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Database on Radionuclides in Workplaces

Version 2.0

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Abstract

One task of the EULEP-EURADOS Action Group on Parameter Values for the Human Respiratory Tract Model was to collate information on important physico-chemical forms of radionuclides encountered in workplaces in European Union member states.

The database contains 531 records from 118 organisations in 12 European countries. The database is by no means complete. The response to our questionnaire varied between countries: some members received more data from the nuclear sector, some from the medical sector. However, although incomplete, the database provides valuable information concerning the physical and chemical forms of the radioisotopes handled in Europe.

Contents

I - Introduction: background and objectives

The EULEP-EURADOS Action Group[1] on "Derivation of parameter values for application to the new model of the human respiratory tract for occupational exposure", had the overall objective of undertaking a review of the behaviour of inhaled radionuclides in physico-chemical forms currently encountered at workplaces in the European Union (EU). This Action Group formed part of the Joint Concerted Action carried out during the period 1997–1999 between EULEP (European Late Effects Project Group), EURADOS (European Radiation Dosimetry Group) and UIR (International Union of Radioecologists) under the Fourth Framework Programme of the European Commission.

The work of the Action Group consisted of three main Tasks[1]:

1. To collate and analyse information from the scientific literature on experimental studies relating to the biokinetics after inhalation of compounds of radionuclides of importance for occupational exposure (EULEP). The database developed to achieve this has been entered in "Radionuclide Biokinetics Database"[2,3].

2. To collate information on: (i) important physico-chemical forms of radionuclides encountered or likely to occur in workplaces in EU member states and (ii) measurements after inadvertent intakes which provide information about the biokinetics of inhaled radionuclides, or that can be used to check model predictions based on animal experimental data, or that might provide examples for future intercomparison exercises (EURADOS). The database developed to achieve this is the main subject of this report and is complementary to the one described above.

3. To conduct an inter-laboratory comparison exercise on the assessment of intakes and doses from monitoring data (EURADOS): the Third European Intercomparison Exercise on Internal Dose Assessment[4,5].

This report, to accompany a diskette with a copy of the current version of the database, is the final report of Task 2 of the Action Group, listed above. Appendix A is a user guide.

A first database was built using Microsoft Access Version 2.0 to allow the EURADOS members of the group to collect the data originating from their countries. All the information on the radioisotopes to which European workers are exposed were then gathered and entered into the database.

II - Radionuclides Database Structure

The database contains 6 tables. The first four tables contain information on the abbreviations used in the other two tables. The last 2 tables contain the data.

- tbl_Country contains a 2 letters code for the different countries

- tbl_frequency contains the code used for the different type of monitoring frequency such as M for month, BM for every 2 months, etc.

- tbl_IndustryType contains a 3 letters code to identify the industry sector from which the data originated.

- tbl_Monit contains the code used for the different type of monitoring such as LU for Lung monitoring, etc.

- tbl_FirmType contains de code of the firm from which the data are coming from with the IndustryType code of the industry sector. (118 records)

- tbl_Isotope contains the data collected for the isotopes used in the European industries. (531 records)

This last table contains information collected for the isotopes used in a particular industry or organisation. Each record consist of 13 fields (not all of these fields are completed).

- Element : the chemical symbol of the element

- Isotope : the isotope number, this field can contain more than one isotope

- Physical form: the physical form of the element such as solid, liquid, aerosol etc. (see query below)

- AMAD μ: if known the AMAD is given in μm

- Chemical form: the chemical form of the element such as oxide, nitrate or the chemical formula

- Number of Workers: is the number of workers handling this radioisotope. This information must be taken with caution. Some of the data refer to the few workers handling really the isotopes but often the number of workers refer to those working in the industry not all of them really handling the isotope.

- Activity in Bq/year: gives the activity of the isotope handled during one year. When given, this should be taken as indicative. For some the activity handled refer to 1998.

- Number Monitored: number of workers monitored. Similar remark as for the number of workers.

- Monitoring Frequency: code for the monitoring frequency, can contain more than one frequency

- Monitoring Type: code for the monitoring type, can contain more than one monitoring type

- Documented Case: Yes or No documented internal contamination case exists for the radioisotope.

- Firm_ID: code for the industry or organisation, the first 2 letters refer to the country where the data are originating from.

- Remarks: any additional remarks concerning the firm, the isotope or the documented case.

III - Overview of the data

The members of the EURADOS group have gathered data from Belgium, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Poland, Slovakia, Sweden and the United Kingdom.

A total of 118 industries or organisations have given information on the radioisotopes used in their premises: 70 from the non-nuclear industry and 48 from the nuclear industry.

Industry Type	Entries number
General Industry	5
Medicine (Therapy or Imaging)	40
Medical Research	5
Research	10
Radio-pharmaceutical	5
Teaching	2
Waste Management & Disposal	3
Nuclear Mining	2
Nuclear Milling	1
Nuclear Fuel Fabrication	10
Nuclear Reactor Operation	13
Nuclear Fuel Reprocessing	3
Nuclear Waste Management &	7
Nuclear Research	4
Nuclear Decommissioning	6
Nuclear Weapons Establishment	2

There are in total 531 records comprising 56 elements and around 90 different isotopes. Some remarks concerning the data:

- **Element**. An means actinides, AP means activation products and FP Fission products. In the database, the most quoted element is Iodine: 92 times for its isotopes 123, 135 and 131. In decreasing number of occurrence the elements quoted are : I, Co, U, H, Tc, Pu, Cs, Ga, In, Sr, Tl, Am, P, Cr, C, S, Th, Y, Fe, Ir, Kr, Ag, Mn, F, Sn, Ca, Nb, Rn, Se, Xe, An, Cd, Cf, Cm, Eu, FP, Mo, Na, Np, Re, Ru, Sm and Zn. Only quoted ones are: AP, Au, Ba, Ce, Cl, Gd, Ge, Os, Pb, Ra, Rb, Sb and Zr.

- **Isotope.**

  - For uranium, besides the isotope number some other abbreviation have been used; NAT for natural, DEP for depleted, ENR for enriched, IRR for irradiated, mix for mixture (? could probably be taken as natural), MOX for mixed oxide in which some plutonium is included.

  - Some entries can be misleading: Pu 238 239 Does this means that Pu 240 is not included? Probably not. Only if only one isotope is given such as Pu 238, it is likely that only this isotope is handled.

  - What is the difference between U 234 235 238 and U NAT? None probably.

  - The most quoted radioisotopes in decreasing number of occurrence are ^{131}I, ^{125}I, ^{3}H, ^{99m}Tc, ^{137}Cs, ^{67}Ga, ^{111}In, ^{60}Co, ^{241}Am, ^{201}Tl, ^{57}Co, ^{51}Cr, ^{32}P, ^{89}Sr and ^{123}I.

  - Interesting also are the radionuclides which are quoted only once: ^{138}Au, ^{133}Ba, ^{141}Ce, ^{36}Cl, ^{153}Gd, ^{68}Ge, ^{191}Os, ^{203}Pb, ^{226}Ra, ^{86}Rb, ^{124}Sb and ^{95}Zr. If ^{226}Ra is certainly less used nowadays, there is probably still some more lying around.

- **Physical form**. Out of the 531 records less than half of them mention a physical form. These are mainly aerosol, solution, solid, liquid, gas and powder.

- **Chemical form**. Around 40% of the records mention a chemical form and these are oxide, nitrate, iodide, chloride, HTO, citrate, phosphate, sulfate, metal and different organic compounds.

- **AMAD**. 32 % of the records mention an AMAD. Of these 93% mention an AMAD of 1 μm or 5 μm which are in fact the default workplace AMAD to be used with the old and new ICRP respectively. The rest of the AMAD mentioned varies from 0.06 μm to 50 μm.

- **Activity handled by year**. 58 % of the records are given with the activity handled by Year for a total of 20 PBq (Peta Bq) or 20 10^{15} Bq. Of this activity, 52 % comes from the radiopharmaceutical industry and 48 % from Nuclear medicine. Obviously there are some difficulties for the nuclear industry to evaluate the activity handled. Activity is rarely mentioned for isotopes handled by this industry. Only 0.15% of the total activity is in the database attributed to the nuclear sector.

- **Documented case.** 46 records mention documented case of internal contamination. From the information given in the database, the contamination by some of these radioisotopes ^{110m}Ag, ^{241}Am, ^{60}Co, ^{137}Cs, ^{154}Eu, ^{59}Fe, ^{3}H, ^{192}Ir, ^{54}Mn, ^{95}Nb, ^{191}Os and enriched U, are probably well documented cases of internal contamination. For the other contamination by $^{58-60}$Co, ^{125}I, ^{131}I, ^{99m}Tc, ^{95}Zr, Pu and U, the extend of the documentation is not specified.

All this information can be found in the queries or reports build into the database RADIOISO.mdb for Access 2.0 or RADIOISO97.mdb for Access 97. Some more specific queries or report can still be build.

IV - Conclusion

The database is certainly not complete. Less than 10% of the questionnaires send were returned. The response varied between countries; some received more data from the nuclear sector, some from the medicine or radiopharmaceutical sector, some other a mixture of these two.

But, although not complete, this database provides valuable information concerning the physical and chemical form of the radioisotopes handled in Europe.

From the AMAD data, it can be deduced that most of the industries used the default AMAD given by ICRP and that very few have really tried to determine the dimension of their aerosols.

It is interesting to note that there are only a few documented cases of internal contamination. Does that mean that there are few internal contamination accidents in Europe? Most certainly, the answer should be: "Perhaps yes, perhaps no." Some of the responses to the questionnaire were received because there had been a contamination case and some did not answer because there was no contamination case in their organisation or firm. With the current contamination cases, it would be interesting to go back to them to see if the data on these cases have been exploited to the full extent to check, for example, the biokinetic model associated with the particular radionuclide in its particular physical and/or chemical form.

V - References

1. Bailey, M R and Doerfel, H. Derivation of parameter values for application to the new model of the human respiratory tract for occupational exposure. EULEP-EURADOS Action Group 1.3. EULEP-EURADOS-UIR Newsletter No.2, December 1997, pp. 16–18 (1997).

2. Bailey, M.R. and Hurtgen, C. *Complementary databases on radioactive materials: Chemical forms found in workplaces and experimental studies of lung clearance.* EULEP-EURADOS-UIR Newsletter No.4 January 1999, pp. 39–41 (1999).

3. Bailey, M. R., Ansoborlo, E., Kreyling, W. G., Newton, D., Poncy, J-L., Stradling, N., and Taylor, D. M. Radionuclide biokinetics database version 1.0. NRPB Memorandum (in press).

4. Bailey, M. R. and Doerfel, H. Workshop on the Third European Intercomparison Exercise on Internal Dose Assessment. Weimar, Germany 17–19 May 1999. EULEP-EURADOS-UIR Newsletter No.5 July 1999 pp. 12–14 (1999).

5. Doerfel, H., Andrasi, A., Bailey, M., Birchall, A., Castellani, C-M., Hurtgen, C., Jarvis, N., Johansson, L., LeGuen, B., Tarroni, G. *Third European Intercomparison Exercise on Internal Dose Assessment.* Forschungszentrum Karlsruhe Report (1999, in press).

Appendix: User Guide

1. Introduction

The Radionuclides Database has been built using Microsoft Access Version 2.0. It would be useful, but not essential, to have some knowledge of Access. It is beyond the scope of this User Guide to provide explanations of databases or of Access in particular. Description of the different tables is given in the report.

Users interested in building new queries or reports than those existing already in the database need to have some knowledge of Access.

2. Installation

The current version (January 2000) of the software contains RADIOISO.mdb and RADIOISO97.mdb.

These two databases are identical except that the latter one has been converted to Access97. RADIOISO97.mdb can only be used with Access97. RADIOISO.mdb can be used with both version of Access.

The database needs to be installed on a PC, which has Microsoft Access Version 2.0 or later.

3. Opening the database

Either, open Access, and then use the File Menu: Open command, and select RADIOISO.mdb, or double-click directly on RADIOISO.mdb.

Opening the database opens automatically the opening Form "Radionuclides Database".

This form contains 3 large buttons and two small ones, namely:

- Radioisotopes & Institutions View Data
- Available Reports
- Some queries
- This symbol allows you to close the form and is valid throughout the database.

 This button allows you to close the database and Access.

4. "Radioisotopes & Institutions View Data"

Clicking this button opens the form "Institutions & Radioisotopes".

The top of this form contains information on the institution from which the data originated.

These institutions are ordered by alphabetic order of their code. It starts with BE00 and ends with UK15. The Firm-ID or Code, information on the Field of activities, the country can be found for each institution. Four buttons allow you to navigate through all the different institutions for which data are recorded. (Previous, Next, 1st and Last Institution).

The bottom of the form "Institutions & Radioisotopes" contains information about the radioisotopes handled by the institution given above.

On the top right of this part, a field gives the total number of isotopes handled in this institution.

Four buttons allow you to navigate through all the different radioisotopes (previous, next and last isotope).

5. "Available Reports"

Clicking this button opens the form "Report".

⊞ Report	**☒**

Reports available

Number of pages for the report.

Report	Pages
Element in Database	6
Industry Type	6
Radioisotope activity used / Year in each Industry	14
Total Activity used / Year in each Industry	1
Radionuclide Data (ordered by Institution ID)	161
Documented cases of Internal contamination (ordered by Institution ID)	8
Documented cases of Internal contamination (ordered by Element)	4
Available Industry ID — Radionuclide Data (Input Institution ID)	from 1 to 6
Available Element — Radionuclide Data per Element (Input Element)	from 1 to 6

Nine buttons provide different types of report whose content is given by the button name. Right of these buttons a number gives the number of pages of the report produced (this could vary according to the type of printer on which the report is produced).

Button "Radionuclide Data (Ordered by Institution ID)"

Radionuclide Data (ordered by Institution ID)

This produces a report of 161 pages containing all the data in the database ordered by institution ID (Identification), element and isotope.

Button "Radionuclide Data (Input Institution ID)"

Radionuclide Data (Input Institution ID)

This produces the same report as above but only for one institution and you are requested to give the Institution ID. The available institution ID can be found by clicking on the small button on the left of this button. Available Industry ID [±]

Button "Radionuclide Data per Element (Input Element)"

| Radionuclide Data per Element (Input Element) |

This produces a report for an element in the database. Here also you are requested to give the element symbol. The available element in the database can be found by clicking on the small button on the left of this button. Available Element [±]

All the abbreviations used in those reports can be found in the queries found in the form "Some queries".

6. "Some queries"

| Some queries |

Clicking this button opens the form "Some queries".

Some Queries
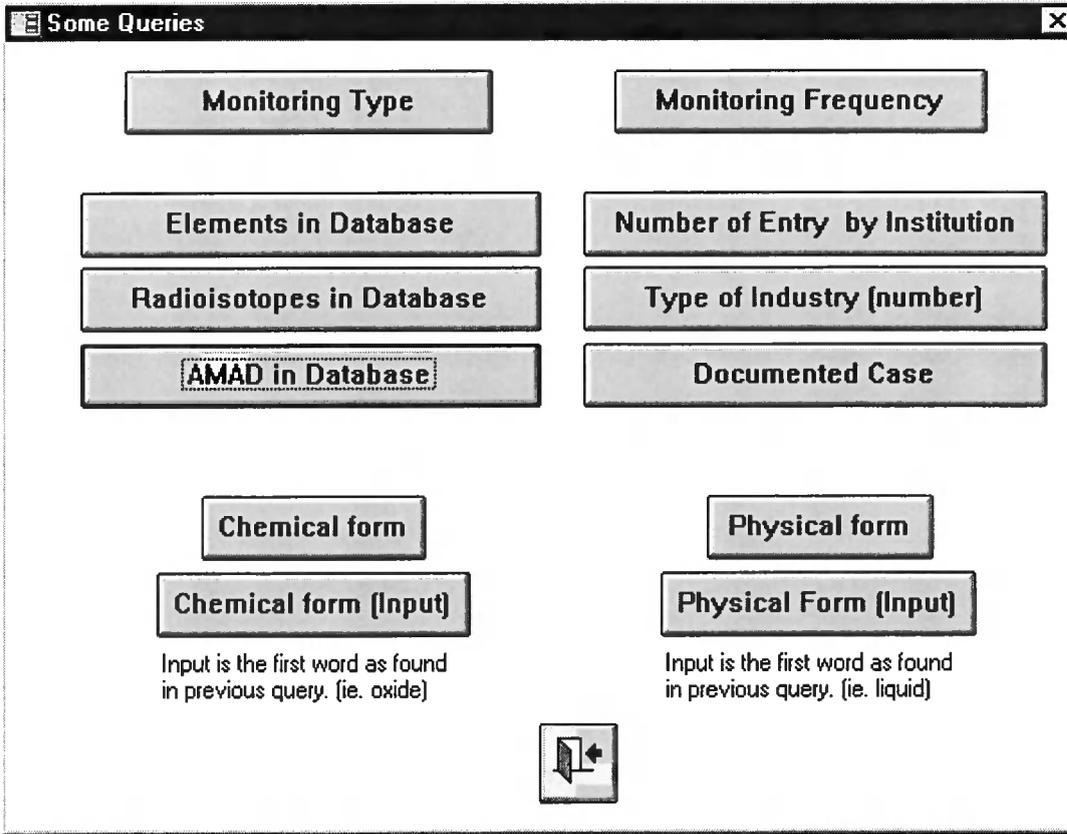
| Monitoring Type | | Monitoring Frequency |

| Elements in Database | | Number of Entry by Institution |

| Radioisotopes in Database | | Type of Industry (number) |

| AMAD in Database | | Documented Case |

| Chemical form | | Physical form |

| Chemical form (Input) | | Physical Form (Input) |

Input is the first word as found
in previous query. (ie. oxide)

Input is the first word as found
in previous query. (ie. liquid)

The first two buttons provide information on the abbreviation used in the database and the reports.

| Monitoring Type | | Monitoring Frequency |

The other six buttons provide information on the data found in the database.

Elements in Database		Number of Entry by Institution
Radioisotopes in Database		Type of Industry (number)
AMAD in Database		Documented Case

The following two buttons provide all information on the chemical and physical form of the radioisotopes in the database.

| Chemical form | | Physical form |

The last two buttons provide similar information but limited to one type of chemical or physical form found in the database and you are requested to give the chemical or physical form.

| Chemical form (Input) | | Physical Form (Input) |

The button found on these queries allows you to print the form resulting from these queries.