A DATABASE STRUCTURE FOR
RADIOLOGICAL OPTIMIZATION ANALYSES
OF DECOMMISSIONING OPERATIONS

Theo Zeevaert, Bartel Van de Walle
SCK•CEN
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BLG-686
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### Distribution List

**SCK·CEN**

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<td>L. Veuchelen, contract manager</td>
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<td>P. Vermaercke, quality assurance manager</td>
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<td>M. Loos, head radiation protection research unit</td>
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<td>H. Vanmarcke, manager radiation protection research activities</td>
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**Departmental Advisory Committee**

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<td>A. Cremers</td>
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<td>G. Gerber</td>
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<td>C. Huyskens</td>
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**CEPN**

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<td>C. Lefaure</td>
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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 cells 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**
- Task ID*
- Task Type*
- Technique Type*
- Technique Specification*
- Object ID
- Job Period
- Refvalki*(1)
- Reference Value*
- Refeunit*(1)
- Number of elementary tasks
- Task Description*

**Labour/Dose**
- Task ID
- Individual ID
- Fixed Dose
- Variable Dose
- Fixed Labour Time
- Variable Labour Time

**Equipment**
- Equipment ID*
- Equipment Name*
- Kerf width
- Cutting step
- Execution speed
- Equipment Cost*
- Totalnac*(1)

**Equipm_in_Tasks**
- Task ID*
- Equipment ID*
- Number of equipment*

**Objects**
- Object ID
- Object Name
- Installation ID
- Ambient Dose Rate
- Air Contamination
- Object Type
- Activity Type
- Activity Concentration
- Material Type
- Object shape/form
- Object mass
- Object volume
- Object thickness
- Object diameter
- Object height/length

**Suppl_Coll_Dose**
- Task ID*
- Fixed Coll. Dose*
- Variable Coll. Dose
- Fixed Labour Time*
- Variable Labour Time*
- Individual ID*

**Personnel**
- Individual ID*
- Qualification ID*
- Persnumb*(1)
- (Firm)
- (Name)

**Qualifications**
- Qualification ID*
- Qualification Description*
- Qualification Unit Cost

**Consumables**
- Consumable ID*
- Consumable Name*
- Composition
- Application
- Diameter Cons
- Thickness Cons
- Length/Height Cons
- Volume Cons
- Unit Cons Cost*
- Tconsnac*(1)

**Waste**
- Waste ID*
- Waste Type*
- Package Form*
- Caskvolu*(1)
- Unit Waste Cost*
- 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

<p>| 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 |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Size</th>
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</tr>
<tr>
<td>Source Table: Tasks</td>
<td>Description: Task Identification</td>
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</tr>
<tr>
<td>Format: General Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TASK TYPE</strong></td>
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<td>Source Table: Tasks</td>
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<td>Description: Type of technique</td>
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<td><strong>TECHNIQUE SPECIFICATION</strong></td>
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<td>Description: Specific technique</td>
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<td><strong>OBJECT ID</strong></td>
<td>Number (Integer)</td>
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<td>Source Table: Tasks</td>
<td>Description: Object Identification</td>
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<tr>
<td>Format: General Number</td>
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<td></td>
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<td>Description: Year of job</td>
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<tr>
<td>Format: General Number</td>
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REFVALKI
Source Table: Tasks
Description: Name of reference value

REFERENCE VALUE
Source Table: Tasks
Description: Reference Value
Format: General Number

REFÉUNIT
Source Table: Tasks
Description: Unit of reference value

NUMBER OF ELEMENTARY TASKS
Source Table: Tasks
Description: Number of elementary tasks per task identified
Format: General Number

TASK DESCRIPTION
Source Table: Tasks
Description: Description of the task
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<tr>
<td>Description:</td>
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<tr>
<td>Description:</td>
<td>Name of the object</td>
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<tr>
<td>Description:</td>
<td>Installation identification</td>
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<tr>
<td>Format:</td>
<td>General Number</td>
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<td>AMBIENT DOSE RATE</td>
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<tr>
<td>Description:</td>
<td>Ambient dose rate (microSv/h)</td>
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<td>AIR CONTAMINATION</td>
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<td>Description:</td>
<td>Air contamination (Bq/cubic dm)</td>
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</table>
**OBJECT TYPE**

Source Table: Objects
Description: Single Component; Assembly; Structure; System

**ACTIVITY TYPE**

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**

Source Table: Objects
Description: Type of material

**OBJECT SHAPE/FORM**

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

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<tr>
<td>Description: Identification of the installation</td>
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<tr>
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<tr>
<td>Description: Name of the installation</td>
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<td>INSTALLATION PART</td>
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<td>Description: Part of the installation</td>
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<td>Description: Name of the institution the installation belongs to</td>
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<td>Description: Installation address: City</td>
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<td>Description: Installation address: Country</td>
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<tr>
<td>Format:</td>
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<td>INDIVIDUAL ID</td>
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<tr>
<td>Source Table:</td>
<td>Labour/Dose</td>
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<tr>
<td>Description:</td>
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<td>Format:</td>
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<td>FIXED DOSE</td>
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<tr>
<td>Source Table:</td>
<td>Labour/Dose</td>
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<tr>
<td>Description:</td>
<td>Fixed dose per individual and task specified (mSv)</td>
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<td>Format:</td>
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<tr>
<td>VARIABLE DOSE</td>
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<tr>
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<td>Variable dose per individual and task specified (mSv)</td>
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<td>FIXED LABOUR TIME</td>
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<tr>
<td>Description:</td>
<td>Fixed working time per individual and task specified (h)</td>
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<tr>
<td>Description:</td>
<td>Depth of cutting in mm in one step (for cutting equipment only)</td>
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<tr>
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<tr>
<td>Description:</td>
<td>Surface area treated or cut in square dm per hour</td>
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</tr>
<tr>
<td>Format:</td>
<td>Standard</td>
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<tr>
<td>EQUIPMENT COST</td>
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<td>Source Table:</td>
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<tr>
<td>Description:</td>
<td>Cost of the equipment</td>
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<td>TOTALNAC</td>
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<td></td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
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Source Table: Equipment  
Description: Currency of cost
### Table 2.8

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<td>Source Table: Consumables</td>
<td>Description: Consumable identification</td>
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<tr>
<td>Format: General Number</td>
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<td>CONSUMABLE NAME</td>
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<td>Source Table: Consumables</td>
<td>Description: Name, Specification of the consumable considered</td>
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<td>COMPOSITION CONS</td>
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<tr>
<td>Source Table: Consumables</td>
<td>Description: Parts, Material(s) the consumable is composed or made of</td>
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<td>APPLICATION CONS</td>
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<tr>
<td>Source Table: Consumables</td>
<td>Description: Process in which consumable is used</td>
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<td>DIAMETER CONS</td>
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<td>Source Table: Consumables</td>
<td>Description: Maximum diameter of consumable in mm (If relevant; otherwise 0)</td>
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<tr>
<td>Format: Standard</td>
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<td>THICKNESS CONS</td>
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<td>Description: Thickness of consumable in mm (If relevant; otherwise: 0))</td>
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<td></td>
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<tr>
<td>LENGTH/HEIGHT CONS</td>
<td>Number (Single)</td>
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<tr>
<td>Source Table: Consumables</td>
<td>Description: Total length/height of consumable in m (If relevant; otherwise: 0)</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
VOLUME CONS
Source Table: Consumables
Description: Total volume of consumable in cubic dm (with package)
Format: Standard

UNIT COST CONS
Source Table: Consumables
Description: Cost per consumable unit
Format: Standard

TCONSNAC
Source Table: Consumables
Description: Currency of cost
### Table 2.9

<table>
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<tr>
<th>Name</th>
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<tr>
<td>Source Table:</td>
<td>Waste</td>
<td></td>
</tr>
<tr>
<td>Description:</td>
<td>Wastetype + package form identification</td>
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</tr>
<tr>
<td>Format:</td>
<td>General Number</td>
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<td>Description:</td>
<td>Type of waste considered</td>
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<td>Waste</td>
<td></td>
</tr>
<tr>
<td>Description:</td>
<td>Form unit in which waste of each type is packaged</td>
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<tr>
<td><strong>CASKVOLU</strong></td>
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<td>Waste</td>
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</tr>
<tr>
<td>Description:</td>
<td>Volume per package (square m)</td>
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<td>Number (Single)</td>
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<td>Source Table:</td>
<td>Waste</td>
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<tr>
<td>Description:</td>
<td>Cost of waste evacuation per form unit (kBF)</td>
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<td>Format:</td>
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<td>Waste</td>
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<td>Currency of cost</td>
<td></td>
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<td>Name</td>
<td>Type</td>
<td>Size</td>
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<tr>
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<td>------</td>
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<tr>
<td>Source Table:</td>
<td>Equipm_in_Tasks</td>
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<tr>
<td>Description:</td>
<td>Task identification</td>
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<tr>
<td>Format:</td>
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<td>Description:</td>
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<tr>
<td>Description:</td>
<td>Task identification</td>
<td></td>
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<tr>
<td>Format:</td>
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<td>Source Table:</td>
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<tr>
<td>Description:</td>
<td>Task identification</td>
<td></td>
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<tr>
<td>Format:</td>
<td>General Number</td>
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<tr>
<td>Source Table:</td>
<td>Waste_in_Tasks</td>
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<td>Description:</td>
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</tr>
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<td>Source Table:</td>
<td>Waste_in_Tasks</td>
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<tr>
<td>Description:</td>
<td>Waste Type + Package form identification</td>
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<tr>
<td>Format:</td>
<td>General Number</td>
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<td>AMOUNT WASTE</td>
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<tr>
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<tr>
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<td>Source Table:</td>
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<tr>
<td>Description:</td>
<td>Unit of amount of waste</td>
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</table>
MATERIAL COLLECTED

Source Table: Waste_in_Tasks
Description: Amount of particulates (kg) collected
Format: Standard

ACTIVITY

Source Table: Waste_in_Tasks
Description: Activity (in Bq) of each waste type and per type of consumable produced in each task
Format: Scientific
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<tr>
<td>Source Table:</td>
<td>Suppl_Coll_Dose</td>
<td></td>
</tr>
<tr>
<td>Description:</td>
<td>Task identification</td>
<td></td>
</tr>
<tr>
<td>Format:</td>
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<td></td>
</tr>
<tr>
<td>FIXED COLL DOSE</td>
<td>Number (Single)</td>
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<tr>
<td>Source Table:</td>
<td>Suppl_Coll_Dose</td>
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</tr>
<tr>
<td>Description:</td>
<td>Fixed dose per individual and task specified (mSv)</td>
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<td>VARIABLE COLL DOSE</td>
<td>Number (Single)</td>
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<tr>
<td>Source Table:</td>
<td>Suppl_Coll_Dose</td>
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</tr>
<tr>
<td>Description:</td>
<td>Variable dose per individual and task specified (mSv)</td>
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<tr>
<td>Format:</td>
<td>Standard</td>
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<tr>
<td>FIXED LABOUR TIME</td>
<td>Number (Double)</td>
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</tr>
<tr>
<td>Source Table:</td>
<td>Suppl_Coll_Dose</td>
<td></td>
</tr>
<tr>
<td>Description:</td>
<td>Fixed total working time per individual and task specified</td>
<td></td>
</tr>
<tr>
<td>Format:</td>
<td>Standard</td>
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</tr>
<tr>
<td>VARIABLE LABOUR TIME</td>
<td>Number (Double)</td>
<td></td>
</tr>
<tr>
<td>Source Table:</td>
<td>Suppl_Coll_Dose</td>
<td></td>
</tr>
<tr>
<td>Description:</td>
<td>Variable total working time per individual and task specified</td>
<td></td>
</tr>
<tr>
<td>Format:</td>
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<td>INDIVIDUAL ID</td>
<td>Number (Integer)</td>
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<tr>
<td>Source Table:</td>
<td>Suppl_Coll_Dose</td>
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<td>Description:</td>
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<td>Format:</td>
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Table 3: Design of queries in database DECOM

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<tr>
<td>Table 3.2</td>
<td>Individual Doses</td>
</tr>
<tr>
<td>Table 3.3</td>
<td>Ind_Dose-Distribution</td>
</tr>
<tr>
<td>Table 3.4</td>
<td>Total Labour Cost</td>
</tr>
<tr>
<td>Table 3.5</td>
<td>Tot_Equipment_Cost</td>
</tr>
<tr>
<td>Table 3.6</td>
<td>Tot_Cons_Cost</td>
</tr>
<tr>
<td>Table 3.7</td>
<td>Tot_Waste_Cost</td>
</tr>
</tbody>
</table>
### Table 3.1

#### Crosstab Query: Total Coll Dose (Crosstab)

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<th>Field</th>
<th>Expression</th>
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</thead>
<tbody>
<tr>
<td>Total Collective Dose</td>
<td>[\text{Sum}(\text{Fixed Dose})/\text{Total Surface}] + \text{Sum}(\text{Fixed Coll Dose})/\text{Total Surface} + \text{Sum}(\text{Variable Dose})/\text{Total Surface}]</td>
</tr>
<tr>
<td>Total</td>
<td>Value</td>
</tr>
<tr>
<td>Crosstab</td>
<td>or</td>
</tr>
<tr>
<td>Sort</td>
<td>Criteria</td>
</tr>
</tbody>
</table>

#### Diagram

The diagram illustrates the relationships and calculations involved in the Total Coll Dose query, including fields such as `OBJECT ID`, `TECHNIQUE TYPE`, `SUM(REFERENCE Surface Area)`, `GLOBAL Surface`, `INDIVIDUAL ID`, and `VARIABLE COLLABOR`. The query uses these fields to compute the total collective dose.
Table 3.2

Select Query: Individual_Doses

<table>
<thead>
<tr>
<th>Labour/Dose</th>
<th>Tasks</th>
<th>Total_Surface_Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASK ID</td>
<td>TASK ID</td>
<td>TASK ID</td>
</tr>
<tr>
<td>INDIVIDUAL ID</td>
<td>TASK TYPE</td>
<td>Task Type</td>
</tr>
<tr>
<td>FIXED DOSE</td>
<td>TECHNIQUE TYPE</td>
<td>Technique Type</td>
</tr>
<tr>
<td>VARIABLE DOSE</td>
<td>TECHNIQUE SPECIFICATION</td>
<td>SumOfReference Surface Area</td>
</tr>
<tr>
<td>FIXED LABOUR TIME</td>
<td>OBJECT ID</td>
<td>Object ID</td>
</tr>
<tr>
<td>VARIABLE LABOUR TIME</td>
<td>JOB PERIOD</td>
<td>Total_Surface</td>
</tr>
<tr>
<td>REFERENCE SURFACE AREA</td>
<td>REFEREECE_SURFACE_AREA</td>
<td></td>
</tr>
<tr>
<td>NUMBER OF ELEMENTARY TASKS</td>
<td>NUMBER_TASKS</td>
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</tr>
<tr>
<td>TASK DESCRIPTION</td>
<td>TASK_DESCRIPTION</td>
<td></td>
</tr>
</tbody>
</table>

Field: Ind_Dose: Sum(Fixed_Dose/[Total_Surface]+Variable_Dose/[SumOfReference_Surface_Area])

Expression •-
Table 3.3

Crosstab Query: Ind_Dose_Distribution

<table>
<thead>
<tr>
<th>Field</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Doses</td>
<td>Classes: if([Ind Dose]&lt;0.0004,'1Very Low',if([Ind Dose]&lt;0.001,'2Low',if([Ind Dose]&lt;0.01,'3Moderate',...))</td>
</tr>
<tr>
<td>OBJECT ID</td>
<td></td>
</tr>
<tr>
<td>TECHNIQUE TYP</td>
<td></td>
</tr>
<tr>
<td>INDIVIDUAL ID</td>
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<tr>
<td>Ind Dose</td>
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</tr>
</tbody>
</table>

Group By

Column Heading
Table 3.4

Crosstab Query: Total_Labour_Cost (Crosstab)

- Field: Total Labour Cost: Sum([Variable Labour Time]*[Qualification Unit Cost])/(Sum([Reference Surface Area]) + Sum)
- Total: Expression
- Crosstab: Value
- Sort: Criteria: or:

Task ID
- TASK ID
- TASK TYPE
- TECHNIQUE TYPE
- TECHNIQUE SPECIFIC
- OBJECT ID
- JOB PERIOD
- REFERENCE SURFACE
- NUMBER OF ELEMENTS
- TASK DESCRIPTION

Labour/Dose
- TASK ID
- INDIVIDUAL ID
- FIXED DOSE
- VARIABLE DOSE
- FIXED LABOUR TIME
- VARIABLE LABOUR

Personnel
- INDIVIDUAL ID
- QUALIFICATION ID
- FIRM
- NAME

Qualifications
- QUALIFICATION ID
- QUALIFICATION DEPARTMENT
- QUALIFICATION UNIT

Global_Surface
- OBJECT ID
- TECHNIQUE_TYPE
- SumOfReference

Total_Surface
- OBJECT ID
- TECHNIQUE_TYPE
- SumOfReference

Object ID
- Total_Surface
Table 3.5

Crosstab Query: Tot_Equipment_Cost (Crosstab)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Equipm_in_Tasks</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASK ID</td>
<td>TASK ID</td>
<td>EQUIPMENT ID</td>
</tr>
<tr>
<td>TASK TYPE</td>
<td>EQUIPMENT ID</td>
<td>EQUIPMENT NAME</td>
</tr>
<tr>
<td>TECHNIQUE TYPE</td>
<td>NUMBER OF EQUIF</td>
<td>KERF WIDTH</td>
</tr>
<tr>
<td>TECHNIQUE SPECIFICATION</td>
<td></td>
<td>CUTTING STEP</td>
</tr>
<tr>
<td>OBJECT ID</td>
<td></td>
<td>EXECUTION STEP</td>
</tr>
<tr>
<td>JOB PERIOD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REFERENCE SURFACE AREA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUMBER OF ELEMENTARY TASKS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TASK DESCRIPTION</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Field: TECHNIQUE TYPE | Ref_equip_Cost: Sum([Number of equipment] * [Equipment Cost] / [Total Surface])
Group By: Expression
Column Heading: Value

or:
Table 3.6

Crosstab Query: Tot_Con5_Cost (Crosstab)

<table>
<thead>
<tr>
<th>Field:</th>
<th>Technique Type</th>
<th>Cons_Ref_Cost: Sum([Amount Cons]*[Unit cons cost]/[Sum of Reference Surface Area])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total:</td>
<td>Group By</td>
<td>Expression</td>
</tr>
<tr>
<td>Crosstab:</td>
<td>Column Heading</td>
<td>Value</td>
</tr>
<tr>
<td>Sort:</td>
<td>Criteria:</td>
<td>or</td>
</tr>
</tbody>
</table>
Table 3.7

Crosstab Query: Tot_Waste_Cost (Crosstab)

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TECHNIQUE_TYPE</td>
<td>Cost_waste: Sum([Amount Waste]*[Unit Waste Cost]/[Sum of reference Surface Area])</td>
</tr>
<tr>
<td>Total</td>
<td>Crosstab</td>
</tr>
<tr>
<td>Crosstab</td>
<td>Expression</td>
</tr>
<tr>
<td>Sort</td>
<td>Value</td>
</tr>
<tr>
<td>Criteria: or:</td>
<td></td>
</tr>
</tbody>
</table>