; Removable Contamination; Not Radioactive

ACTIVITY CONCENTRATION Number (Single) 4

Source Table: Objects

Description: Radioactivity concentration of the object (Bq per cubic dm for activation; Bq per square dm for contamination)

Format: Scientific

MATERIAL TYPE Text 50

Source Table: Objects

Description: Type of material

OBJECT SHAPE/FORM Text 50

Source Table: Objects

Description: Shape or form of the object

OBJECT MASS Number (Single) 4

Source Table: Objects

Description: Mass of the object (kg)

Format: Scientific

OBJECT VOLUME Number(Single) 4

Source Table: Objects

Description: Volume of the object (cubic dm)

Format: Scientific

OBJECT THICKNESS Number (Single) 4

Source Table: Objects

Description: Thickness of the object (mm)

Format: General Number

OBJECT DIAMETER Number (Single) 4

Source Table: Objects

Description: Diameter of sphere or cylinder (m)

Format: General Number

OBJECT HEIGHT Number (Single) 4

Source Table: Objects

Description: Height/Length of the object (m)

Format: General Number

Table 2.3

Installation		
<i>Name</i>	<i>Type</i>	<i>Size</i>
INSTALLATION ID	Number (Integer)	2
Source Table: Installation Description: Identification of the installation Format: General Number		
INSTALLATION TYPE	Text	50
Source Table: Installation Description: Type of the installation		
INSTALLATION NAME	Text	50
Source Table: Installation Description: Name of the installation		
INSTALLATION PART	Text	50
Source Table: Installation Description: Part of the installation		
INSTITUTION NAME	Text	50
Source Table: Installation Description: Name of the institution the installation belongs to		
CITY	Text	50
Source Table: Installation Description: Installation address: City		
COUNTRY	Text	50
Source Table: Installation Description: Installation address: Country		

Table 2.4

Labour/Dose		
<i>Name</i>	<i>Type</i>	<i>Size</i>
TASK ID	Number (Integer)	2
Source Table:	Labour/Dose	
Description:	Task identification	
Format:	General Number	
INDIVIDUAL ID	Number (Integer)	2
Source Table:	Labour/Dose	
Description:	Individual identification	
Format:	General Number	
FIXED DOSE	Number (Single)	4
Source Table:	Labour/Dose	
Description:	Fixed dose per individual and task specified (mSv)	
Format:	Standard	
VARIABLE DOSE	Number (Single)	4
Source Table:	Labour/Dose	
Description:	Variable dose per individual and task specified (mSv)	
Format:	Standard	
FIXED LABOUR TIME	Number (Single)	4
Source Table:	Labour/Dose	
Description:	Fixed working time per individual and task specified (h)	
Format:	Standard	
VARIABLE LABOUR TIME	Number (Single)	4
Source Table:	Labour/Dose	
Description:	Variable working time per task specified (h)	
Format:	Standard	

Table 2.5

Personnel		
<i>Name</i>	<i>Type</i>	<i>Size</i>
INDIVIDUAL ID	Number (Integer)	2
Source Table: Personnel Description: Individual identification Format: General Number		
QUALIFICATION ID	Number (Integer)	2
Source Table: Personnel Description: Qualification of personnel involved Format: General Number		
PERSNUMB	Number (Integer)	
Source Table : Personnel Description : Number of personnel		
FIRM	Text	50
Source Table: Personnel Description: Firm the individual belongs to (Optional)		
NAME	Text	50
Source Table: Personnel Description: Name of the the individual (Optional)		

Table 2.6

<hr/> Qualifications <hr/>		
<i>Name</i>	<i>Type</i>	<i>Size</i>
QUALIFICATION ID	Number (Integer)	2
Source Table: Qualifications		
Description: Identification of qualification		
Format: General Number		
QUALIFICATION DESCRIPTION	Text	50
Source Table: Qualifications		
Description: Description of qualification		
QUALIFICATION UNIT COST	Number (Single)	4
Source Table: Qualifications		
Description: Cost of unit manpower (kBF/h)		
Format : Standard		

Table 2.7

Equipment		
<i>Name</i>	<i>Type</i>	<i>Size</i>
EQUIPMENT ID	Number (Integer)	2
Source Table: Equipment Description: Equipment identification Format: General Number		
EQUIPMENT NAME	Text	50
Source Table: Equipment Description: Name of equipment		
KERF WIDTH	Number (Single)	4
Source Table: Equipment Description: Width of the kerf in mm (for cutting equipment only) Format: Standard		
CUTTING STEP	Number (Single)	4
Source Table: Equipment Description: Depth of cutting in mm in one step (for cutting equipment only) Format: Standard		
EXECUTION STEP	Number (Single)	4
Source Table: Equipment Description: Surface area treated or cut in square dm per hour Format: Standard		
EQUIPMENT COST	Number (Single)	4
Source Table: Equipment Description: Cost of the equipment Format: Standard		

TOTALNAC

Text

10

Source Table : Equipment

Description: Currency of cost

Table 2.8

Consumables		
<i>Name</i>	<i>Type</i>	<i>Size</i>
CONSUMABLE ID	Number (Integer)	2
Source Table: Consumables		
Description: Consumable identification		
Format: General Number		
CONSUMABLE NAME	Text	50
Source Table: Consumables		
Description: Name, Specification of the consumable considered		
COMPOSITION CONS	Text	50
Source Table: Consumables		
Description: Parts, Material(s) the consumable is composed or made of		
APPLICATION CONS	Text	50
Source Table: Consumables		
Description: Process in which consumable is used		
DIAMETER CONS	Number (Single)	4
Source Table: Consumables		
Description: Maximum diameter of consumable in mm (If relevant; otherwise 0)		
Format: Standard		
THICKNESS CONS	Number (Single)	4
Source Table: Consumables		
Description: Thickness of consumable in mm (If relevant; otherwise: 0))		
Format : Standard		
LENGTH/HEIGHT CONS	Number (Single)	4
Source Table: Consumables		
Description: Total length/height of consumable in m (If relevant; otherwise: 0)		
Format: Standard		

VOLUME CONS Number (Single) 4

Source Table: Consumables

Description: Total volume of consumable in cubic dm (with package)

Format: Standard

UNIT COST CONS Number (Single) 4

Source Table: Consumables

Description: Cost per consumable unit

Format : Standard

TCONSAC Text 10

Source Table: Consumables

Description: Currency of cost

Table 2. 9

Waste		
<i>Name</i>	<i>Type</i>	<i>Size</i>
WASTE ID	Number (Integer)	2
Source Table: Waste		
Description: Wastetype + package form identification		
Format: General Number		
WASTE TYPE	Text	60
Source Table: Waste		
Description: Type of waste considered		
PACKAGE FORM	Text	50
Source Table: Waste		
Description: Form unit in which waste of each type is packaged		
CASKVOLU	Number(Double)	
Source Table: Waste		
Description : Volume per package (square m)		
UNIT WASTE COST	Number (Single)	4
Source Table: Waste		
Description: Cost of waste evacuation per form unit (kBF)		
Format: Standard		
CURRENCY	Text	5
Source Table: Waste		
Description : Currency of cost		

Table 2.10

Equipm_In_Tasks

<i>Name</i>	<i>Type</i>	<i>Size</i>
TASK ID	Number (Integer)	2
Source Table: Equipm_in_Tasks		
Description: Task identification		
Format: General Number		
EQUIPMENT ID	Number (Integer)	2
Source Table: Equipm_in_Tasks		
Description: Equipment identification		
Format: General Number		
NUMBER OF EQUIPMENT	Number (Single)	4
Source Table: Equipm_in_Tasks		
Description: Amount of equipment used in task indicated		
Format: General Number		

Table 2.11

Cons_In_Tasks		
<i>Name</i>	<i>Type</i>	<i>Size</i>
TASK ID	Number (Integer)	2
Source Table: Cons_in_Tasks		
Description: Task identification		
Format: General Number		
CONSUMABLE ID	Number (Integer)	2
Source Table: Cons_in_Tasks		
Description: Consumable identification		
Format: General Number		
AMOUNT CONS	Number (Single)	4
Source Table: Cons_in_Tasks		
Description: Number of consumables used in task		
Format: General Number		

Table 2.12

Waste_in_Tasks		
<i>Name</i>	<i>Type</i>	<i>Size</i>
TASK ID	Number (Integer)	2
Source Table: Waste_in_Tasks		
Description: Task identification		
Format: General Number		
CONSUMABLE ID	Number (Integer)	2
Source Table: Waste_in_Tasks		
Description: Consumable identification		
Format: General Number		
WASTE ID	Number (Integer)	2
Source Table: Waste_in_Tasks		
Description: Waste Type + Package form identification		
Format: General Number		
AMOUNT WASTE	Number (Single)	4
Source Table: Waste_in_Tasks		
Description: Amount of waste (number of form units)		
Format: General Number		
SWAMOUNT	Number(Double)	
Source Table: Waste_in_Tasks		
Description: Amount of waste in other units		
SWAMUNIT	Text	50
Source Table: Waste_in_Tasks		
Description : Unit of amount of waste		

MATERIAL COLLECTED Number (Single) 1

Source Table: Waste_in_Tasks

Description: Amount of particulates (kg) collected

Format: Standard

ACTIVITY Number (Single) 4

Source Table: Waste_in_Tasks

Description: Activity (in Bq) of each waste type and per type of consumable produced in each task

Format: Scientific

Table 2.13

Suppl_Coll_Dose		
<i>Name</i>	<i>Type</i>	<i>Size</i>
TASK ID	Number (Integer)	2
Source Table: Suppl_Coll_Dose Description: Task identification Format: General Number		
FIXED COLL DOSE	Number (Single)	4
Source Table: Suppl_Coll_Dose Description: Fixed dose per individual and task specified (mSv) Format: Standard		
VARIABLE COLL DOSE	Number (Single)	4
Source Table: Suppl_Coll_Dose Description: Variable dose per individual and task specified (mSv) Format: Standard		
FIXED LABOUR TIME	Number (Double)	
Source Table: Suppl_Coll_Dose Description: Fixed total working time per individual and task specified Format: Standard		
VARIABLE LABOUR TIME	Number (Double)	
Source Table: Suppl_Coll_Dose Description: Variable total working time per individual and task specified Format: Standard		
INDIVIDUAL ID	Number (Integer)	2
Source Table: Suppl_Coll_Dose Description: Arbitrary individual ID Format: General Number		

Table 3: Design of queries in database DECOM

Table 3.1	Total_Coll_Dose
Table 3.2	Individual_Doses
Table 3.3	Ind_Dose-Distribution
Table 3.4	Total_Labour_Cost
Table 3.5	Tot_Equipment_Cost
Table 3.6	Tot_Cons_Cost
Table 3.7	Tot_Waste_Cost

Table 3.1

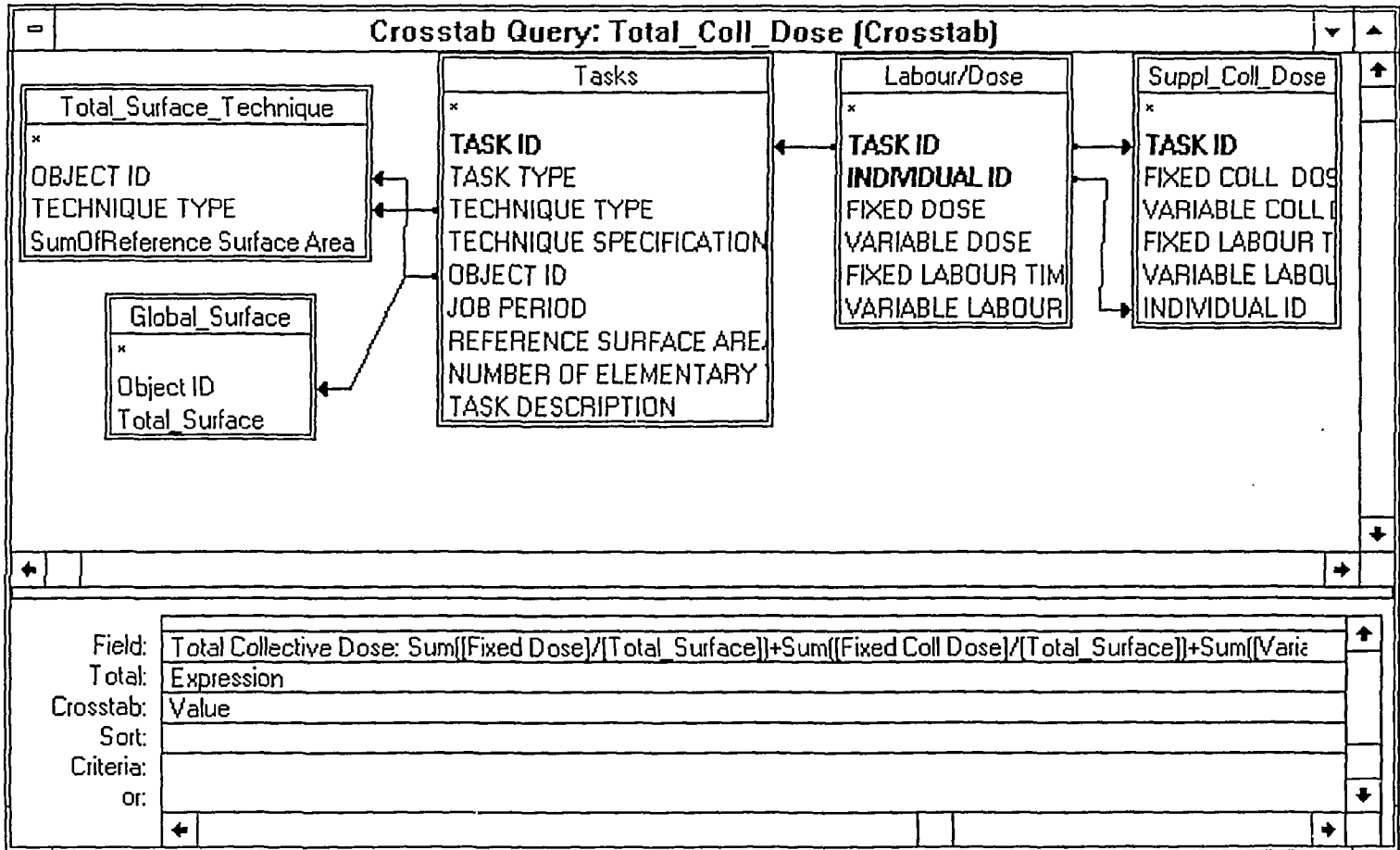


Table 3.2

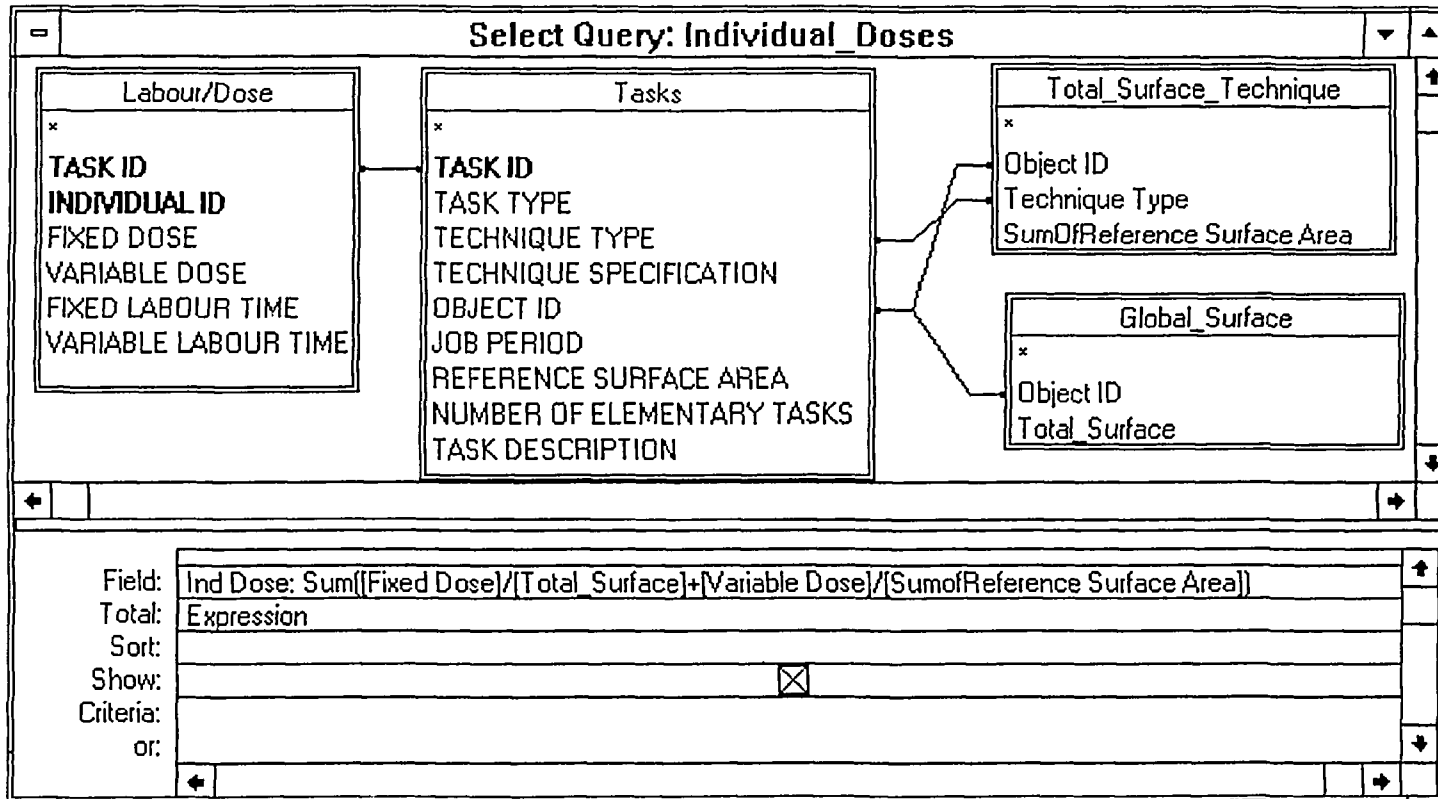


Table 3.3

Crosstab Query: Ind_Dose_Distribution

Individual Doses

- OBJECT ID
- TECHNIQUE TYP
- INDIVIDUAL ID
- Ind Dose

Field: Classes: If([Ind Dose]<0.0004,"1Very Low",If([Ind Dose]<0.001,"2Low",If([Ind Dose]<0.01,"3Moderate",If([Ind Dose]<0.05,"4High",If([Ind Dose]<0.1,"5Very High",If([Ind Dose]>0.1,"6Extremely High")))))

Total: Group By

Crosstab: Column Heading

Sort:

Criteria:

or:

Table 3.4

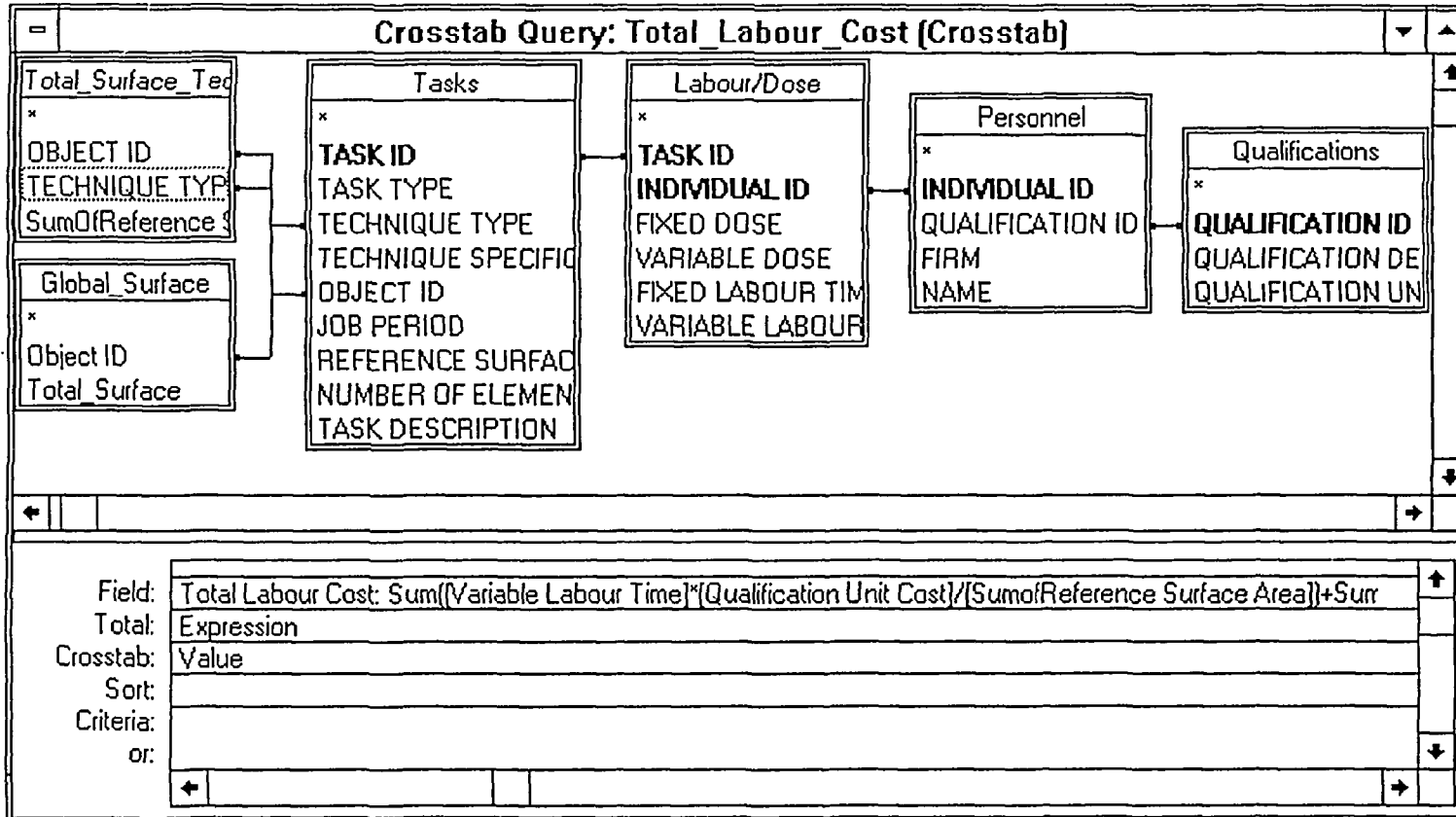


Table 3.5

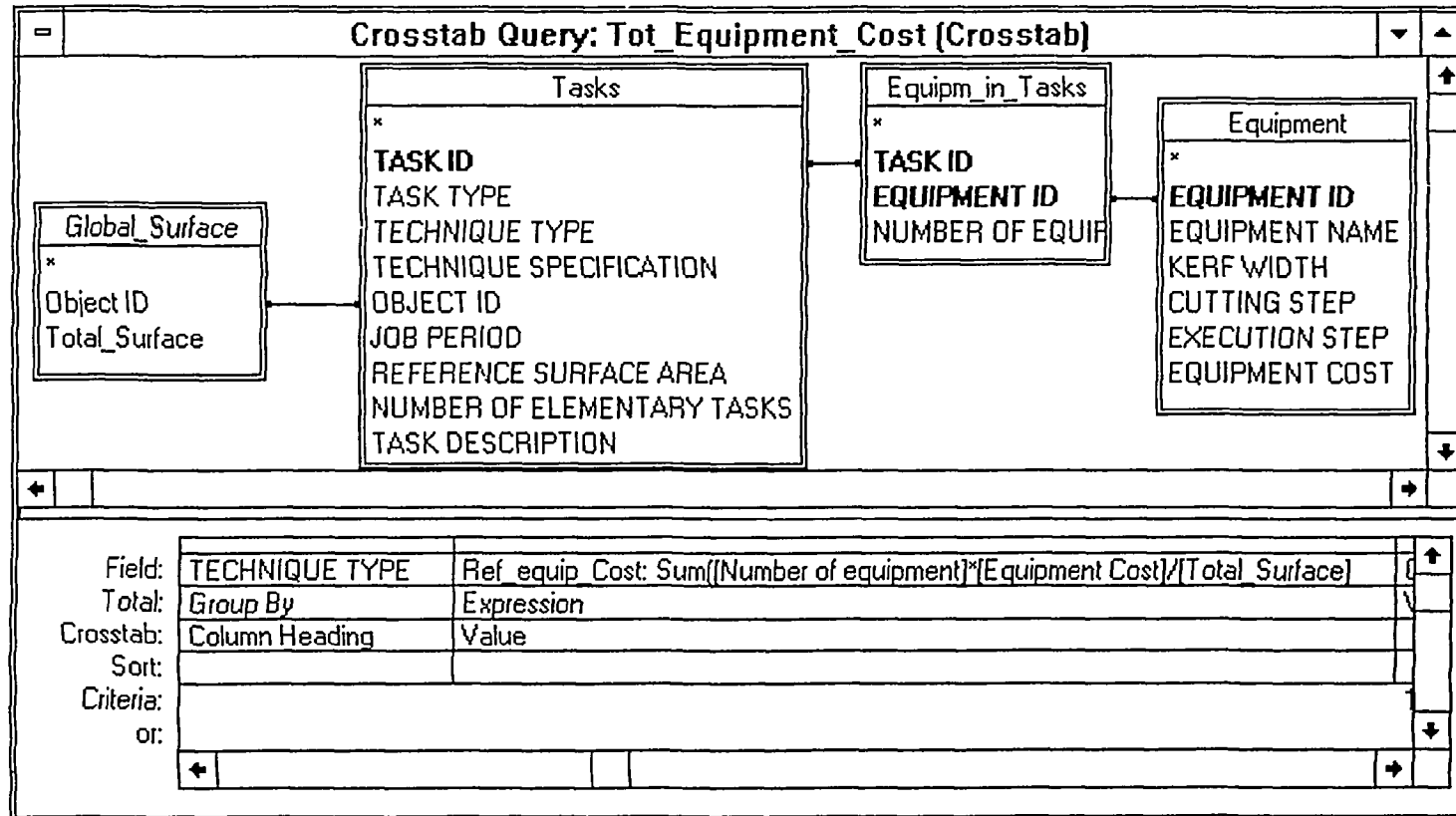


Table 3.6

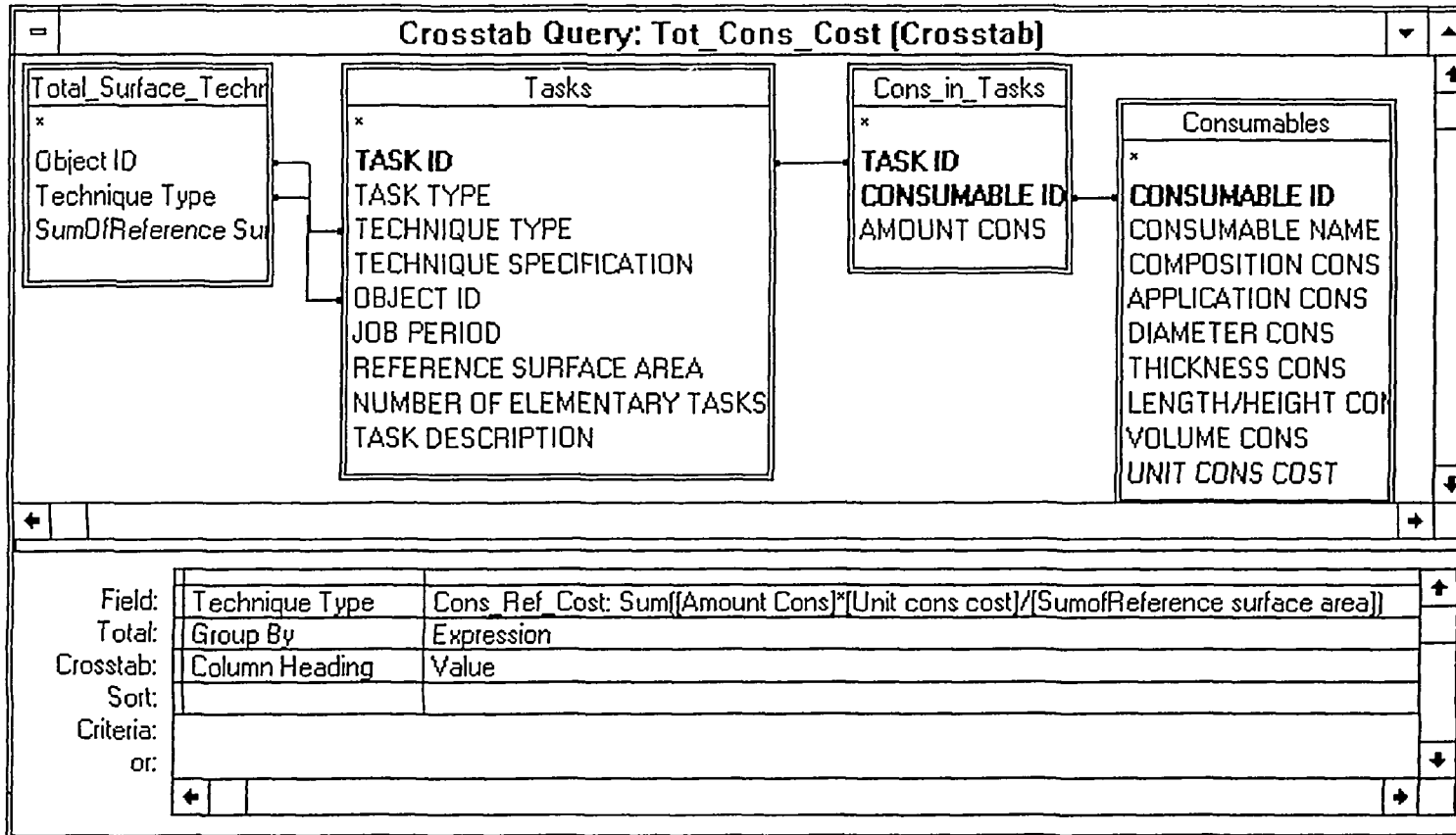


Table 3.7

