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CALICE
An Essential Software Tool for Criticality Engineers

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1. Introduction

To carry out their everyday tasks, it is very useful for nuclear criticality engineers to be able to quickly and reliably retrieve data usually used to value criticality risks. These data are

- Fissile materials properties, such as the infinite multiplication factor k_∞, the material buckling factor $B^2_{m...}$, tabulated as a function of the moderation ratio or the concentration,
- Criticality parameters (safe, permissible or critical values) which correspond to one dimension geometries (infinite height cylinder, spherical volume...).

This information is widely used in criticality safety analysis, in technical meetings with French Nuclear Safety Authorities and also, during crisis management.

These data are calculated by means of one-dimensional deterministic transport codes which lead to the production of documents called "Criticality standards".

The aim of the CALICE project is to store all these data (more than one million) into a database which can be accessed through a useful tool with a friendly graphical interface.

As a result, version 2.0 of the CALICE software allows access to the criticality parameters and the fissile properties calculated with various codes such as CRISTAL[1], SCALE or MCNP or collected in international standards for:

- homogeneous or heterogeneous media,
- media with homogeneous moderation or heterogeneous moderation,
- poisoned media,
- media taking into account Burn-Up Credit or not.

Besides accessing data, CALICE v2.0 can also perform the following tasks:

- graphically display parameters as a function of moderation ratio or concentration,
- interpolate between two values stored in a database,
- compute simple one energy group theory calculations,
- export data to ASCII files,
- generate pre-formatted documents,
- import data from formatted ASCII files,
- edit and modify data stored in the database.

2. Technical specifications

To develop a tool working under WINDOWS and of intuitive use while privileging robustness and perpetuity, the reserved solution was to develop this application with the environment of development DELPHI from BORLAND.

The choice of DELPHI 7 allows exploiting the specificities and advantages of an object- oriented language to develop a tool which will be:

- **efficient,**
- **stable,**
- **evolutionary.**

Computer architecture based on an object oriented language also allows to guarantee an evolutionary and corrective maintenance of the software application and so, to anticipate the addition of new features.

DELPHI 7 is an environment of development based on a well-known language: the **Pascal Object**. This environment dedicated to the fast development of graphical interfaces guarantees a good productivity in the realization of the interfaces, while keeping the quality inherent to an object-oriented development. The main qualities of DELPHI 7 are summarized below:

high quality of the Integrated Development Interface (IDE),
high quality of the compiler, which does not compromise the efficiency of the generated executable code,

- the power of the programming language without useless increase of complexity,
- flexibility and evolution potential of the architecture
- re-use of components allowed by the infrastructure.

The use of this language has allowed to develop CALICE and to generate a setup file which allows to install it on any PC equipped with WINDOWS NT, WINDOWS 2000 or 98. The version so installed will require none of the software used for the development (DELPHI, ACCESS).

CALICE should work under WINDOWS, without real optics of installing it on any other platforms, there is thus no necessity of implementing a multi-platforms environment. However, DELPHI authorizes the double compilation WINDOWS / LINUX, from the same file sources.

Concerning databases, the number of data to be stored is very important and can exceed several hundreds of thousand values to possibly reach a million data. The reserved solution consists in structuring the data in ACCESS databases. A database corresponding to a particular fissile medium.

Besides, to guarantee a possible transfer of the data in another database management system, one of the features of CALICE allows to create ASCII files readable under EXCEL or with any other text editor.

3. Architecture

A simple way of representing the software architecture of CALICE is given in the following figure:

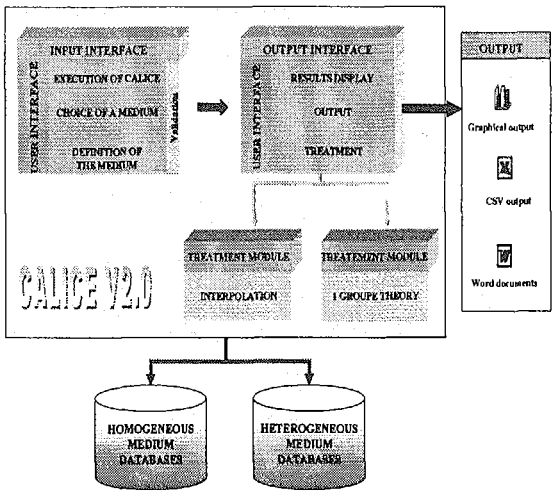

Fig. 1: Software architecture of CALICE v2.0

It is composed of three main items:

The user interface

- **The user front-end** allows users to choose its fissile and moderated media (homogeneous or heterogeneous), to take into account or not the combustion rate and finally to select the set of parameters necessary for the complete definition of the chosen medium (density, acidity, geometry ...).
- **The output interface** allows users to consult criticality parameters and to eventually do a post-treatment of the data (graphic output, interpolation...).
- **The treatment modules** are independent. Each module is a black box requiring input parameters and supplying output results by answering a particular elementary function.

The data

Databases are structured according to the type of fissile media:

- homogeneous,
- heterogeneous.

They can only be modified by a limited number of users (administrators).

Depending on the preliminary choices of the user:

- fissile medium,
- moderated medium,
- burn up credit,

CALICE accesses a specific database and asks the user to completely define the medium by choosing a

specific set of parameters among those stored in the database: density, acidity, poison ...

Once the medium is defined, the user can execute his request. The output interface extracts the results of the relevant database and displays them on the screen.

The output

The outputs that can be produced by CALICE are of three types:

- tables of results,
- Graphical results,
- CSV documents,
- WORD documents.

4. Three types of users

Three types of users have been defined, according to their level of expertise and the nature of their needs:

Standard user

This profile corresponds to a user who, for the needs of a study, should make one or a set of consultations from data stored in database. The basic features of CALICE are foreseen for this type of user who can use directly the results of consultations.

Expert user

This profile is dedicated to users who, for the needs of an expertise or a study of criticality, can be brought to import one or several databases without modifying their contents. Contrary to a standard user, the "expert" can also realize interpolation. To do it, this type of user has access, via a login and a password, to these functions.

The administrator

The administrator guarantees the distribution of CALICE to potential users. The administrator can also create new databases, modify their contents as well as the title of each field. To do it, the administrator has access to a specific database management tool. This profile is distributed to a very limited number of users.

5. CALICE functionalities

The choice, in the "File" menu, to consult criticality parameters leads to the opening of a window which allows to define completely the database which will be opened and from which the data will be extracted. The figure below represents this window:

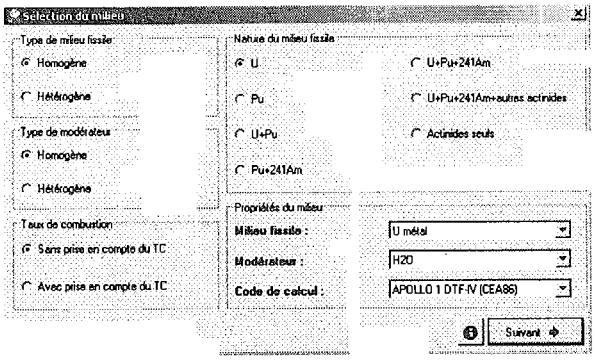

Fig. 2: Window allowing to chose a fissile medium

The parameters of this window characterize completely a database. The validation, leads to the opening of a second window from which the user can choose the characteristic parameters of the fissile medium (density, acidity, geometry ...). The ergonomics of this second window depends on the type and on the nature of the selected medium. The following figures show two examples of windows:

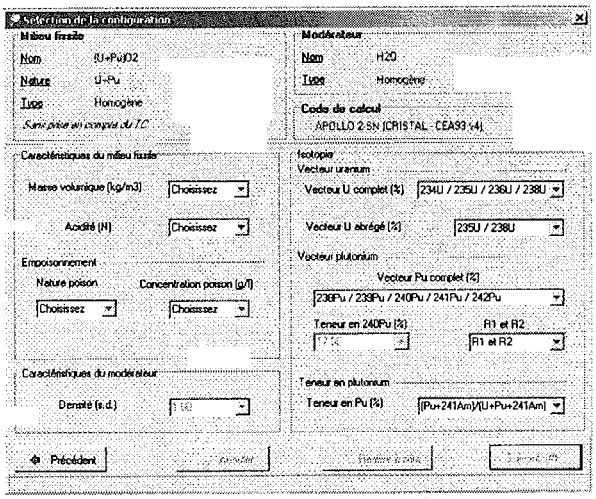

Fig. 3: Characteristics of a homogeneous fissile medium

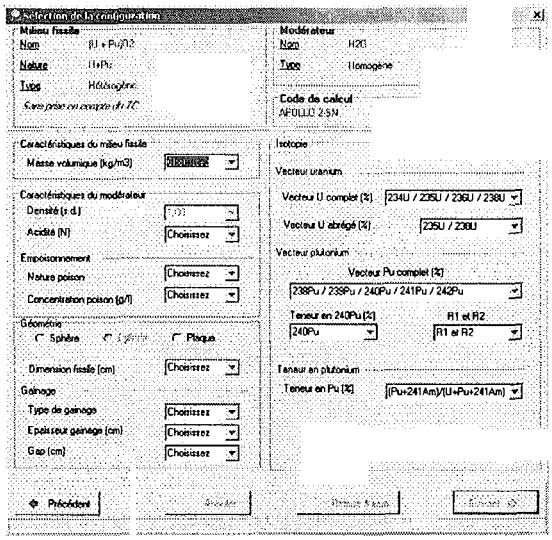

Fig. 4: Characteristics of a heterogeneous fissile medium

The validation via the button "Next" leads to the screen of presentation of the criticality parameters. This window consists of three zones:

- a zone reminding the properties of the selected fissile medium,
- a zone allowing to select the parameters to see (criticality parameters, neutronic constants and any other physical parameters),
- a zone displaying the parameters selected as a function of the concentration and the moderation ratio.

The figure below represents the window of consultation:

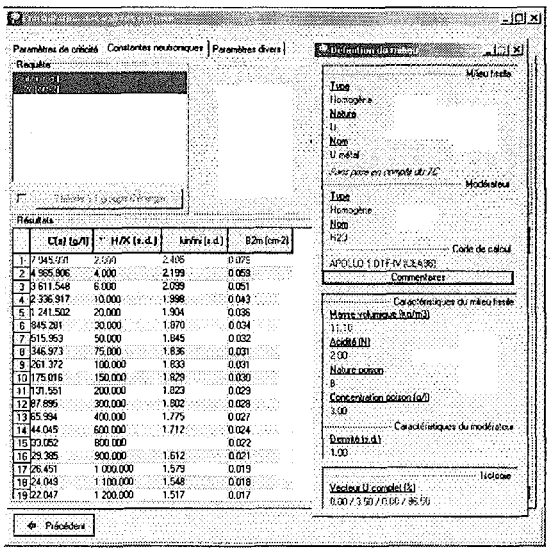

Fig. 5: Neutronic constants display of CALICE

Once the criticality parameters have been selected, users can easily find the minimum critical value and realise any post-treatment, such as requiring a graphical display. The figure below, represent an example of plot produced with CALICE:

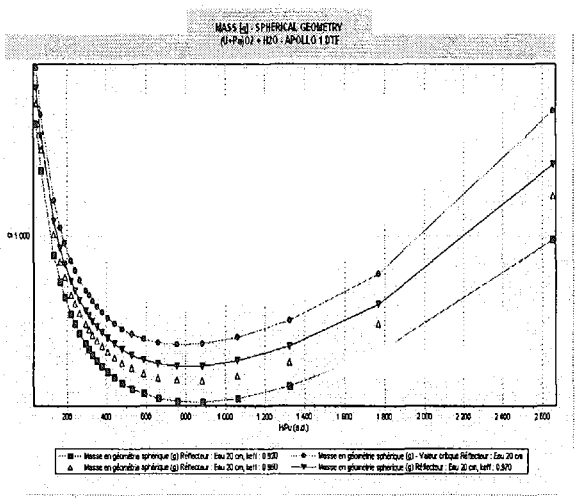

Fig. 6: Graphical output of CALICE v2.0

6. Conclusion

CALICE v2.0 is thus an intuitive, user friendly, fast and effective analytic application which is accessible at any time on the criticality engineer's personal computer.

Its helps nuclear criticality engineers, in their everyday tasks, to quickly access data usually used to value the criticality risks on an installation.

Références

1) J.M. et al, "The Cristal Criticality Safety Package", ICNC'99