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Development of Input/Output System for the Reactor Transient Analysis System (RETAS)

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1. Introduction

A Korea Institute of Nuclear Safety Reactor Transient Analysis System (KINS-RETAS) aims at providing a realistic prediction of core and RCS response to the potential or actual event scenarios in Korean nuclear power plants (NPPs). A thermal hydraulic system code MARS is a pivot code of the RETAS, and used to predict thermal hydraulic (TH) behaviors in the core and associated systems. MARS alone can be applied to many types of transients, but is sometimes coupled with the other codes developed for different objectives. Many tools have been developed to aid users in preparing input and displaying the transient information and output data. Output file and Graphical User Interfaces (GUI) that help prepare input decks, as seen in SNAP (Gitnick, 1998), VISA (K.D. Kim, 2007) and display aids include the eFAST (KINS, 2007). The tools listed above are graphical interfaces. The input deck builders allow the user to create a functional diagram of the plant, pictorially on the screen. The functional diagram, when annotated with control volume and junction numbers, is a nodalization diagram. Data required for an input deck is entered for volumes and junctions through a mouse-driven menu and pop-up dialog; after the information is complete, an input deck is generated.

Display GUIs show data from MARS calculations, either during or after the transient. The RETAS requires the user to first generate a set of "input", two-dimensional pictures of the plant on which some of the data is displayed either numerically or with a color map. The RETAS can generate XY-plots of the data. Time histories of plant conditions can be seen via the plots or through the RETAS's replay mode.

The user input was combined with design input from MARS developers and experts from both the GUI and ergonomics fields. A partial list of capabilities follows.

- 3D display for neutronics.
- Easier method (less user time and effort) to generate "input" for the 3D displays.
- Detailed view of data at volume or junction with just a mouse click on the screen.
- Interactive MARS run control (start, pause, restart, replay and stop).
- Easy access to MARS peripherals.
- Easy access to helpful applications such as text editor and spreadsheet.
- Portability across workstations (UNIX) and PCs (Windows 98, Me, Xp, 2003 or Vista).
- Window/menu/ mouse interfaces.

These ideas were used as the basis for the design of RETAS. The result is a fundamentally new kind of GUI in the nuclear power plant analysis field. MARS is no longer the central focus, but rather, the focus becomes doing nuclear safety analyses from a central workspace with an arsenal of tools at the analyst's disposal. The workspace is the same on any PC, but with the native look and feel of the platform. MARS is the principal application; but others are accessible through the workspace and can be used simultaneously and in conjunction with one another to enhance the user's ability to do complicated analyses.

2. Design of RETAS

After the high level design of RETAS was constructed, it was necessary to select implementation languages, a graphics package, and toolkits before the detailed design could be developed. Selection criteria were compiled and candidate software was reviewed. Some of the criteria were:

- Maintainability: A single RETAS source must run on Windows based platforms.
- Use of a widely accepted and available 3D graphics standard.
- Compatible with Fortran 90 and C (the languages of MARS and RETAS).
- No third party licenses (no extra cost to users).

2.1 MARS Interface

Among the software choices that passed these criteria, the following selections were made. Fortran 90 and C were selected as the primary programming languages. In its original design, MARS was the central focus and ran all peripheral operations, such as printing output, generating XY-plots. In the new design, the focus is on the analysis with the analyst, rather than MARS, directing the operations through RETAS.

To accommodate the fundamental change to RETAS running MARS, considerable modification had to be made to the main program and some subroutines. However, these changes had to accommodate two other requirements:

- MARS can be run without RETAS from a command line prompt as before.
- MARS run speed is not impacted when RETAS is not in use.

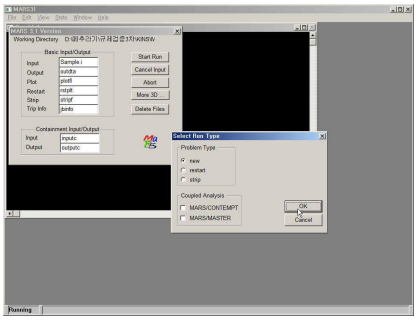

Fig. 1. MARS Interface and Run.

The changes to MARS allow it to be compiled with or without the RETAS coding. There is no measurable impact on run speed. Further, even when compiled with RETAS coding, it can be run from a command line prompt and either present graphical images or not depending on command line run options. It can also be run as an application from RETAS. Finally, permanent user-modifiable information for RETAS is kept in disk files. This includes such data as default settings, fonts and other format information, preferences, the default MARS run options, etc. Disk files are also used to store large collections of textual information, such as help files.

2.2 Design of RETAS

The main purpose of RETAS is to provide a workspace for nuclear power plant analysis with MARS. The workspace must have the same structure on PCs with the other Windows operating systems, so that code users with either background can quickly become accustomed to using the workspace. It is therefore designed to look like a typical PC application with windows, menus and dialogs. Having also a command line interface makes it look much like many internet access applications.

From the workspace, the basic capabilities are easily accessed through the menu-dialog interface. These capabilities are broken into three areas. First is running and interacting with MARS. Second is performing MARS-related analysis activities, such as creating or modifying an input file, viewing an output file, graphing data, preparing a steady-stated deck, etc. Third is managing the workspace which involves formats, preferences, accessing the operating system, accessing the network, and other high level functions.

The workspace is provided graphically through several screens. The main screen that provides access to the three capability areas is called the RETAS Model Editor. The MARS run capability is broken into two parts, selection of MARS run options and the isometric hydrodynamic display. The second and third capability areas are accessed through the RETAS Model Editor, which may bring up dialog boxes in the process.

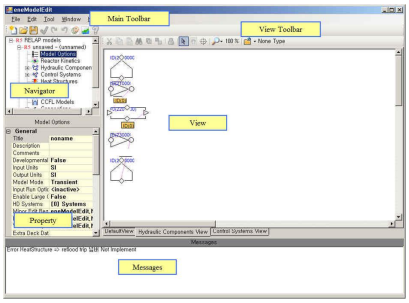

Fig. 2. Main Display of RETAS Platform.

As described above, the RETAS Model Editor is the workspace from which work starts. It is comprised of three sections, a "Navigator" area, a "Property" area, and the "View" area. The menu system is built to be similar to many standard menus. The menu names are File, Edit, and Tools. The File and Edit menu items are the standard ones. The "Run MARS" item is found in the File menu. The Tools menu has items for font changes and access to certain MARS applications.

3. Conclusions

There are numerous ways to use the capabilities of RETAS in its current level of implementation to enhance MARS analyses. The isometric image is automatically generated for any valid MARS or RELAP5/MOD3 input deck. With no modification to the deck or additional information, a nodalization diagram can be generated immediately. This is very helpful when an analyst receives an input deck with no corresponding nodalization diagram. Many of the best ideas come from the code users and developers who have taken the time to demo and comment on RETAS, and such input will continue to shape the development of RETAS.

Acknowledgement

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