User Guide for the Prognosis Models of RODOS-PV5.0

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Document History
1 Overview

Note: The atmospheric dispersion model RIMPUFF is not included in the RODOS version for which this User Guide applies. All references to RIMPUFF must be ignored.

1.1 Prognosis programs and their applicability

The Prognosis module of RODOS is applicable in the near range, that is, below 100-km distance from a nuclear power plant. It allows for prognoses of the radiological situation when using meteorological forecast data from meteorological services, or for the calculation of past episodes, when using recorded meteorological data. In the following, both ways of use are called “prognosis”.

In RODOS version PV5.0, two atmospheric dispersion models (ADM), ATSTEP and RIMPUFF, are implemented. Both have common features, e.g. use of the same dispersion parameters, but differ in the realisation of the puff advection: RIMPUFF is a puff model and releases several puffs per time step; ATSTEP is an elongated puff model and considers one puff per time step.

In the Prognosis mode, RODOS-PV5.0 provides three executable programs with different complexity. The simplest program is called QuickPro which has ATSTEP as ADM. QuickPro uses only meteorological on-site information provided by the user via hand-input or by data files. LSMC (local Scale Model Chain) is a more complex program, which includes as ADM either RIMPUFF (RODOS module RLSMC), or ATSTEP (RODOS module ALSMC) together with a meteorological pre-processor and a simple wind-field model. The meteorological pre-processor calculates the meteorological parameters required by the atmospheric dispersion models by interpolation or by specific models, taking into account for the topography and the roughness of the area. The simple wind field calculates a three-dimensional flow-field in a layer above the calculation grid from a single wind speed/direction pair at a given height at a given point or by using the information from the NWP data of the local scale model.

These different features result in different areas of applicability. QuickPro, being the fastest and least sophisticated code, is most suitable for demonstrations and training with simple scenarios. LSMC enables to use both meteorological forecast data and data from meteorological towers (and, in addition, user input). LSMC can therefore describe spatially distributed wind-fields and boundary layer conditions, which provides a more realistic dispersion calculation under a wide range of meteorological conditions than possible with QuickPro with its spatially uniform wind-field. Thus, in emergency conditions, LSMC has to be used. In the Interactive Mode, both
ALSMC and RLSMC are suitable, and the results do not differ significantly. However, ALSMC needs less computing time.

One of the major changes in RODOS-PV5.0 is the possibility to perform prognostic calculations for more than one month. The upper bound is set at the moment to 47 days. However, in case of LSMC, prognostic calculations are in general limited to the extend numerical weather prognosis (NWP) data are available. In case the user is interested to re-calculate events from the past, NWP data has to be collected in the data base or user defined meteorological input has to be applied. Performing a prognosis over a long time, the user has to be aware of the amount of data which is generated and the computing time of the particular run.

1.2 Input

For an interactive Prognosis run with RODOS, the data depending on the actual situation and problem cannot be made available by the system in an a-priori manner. Such data are in the following referred to as *situation data*; they have to be introduced into the system by the user with the RODOS *Initialization* windows.

The Prognosis situation data and the hierarchy of the *Initialization* windows are shown in Table 1 and explained below. With some exceptions in the meteorology part, which are indicated in the table, the windows apply to all three Prognoses programs.

**Table 1: Prognosis situation data and input window hierarchy**

<table>
<thead>
<tr>
<th>Prognosis: Data group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(React-1.0) Reactor power/operation time</td>
<td></td>
</tr>
<tr>
<td>(CGrid-1.0) Calculation grid</td>
<td></td>
</tr>
<tr>
<td>(CGrid-2.0) Comment</td>
<td></td>
</tr>
<tr>
<td>(CGrid-3.0) Size of inner grid cells</td>
<td></td>
</tr>
<tr>
<td>(RTime-1.0) Input of prognosis time</td>
<td></td>
</tr>
<tr>
<td>(RTime-2.1) Start/end of prognosis</td>
<td></td>
</tr>
<tr>
<td>(RTime-2.2) Prognosis length</td>
<td></td>
</tr>
<tr>
<td>(STerm-1.0) Source term</td>
<td></td>
</tr>
<tr>
<td>(STerm-2.0) Comment</td>
<td></td>
</tr>
<tr>
<td>(STerm-3.0) Input mode</td>
<td></td>
</tr>
<tr>
<td>Read from file</td>
<td></td>
</tr>
<tr>
<td>(STerm-4.0)</td>
<td></td>
</tr>
<tr>
<td>Hand input</td>
<td></td>
</tr>
<tr>
<td>(STerm-5.0) Start window</td>
<td></td>
</tr>
<tr>
<td>(STerm-5.1) Identifier, end of chain reaction, release height, thermal power, released iodine fractions</td>
<td></td>
</tr>
<tr>
<td>(STerm-5.2) Input mode for the activity</td>
<td></td>
</tr>
</tbody>
</table>
As can be seen from the table, the Prognosis situation data are divided into several data groups.

1. Reactor power and operation time

2. Calculation grid

RODOS version PV5.0 calculates on a non-uniform Cartesian grid. By default, the size of the inner grid cells is 1x1 km². Figure 1 on page 18 shows the structure of such a non-uniform grid.

For special applications, in particular for exercises, it can be useful to vary the size of the inner cells. This can be done with the grid Initialization window.

3. Start and end of prognosis time

By default, the data and time when the Prognosis run is started is used as the date and time for the initial release. You can assign other values with the release time Initialization window.

4. Source term

Source terms are certainly the items that have to be specified frequently by the user. You may select a source term from the fixdata
base with the RODOS configuration option. Or you may specify a new source term of your own or modify an existing one with the source term *Initialization* windows. The input quantities are the time span between the end of the chain reaction and the start of the initial release, the release height, the released thermal power, iodine fractions, and the released activity. For input of the latter, various modes are possible. Table 3 on page 26 shows the available modes.

If the source term data do not refer to individual nuclides, a core inventory is needed to generate the nuclide-specific information RODOS requires. For all reactor blocks implemented in the system, RODOS provides a file with the inventory data, which is then used [RODOS(RA7)-TN(00)-01]. The general user cannot modify the inventory files.

5. **Nuclides**

RODOS can perform the near range calculations with 1 to 15 nuclides, which are termed *calculation nuclides* in the following. By default, the following 15 nuclides are considered: Kr-88, Xe-133, Xe-135, I-131, I-132, I-133, I-134, I-135, Rb-88, Sr-89, Sr-90, Te-132, Cs-134, Cs-137, Ba-140. If the calculations shall be carried out with other nuclides, the selection must be done by hand in the dynamic nuclide selection windows which open automatically during run time.

6. **Meteorology**

Prognostic meteorological data can be taken either from a national weather service, which is the default, or can be put in by the user via the meteorology *Initialization* windows. An input of the meteorological data by the user is cogent when running with QuickPro. When running with ALSMC or RLSMC, one can choose the user input mode if the meteorological conditions are pre-defined, for instance in exercises, or if by one reason or the other the prognosis data from a national weather service are not available.

Apart from that, the meteorology windows serve for input concerning initial plume broadening, land use and turbulence parameterisation.

1.3 **Output**

The results of a RODOS prognosis run are the development in space and time of air and ground level concentrations, and the resulting radiation fields and potential doses that follow an accidental atmospheric release of radioactive material from a nuclear power plant. Additional information such as wind fields and protocols of the situation data used in a run is also provided.

The Prognosis output, that is accessible with the RODOS graphics, is summarised in Table 2. The table also shows the keywords, under which the results can be located in the RODOS graphics, and the
physical units. With one exception (wind field), the output is provided by all three Prognoses programs.

### Table 2: Output from Prognosis

<table>
<thead>
<tr>
<th>result</th>
<th>key in graphics</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>[Con&amp;Depos] Concentration and deposition fields</strong>&lt;br&gt;All results except rain intensity for 1 to 15 selected calculation nuclides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration in air near ground</td>
<td>[ConAir]</td>
<td>Bq/m³</td>
</tr>
<tr>
<td>Time-integrated concentration in air near ground</td>
<td>[TiConAir]</td>
<td>Bq·s/m³</td>
</tr>
<tr>
<td>Ground contamination: Total deposition (dry + wet)</td>
<td>[CoGround]</td>
<td>Bq/m²</td>
</tr>
<tr>
<td>Ground contamination: Wet fraction only</td>
<td>[CoGroundWet]</td>
<td>Bq/m²</td>
</tr>
<tr>
<td>Rain intensity</td>
<td>[ActualRainField]</td>
<td>mm/h</td>
</tr>
</tbody>
</table>

| **[Rad&Doses] Radiation fields and doses: Dose rate results**<br>Actual values for each Prognosis time step | | |
| Nuclide-specific results for 1 to 15 selected calculation nuclides | | |
| Potential gamma dose rate from plume (effective dose)<br>(for a height of 1 m above ground)<br>- nuclide-specific<br>- sum over calculation nuclides | [CloudRateNu] [CloudRateSum] | mSv/h |
| Potential gamma dose rate from ground (effective dose)<br>- nuclide-specific<br>- sum over calculation nuclides | [GroundRateNu] [GroundRateSum] | mSv/h |
| Potential local gamma dose rate (effective dose)<br>- nuclides sum | [LocDoseR] | mSv/h |

| **[Rad&Doses] Radiation fields and doses: Dose results**<br>Nuclide-specific results for 1 to 15 selected calculation nuclides<br>Organ-specific results for lung, bone marrow, thyroid, uterus, effective | | |
| | | |
| Potential gamma dose from plume<br>- nuclide-specific effective dose<br>- sum over calculation nuclides for individual organs | [CloudDoseNu] [CloudDoseSum] | mSv |
| Potential 7-days gamma dose from ground resulting from actual ground contamination in each Prognosis time step<br>- sum over calculation nuclides for individual organs | [GroundDoseSum] | mSv |
| Potential 50 years dose from inhalation resulting from actual inhaled radioactive material in each Prognosis time step<br>- sum over calculation nuclides for individual organs | [InhalDoseSum] | mSv |
Local skin dose from self-irradiation of contaminated skin from actual deposited radioactive material in each Prognosis time step integrated over 24 hours (alpha-, beta-, gamma-irradiation) \[\text{LocalSkinDose}\] mSv

**Additional results/information**

<table>
<thead>
<tr>
<th>Times of plume arrival at locations on the map [\text{PlumeArrive}] h</th>
<th>Wind field (LSMC only) [\text{Windfield}] m/s</th>
</tr>
</thead>
</table>

**Tables** Situation data protocols

<table>
<thead>
<tr>
<th>Site and calculation grid [\text{SiteData}]</th>
<th>Nuclides [\text{NuclideData}]</th>
<th>Inventory [\text{InventoryData}]</th>
<th>Source term: Input from user [\text{STermFromUser}]</th>
<th>Source term: Additional, derived information [\text{STermMoreInfos}]</th>
<th>Source term: Time step source term for ADM-modell [\text{STermTStep}]</th>
<th>Meteorological data and dispersion-related data [\text{MeteoFromUser}]</th>
</tr>
</thead>
</table>

1.4 References

**For ATSTEP:**

J. Päsler-Sauer, Description of the Atmospheric Dispersion Model ATSTEP - Version RODOS-PV5.0, RODOS(RA2)-TN(03)-01.

**For Meteorological Pre-Processor (MPP):**

Wolfgang Raskob, Jürgen Päsler-Sauer, Thomas Schichtel Spyros Andronopoulos, John Barzis, First definition of the revised meteorological pre-processor for RODOS PV 5, RODOS(RA2)-TN(00)-01

**For source term model (including inventory):**

[RODOS(RA1)-TN(02)-01] (draft) C. Landman, Program Package STerm in RODOS PV5.0.

**For nuclides in Prognosis models, nuclide naming conventions:**

[RODOS(RA1)-TN(02)-04] C. Landman, Documentation of the NucInfo software package in RODOS-PV5.0.

**For available scenario data for use in RODOS:**

[RODOS(RA7)-TN(00)-01] C. Landman, Scenario data sets and scenarios for RODOS (Versions PV4 and PV5).
2 Starting a Prognosis run in the interactive mode

2.1 Before starting the run

You must consider if you want

- to run with the site your RODOS system is implemented for, or with another site (for example, for exercises);
- to recall a source term from the RODOS fixdata base for use in the run without or with modification;
- to make some hand-input or modifications of the situation data with the Initialization windows.

Using a pre-defined source term from the fixdata base can be helpful for example for exercises. The available fixdata source terms are described in [RODOS(RA1)-TN(00)-01]. You can modify the recalled fixdata base source term on the level of the RODOS Initialization windows. The storage of a source term into the fixdata base, however, is not possible for the general user.

Having decided what you want, carry out the corresponding steps described in Chapter 2.2.

2.2 Starting the run

2.2.1 Overview

Starting an interactive Prognosis run requires the following steps:

1. (Optional) Selection of a site other than the default site.
2. (Cogent) Start of interactive manager.
3. (Optional) Selection of the run option.
4. (Optional) Selection of a source term from the fixdata base.
5. (Cogent) Start of the Prognosis run without or (optional) with input or modification of situation data.

It is important that the steps are carried out in the sequence shown in the list above. All steps are described below. You may skip the sections referring to the optional steps if you do not want to carry them out.

The situation data used in each Prognosis run are recorded; see Chapter 6.6 for more details.

2.2.2 Selection of a site other than the default site

In the tool bar of the Main Dialogue Window of RODOS select (Option). A new menu pops up (not shown here). Click on (Site selection). The Site Selection window appears (not shown here). In the
upper part of this window is a scrollable list with all available blocks for all available sites. Click on the desired block. Below the list, the geographical co-ordinates and the bounding box will display the corresponding values for the chosen block. Finally, click on [Apply]. An hourglass appears; you must wait until the update is completed, that is, until the hourglass disappears.

2.2.3 Start of interactive manager

In the tool bar of the Main Dialogue window of RODOS select the button [Interactive]. The Interactive Manager window appears.

For details about the Interactive Manager window see [RODOS User Guide of the System Interface].

2.2.4 Selection of run option

In the tool bar of the Interactive Manager window, press (Option). A new menu pops up (not shown here). Select the desired run option by clicking on □default or □temporary.

The default run option is “default”. For details about the meaning of the run option see [RODOS User Guide of the System Interface].

2.2.5 Selection of a source term from the fixdata base

In the tool bar of the Interactive Manager window, first press (Configuration) and then (Reassigning Dataset from Fixdata-Base). A window called Target Programs appears. In this window, choose

- QUICKPRO when running with QuickPro,
- ALSMCprogn when running with ALSMC,
- RLSMCprogn when running with RLSMC.
The *Configuration* window appears.

![Configuration window](image)

In the top line of this window, activate **exactly** the run option (default or temporary) which is active for your run.

In the *Program List* in the left part of the window, press

- `[QuickProgno]` for QuickPro,
- `[ALSMCprgn]` for ALSMC,
- `[RLSMCprgn]` for RLSMC.

In the *Category List* in the right part of the window, press *(SourceTerm)* for changing the source term. **Do not activate any of the other items present in the list.**

Then press the [OK] button in the bottom line of the *Configuration* window.

The *Identification List* appears (not shown here). Activate the desired set of source term data by mouse-click. Then click on the [Apply] button in the *Identification List*.

If all was successful, a message appears that the configuration was completed, which must be closed with [OK]. If not, an error message indicating the problem appears, and you can try again. **Attention:** If you get an error message, although you carried out all steps in the correct way, proceed with the instructions in Chapter 2.2.7.

Leave the configuration menu by clicking on [Close].

### 2.2.6 Start of Prognosis run without or with input or modification of situation data

In the *Interactive Manager* window, click on

- `[QUICKPRO]` for QuickPro,
- [ALSMProgn] for ALSMC,
- [RLSMCprogn] for RLSMC.

The Start window pops up.

First, enter the Run-ID.

If you want to input or modify situation data, press [Initializing]. If the system then informs you, that there is no load list, and an automatic copy will be generated, proceed with the instructions in Chapter 2.2.7. When the load list is present, the Initialization windows will open, which are described in detail in Chapters 3, 4, and 5. On return from the initialization windows you automatically come back to the Start window.

Start the Prognosis run by pressing [Start], or cancel the start preparations by pressing [Cancel].

After the run has been started, the Control & Services window appears. This window is described in detail in [RODOS User Guide of the System Interface].

2.2.7 Messages resulting from missing load lists during the different start phases, and corresponding user actions

If you wanted to carry out a configuration step in the Interactive Manager window, and an error message (Configuration not completed) appears when the system is going to perform the configuration, although you carried out all steps in the correct way, this means that there is no load list. Then go to the Start window and click [Start]: The system will generate an automatic copy. You must wait until the ready-message appears, and then repeat the site selection, if you made one, and the configuration step.

If you wanted to carry out an initialization step with the Initialization windows, and the system informs you, that there is no load list, and an automatic copy will be generated, you first must wait until that was finished. Afterwards, you must repeat any site selection and configuration you have performed so far.
3 Initialization windows for Prognosis: Overview; how to enter and leave; entry window

The start and the end of the Prognosis initialization are described in Chapter 3.1. The entry Prognosis initialization menu PROGNOSIS: Data group is described in Chapter 3.2. From that entry window, the input windows for the specifications of nuclides, grid, release time, source terms (Chapter 4) and meteorology (Chapter 5) are reached. The window hierarchy is summarised in Table 1 on page 4.

Each data set that has been applied after leaving the Prognosis Initialization windows will be archived and can be used again. Such data sets are called temporary data sets. The last created data set is called temporary data set of the previous initialization. After a new installation of the RODOS-System the default data set and the temporary data set are equal.

All the Prognosis Initialization windows are arranged in the form of a tree. It is always possible to proceed to the next branch or return to the previous branch.

Some of the windows have a [Help] button. By pressing this button, you get more information about the items in the corresponding menu. This button is omitted in the following menu descriptions.

Some of the windows have a [Print] button. By pressing this button, you get a printout of the corresponding menu. This button is omitted in the following menu descriptions.

3.1 Starting and ending the Prognosis initialization

After having pressed [Initializing] in the Start window, the Program Initialization window appears. As an example, the picture below shows the Program Initialization window for an interactive Prognosis with ALSMC.
On return from the Prognosis *Initialization* windows you come back to this menu.

For the meaning of the two buttons [single-display], which is the default, and [double-display], see [RODOS User Guide of the System Interface].

### 3.1.1 Starting the initialization

In the *Program Initialization* window, click on the program name (QUICKPRO, ALSMCprgn or RLSMCprgn). The *Dataset Selection* window comes up.

This window switches between modification of either the data from the previous initialization, or the data from another initialization made earlier. After pressing the appropriate button (details not shown here), the main Prognosis initialization menu *PROGNOSIS: Data group* pops up.

### 3.1.2 Ending the initialization

On return from the *Initialization* windows you come back to the *Program Initialization* window. Now you have three choices:

- To apply the input made in the *Initialization* windows, click on [Apply]. After the system finished working, click on [Return].
- To cancel all input made in the *Initialization* windows and then start again with new input, click first on [unlock buttons], then proceed again from Chapter 3.1.1.
- To ignore all input made in the initialization, click on [Return].

Leaving the Prognosis initialization brings you back to the *Start* window.

### 3.2 PROGNOSIS: Data group

Menu *PROGNOSIS: Data group* is the entry window for a Prognosis initialization.

The window serves for the selection of the input of Prognosis items. Clicking on the corresponding input item accesses the sub-windows for the actual input.
In RODOS PV5.0 the data group 'Calculation nuclides' is removed from this entry window; the corresponding data are now specified in dynamic input windows which open automatically during run time. They are also described in the following chapter.
4 Initialization windows for Prognosis: Reactor data, grid, start/end, source term, nuclides

Except for the nuclide selection, all windows described in this Chapter are identical for ALSMC, RLSMC, and QuickPro.

The figures shown are for an example run with run-identification “demo”. This run-ID appears as the leftmost item [demo] in the title line of each window.

4.1 Reactor data: reactor power and operation time

For the reactor under consideration the thermal power (in MW) and the operation time (in days) is displayed as taken out of the database. If necessary, the user can modify these values for a specific purpose.

![Diagram of Reactor Power/Operation Time Window]

4.2 Calculation grid

4.2.1 Non-uniform grid; changeable item; how to start

The calculation grid is a square grid with Cartesian X and Y coordinates, the X-axis showing to the East, the Y-axis to the North. It is covered with square cells, the size of which increases with the distance from the grid centre, where the NPP is situated. Therefore it is called non-uniform grid.

Figure 1 shows the grid structure. There is a square central region with highest resolution, i.e. smallest grid cells. By default, the size of the inner grid cells is 1 x 1 km². Three square frames containing cells with double size, 4-fold, and 8-fold size, surround this region.

For special applications it is sometimes desirable to have a higher resolution very near to the site, or to calculate to even farther distances. Therefore, the size of the grid can be scaled to smaller and larger size. This is achieved by changing the size of the inner grid cells.
The grid specification entry window CGrid-1.0 opens when pressing on ◊ Calculation Grid in the PROGNOSIS: Data group window.

Figure 1: Structure of the non-uniform calculation grid

4.2.2 (CGrid-1.0) Calculation grid, and (CGrid-2.0) Comment

Menu CGrid-1.0 is the entry window for grid input.
The data input can be supplied with a comment by clicking on ◊Comment and entering a text into the successor window CGrid-2.0 (not shown). Hint: It is useful to insert such a comment to distinguish temporary data sets from each other.

The sub-window for the data input is accessed by clicking on ◊Calculation grid, which brings you to the menu CGrid–3.0. [Close] brings you back to the Prognosis: Data group menu.

4.2.3 (CGrid-3.0) Size of inner grid cells

Enter the width of the inner grid cells in [m]. [Close] exits the window without storing any input. [Update] confirms any input.

4.3 Start and end of prognosis

After pressing ◊Start and end of prognosis in the PROGNOSIS: Data group window, the prognosis times Initialization window (RTime-1.0) opens. [Close] exits the window without storing any input. [Update] confirms any input. In either case, you come back to the Prognosis: Data group menu.

There are two options for defining the prognosis times:

- By default, the data and time when the Prognosis run is started is used as the date and time for the initial release. Clicking to
◊ **Prognosis start at actual date/time** opens window *(RTime-2.2)* where the prognosis length has to be given; the default is 24 hours.

- You can assign other values by clicking to ◊ **Input of start and end time**. Enter year, month, day, hour and minute for both time points in window *(RTime2-1)*. The window shown here has negative values, as this option is not used as default.

[Close] exits the corresponding window without storing any input. [Update] confirms any input. In either case, you come back to window *(RTime-1.0)* **Input of prognosis times**.

The prognosis period determines the so-called EmerSimDay, on which all emergency actions are assumed to be simulated in EmerSim. This day starts at midnight of the last day within the prognosis period and ends with the end time of the prognosis. If the actions should take place earlier, the duration of the prognosis has to be shortened.
4.4 Source terms

4.4.1 Overview; how to start

The selection of a source term from the fixdata base with the RODOS configuration option was already described in Chapter 2.2.5. The current Chapter deals with the specification of a new source term of your own, and with the modification of an existing one with the source term specification windows.

With regard to the source term, the following information is required:

- The time span between the end of the chain reaction and the start of the initial release.
- Height of release and released thermal power as a function of time.
- Fractions of elemental iodine, organically bound iodine and iodine aerosols of the entire amount of iodine as a function of time.
- Released activity as a function of time.

The released activity can be specified in many different ways – see Chapter 4.4.5.2 for more details.

The source term entry window, STerm-1.0, opens when pressing Source term in the PROGNOSIS: Data group window.

4.4.2 (STerm-1.0) Source term, and (STerm-2.0) Comment

Menu STerm-1.0 is the entry window for source term input.

The data input can be supplied with a comment by clicking on Comment and entering a text into the successor window STerm-2.0 (not shown). **Hint:** It is useful to insert such a comment to distinguish temporary data sets from each other.

Clicking on Source term, which brings you to the menu STerm-3.0, accesses the sub-windows for the data input.

[Close] brings you back to the Prognosis: Data group menu.
4.4.3  *(STerm-3.0) Input mode*

◊ **Input by hand** brings you to window *STerm-5.1*. For version PV5.0, currently seven different ways to put in a source term by hand are possible; these are described in connection with window *STerm-5.1*. This option is the **default**.

Alternatively, the source term can be read from a pre-written, strictly formatted source term file. Such file input allows more possibilities to specify source terms than the hand-input mode [RODOS(RA1)-TN(02)-01:06], but their creation is a topic more for specialists rather than for the general user mode [RODOS(RA7)-TN(00)-01]. In case you want to use a file of this kind, choose the option ◊ **Read from file**, and enter the name in window *STerm-4.0*.

[Close] exits the window without storing any input. [Update] confirms any input.

4.4.4  *(STerm-4.0) Read from file*

The input file must be contained in directory ~rodos/roextern/data/sourceterm/input. Enter the file name exactly as it is written in that directory (name must be specified left adjusted).

[Close] exits the window without storing any input. [Update] confirms any input.
4.4.5 Hand input

The identification, the time span between the end of the chain reaction and the start of the initial release, the release height, the released thermal power, and the iodine fractions, are entered independently from the released activity. The window \textit{STerm-5.1}, in which you can make the corresponding specifications, opens after pressing \textbf{\textcolor{green}{Input by hand}} in window \textit{STerm-3.0}.

By pressing [\textbf{Continue+Upd}] in window \textit{STerm-5.1} automatically leads you to window \textit{STerm-5.2}, in which you must select the input mode for the released activity.

\textbf{Hint:} If you want to put in a completely new source term by hand, first load the zero source term with name AAAZero from the fixdata base, in which all data entries are pre-set with zeroes.

4.4.5.1 (\textit{S}Term-5.1) Hand input: Identification, EOC, timing, height, thermal power, iodine fractions

Window \textit{Sterm-5.1} is rather large. On top, give a two-line \textbf{identification} for the source term (it appears in the control printout).

Below that, enter the \textbf{time span between the end of the chain reaction (EOC) and the start of the initial release} relative to the time point "end of chain reaction".

The release data can be entered for up to 24 \textbf{time periods} (release phases) of arbitrary duration. The lower and upper boundaries of the time intervals must be given in terms of hours after the start of the release. There is no principal upper limit for the duration of a source term, provided that the specification fits into 24 time intervals; however, there is a practical limit as the duration of an interactive prognosis calculation is 48 days in RODOS-PV5.0.

Please note the following peculiarities when specifying the time periods for the source term input:

- Overlaps of intervals are not allowed (else error message and run termination).

- The first release phase must start at time 0, that is directly after the begin of the release defined above; thus, the value of the lower boundary of the first release phase cannot be changed.

- There can be gaps between the different phases, that is, the time span between the start and the final termination of all releases needs not to be covered continuously. For all time periods without source term specification it is assumed in RODOS that there is no
release. However, for all time periods with source term specification there must be non-zero release data (else error message and run termination).

- It is possible to change or extend an existing timetable, even to put in intervals with earlier times at the end of the table, provided that there are no interval overlaps. In addition, intervals with identical start and end times will be ignored. Both properties together enable an easy correction of source term specifications already earlier in the windows.

Define at first the timing of the release by entering the start and the end times of the phases. Then enter the following information for all release phases you defined (scroll right and down to reach all times):

- The release height ([m]) in each time interval.

   Normally, the release height corresponds to the height of the stack or the point of release from the reactor building. In case of a release of unknown thermal energy and an estimation of the excess height of the plume being available, the latter may be taken into account by entering the estimated effective height for the height of release and zero for the thermal power.

   The release height must be 10 m at least. If you enter a value between 0 and 10 m in any release time interval, a height of 10 m will be inserted for that time interval, and a corresponding message is written into the protocol of the source term data.

   If you specify negative values for the release for any release time interval, the stack height for the site under consideration (contained in the fixdata base) will be inserted for that time interval, and a corresponding message is written into the protocol of the source term data.
• The **thermal power** ([MW]) released in each time interval:

The thermal power must be greater or equal to zero. If this constraint is violated, the program execution will stop and a corresponding message is written into the protocol of the source term data.

• The fractions of **elemental iodine**, **organically bound iodine** and **iodine aerosols**, or, for short, the **iodine fractions**, in each time interval:

These fractions have to be given in percent and must refer to the total amount of iodine released for each time interval. The sum of all three fractions must equal 100 %. If this constraint is violated, program execution will stop and a corresponding message is written into the protocol of the source term data.

If there is a release of iodine in a release time interval, but you did not specify the iodine fractions, 100 % elemental iodine will be inserted for that time interval. This represents the most conservative assumption because elemental iodine has the strongest deposition.

If there is no release of iodine in a release time interval, 100 % aerosol iodine will be inserted for that time interval, and any specification for that time interval made by you will be ignored. That is because the iodine resulting from mother decays after emission from the reactor is in the aerosol form.
[Close] exits the window without storing any input. [Continue+Upd] opens the subsequent input window for the released activity and updates the input just made.

4.4.5.2 (STerm-5.2) Hand input: Input mode for the activity

Before you can input the activity release you must select the input mode for the activity best suited for your purpose. For hand-input, seven modes are currently available, which are summarised in Table 3. Mode F1 is for fractions of activities for nuclide groups, modes F3, F4 and F5 for released activities for nuclide groups or a combination of nuclides and groups, and the modes F6 and F7, respectively for activities and activity rates, respectively, for single nuclides (without inventory reference). Mode F2 is for activities for single nuclides with inventory reference.

Input modes F1 to F5 require an inventory, which is provided by RODOS for each installed site. The inventory data used, if any, are documented in the protocol of the inventory situation data.

Table 3: Activity input modes for hand-input

<table>
<thead>
<tr>
<th>Mode key</th>
<th>Description a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Fractions ([%]) of the initial core inventory released for the nuclide release groups b)</td>
</tr>
<tr>
<td></td>
<td>• noble gases</td>
</tr>
<tr>
<td></td>
<td>• iodine</td>
</tr>
<tr>
<td></td>
<td>• alkaline metals</td>
</tr>
<tr>
<td></td>
<td>• tellurium and antimony</td>
</tr>
<tr>
<td></td>
<td>• alkaline earth</td>
</tr>
<tr>
<td></td>
<td>• ruthenium group (e.g. Ru, Rh, Mo, Tc)</td>
</tr>
<tr>
<td></td>
<td>• lanthanides (e.g. Y, La, Zr, Nb, Ce, Pr, Np, Pu, Am, Cm).</td>
</tr>
<tr>
<td>F2 c)</td>
<td>Released activity ([Bq]) for individual nuclides with inventory reference.</td>
</tr>
<tr>
<td>F3</td>
<td>Released activity ([Bq]) for the sum of calculation nuclides b) in the nuclide release groups noble gases and total aerosol, and for the individual nuclide I-131 together with release fractions for the nuclide release groups alkaline metals, tellurium and antimony, alkaline earth, ruthenium group, lanthanides</td>
</tr>
<tr>
<td>F4</td>
<td>Released activity ([Bq]) for the sum of calculation nuclides b) in the nuclide release groups noble gases, iodine, total aerosol, together with release fractions for the nuclide release groups alkaline metals, tellurium and antimony, alkaline earth, ruthenium group, lanthanides.</td>
</tr>
<tr>
<td>F5</td>
<td>Released activity ([Bq]) for the sum of calculation nuclides in the nuclide release groups b) listed for F1.</td>
</tr>
<tr>
<td>F6 c)</td>
<td>Released activity ([Bq]) for individual nuclides without inventory reference.</td>
</tr>
<tr>
<td>F7</td>
<td>Released activity rates ([Bq/s]) for individual nuclides without inventory reference.</td>
</tr>
</tbody>
</table>

Notes

a) The formats for specifying the start of initial release, the release height, the released thermal power and the iodine fractions are the same for F1-F7.
b) Calculation nuclides are the subset of 1 to 15 nuclides from all possible nuclides selected for a run. If, for instance, a release of 10E18 Bq is specified for the noble gas group, the results will be different when Kr-88 only or Kr-88, Xe-133, Xe-135 were selected as calculation nuclides.

c) The data input for modes F2 and F6 is the same. However, with mode F2 it is checked in each time step, that the specified activity release does not exceed the activity present in the reactor, which is calculated taking into account the activity release from the reactor and radioactive decay and build-up from radioactive decay chains in the reactor. If the calculated inventory is exceeded, a message is issued, the calculated value is taken, but program execution continues.

Activate the chosen mode by clicking on the corresponding item in window STerm-5.2, which opens after pressing [Continue+Upd] in window STerm-5.1 (scroll down to reach all modes). Subsequently, the corresponding window for the data input will open.

[Close] exits the window without storing any selection made.

Note: The switches in window STerm-5.2 determine the input mode. Once the mode selection was made, the data have to be typed in into the correct form for the mode. There is no data processing at this stage, which means, simply pressing another switch does not convert the data from one mode to another mode. In the example window, the switch for "Fractions released [Bq] for the nuclide groups noble gases, iodine, alkaline metals, tellurium/antimony, alkaline earths, ruthenium group, lanthanides
lanthanides" appears in a pressed position, which means, that this input mode is the active one; it is also the default mode.

**Remarks on the application and applicability of the different activity input modes:**

The activity release data for source terms of generic nature from PSA-studies are derived for a utility representative of its kind and usually are given as initial release fractions (mode key F1). This parameterisation makes it possible to apply them to reactors of similar type but different power. Of course they should not be applied blindly to reactors of types other than those they were intended for.

Release data in the form "Bq or Bq/s for individual radionuclides" (keys F6, F7) are taken in RODOS without any reference to a reactor inventory. This allows to use them even in the case that an inventory is by some reason not available because none was provided for the site under consideration, or not foreseen, or not of interest in a particular application, for example in some exercises. Release data of this type must only be used for the special application, reactor type and state they were originally intended for.

There exist accident scenarios without reactor shutdown prior or during a release. This means that application of the formalism developed for modes F1, F2, F3, F4, and F5 in RODOS ([RODOS(RA1)-TN(01)-01]) makes no sense because nuclides are created or destroyed at any moment by fission processes not accounted for at all in the model. In such situations, input modes F6 and F7 are the only remaining options.

Because of the conceptual difficulties outlined in Footnote b) in Table 3, input modes F3, F4, F5 should be used only if release information in other form is not available. The results of calculations based on such source terms should be carefully analysed and interpreted, and used with the necessary caution.

In RODOS there exists an import/export facility that allows source term exchange between different RODOS users for one specific scenario. This facility makes use of source term files generated by the source term code package of RODOS. Such files show the key "FX" and contain data in all formats shown in Table 3 that are derivable from the original input format by the source term code. FX-files can be applied in RODOS only for an utility with the same thermal power and days of operation, and in runs with the same selection of the calculation nuclides. All these conditions are checked and lead to an error exit when violated.
4.4.5.3 (STerm-5.21/-5.25/-5.26/-5.27) Hand input of released activity for source term input modes F1, F2, F5, F6, F7

The release data have to be entered for all release phases defined in window STerm-5.1. Which of the windows STerm-5.21, -5.25, -5.26, -5.27 actually will appear depends on the input mode selected in window STerm-5.2. All these windows have the same structure and differ from each other only with respect to the release items to be specified, either:

- **Release fractions** - the percentage of the initial activity inventory\(^1\) released during each time interval for the nuclide groups indicated in the window.

Or

- **Activity released** - the total activity released in [Bq] during the time interval for the nuclide groups or nuclides shown in the window.

Or

- **Activity rates released** - the activity rates released in [Bq/s] during the time interval for the nuclides shown in the window.

As an example, the window STerm-5.26 for the input of activity for individual radionuclides is shown above. It is identical for modes F2 and F6 (i.e. with and without inventory reference). In the top lines of the window, the start time of the release as well as the start and end time of the different release phases are shown for information only; that means, they cannot be changed in this window. The data input follows below these lines.

---

\(^1\) Initial inventory = inventory at the time <end of chain reaction>.
Hints

(1) The release resulting from the input data must exceed a certain minimum. If this is not the case, a corresponding error message is issued and program execution stops.

(2) If the source term is put in via release fractions (in percent), no fraction should be less than 0% or greater than 100%. Also, the sum of all fractions must not exceed 100%. Otherwise, a corresponding error message is issued and program execution stops.

(3) If the release rates for individual nuclides are not directly specified but derived from the user input, the following problem may occur: The activity specified by the user for a nuclide or nuclide group exceeds the activity, which is calculated from the inventory data as present in the reactor. In this case, a warning message is issued, the calculated value is taken, and execution of the program continues.

(4) The detection of any of the errors above occurs at runtime of the corresponding RODOS module and not in the Initialization windows. Fatal errors are reported both on the RODOS surface and in the situation data protocols mentioned earlier, minor warnings only in the corresponding situation data protocol.
4.4.5.4 Hand input of released activity for source term input modes F3 and F4

After selection of source term input mode F3 or F4 in window STerm-5.2, two successive input selection windows will pop up to put in the activity specification for these modes. It consists of two parts:

- Input of the released activity for noble gases, I-131 (F3) or iodine (F4), and for total aerosol (see window STerm-5.231 (F3) or STerm-5.241 (F4)),
- input of aerosol fractions, which will be used to derive the contributions of different aerosol groups to the total aerosol activity released (see window STerm-5.24 (F3 and F4)).

4.4.5.4.1 (STerm-5.231/-5.241) Modes F3 and F4: Activity input

After selection of source term input mode F3 or F4 in window STerm-5.2, at first the window STerm-5.231 (for F3) or STerm-5.241 (for F4) opens. Shown below is window STerm-5.241. Window STerm-5.231 (not shown here) looks the same, apart that the label "Iodine" is replaced by "I-131".

In the top lines of the window, the start time of the release as well as the start and end time of the different release phases are shown for information only; that means, they cannot be changed in this window. The data input follows below these lines. The release data have to be entered for each of the release phases defined in window STerm-5.1.

[Close] exits the window without storing any input. [Continue+Upd] opens the subsequent input window for the aerosol fractions and updates the input just made.
4.4.5.4.2 (STerm-5.242 and lower levels) Modes F3 and F4: Input mode for aerosol fractions

After pressing [Continue+Upd] window STerm-5.231 (F3) or STerm-5.242 (F4), window STerm-5.242 opens.

You can input the fractions yourself by pressing ◊ Input by hand, which brings you to window STerm-5.243. Or you can choose predefined aerosol fractions from a data library by pressing ◊ Pre-defined aerosol fractions from data set, which brings you to window STerm-5.244 (default).

[Close] exits the window without storing any input. [Update] confirms any input.

4.4.5.4.2.1 (STerm-5.243) Modes F3 and F4: Aerosol fractions by hand

In window STerm-5.243, you must enter the release fractions, that is, the percentage of the initial activity inventory released, for the nuclide groups indicated in the window\(^2\). These fractions are assumed to stay constant during the whole release duration.

No fraction should be less than 0% or greater than 100%. Otherwise, a corresponding error message is issued and the program execution stops.

\(^2\) Initial inventory = inventory at the time <end of chain reaction>. 
[Close] exits the window without storing any input. [Update] confirms any input.

4.4.5.4.2.2 (STerm-5.244) Modes F3 and F4: Aerosol fractions from data set

In window STerm-5.244, you can select release fractions for aerosols from source terms of the German Risk Study Phase A by typing the corresponding code for the selected release category in the selection field (see below).

[Close] exits the window without storing any input. [Update] confirms any input.

4.5 Nuclide selection

4.5.1 Overview

RODOS-PV5.0 contains data for 70 radionuclides in the fixdata base. Between 1 and 15 of these can be taken into account in the near range calculations; this subset of all possible nuclides is called "calculation nuclides" in the following. A representative selection of 15 calculation nuclides is provided in the system. If the calculations shall be carried out with other nuclides, the selection must be done by hand. The choice of the nuclide set is done in dynamic initialization windows which start with window Nucld-1.0 and open automatically during run time.

However, the far range atmospheric dispersion models of RODOS cannot cope with all 15 maximally possible calculation nuclides, but only with a subset of them, which is called "far range nuclides" in the following. The information about the far-range nuclides needs to be set up already in runs with near range models, because they pass information for the far-range models. The selection of the far range
nuclides is done in window Nucl-4.0 that pops up dynamically during execution of the near range models.

4.5.2 (Nucl-1.0) Option near range nuclides (dynamic windows)

Window Nucl-1.0 is the entry window for the input of the calculation nuclides for the near range; it pops up automatically during execution of QuickPro and A/R-LSMC.

Two options are available for the selection of the nuclides. Either the calculations are performed with the default set of nuclides or the user can select his own set of up to 15 nuclides. Depending on the user's input, the next window will be either Nucl-2.0 or Nucl-3.0.

Leaving the window without any input by pressing [Close] uses the default option. The confirmation of the option selected is done by pressing Update in the subsequent window.

4.5.2.1 (Nucl-2.0) Default near range nuclides

After choosing the option ◊ Calculation with default near range nuclides window Nucl-2.0 opens showing these nuclides for information.
[Close] exits the window without storing the option selected. [Update] confirms the usage of the default nuclide set.

4.5.2.2 (Nucld-3.0) Calculation nuclides for near range

After choosing the option ◊ Calculation with own near range nuclide selection window Nucld-3.0 opens.

From the nuclide list shown between 1 and 15 nuclides can be selected by entering "1" for "take" or "0" for "don’t take" (scroll up/down to reach all nuclides).

[Close] exits the window without storing any input. [Update] confirms any input.

The constraint "at least 1, maximally 15" will be checked after leaving this window with Update and Nucld-1.0 with Close. A violation of the constraint will lead to the issue of a corresponding message in window Nucld-3.1. Pressing [Close] brings you back to window Nucld-3.0 to modify your selection.
4.5.3 (Nucl-4.0) Option far range nuclides (dynamic windows, A/R-LSMC only)

Window Nucl-4.0 is the entry window for the input of the calculation nuclides for the far range; it pops up dynamically during execution of the A/R-LSMC near range models.

Two options are available for the selection of the nuclides. Either the calculations are performed with the default set of nuclides or the user can select his own subset of currently maximally 7 nuclides for the far range calculation from the calculation. Depending on the user's input, the next window will be either Nucl-5.0 or Nucl-6.0.

Leaving the window without any input by pressing [Close] uses the default option. The confirmation of the option selected is done by pressing Update in the subsequent window.

4.5.3.1 (Nucl-5.0) Default far range nuclides

After choosing the option ◊ Calculation with default far range nuclides window Nucl-5.0 opens showing these nuclides for information. Unused positions are marked by hyphens instead of nuclide names.

[Close] exits the window without storing the option selected. [Update] confirms the usage of the default nuclide set.
4.5.3.2 (Nucl-6.0) Calculation nuclides for far range

After choosing the option ◊ Calculation with own far range nuclide selection window Nucl-6.0 opens.

You are presented with a list of the names of the available calculation nuclides; unused positions are marked by hyphens instead of nuclide names (in the above example for window Nucl-6.0 there are no unused positions and thus no hyphens). The selection of up to 7 nuclides is made by entering "1" for "take" or "0" for "don't take" in the number fields below.

Notes:
(a) You must not select more than one iodine nuclide.
(b) You can specify zeroes in all fields, which means that you do not want to select any nuclide for far range calculations.

[Close] exits the window without storing any input. [Update] confirms any input.

If you have activated more than the allowed maximal number of far range nuclides, or more than one iodine nuclide, the error window Nucl-6.1 will pop up and will inform you about that. Press [Close] in this window. Afterwards, window Nucl-4.0 will reappear and you must try again.
5 Initialization windows for Prognosis: Meteorology

The ALSMC- and RLSMC windows are identical. QuickPro uses a subset of the A/R-LSMC windows, namely the windows numbered Meteo-1.0, 2.0, 5.0, 9.0, 10.0, 11.1, and 11.2. A few of these windows differ in connection with QuickPro and A/R-LSMC; this is indicated in the descriptions of the respective windows.

The figures shown are for an example run with ALSMC with the run-identification “demo”. This run-ID appears as the leftmost item [demo] in the title line of each window.

5.1 (Meteo-1.0) Meteorology, and (Meteo-2.0) Comment

Menu Meteo-1.0 is the entry window for meteorology input. Menu Meteo-1.0 for A/R-LSMC is shown in Chapter 5.1.1 and the corresponding menu for QuickPro in Chapter 5.1.2.

In either case, the data input can be supplied with a comment by clicking on ◊ Comment and entering a text into the successor window Meteo-2.0 (not shown here). Hint: It is useful to insert such a comment to distinguish temporary data sets from each other.

All other items in menu Meteo-1.0 are described in the respective chapters for A/R-LSMC and QuickPro.

5.1.1 Meteo-1.0 in ALSMC and RLSMC

By default, the land use data come from the RoGis database and depend on the location. Alternatively, you can specify location-independent land use with the button ◊ Land use data. Pressing this button brings you to window Meteo-4.0.

With ◊ Initial plume broadening, you can select if the atmospheric dispersion calculation shall be carried out without or with taking into account the initial broadening of the released plume. If yes, the lateral
width and height of the building relevant for the plume broadening must be specified. Pressing this button brings you to window *Meteo-5.0*.

You can select between different puff width parameterisation schemes with the button ◇ *Turbulence parameterisation*. Pressing this button brings you to window *Meteo-6.0*.

The button ◇ *Source of meteorological data* allows for the selection between data from meteorological stations/numerical weather predictions, or from user-input data. Pressing this button brings you to window *Meteo-7.0*.

[Close] exits the window without storing any input. [Update] confirms any input. In both cases, you come back to the *Prognosis: Data group* menu.

5.1.2 *Meteo-1.0 in QuickPro*

With ◇ *Initial plume broadening*, you can select if the atmospheric dispersion calculation shall be carried out without or with taking into account the initial broadening of the released plume. If yes, the lateral width and height of the building relevant for the plume broadening must be specified. Pressing this button brings you to window: *Meteo-5.0*.

Press button ◇ *Meteorological data* for input of meteorological data, which brings you to menu *Meteo-9.0*.

[Close] exits the window without storing any input. [Update] confirms any input. In both cases, you come back to the *Prognosis: Data group* menu.
5.2 (Meteo-4.0) Land use data, and (Meteo-4.2) Location independent land use (A/R-LSMC only)

The default selection is RoGis. [Close] exits window Meteo-4.0 without storing any input. [Update] confirms any input.

If ◊Location-independent land use from user was selected, window Meteo-4.2 will pop up, in which you must specify an index for the corresponding surface from a range of available surfaces. [Close] exits window Meteo-4.2 without storing any input. [Update] confirms any input.

5.3 (Meteo-5.0) Initial plume broadening

To start with you must specify if the atmospheric dispersion calculation shall be carried out without or with (default) consideration of the initial broadening of the released plume.

If plume broadening shall not be considered, a source of 1-m radius is assumed, independent of the release height.

If the effect shall be considered, the lateral width and height of the building relevant for the initial broadening of the plume (see below) has to be specified, which are then taken into account for release heights below the specified building height. For release heights above the building height, a source of 1-m radius is assumed.
For the relevant building dimensions, in RODOS by default a characteristic height and width of the corresponding plant will be used for the determination of the initial plume dimension (e.g. height and width of the reactor and generator building). For calculations with special wind directions and stability classes, where the influence of special building structures shall be considered, you can specify corresponding values for the building dimensions.

[Close] exits the window without storing any input. [Update] confirms any input.

5.4 (Meteo-6.0) Turbulence parameterisation (A/R-LSMC only)

Three sigma (puff width) parameterisation schemes can be selected. Numbers 2, 3, and 4 are currently not implemented. These numbers and number 5 in connection with ALSMC should not be used.
[Close] exits the window without storing any input. [Update] confirms any input.

5.5 (Meteo-7.0) Source of meteorological data (A/R-LSMC only)

By clicking onto the corresponding item in the menu, you can choose if you want to use measured data or Numerical Weather Prediction (NWP) data for the calculations (default), or if you want to put in the data by yourself. Choosing measured/NWP data brings you to window Meteo-8.0, choosing user input brings you to window Meteo-9.0.

[Close] exits the window without storing any input. [Update] confirms any input.

5.6 (Meteo-8.0) Selection Measured/NWP-data (A/R-LSMC only)

Default is the use of NWP data. The use of data from meteorological stations for the calculation of past episodes is not possible with the present version.

[Close] exits the window without storing any input. [Update] confirms any input.
5.7 Input of meteorological data by the user

5.7.1 (Meteo-9.0) User input: Input mode

You can choose between two input modes, which are explained below.

◊ **Input by hand**

This mode is for input by hand of up to 48 successive meteorological specifications each valid for a given duration starting from the time of the initial release. Next window is Meteo-11.2.

◊ **Read from file**

The meteorological data will be read from a pre-written, strictly formatted weather information file in form of 144 meteorological specifications each valid for 10 minutes starting from the time of the initial release. The user must specify the file name in window Meteo-10.0. The file name input is described in Chapter 5.7.2.

5.7.2 (Meteo-10.0) Read from file

The file must be located in directory `~rodos/roextern/data/asyprog`. Enter the file name as it is in this directory. The file format is described in report Bericht [RODOS(RA7)-TN(00)-01]. [Close] exits the window without storing any input. [Update] confirms any input.
5.7.3 (Meteo-11.2) Hand input

Required are specifications for the measuring height for the wind, and for each time interval the wind direction and wind speed, the rain intensity, and the diffusion category.

For the wind data, the **measuring height** valid for all time intervals must be specified. This height must be at least 5 m. A violation of this rule will - at runtime of the program - lead to a program stop with issue of a corresponding message.

For QuickPro only (not visible in the figure): The **roughness length** must be given by an Index. Index = 1 means a roughness length of about 0.5 m (rural area); index = 2 denotes a roughness length of about 1.5 m (urban area). If a number other than 1 or 2 is specified, QuickPro will use the default number for the site under consideration, which is contained in the fixdata base; a corresponding message is written in the meteorological situation data protocol.

For the **wind direction**, **wind speed**, **rain intensity** and the **diffusion category**, average values valid for the respective calculation have to be entered for up to 48 successive time intervals. Time zero is the start of the release and also the beginning of the first time interval; this lasts up to the given upper time point, which is the beginning of the second time interval and so on. Time intervals with identical start and end time will be ignored. Thus, it is rather easily possible to modify weather input already made.

The **wind direction** is the direction from where the wind blows.

For the **diffusion category**, letters from A through F according to the Pasquill-Gifford scheme must be entered. Otherwise, the program will stop at runtime with issue of a corresponding message.
For **rain intensity** higher than zero, it is assumed in the calculation that the rain of the given intensity covers the entire calculation area during the respective time interval.

[Close] exits the window without storing any input. [Update] confirms any input.
6 Prognosis results accessible with the RODOS Graphics

6.1 Overview

Which output from Prognosis is accessible with the RODOS graphics system was summarised in Table 2 on page 7. On the level of the graphics system, there is a hierarchical output structure, which is explained in this chapter.

The top level of the hierarchical output representation is obtained by clicking in the Graphics Manager window on the field

- **QUICKPRO** for display of results from QuickPro,
- **ALSMCprogn** for display of results from ALSMC,
- **RLSMCprogn** for display of results from RLSMC.

Under the program name follows the button ◊Prognosis, and then the keys [Con&Depos], [Rad&Doses], [Windfield] (ALSMC and RLSMC only), and [Tables], which stand for

- [Con&Depos]: Concentration and deposition fields,
- [Rad&Doses]: Gamma radiation and dose fields,
- [Windfield]: Wind fields,
- [Tables]: Situation data protocols for site, grid, calculation nuclides, inventory, source term, weather.

The field results are multi-dimensional data fields, where a local value determined in the centre of the respective cell or a set of local values of the result data field is assigned to each cell of the calculation grid. Such results are displayed as colour-coded maps for all locations of the RODOS grid. Assigning various colours to ranges of the results is automatically done by the system. The colour range, however, can be modified by the user with the <Edit Legend> facility of the RODOS graphics system. Clicking in each cell of the calculation grid shows the numerical values, if the mouse is in the inquiry mode (then the pointer has the form<?>)

The different Prognosis results are described in the following Chapter.

6.2 Preparing Prognosis results for graphical display

Results of a Prognosis run still active in the Main Drawing Window can be displayed directly. Runs, which were removed, have first to be loaded again from the run archive.

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3 For more information see [RODOS User Guide of the System Interface].
6.3 [Con&Depos] Concentrations and deposition

By clicking on [Con&Depos] in the Graphics Manager window, a list of keys appears as a submenu. By clicking on one of the keys, the result array will be sent to the Main Drawing Window, where it can be displayed in the usual way (see [RODOS User Guide of the System Interface]).

Below, the keys are listed and marked by bold brackets. Under the keys follow the quantities represented by them (bold), and a brief explanation.

- **[ConAir]**
  **Concentration in air near ground**
  Atmospheric dispersion following the release of a nuclide causes a field of nuclide air concentrations in the environment. This concentration is given in Becquerel per cubic metre air [Bq/m³] in the entire calculation grid 1 m above ground. It is output after each computation step of the dispersion model.

- **[TiConAir]**
  **Time-integrated concentration in air near ground**
  Time-integrated air concentration is output in Becquerel seconds per cubic metre air [Bq*s/m³] in the complete calculation grid 1 m above ground after each computation step of the dispersion model.

- **[CoGround]**
  **Ground contamination - total (dry + wet)**

- **[CoGroundWet]**
  **Ground contamination - wet fraction only**
  Iodine nuclides and nuclides in aerosol form are subject to dry and wet deposition resulting in contamination of the ground surface. Contamination is output in the calculation grid in total and for the wet fraction only in Becquerel per square meter [Bq/m²] after each computation step of the dispersion model.

- **[ActualRainField]**
  **Rain intensity**
  For a certain period of time, rain intensity of greater than 0 mm/h may prevail in the area of the calculation grid during dispersion calculation. The current rain intensity is output in millimetres per hour [mm/h] after each computation step of the dispersion model.

6.4 [Rad&Doses] Radiation fields and doses

By clicking on [Rad&Doses] in the Graphics Manager window, a list of keys appears as a submenu. By clicking on one of the keys, the result array will be sent to the Main Drawing Window, where it can be
displayed in the usual way (see [RODOS User Guide of the System Interface]).

Below, the keys are listed and marked by bold brackets. Note that "Nu" indicates that the result is output in a nuclide-specific manner, and "Sum" the dose summed up over all nuclides. Under the keys follow the quantities represented by them (bold), and a brief explanation.

- **[CloudRateNu]**
  Potential gamma dose rate from cloud (effective dose, individual nuclides)
  The nuclide-specific effective cloud gamma dose rate at 1 m above ground is output in milli-Sievert per hour [mSv/h] in the entire calculation grid after each computation step of the dispersion model.

- **[CloudDoseNu]**
  Potential gamma dose from cloud (effective dose, individual nuclides)
  The nuclide-specific effective cloud gamma dose at 1 m above ground is output in milli-Sievert [mSv] in the entire calculation grid after each computation step of the dispersion model.

- **[GroundRateNu]**
  Potential gamma dose rate from ground (effective dose, individual nuclides)
  The nuclide-specific effective ground gamma dose rate at 1 m above ground is output in milli-Sievert per hour [mSv/h] in the entire calculation grid after each computation step of the dispersion model.

- **[CloudDoseSum]**
  Potential gamma dose from plume (individual organs, nuclide sum)
  The potential gamma organ dose of the plume at 1 m above ground is output in milli-Sievert [mSv] in the entire calculation grid after each computation step of the dispersion model.

- **[GroundDosSum]**
  Potential 7 days gamma dose from ground (individual organs, nuclide sum)
  The potential 7 days ground gamma organ dose at 1 m above ground is output in milli-Sievert [mSv] in the entire calculation grid after each computation step of the dispersion model.

- **[InhalDoseSum]**
  Potential 50 years inhalation dose (individual organs, nuclide sum)
The potential 50 years inhalation organ dose is output in milli-Sievert [mSv] in the entire calculation grid after each computation step of the dispersion model.

- **[CloudRateSum]**
  **Gamma dose rate from cloud (effective dose, nuclide sum)**
  The nuclide-integral effective cloud gamma dose rate at 1 m above ground is output in milli-Sievert per hour [mSv/h] in the entire calculation grid after each computation step of the dispersion model.

- **[GroundRateSum]**
  **Gamma dose rate from ground (effective dose, nuclide sum)**
  The nuclide-integral effective ground gamma dose rate at 1 m above ground is output in milli-Sievert per hour [mSv/h] in the entire calculation grid after each computation step of the dispersion model.

- **[LocDoseR]**
  **Local gamma dose rate (effective dose, nuclide sum)**
  The effective local gamma dose rate, i.e. the integral of the total gamma dose rates of the cloud and the contaminated ground surface at 1 m above ground is output in milli-Sievert per hour [mSv/h] in the entire calculation grid after each computation step of the dispersion model.

- **[LocalSkinDose]**
  **Local skin dose (nuclide sum)**
  The local skin dose is the potential 24 hours skin dose resulting from the self-irradiation of the unsheltered contaminated skin. Alpha-, beta- and gamma radiation components are considered. The dose is put out in milli-Sievert [mSv] in the entire calculation grid after each computation step of the dispersion model.

- **[PlumeArrive]**
  **Plume arrival time at locations on the map**
  As soon as the time integral of the total activity in the air near ground exceeds 1000 Becquerel-seconds [Bq.s] at a place in the surroundings of an NPP, the time elapsed since the start of release is determined for this place in hours [h]. The entire field of the thus defined times of arrival can be represented on the map in a colour-coded manner.

6.5 **[Windfield]** Wind fields (A/R-LSMC only)

By clicking [Windfield] in the Graphics Manager window, the result array will be sent to the Main Drawing Window. There it can be
displayed in the usual way (see [RODOS User Guide of the System Interface]).

The wind field result gives the two-dimensional wind vectors at the height of 10 m; the wind-speed is given in [m/s].

The picture in the graphics shows coloured lines, where the wind-speed is represented by both the colours and the lengths of the lines. Interpreting the lines as wind-vanes derives the wind direction.

6.6 [Tables] Situation data protocols

By clicking on [Tables] in the Graphics Manager window, a list of keys appears as a submenu. The keys are given in brackets, the situation data represented by them are written behind the keys.

[SiteData]: Site and calculation grid

[NuclideData]: Nuclide selection

[Inventory Data]: Reactor inventory

[STermFromUser]: User input of source term

[STermMoreInfos]: Further information about the source term (derived from user input)

[STermTStep]: Source term data that are passed to the ADM in each time step.

[MeteoFromUser]: Meteorological and dispersion-related information

All tables are also recorded on disk (see Chapter 7.4).
7 Trouble shooting

7.1 General remarks

If a Prognosis run terminates normally, the results may be so that you are puzzled by them. This may or may not be an indication of a problem with RODOS. Chapter 7.2 gives some guideline what to do in such a case.

When executing, the Prognosis programs perform checks on the situation data as well as on other data used in the calculations, and attempt an analysis of encountered problems. A few problems are caused by less severe error conditions; they allow continuation of execution. Most problems, however, are caused by unrecoverable fatal errors; they lead to an error stop. For all problems leading to a program stop, a short message is flashed on the screen to inform you about the error exit, and where to look to find more information.

In rare cases, a fatal error is caused by some mistake made when RODOS was installed. Such errors are termed installation errors. The respective problem is recorded in the "RODOS run protocol", which is written on disk but not accessible with the RODOS graphics. Contact your system manager if you encounter such a problem.

More frequent, however, are fatal errors caused by some user input of situation data. In such a case, the respective problem is recorded in the corresponding situation data protocol, which is written on disk and also accessible with the RODOS graphics. Chapter 7.3 explains what to do in case of such fatal "user errors".

Chapter 7.4 shows the addresses of the situation data protocols and the Prognosis run protocol on disk; the situation data protocols can also be displayed with the RODOS graphics.

7.2 Prognosis ends normally, but results look strange: Problem localisation

If you have the feeling that the results of a Prognosis run are not as you expected, in other words, they look strange to your eyes, this can have two different reasons:

I. The run was carried out with other data than you thought.

II. The radiological situation is complicated and you do not fully understand the implication of the otherwise correctly specified scenario.

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4 Errors of this type can be caused for example by missing entries in the fixdata base, or wrong entries in data files requested by the user for the particular installation.

5 Hints for reasons and remedies for installation errors can be found in [RODOS(WG7)-TN(00)-01].
This Chapter gives some guideline how to find out if reason (I) is responsible. Carry out the steps described below. If they fail, reason (II) is likely to be the active agent.

- **Step 1: Inspection of situation data protocols**

Take a thorough look at the situation data protocols. They show the data the Prognosis model actually saw when executing.

Do the protocols contain the data you think they should contain? If the answer is YES, the problem lies elsewhere (e.g. in reason II), and we cannot help you further here. If the answer is NO, proceed with Step 2, if data input was made with the **Initialization** windows and/or with the **configuration option**, or with Step 3, if this was not the case.

- **Step 2: Check of data input with initialization windows or configuration option**

  (2a) **Initialization windows**

  Consider the following:
  
  (a) You made any typing errors when inputting the situation data.  
  (b) You did not leave the initialization procedure in the proper way for application of your data.

  If either (a) or (b) is true, this can explain your problem. Correct the corresponding errors and try again. If not, proceed with Step 3.

  (2b) **Configuration option**

  Consider the following:
  
  (a) You have selected another source term than intended.  
  (b) You have inserted the source term into a run option that was not the one that was active in the run.  
  (c) You did not leave the initialization procedure in the proper way for application of your data.

  If (a), (b) or (c) is true, this can explain your problem. Correct the corresponding errors and try again. If not, proceed with Step 3.

- **Step 3: Check of run option**

If all steps so far could not provide insight, the next likely reason for your problem is that you are using another run option (default or temporary) as intended. If this is the case, correct the corresponding error and try again. If not, proceed with Step 4.

- **Step 4: Review of all steps carried out when starting the run**

If all steps so far failed, the last remaining resort is a thorough review of all steps undertaken to start the run. Consider the following:

  (a) Were all necessary steps carried out?
(b) Were all steps carried out in the correct order?
If (a) or (b) explains your problem, correct the corresponding error and try again. If not - well, maybe it is really reason (II) mentioned earlier!

7.3 Abnormal termination from fatal error caused by user input

An error message appears on the RODOS screen during a run, and the calculation stops. Then follow the steps laid out below to locate and correct the error.

- Study the message that appeared on the screen. It will point out to a Table containing further information.
- Load the indicated Table into the Graphics. ATTENTION: Because the run has terminated abnormally, the graphics items are not directly accessible! CURE: First abort and terminate the run. Then retrieve the run from the archive. After that, the Table can be displayed with the Graphics system.
- Scroll down to the bottom of the Table, study the last two lines.
- Scroll up slowly, looking out for line(s) with error messages.
- Correct the error(s) and start anew.

<table>
<thead>
<tr>
<th>condition checked</th>
<th>error message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nuclides &gt; zero</td>
<td>No nuclide selected for the calculation</td>
</tr>
<tr>
<td>Number of nuclides &lt; 16</td>
<td>Too many nuclides selected for the calculation</td>
</tr>
</tbody>
</table>

Table 6: Fatal run time errors from user input of source terms

<table>
<thead>
<tr>
<th>condition checked</th>
<th>error message</th>
</tr>
</thead>
<tbody>
<tr>
<td>all source term input modes</td>
<td></td>
</tr>
<tr>
<td>start of initial release ≥ zero</td>
<td>Start of release before end of chain reaction at present not implemented!</td>
</tr>
<tr>
<td>thermal power ≥ zero</td>
<td>?) Not interpretable specifications</td>
</tr>
<tr>
<td>iodine fraction between 0% and 100%</td>
<td>- Thermal power smaller than zero, and/or</td>
</tr>
<tr>
<td>activity released ≥ 1 Bq</td>
<td>- Iodine fractions smaller than zero or sum not 100%.</td>
</tr>
<tr>
<td></td>
<td>Release 1 Bq or less -&gt; No calculation!</td>
</tr>
<tr>
<td>source term entry mode &quot;read from file&quot; only</td>
<td></td>
</tr>
<tr>
<td>input file opens correctly</td>
<td>ERROR ON FILE OPEN</td>
</tr>
<tr>
<td>input file opens correctly</td>
<td></td>
</tr>
<tr>
<td>source term input mode F1 &quot;release fractions&quot; only</td>
<td></td>
</tr>
<tr>
<td>individual release fraction (&gt; than zero) and. (&lt; 100%)</td>
<td>Corresponding message + printout of item(s) that caused the trouble</td>
</tr>
<tr>
<td>Sum of release fractions = 100%</td>
<td>Corresponding message + printout of item(s) that caused the trouble</td>
</tr>
</tbody>
</table>
source term input mode F3 "activity for noble gases, I-131, total aerosol, and aerosol fractions"

<table>
<thead>
<tr>
<th>I-131 among calculation nuclides</th>
<th>RELEASE-INPUT NEEDS I-131. THIS NUCLIDE IS NOT AMONG THE CALCULATION NUCLIDES.</th>
</tr>
</thead>
<tbody>
<tr>
<td>aerosol group selection does match the release group selection</td>
<td>RELEASE GROUP TYPE {name}, RELEASE GROUP TYPE {name}, GROUP TYPES ARE INCOMPATIBLE.</td>
</tr>
<tr>
<td>each aerosol fraction greater than zero</td>
<td>AEROSOL FRACTION(S) SMALLER THAN ZERO</td>
</tr>
<tr>
<td>sum of aerosol fractions ( \leq 1 )</td>
<td>SUM OF AEROSOL FRACTIONS GREATER THAN 1.</td>
</tr>
</tbody>
</table>

source term input mode F4 "activity for noble gases, iodine, total aerosol, and aerosol fractions"

| aerosol group selection does match the release group selection | RELEASE GROUP TYPE {name}, RELEASE GROUP TYPE {name}, GROUP TYPES ARE INCOMPATIBLE. |
| each aerosol fraction greater than zero                      | AEROSOL FRACTION(S) SMALLER THAN ZERO                                           |
| sum of aerosol fractions \( \leq 1 \)                       | SUM OF AEROSOL FRACTIONS GREATER THAN 1.                                       |

Table 7: Fatal run time errors from user input of meteorology

<table>
<thead>
<tr>
<th>condition checked</th>
<th>error message</th>
</tr>
</thead>
<tbody>
<tr>
<td>measuring height for wind ( &gt; 5 \text{ m} )</td>
<td>Minimum for measuring height is 5 m.</td>
</tr>
<tr>
<td>wind direction range 0 - 360 degree; wind speed ( \geq 0 \text{ m/sec} ); rain intensity ( \geq 0 \text{ mm/hour} ); Pasquill-Gifford-category is A to F.</td>
<td>Error in wind speed, wind direction, rain intensity, or diffusion category</td>
</tr>
<tr>
<td>Only for data input by user in mode “read from file”</td>
<td></td>
</tr>
<tr>
<td>input file opens correctly</td>
<td>ERROR on FILE OPEN</td>
</tr>
</tbody>
</table>

7.4 Location of situation data protocols and Prognosis run protocol on disk

The situation data used in each Prognosis run, some additional information derived from these data, and eventual error messages and warnings are recorded on disk in tabular form. This recording is done independent from the fact if any optional input or modification of the situation data was performed. The path for the directory is

\(`\sim \text{rodos/roextern/outall}/\text{user-Id}/\{run-Id\}`),

the file names are listed below.

- Site/grid: \(<\text{Prognose.SiteData}>\)
- Nuclides: \(<\text{Prognose.NuclideData}>\)
- Inventory: \(<\text{Prognose.InventoryData}>\)
- Source term, user input: \(<\text{Prognose.STermFromUser}>\)
- Source term, further information: \(<\text{Prognose.STermMoreInfo}>\)
- Source term, sent to ADM in each time step: \(<\text{Prognose.STermTStep}>\)
• Meteorology/Dispersion information: <Prognose.MeteoFromUser>.

• Meteorology/Dispersion information, sent to ADM in each time step: <Prognose.MeteoTStep>

Installation errors and other fatal errors not coming from the input of situation data are recorded in the Prognosis run protocol on disk. The path for the directory is \~rodos/roextern/outall\{user-Id\}/\{run-Id\}, the file name is \{program name\}.termlog.
8 Example runs

To get familiar with running the Prognosis models interactively, you can exercise with the manual [RODOS(RA1)-TN(00)-01, Irmgard Hasemann, RODOS Test Concept: Application Software (Version 4.0F)] by following the instructions and examples laid out there in Chapters:

- Chapter 1.1 (run preparations);
- Chapters 1.2 (running QUICKPRO, ALSMC, RLSMC);
- Chapters 2.1, 2.2, 2.3 (graphically displayable results);
- Chapters 5.1 (input data protocols).