



ERICA

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(D-N°:1) – **Progress on the Production of the Web-based Effects Database: FREDERICA** 2/23

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ERICA (Environmental Risk from Ionising Contaminants: Assessment and Management) will provide an integrated approach to scientific, managerial and societal issues concerned with the environmental effects of contaminants emitting ionising radiation, with emphasis on biota and ecosystems. The project started in March 2004 and is to end by February 2007.



Erica tetralix L.

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Executive Summary

The objective of this deliverable is to update the FASSET Radiation Effects Database (FRED) to include new references (including the merger of the FRED and EPIC¹ effects database) and search options, and to improve the output from those search options as well as the user friendliness of the database. Another key task has been a review of the references included in FRED to determine whether sufficient information has been reported within each reference is adequate for using the effects data within a radiological assessment. As part of this the database has been renamed FREDERICA and has been prepared for use over the internet.

The report is split into three sections:

- Section 1, “Introduction”, describes the project background and purpose of this aspect of Work Package 1;
- Section 2, “Production of the FREDERICA database”, reviews the work conducted to date, describes the issues of merging the EPIC and FRED databases and uploading the database to a website; and
- Section 3, “Future work”, describes the work planned for the coming 12 months to integrate FREDERICA with the ERICA assessment tool.

The integration of FREDERICA with the ERICA assessment tool is ongoing and will be completed by the end of the ERICA project and will allow users to undertake dose predictions to non-human species and then to establish the likely effects of exposure of wildlife to the predicted dose rates. This report highlights how the integration with the assessment tool will be conducted.

¹ EPIC – “Environmental Protection of Ionising Contaminants in the Arctic”; Project no. ICA2-CT-2000-10032 supported under the EC’s 5th Framework, Inco-Copernicus Programme.





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1 Introduction

The FASSET project identified that any system for assessing the impact of a contaminant on the environment requires an analysis of the possible effects on the organisms and ecosystems concerned and produced two key outputs: 1) the FASSET (2003) Deliverable D4 publication and 2) the FASSET Radiation Effects Database (hereafter known as FRED) to help to address these issues. FASSET (2003) reviewed the information contained within FRED and used it to extract summary information on the effects of ionising radiation on different wildlife groups under four umbrella endpoint headings: mutation, morbidity, reproductive capacity and mortality.

It is apparent from the work conducted in the FASSET project that the availability of data is deficient in many respects, particularly in terms of information relevant to the radiation dose rates likely to occur in the environment as a consequence of anthropogenic activities involving the use of radioactive substances and for many of the wildlife groups and umbrella effect categories of concern.

Within the FASSET project, 1,033 references were reviewed and entered in FRED. FRED covered literature on the biological effects following exposure to ionising radiation for the time period 1945 to 2001. The database contained approximately 25,000 data entries. At the time of the project, FRED was designed as a method of extracting and collating the information from the scientific literature and there was little thought given to the method of outputting the collated data for subsequent evaluation. Furthermore, FRED was a stand alone product distributed via CD or download on to a personal computer from the FASSET website and was known to only contain a proportion of the available literature on the biological effects of exposure to ionising radiation. Finally, there were a few issues relating to the consistency and applicability of the information entered into FRED.

To address these issues within the ERICA project, Work Package 1 has been further developing FRED by:

- Merging FRED with the effects database that was produced under the EPIC² project. The EPIC database contains a large dataset from Russia-language literature on the biological effects of exposure to ionising radiation;
- Insertion of the post 2001 articles and a review of the existing data for any obvious missing references;
- Undertaking a review of the reference data already collated within FRED;
- Producing an online version of the database (to avoid problems with future version updates) and to facilitate integration with the ERICA assessment tool;
- Updating the structure of the database in line with comments received on the user-friendliness of FRED and to improve the search capability and outputting of the data.

There are two phases to this work. The first phase focuses on getting FRED online (including some limited structural changes to the database), undertaking the review of the references included in FRED and insertion of post 2001 to end 2004 references and merging of FRED and EPIC database to produce the online FREDERICA effects database (hereafter known as FREDERICA). The second phase will insert new references up to the end of the ERICA project (including the output from the experiments being conducted in Work Package 2), improve the search and output capabilities and integrate FREDERICA with the ERICA assessment tool.

² EPIC – “Environmental Protection of Ionising Contaminants in the Arctic”; Project no. ICA2-CT-2000-10032 supported under the EC’s 5th Framework, Inco-Copernicus Programme.





This report is a supporting document to the online FREDERICA database providing a concise overview of functionality and recent developments. FREDERICA is now available by following the link on the www.ericaproject.org website and following the online instructions. Any comments on the structure and functionality of FREDERICA should be submitted to Frederica@ericaproject.org and we will endeavour to take them on board within time remaining for the ERICA project.

FREDERICA now contains 1509 references covering the literature from 1945 to 2004 and contains 29,400 data entries.

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2 Production of the FREDERICA database

It should be noted that as part of the update to FRED, all the reference information (except the Russian references) is now held by the EA and can be used as a reference source by interested parties. Various tasks have been undertaken in the production of the FREDERICA database and these are reviewed in the following sections.

2.1 Review of the references included in FRED

Each of the references held within FRED was subject to a review to determine whether sufficient information has been provided within the reference to enable the data to be used in the process of defining biological effect levels. The review focused on the published content of a reference (i.e. what information is actually available to the reader) and is not a comment on how the author(s) designed or undertook the experiment. In other words the review tries to determine whether it would be possible to reproduce the experiment and to assess whether sufficient detail is provided for the data to be used for the purposes of radiological assessment on non-human species. Previous evaluation of the scientific literature has shown that experiments have not always been conducted in a consistent manner and in a way that can be used for radiological assessments.

Three criteria, assessing the dosimetry, experimental design and statistics used, were evaluated for each paper. Table 2.1 details the specification points used under each of these headings:

Table 2.1: Specifications and criteria used.

QC CRITERIA	SPECIFICATIONS
DOSIMETRY	<p>Determination of DOSE (e.g. Number of TLDs used / number of positions TLDs placed in/ Equations used for calculation of dose)</p> <p>Determination of DOSE RATE (Already calculated or able to be calculated)</p> <p>Background levels (in both lab and field studies expressed as a dose or dose rate)</p>
EXPERIMENTAL DESIGN	<p>Endpoint analysed: <u>where</u> (tissue/organ) <u>when</u> (in relation to irradiation and to the total lifetime of the species studied) <u>how</u> (method used) <u>ecological relevance</u></p> <p>Control groups (held in appropriate conditions)</p> <p>Exposure conditions to radiation (range of doses studied / single or multi contaminant (multi nuclide source – whether it emits both alpha and gammas)</p> <p>Test Organism: <u>Male/female</u> (for some endpoints it is important) <u>life cycle stage</u> (embryonic/adult) <u>whether bred in the lab or from the field;</u> <u>Maintenance Conditions</u> (i.e. husbandry of test organisms / what conditions were they kept in)</p>
STATISTICS	<p>Number of replicates of the experiment; Number of samples per point; Number of individuals; Number of points per curve ; Method used for statistical analysis ; Confidence limits</p>

The criteria were translated into a series of statements (Table 2.2 (a, b and c)) that could be evaluated for each paper in a consistent manner. These were each given a score value and prepared in a Microsoft[®] Excel spreadsheet. The relevant statement was finally picked by the reviewer and recorded in the spreadsheet.

Once the criteria were established and agreed an intercomparison exercise was undertaken to ensure a) consistency in application and b) understanding of the criteria statements. The three references were reviewed by five reviewers. Table 2.3 provides an example of the range of scores generated in this exercise for one reference.





Table 2.2: (a) Specific criteria for assessing dosimetry.

DOSIMETRY	Marks available
Determination of Dose	Select each appropriate statement and add the scores of these statements together
No value for dose given	0
Type of TLDs given	1
Number and position of TLDs given	1
Total dose could be calculated from information given	1
Value for dose given	1
Calculation of dose given	1
Determination of Dose Rate	Select one statement only and enter that statements score
Dose rate not given	0
Dose rate can be calculated from the information given	3
Dose rate determined	5
Background levels	Select one statement only and enter that statements score
No background dose or dose rate given	0
Background dose/dose rate can be calculated	3
Background dose and dose rate given	5
TOTAL FOR SECTION	MAXIMUM 15

Table 2.2: (b) Specific criteria for assessing experimental design.

EXPERIMENTAL DESIGN	Marks available
Endpoint analysed	Select each appropriate statement and add the scores of these statements together
Endpoints do not come under the FASSET umbrella endpoints	0
One FASSET umbrella endpoint considered	1
Two or more FASSET umbrella endpoints considered	2
One specific endpoint studied and methods stated	1
Two or more specific endpoints studied, methods stated	2
Ecological relevance of endpoint stated	1
Control Groups	Select one statement only and enter that statements score
No Control group	0
Control groups used	3
Information confirming that control groups are kept in comparable conditions to experimental groups given	5
Exposure conditions to radiation	Select each appropriate statement and add the scores of these statements together
Only one dose/dose rate used	1
More than one dose/dose rate used	2
Details of source(s) given (use of multi nuclide sources if applicable)	2
Duration of exposure given	1
Test Organism	Select each appropriate statement and add the scores of these statements together
Species named	1
Sex (if relevant) and life cycle stage stated	2
Source of test organism stated	1
Details of husbandry/maintenance stated	1
TOTAL FOR SECTION /20 * 2	MAXIMUM 40





Table 2.2: (c) Specific criteria for assessing statistics.

STATISTICS	Marks available
Number of replicates of the experiment	Select one statement only and enter that statements score
No replicates	0
1-3 replicates	2
4-6 replicates	3
7-9 replicates	4
10 or more replicates	5
Number of individuals	Select one statement only and enter that statements score
1-3 individuals	2
4-6 individuals	3
7-9 individuals	4
10 or more individuals	5
Number of points per curve	Select one statement only and enter that statements score
No dose response undertaken (only one dose given)	0
2 points	1
3 points	2
4 points	3
5 points	4
6 or more points	5
Method used for statistical analysis	Select each appropriate statement and add the scores of these statements together
No statistical methods used	0
Name of statistical methods stated	1
Calculation of statistics stated	2
Reasons/justification of statistical methods used stated	2
Confidence Limits	Select one statement only and enter that statements score
No confidence limits given	0
All significant differences reported to <0.10	2
All significant differences reported to <0.05	3
All significant differences reported to <0.01	5
TOTAL FOR SECTION	MAXIMUM 25
GRAND TOTAL	MAXIMUM 80



Table 2.3: Scores from five reviewers grading paper ID 583 using the criteria listed in Table 2.2.

DOSIMETRY	Marks available	Scorer 1	Scorer 2	Scorer 3	Scorer 4	Scorer 5
Determination of Dose						
No value for dose given	0	0	0	0	0	0
Type of TLDs given	1	0	0	0	0	0
Number and position of TLDs given	1	0	0	0	0	0
Total dose could be calculated from information given	1	0	0	0	0	0
Value for dose given	1	1	1	1	1	1
Calculation of dose given	1	1	0	0	1	0
Determination of Dose Rate						
Dose rate not given	0	0	0	0	0	0
Dose rate can be calculated from the information given	3	0	0	0	0	0
Dose rate determined	5	5	5	5	5	5
Background levels						
No background dose or dose rate given	0	0	0	0	0	0
Background dose/dose rate can be calculated	3	0	0	0	0	0
Background dose and dose rate given	5	0	0	0	0	0
TOTAL FOR SECTION	MAXIMUM 15	7	6	6	7	6
EXPERIMENTAL DESIGN						
Endpoint analysed						
Endpoints do not come under FASSET umbrella endpoint	0	0	0	0	0	0
One FASSET umbrella endpoint considered	1	1	1	1	1	1
Two or more FASSET umbrella endpoints considered	2	0	0	0	0	0
One specific endpoint studied and methods stated	1	1	1	1	1	1
Two or more specific endpoints studied and methods stated	2	0	0	0	0	0
Ecological relevance of endpoint stated	1	0	1	0	0	0
Control Groups						
No Control group	0	0	0	0	0	0
Control groups used	3	3	3	0	3	3
Information confirming that control groups are kept in comparable conditions to experimental groups given	5	0	0	5	0	0
Exposure conditions to radiation						
Only one dose/dose rate used	1	0	0	0	0	0
More than one dose/dose rate used	2	2	2	2	2	2
Details of source(s) given (use of multi nuclide sources if applicable)	2	2	2	2	2	2
Duration of exposure given	1	0	1	0	1	0
Test Organism						
Species named	1	1	1	1	1	1
Sex (if relevant) and life cycle stage stated	2	2	2	2	2	2
Source of test organism stated	1	0	0	0	0	0
Details of husbandry/maintenance stated	1	1	0	0	0	0
TOTAL FOR SECTION /20 * 2	MAXIMUM 40	26	28	28	26	24





Table 2.3. (cont.): Scores from five reviewers grading paper ID 583 using the criteria listed in Table 2.2.

STATISTICS						
Number of replicates of the experiment						
No replicates	0	0	0	0	0	0
1-3 replicates	2	0	0	0	0	0
4-6 replicates	3	0	0	0	0	0
7-9 replicates	4	0	0	0	0	0
10 or more replicates	5	0	0	0	0	0
Number of individuals						
1-3 individuals	2	2	2	2	2	2
4-6 individuals	3	0	0	0	0	0
7-9 individuals	4	0	0	0	0	0
10 or more individuals	5	0	0	0	0	0
Number of points per curve						
No dose response undertaken (only one dose given)	0	0	0	0	0	0
2 points	1	0	0	0	0	0
3 points	2	0	0	2	0	0
4 points	3	3	3	0	3	3
5 points	4	0	0	0	0	0
6 or more points	5	0	0	0	0	0
Method used for statistical analysis						
No statistical methods used	0	0	0	0	0	0
Name of statistical methods stated	1	1	0	0	0	0
Calculation of statistics stated	2	0	0	0	0	0
Reasons/justification of statistical methods used stated	2	0	0	0	0	0
Confidence Limits						
No confidence limits given	0	0	0	0	0	0
All significant differences reported to <0.10	2	0	0	0	0	0
All significant differences reported to <0.05	3	0	0	0	0	0
All significant differences reported to <0.01	5	0	0	0	0	0
TOTAL FOR SECTION	MAXIMUM 25	6	5	4	5	5
GRAND TOTAL		MAXIMUM 80	39	39	38	38

The intercomparison demonstrated that the criteria were suitable and that the reviewers were in general agreement over their application (scores were within a maximum of five marks of each other). Subsequently the references were divided up by wildlife group between reviewers and scored. The results were recorded in Excel spreadsheets against the reference ID number along with any specific comments that the reviewer might have. Some references were not scored for the following reasons:

- an abstract only was available rendering a more detailed analysis impracticable;
- the reference did not describe any effects of exposure to ionising radiation (for example, some references only reviewed other effects references and some references only described activity concentrations);
- not all the experimental detail was provided, for example in the case of some translated Russian-language papers.



The review scores have been added as a table to FREDERICA linked via the reference ID number. The total score will be viewed as one of the search output options. To put the scores into immediate perspective the following range has been derived (Table 2.4) and this information is also available within FREDERICA:

Table 2.4: Grading scheme for FREDERICA references.

Grade as shown in FREDERICA	Equates to a score between	Supporting details
A	71-80	Paper contains all relevant information and can be used within a radiological assessment and for deriving screening levels
B	61-70	Paper contains most of the relevant information and can be used within a radiological assessment and for deriving screening levels
C	41-60	Data should be ok for use within the assessment although it may be deficient in data under a particular criteria. This data and above is used by default in any ERICA assessments
D	21-40	Some data deficient, we recommend that you review the review scores to determine whether the information is fit for your purpose. For example, in some cases it may be that the information on the statistics is not given and this may be important if you are trying to use the data to define species sensitivity distribution curves. However, data may be suitably used in the derivation of a lookup table to determine an effect that may be observed at particular dose rate.
E	0-20	Very few experimental details provided, the data should be used with caution

During the review, it should be noted that all the references held within FRED were reviewed to ensure that all the relevant data had been entered into FRED correctly.

2.2 Merging of EPIC and FRED

The EPIC database on the effects of radiation exposure in natural biota was created as a part of the EC EPIC project (Environmental Protection from Ionizing Contaminants in the Arctic, 2000-2003). The key objective of EPIC database was to compile and analyze the published data relating to dose-effects relationships for flora and fauna in the Arctic and northern areas (EPIC Project, Deliverable 5, 2002).

The EPIC database “Radiation effects on biota” is based exclusively on Russian/Former Soviet Union experimental and field studies of the radiation effects on flora and fauna from the northern/Arctic climatic zone. Data collation has focused on wildlife; as a rule, domestic animals and agricultural plants have not been considered. Chronic/lifetime exposures were also selected as a focus of this work owing to the fact that this exposure type is the most useful in radiological assessments for biota, as discussed above.

The unique feature of Russian data is the availability of long-term observations of radiobiological effects in natural conditions. For many years radiobiological studies have been carried out in the following areas: Kyshtym radioactive trace in the Southern Urals (contaminated in 1957 as a result of the Kyshtym radiation accident); large territories in Ukraine, Belarus and Russia contaminated as a result of the Chernobyl accident of 1986; local areas with high natural radioactivity in Komi Republic of Russian Federation. The database also includes results of radiobiological experiments conducted under laboratory conditions.

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The following general restrictions were made in the selection of information for inclusion in the EPIC database:

- from a great number of data for effects under acute exposure regimes, only effects of organism's exposure under field conditions were included in the database;
- since the analyses of radiation effects on domestic animals and agricultural plants were outside the scope of the project, data on these organisms, as a rule, were not considered;
- taking into account the general orientation of the EPIC project towards Northern/Arctic organisms, data relating to warm-climate organisms, with few exceptions, were not included in the database.

The fact that the EPIC database contains unique long-term information makes it a valuable source of data on the biological effects of ionising radiation on wildlife and hence the intention to combine the datasets within EPIC and FRED.

The EPIC database contained the information on radiation effects in Microsoft® Excel in a unified format consisting of 12 vertical columns and horizontal rows. The special format of the EPIC database provides a possibility for analyzing the “dose-effect” relationships by mapping the calculated dose onto a given effect (Sazykina, 2002). The original EPIC database consists of the following sub-databases:

- Radiation effects on terrestrial animals;
- Radiation effects on aquatic animals;
- Effects on terrestrial plants and herbaceous vegetation;
- Effects on soil fauna.

The EPIC database information covers a very wide range of radiation dose rates to wild flora and fauna: from below 10^{-5} Gy d⁻¹ up to more than 1 Gy d⁻¹. A great variety of radiation effects are registered in the EPIC database. These encompass effects from stimulation at low doses up to death from acute radiation syndrome at high doses.

Dosimetric data in the database records are given in two forms: (i) estimations of doses as they were published in the original publications, (ii) dose reconstructions were made, in some cases, by the authors of the database using data on levels of radioactive contamination in the organism/environment and appropriate dose models.

2.2.1 Biological species represented in the EPIC database

Among terrestrial animals, the most extensive studies were carried out on small mammals, such as mice, voles and other mouse-like rodents. Mice have been favoured test subjects for radiobiological investigations in all areas with high levels of radioactivity.

Among terrestrial plants, the most extensive studies were carried out on pine; fewer data were available for spruce, birch and also some widespread herbaceous plants (dandelion, ribwort, etc.).

Among aquatic organisms, the most extensive radiobiological studies have been conducted on fish and fish eggs.

2.2.2 Types of radiobiological effects in the EPIC database

In the original EPIC database the following umbrella endpoints were considered:

- Morbidity (worsening of physiological characteristics of organisms; effects on immune system, blood system, nervous system, etc.);



- Reproduction (negative changes in fertility and fecundity, resulting in reduced reproductive success);
- Mortality (shortening of lifetime as a result of combined effects on different organs and tissues of the organism);
- Cytogenetic effects;
- Ecological effects (changes in biodiversity, ecological successions, predator-prey relationships);
- Stimulation effects;
- Adaptation effects.

From the categories listed above, the last three are additions to those defined within the FASSET project and the structure of FRED has been amended to incorporate them.

2.2.3 Contents of the EPIC database

In total, the EPIC database “Radiation effects on biota” contains about 1400 records from 435 references and books.

- sub-database “Radiation effects on terrestrial animals” includes 428 records from 114 publications;
- sub-database “Radiation effects on aquatic organisms” includes 511 records from 122 publications;
- sub-database “Radiation effects on terrestrial plants” includes 249 records from 106 publications;
- sub-database “Radiation effects in soil fauna” includes 178 records from 53 publications.

2.2.4 Merging the EPIC and FRED databases into the FREDERICA database

Within the framework of the ERICA project, the two databases on radiation effects in natural biota were to be combined into one electronic database with unified format in Microsoft[®] Access initially and then online as outlined in the following section. To achieve this purpose, the original EPIC electronic Excel tables were extended to the format used within FRED by including full references, adding service columns, and transforming some of the text columns into numerical fields. The extended EPIC data tables were imported into the Access database, compatible with FRED and then merged with FRED data to produce FREDERICA.

2.3 Production of online FREDERICA database

To improve the accessibility of FREDERICA and to enable the ERICA assessment tool to call on FREDERICA database, a decision was made to transfer the database to an online version. Eventually this online version will contain not only the original functionality of FRED along with improved data searches and output, but will also permit anyone to submit effects data to the database. When first entered the information will be held in a holding area pending submission into the main data tables. This submission can then be reviewed by a gatekeeper³ and, if the information has been entered correctly and the scoring review has been undertaken, the entered data can then be passed into the

³ Gatekeeper here is used to refer to a person or persons who have appropriate access rights to permit the entered data to be added to the main data tables within FREDERICA such that the data can then be searched and results outputted using the FREDERICA search options.





main data tables within FREDERICA. This stage will be completed and fully functional by the end of the ERICA project.

One planned change to the FREDERICA database is that we are now thinking of asking people to register to use the database. This will simply allow us to collect information about who is using FREDERICA and this will also allow more interaction with users to improve the functionality of the database.

2.3.1 Translation of the database to online version

The translation of the FRED Microsoft® Access format into an online SQL database has been undertaken within the Environment Agency's data handling group and the website hosted on a project team accessible server with a link provided from the ERICA project website. During this translation a number of changes were made to FRED structure. Other structural changes are planned and the key ones are highlighted in Section 3. The current functionality is similar to that found in FRED and is all menu driven. Context help will be provided in the final version of FREDERICA by the end of the ERICA project.

A prototype of FREDERICA is now available by following the link from the ERICA project website and it is hoped that users will provide feedback on the structure and functionality so that we can further refine and improve FREDERICA until the end of the ERICA project. All comments should be returned to FREDERICA@erica-project.org.

2.3.2 Structural changes made to the data tables

There are two main structural changes to the database.

The first is the inclusion of the ICRP reference organism list and a function that maps these ICRP reference organisms onto the wildlife groups/species as they currently exist within FRED. This reflects the likelihood that the ICRP reference organisms will become a common output requirement in the future.

The second major structural change revolves around the addition of the activity concentrations (if given in the reference) to the appropriate effects data so that the information would be extracted as follows (Table 2.5), instead of just providing the dose(rate) and effect measure details.

Table 2.5: Input/output of effects data in FREDERICA.

Activity concentration in media	Media type	Activity concentration in biota	Dose (rate)	Effect measure	Comments

In addition to the two main structural changes some fields have been modified or removed from FREDERICA as follows:

- 1) Journal title - Where only an abbreviated journal title was available in FRED these have been located now and are reported in full within FREDERICA.
- 2) FASSET wildlife Group - It has been noted that the FASSET wildlife groups are not mutually exclusive, for example a freshwater mussel may be categorised as either a mollusc or an aquatic invertebrate. Consequently, the choice of wildlife group is being reviewed and additional functionality has been added to the database to allow more than one wildlife group to be selected. This means that, in the future, the data for the freshwater mussel will be extracted during a search on both the mollusc and aquatic invertebrate category.
- 3) Login screen - There is a new login screen for the database reflecting the fact that this is a different EC funded project to FASSET and incorporating the new logo information.

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- 4) Keywords - within FRED there were 6 key word fields, these have been merged to 1 field and the data entry field has been amended accordingly. This makes it easier to run the searches on the keywords entered into the field.
- 5) Umbrella endpoints field - there is now the ability to select more than one umbrella endpoint type in the field. This will allow for data from experiments such as mortality of offspring, which could currently be classed as the mortality or reproduction endpoint to appear under searches for both mortality and reproduction.
- 6) Holding information - The fields for institute holding reference, person completing the form and institute reference code has been removed from the search screens (although they still exist in the underlying data tables). The information contained within these fields has also been amended to reflect the fact that the Environment Agency now holds a hard copy of all the references.
- 7) Lifestage - A new field has been added which lists the lifestage being exposed if given in the reference.

2.3.3 New search capabilities

Within FRED the search capabilities were limited to a manual search of the data (by reference) and a search output based, sequentially, on wildlife group, umbrella endpoint and finally dose or dose rate. It was possible to export the output from the search at each of these three stages. Additional search capabilities have been added in the form of:

- Search by:
 - Author;
 - Keywords;
 - Source of radiation (internal, external etc);
 - Specific type of radiation (alpha, beta and gamma);
 - For specific radionuclides as the source of radiation;
 - Specific endpoints;
 - You can now select particular species (or all) from within a particular wildlife group.
- During the sequential wildlife group, umbrella endpoint and finally dose or dose rate steps an option to select all umbrella endpoints has been provided so that you can select all the umbrella endpoints but still search on a given dose range. This eliminates the need to do essentially the same search four times.

2.4 Insertion of new references (up to 2004)

A total of 41 new references have been added to FREDERICA (not including those from EPIC). These were identified following targeted literature searches using online reference search engines such as the Web of Science. For example the information on mammals in FRED highlighted that:

- there were considerably less data available on the effects of chronic irradiation compared with acute exposures (34% and 62% of the available data respectively; the remaining 4% corresponded to transitory irradiation);
- data on the biological effects of alpha emitters administered via inhalation and ingestion was scarce for the four umbrella endpoints considered;
- most studies have been conducted on mice or rats (85% of the data), with few data for other mammalian species;



- almost all the data corresponds to studies done under laboratory conditions.

Using this type of information for each wildlife group, the searches targeted all references post 2001 and particularly those focused on the types of missing data as identified for mammals above. For example, the searches conducted on mammals have addressed the gap on alpha emitters administered via inhalation, one of the gaps identified in FRED.

2.5 Preparation of suggested lookup table for mammals table (part of the integration with the ERICA assessment tool)

At the current time, ERICA is moving towards using a tiered assessment approach (see Deliverable D4a and D4b). The discussion of how FREDERICA will be used as part of the assessment tool has focused on its application in Tier 2 and Tier 3 and the way that the outputs from FREDERICA will be used for this are described below.

As a brief background to the tiered approach:

Using the ERICA reference organisms, Tier 1 will make use of conservative assumptions to derive dose limiting activity concentrations in environmental media (e.g. soil, air or water) for comparing with measured or predicted environmental concentrations around the (proposed) site. The derivation of a screening activity concentration will make use of a number of evaluations of effects data but will be based on threshold values below which effects are unlikely to be observed.

Tier 2 assessments will predict dose rates to the reference organisms in ERICA and these will be compared to the same dose rate as used to derive the screening level in Tier 1. However it is felt that assessors might find it useful to evaluate the types of effects that may occur in different wildlife groups for the predicted dose rates. The plan is that the ERICA project will generate look up tables for this - see below.

Tier 3 assessments will predict dose rates and the assessments will focus on the effects that may be observed within the different wildlife groups. At this stage we think there should not be a screening level but that the results should be compared and evaluated with stakeholders. In this case the intention is to provide a direct link within the ERICA assessment tool from the dose prediction phase to run the existing searches within FREDERICA. Additional searches may also be developed but essentially the assessor would be given all available information on the effects for the predicted dose rate.

Initial discussions have taken place with the developers of the assessment tool in Work Package 1 and the overall approach as outlined briefly above has been agreed. To that end a draft version of a look up table for the chronic exposure of mammals has been generated (Table 2.6) for the purposes of discussion. This is the type of information that is proposed for Tier 2 assessments. The adequacy of this information is being discussed within the ERICA consortium and with the EUG.



Table 2.6: Proposed look up table for Tier 2 assessment based on chronic exposure of mammals.

Range (μGy/h)	Dose rate (μGy/h)	Exposure time	Specie	Radiation	Endpoint	Effect
<100			Rodent	γ; β<10keV	MB	No effects on body weight
	12.5	22 days	Rodent	β<10keV	MB	Reduced brain weight
			Rodent	γ; β<10keV	MT	No effects on survival or life-shortening
	71	98 days	Rodents	Neutrons	MT	Reduced survival
			Rodent	γ; β<10keV	RC	No effects on fertility or fecundity
100-1,000	125	22 days	Rodent	β<10keV	MB	Reduced body weight
	420	313 days	Rodent,	γ	MUT	Increased mutation frequency
	312	Not specified	Dog	γ	MT	Life-shortening
	960-2,750	28-735 days	Rodent	γ	MT	Life shortening (Depending on strain and length of exposure)
	129	200 days	Rodent	Neutron	MT	Life shortening
	100	4-6 months	Rodent	γ	RC	Sterility of males; reduced number of offsprings
	104	In utero irradiati.	Pig	γ	RC	Reduced primitive stem germ cells per cross section of seminiferous tubule; Reduced N° oocytes; Increased dead foetuses/sow in 2 nd pregnancy
	190	3 consecutive generations	Rodent	γ	RC	Sterility; reduced litter size; increased % of early deaths.
	330	Not specified	Rodent	γ	RC	Reduced N° litters/female; increased mortality after birth
	417	Not specified	Pig	γ	RC	Increased N° of dead piglets in 1 st pregnancy
	420	1 month	Rodent	γ	RC	Decreased N° of A1 spermatogonia
	450	108 days	Pig	γ	RC	Reduced ovary and testes weight (in utero irradiation)
	700	Not specified	Rodent	β<10keV	RC	Reduced N° of primary oocytes (gestation irradi.)

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Table 2.6 (cont'd): Proposed look up table for Tier 2 assessment based on chronic exposure of mammals.

Range (μGy/h)	Dose rate (μGy/h)	Exposure time	Specie	Radiation	Endpoint	Effect
1,000-5,000	1,833	Not specified		β>10keV	MB	Reduced blood cell counts
	1,360	108 days	Pig	γ	MB	Reduced brain weight
	3,200	108 days	Pig	γ	MB	Reduced body weight
	2,580-24,000	230-590 days	Rodent	γ	MT	Reduced survival (depending on strain and length of exposure)
	1,300	371 days	Goat	γ	RC	Reduced total sperm production
	3,500	608 days	Goat	γ	RC	Reduced N° of born/female in 3 rd generation
	1,360	21 days	Rodent	γ	RC	Reduced N° of germ cells in males and females
	2,085	70,6 days	Rodent	γ	RC	Reduced testes weight
	2,919	14,3 days	Rodent	γ	RC	Reduced testes weight
	2,083-3,500	4-90 days	Rodent	γ	RC	Reduced fertility span; reduced testicular weight; reduced germ cells/ovary
	1,250	From gestation to 14 days of age	Rodent	β<10keV	RC	Reduced litter size; Increased resorptions
5,000-10,000	8,916	1,300 days	Sheep	β>10keV	MB	Reduced number of leukocytes
	9,960	4 days	Rodent	γ	MUT	Increased paternal mutation frequency
	9,480	4 days	Rodent	γ	RC	Reduced germ cells/ovary
> 10,000	11,917	22 minths	Sheep	β>10keV	MB	Impaired thyroid function
	14,000	10,7 days	Pig	γ	MT	Life-shortening
	20,000	50 days	Goat	γ	MT	Life-shortening
	60,000	540 days	Dog	β>10keV	MT	Reduced survival (dose in squeueleton)

MT = Mortality; MUT = Mutation; RC = Reproductive capacity; MB = Morbidity

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3 Future work

A number of tasks are still to be performed over the remaining period of the ERICA project. These include the following tasks:

- 1) To integrate FREDERICA within the ERICA integrated assessment by firstly producing a series of lookup tables for each wildlife group/chronic or acute exposure and linking this to the Tier 2 assessment stage. Secondly by providing a direct link to the searches that are currently available within FREDERICA within the assessment tool and, as necessary, improving or modifying the searches and search output to make it more user-friendly. This will also include the writing of context help within FREDERICA to provide support to the users and also to write and provide some guidance on the interpretation of the search output from FREDERICA for use within the assessment.
- 2) The completion of the structural changes as listed in Section 2 and the inclusion of any new structural changes identified by users of FREDERICA and reported to the project team within the remaining time period of the ERICA project.
- 3) One point to be discussed, within the ERICA consortium, is whether we should consider calculating percentage values of the effects compared with the control/background values per experiment, where the authors have not already done this. This may be of use and may make it easier for an assessor to interpret the results of any FREDERICA searches. This is to be explored further.
- 4) Insertion of new data from the experimental work being undertaken in Work Package 2. Insertion of other reference information identified between the end of 2004 and the end of 2006. In addition, any references identified as missing or needed that are submitted via the online submission form at www.ERICA-project.org by anybody with an interest in the ERICA project will be incorporated if time permits.
- 5) To undertake some retrospective dose assessment work on high priority references. There are a number of references which contain useful effects data that could be used within the effects data evaluation but unfortunately the references only contain activity concentration data. Where sufficient data exists within the paper it is possible to reconstruct the dose (rate) information which would allow dose response curves to be generated. Two test references have already been evaluated and the retrospective dose assessment approach has been demonstrated. Currently references are being selected and evaluated for this purpose. The references will be prioritised on the basis of a) sufficient information available within the paper, and b) where there are data gaps that the information if available would help to address.
- 6) Preparation and provision of FREDERICA online context help to assist users of the database. This will be provided at all stages within FREDERICA.
- 7) The search output will be improved and in particular will allow the user to select their own output requirements instead of outputting everything as occurred in FRED. This will allow greater flexibility in the search output.
- 8) There are a few non-English references available which appear to contain useful information on effects data. These are currently in a range of languages for example Italian, Russian and French. Volunteers have been located within the ERICA consortium to evaluate the usefulness and then translate as necessary these additional references.





References

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