

## Development of a Visual Interactive RETRAN Running Environment

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### ABSTRACT

A visual interactive RETRAN running environment (ViRRE) has been developed to assist RETRAN users in their input preparation, code execution, and output interpretation. ViRRE provides dialog boxes and graphical modules for base input data generation and transient initiation on a user-friendly basis, and special graphical displays to provide an in-depth understanding of the major thermal-hydraulic phenomena during normal and accident conditions for nuclear power plants. ViRRE was developed using Delphi 4.0 and Visual Fortran 6.0 and it runs on personal computers. This paper presents the main features of ViRRE.

### INTRODUCTION

In the past two decades, best-estimate thermal-hydraulic system codes have been developed to capture the major physical phenomena during a wide range of incident and accident conditions in nuclear power plants [1,2,3,4]. Their application, however, has been limited to only a few groups of specialists due to the requirement of high computer performance and much expertise from their users. Rapid advances in computer technology enable the code users to run the codes on a personal computer instead of main frame computers. However, it is still difficult to use the best-estimate codes system because of the complicated I/O structure of the codes. In order to provide easy-to-use system analysis tools, the development of a nuclear plant analyzer (NPA) based on the best-estimate codes has become popular now [5, 6, 7].

One of the best-estimate codes, RETRAN, can be used in various plant support activities such as licensing calculations for plant design changes, emergency operation procedure (EOP) validation, and training. The use of RETRAN, however, has been limited because of the difficulties involved in its usage. To assist ordinary users in their input preparation, code execution, and output interpretation, KAERI and KEPCO have jointly developed a graphical user interface (GUI) based RETRAN running environment named ViRRE [8].

The primary concern of the ViRRE development was to provide valuable aid to all level of RETRAN users ranging from plant engineers to experts without affecting the code results. In this regard, the following development requirements were established:

- Minimize the modifications of the original RETRAN source program except the I/O modules.
- Maintain the current input feature to fully utilize the existing input data.
- Keep the current physical models to obtain the same results.
- Make it possible to run ViREE by itself without any graphics software.
- Generalize ViRRE to be easily adapted to other system codes.

ViRRE was developed using Delphi 4.0 [9] and Visual Fortran 6.0 [10] and it runs on personal computers (Windows 95, 98, 2000, and NT). Figure 1 shows a schematic of the ViRRE program. It consists of the modules for interactive input generation, visual output processing, RETRAN execution control, and others. ViRRE loads RETRAN3D generated as a dynamic link library (DLL) at the time of execution. ViRRE takes two sets of basic input data: a normal RETRAN input deck and a graphic file containing plant mimics or a nodalization diagram produced by any drawing software. The latter is used for dynamic display of the plant operation status. Special graphical displays are also provided for an in-depth understanding of the major thermal-hydraulic phenomena. In addition, ViRRE provides a replay function, on-line help, etc.

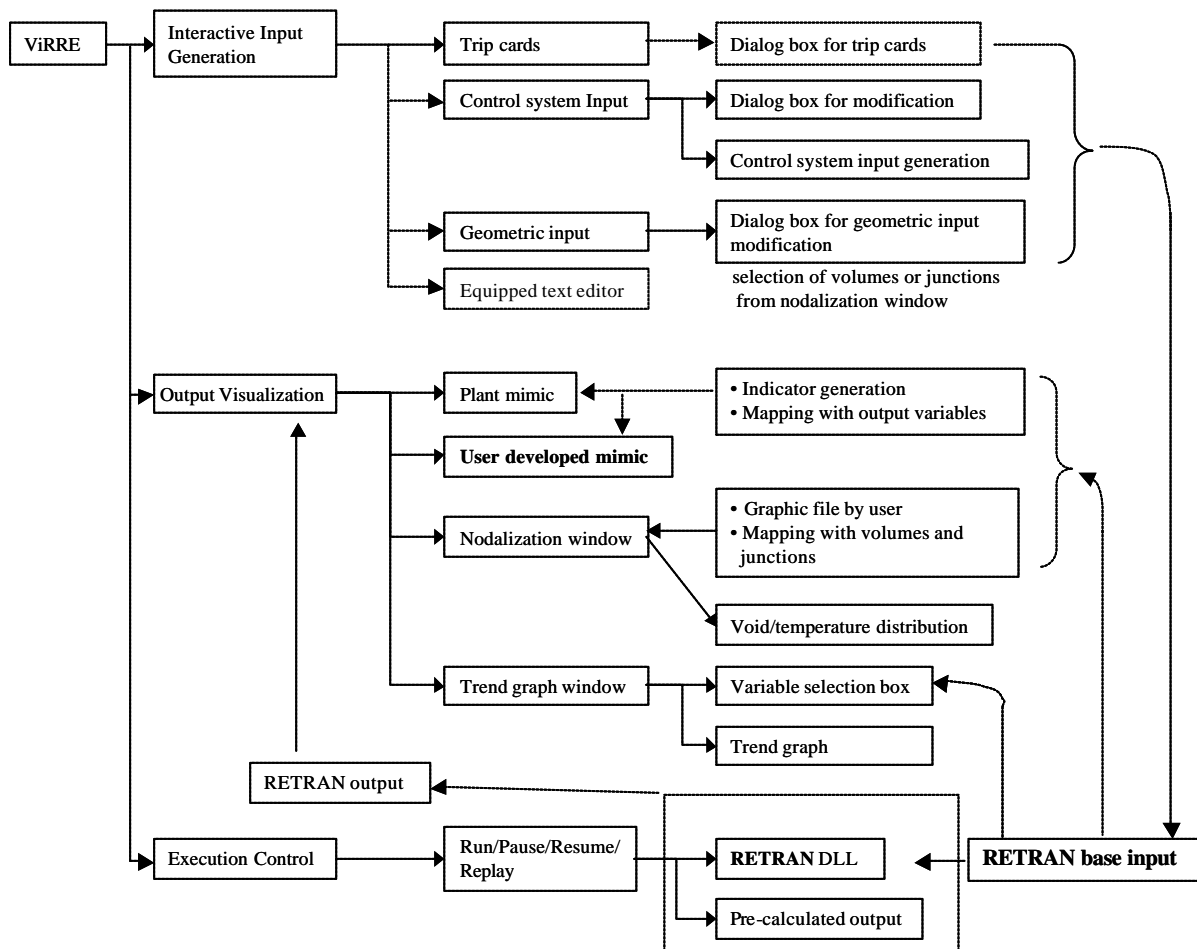


Figure 1. Schematic of the ViRRE program

## INTERACTIVE INPUT GENERATION FEATURES

The interactive input modification capability is unique features of ViRRE, which is not provided in full-scope simulators and other NPAs. This feature makes it possible to reflect the plant modifications right away without much effort. The interactive input preparation modules consist of (i) control system edit window, (ii) dialog box for trip cards, and (iii) dialog boxes for volume and junction input cards. Efforts are focused to develop the control system edit window on user-friendly basis.

### Control System Input

Once the input for a specific plant is prepared, it rarely needs to change the input data except the input cards related to transient initiation, plant protection, and control system that may be necessary to modify for changing the setpoints and time constants, etc. The roles of the interactive control system input feature are

- to graphically display and modify the current control system input. Figure 2 shows an example, where the list of all control system in base input, logic diagram of the selected control system and dialog box for input modification are available
- to generate a new control system input by drag and drop of elementary components (See Fig 3).

The output of the control system edit window is to generate the text-type RETRAN input data, which is appended (i.e. overwritten) to the existing input before the beginning of the RETRAN calculation.

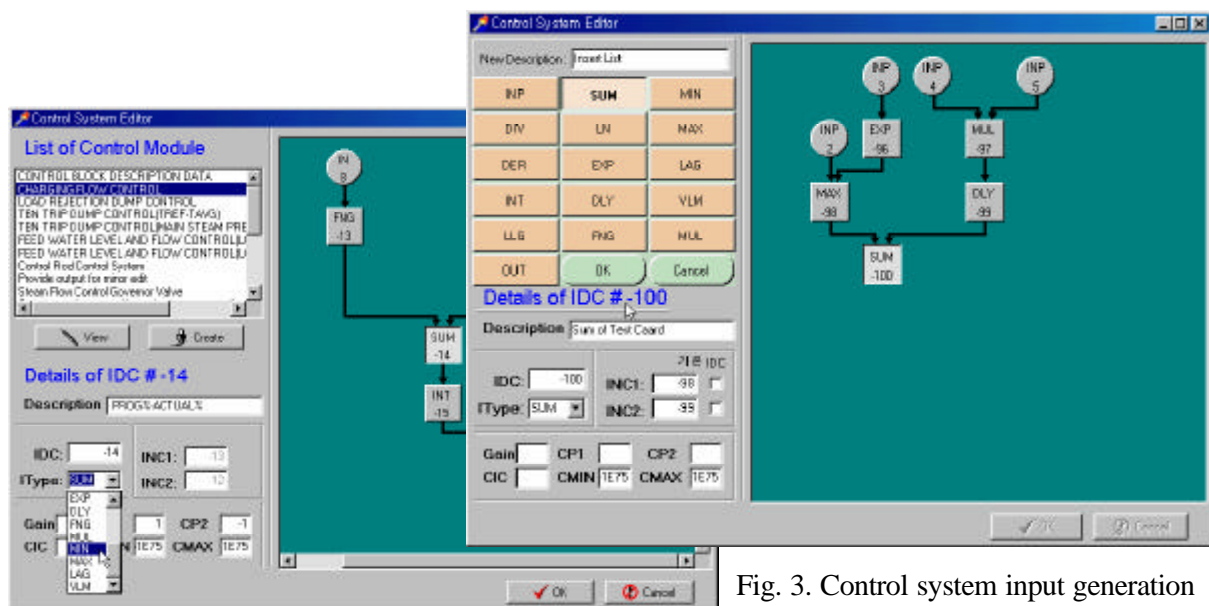


Fig. 2. Control system input modification

Fig. 3. Control system input generation

### Trip cards

The dialog box for trip cards shows the list of trip cards existing in the base input deck and enables to modify the selected trip card information as shown in Fig. 4. Before the transient calculation, users can control the transient by modifying the trip card input value such as initiation time, setpoints, delay time, etc. This dialog box is also used to modify setpoints for open/close of valves and on/off of pumps, etc. Because signal type can be selected from a menu in the combo box and signal limit through radio button, user can modify trip input without difficulty. The resulting trip input is also appended to the base input.

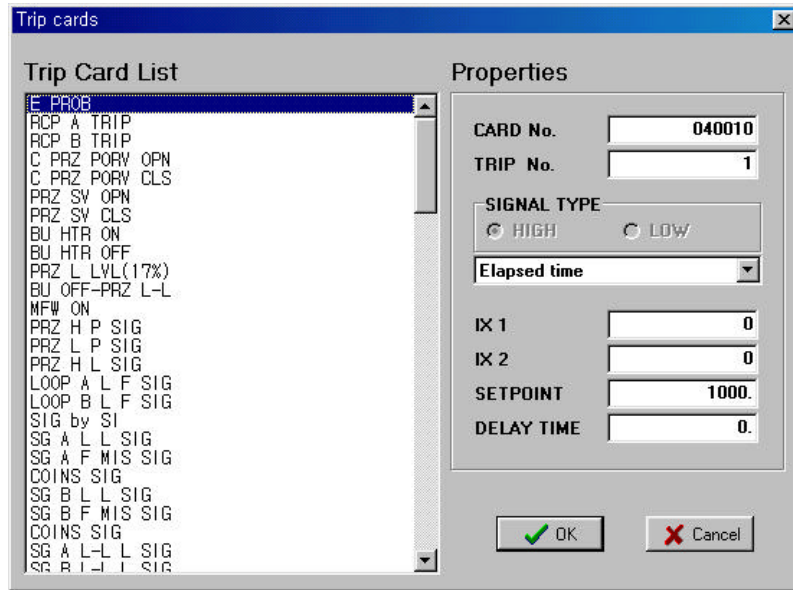


Fig. 4. Dialog box for trip card editing

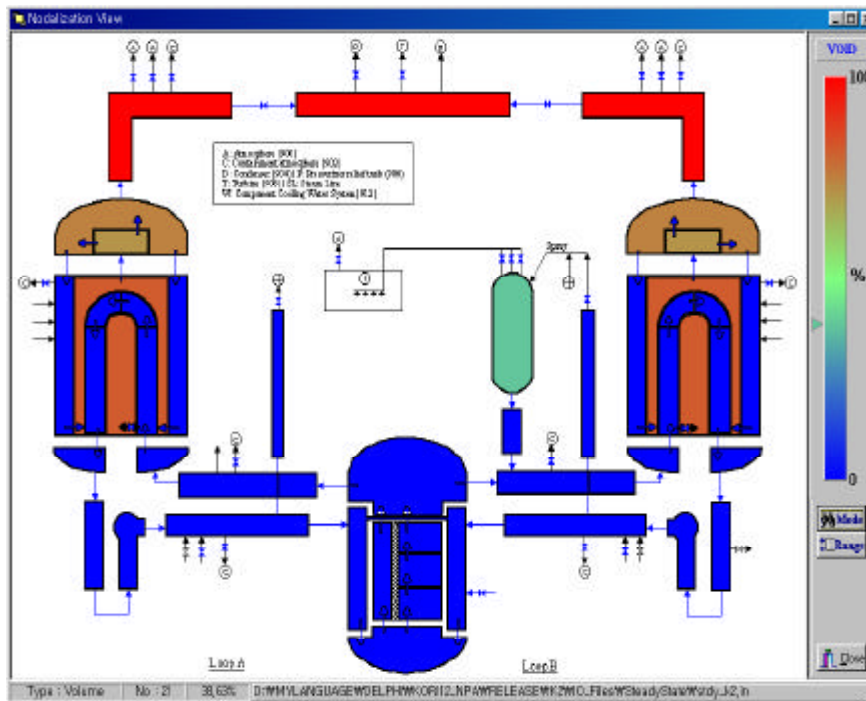


Fig.5 An example of the nodalization window

Input data for volume and junction cards

The volume and junction input data can be also modified using the dialog boxes. In order to use this feature, a nodalization diagram should be given by user. Then, each volume and junction in the nodalization window (See Fig. 5) has to be mapped using the base input. The volume and junction lists in the dialog box for mapping are automatically generated using the information from the base input deck. Each volume can be mapped interactively by clicking the corresponding location and selecting the appropriate volume index from dialog box. Each junction can also be mapped with junction index in base input deck by selecting the small region for a specific junction and choosing the corresponding

junction index from dialog box. Then, the input cards for the component to be modified can be selected by just clicking the appropriate location in the nodalization window.

## GRAPHICAL REPRESENTATION OF THE OUTPUT

RETRAN produces a large amount of text-based output after transient simulation. From this kind of text-based output, it is not easy to obtain a deep insight of physical phenomena during the transient conditions. ViRRE provides various graphical displays during and/or after the transient simulation to help to understand the root-causes of plant responses.

The calculated outputs available for various graphical representation includes all major parameters, such as temperature, pressure, enthalpy, void fraction, saturation temperature, heat addition rate for each volume, mass flow, junction area for each junction, and all minor edit variables.

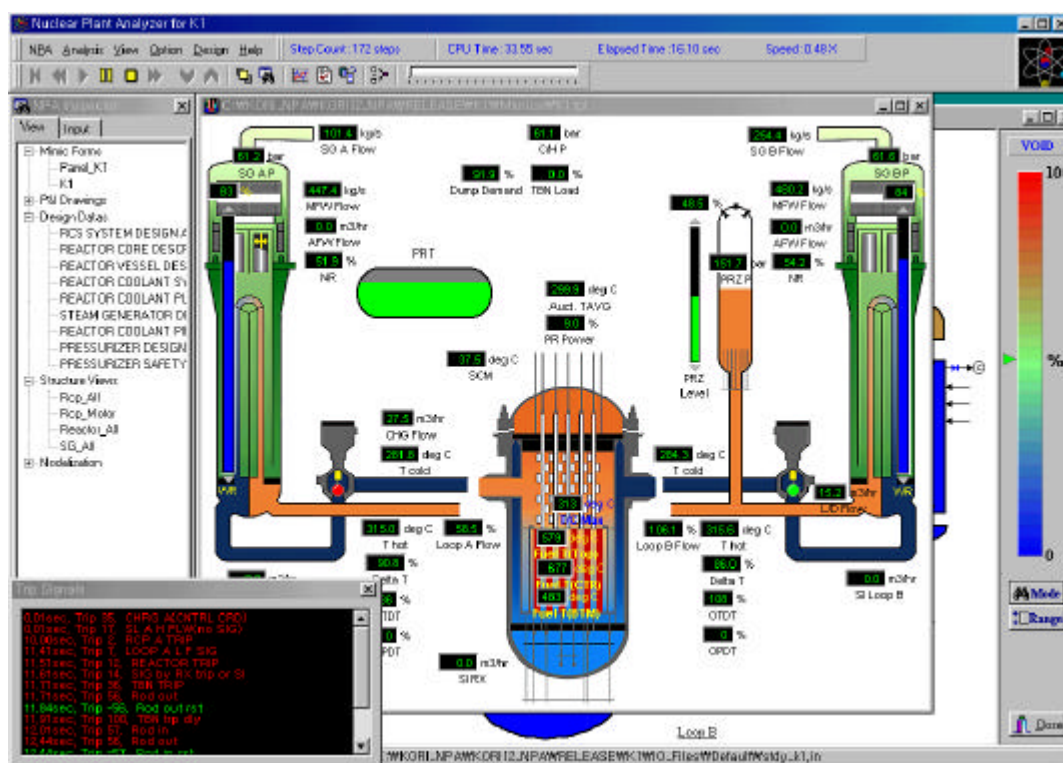


Fig. 6. The plant mimic window in ViRRE (Main window)

### Plant and Panel Mimic

The plant mimic window shows major parameters through some selected indicators as shown in Fig. 6. ViRRE provides various types of indicators as shown in Figs. 7 and 8, such as digital meters, level gauges, dial meters, LED indicator, and etc. These can be added into the plant mimic by drag-and-drop operations. The added indicators can be mapped with the specific output using the dialog box. The plant mimic in Fig. 6 was created using by other drawing software.

The panel mimic is created to efficiently show the trip information, valve positions using LED indicators, flows, level, etc through various meters (See Fig. 9). The panel mimic is established by drag-and-drop operations of menu items and each component in the mimic can be mapped. Users can also create additional mimics if they want.

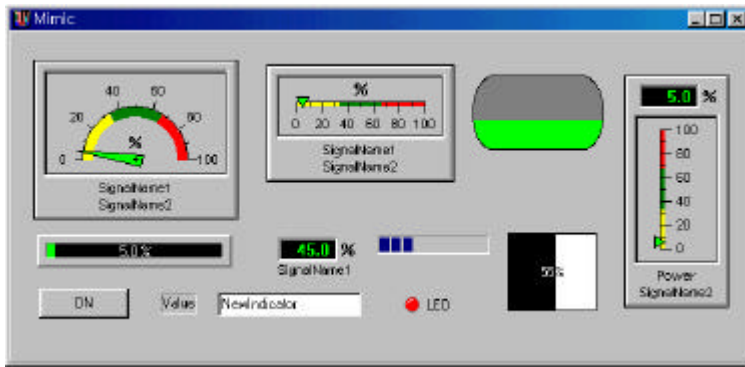


Fig. 7. Indicators available in ViRRE

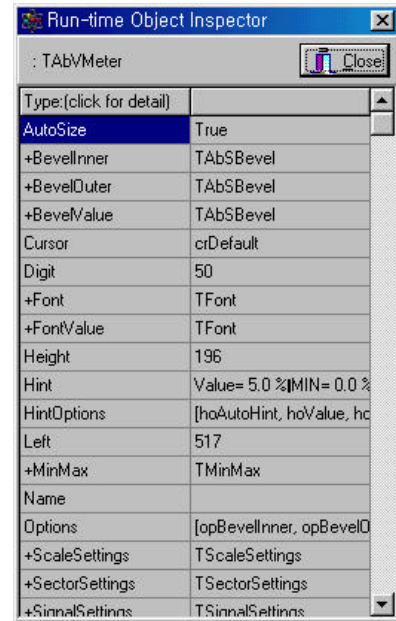


Fig. 8. Dialog box for the indicator editing →

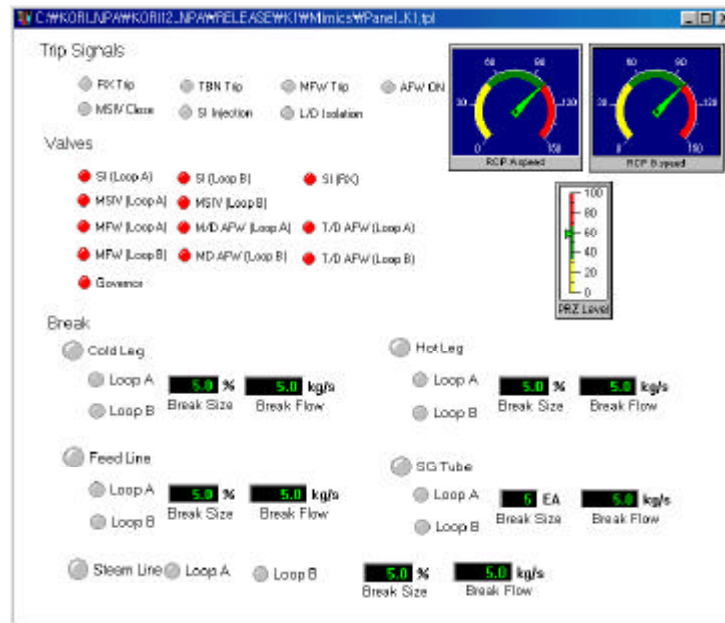


Fig.9 An example of the panel window

### Trip window

The trip window shows trip times and description for each trip at the time of occurrence. This window is given on the left bottom of the plant mimic window. The scroll bar makes it possible to examine the previous trip occurrences during the transient. This feature is useful to tracking the causes of discontinuous change in trend during the transient. For user's convenience, two different colors are used for trip message in order to distinguish between normal trip and reset trip.

### Nodalization window

This window shows void and temperature distributions in a color spectrum (See Fig. 6). Users can see the exact value in the status bar by moving the cursor into the location

### Trend windows

The trend window shows on-line X-Y graphs for user-selected variables. The user can select major volume and junction properties and minor edit variables through the dialog box (See Figs. 10 and 11). Multiple variables can be drawn in a graph window and additional trend windows can be created by user's request.

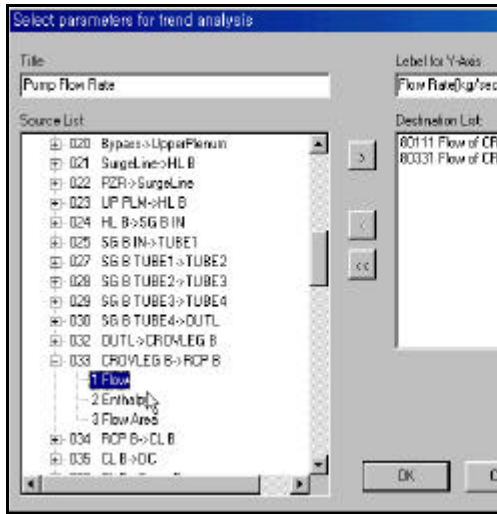


Fig. 10. Dialog box for graph variable selection

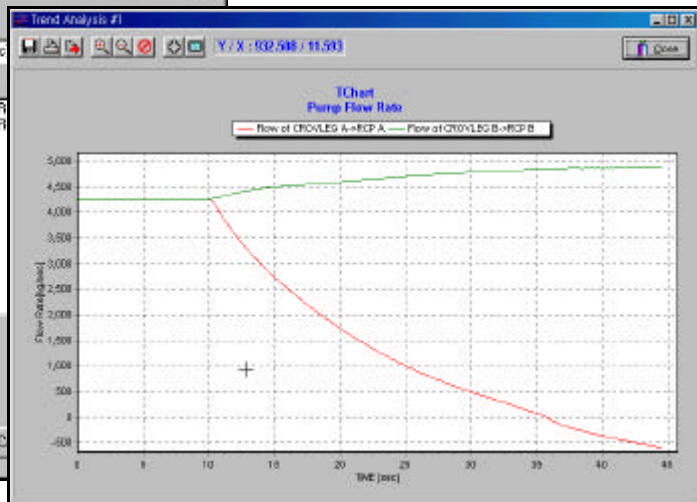


Fig. 11. An example of Trend graph

## OTHER FEATURES

### RETRAN execution, pause, resume, and termination

User can start the RETRAN module, and pause / resume / terminate the execution by clicking the speed button in the menu bar on the top of Fig. 6. ViRRE activates the speed button which user can select such that the buttons for pause / resume / termination is inactive before problem starts and pause and termination button becomes activated while start button is inactivated after problem starts.

### Integrated database including scanned P&I drawings, plant design data, structural views

ViRRE includes the functions of plant information database. User can include the plant information and drawings into ViRRE. The included information and drawings can be seen by selecting the item of view tab in the NPA inspector window on the left of Fig. 6. As shown in Fig. 12, a selected drawing appears in a separate window and user can move, zoom in/out, etc.

### Replay feature using pre-calculated results in fast/slow/ real time modes

Since ViRRE uses the RETRAN without modification, real-time calculation can often not be achieved. The replay function of ViRRE can provide the reproduction of the pre-calculated results by selecting fast/slow/real time mode on the top window in Fig. 6. The animator for execution status indicates the running mode whether the current results is from replay or

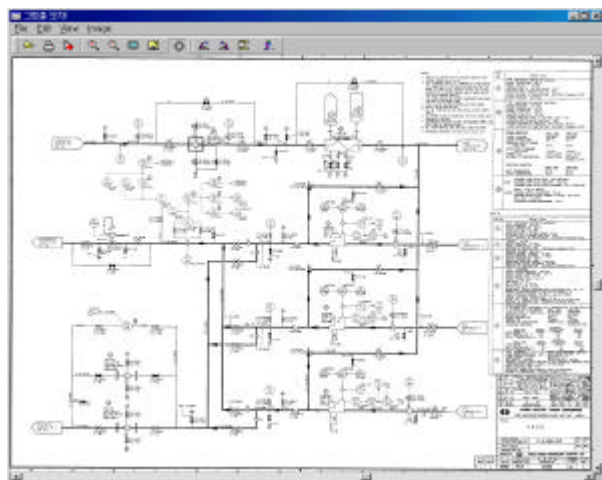


Fig. 12. Scanned P&I drawing

RETRAN execution.

#### Target plant selection

User can include plant input sets (RETRAN input, mimics, database) into ViRRE and load a selected plant input set from input tab in the NPA inspector window.

## CONCLUSIONS

KEARI and KEPCO jointly developed ViRRE to assist RETRAN users in their input preparation, code execution, and output interpretation. This work was initiated to provide general users of RETRAN with an easy-to-use tool to capture the physical insight of a wide range of plant transients.

The major advantages of ViRRE can be summarized as:

1. High fidelity based on the best-estimate code, RETRAN.
2. High accessibility, portability, and low cost of the target machine.
3. Easy-to-use interactive input preparation on a user friendly basis
4. Various graphical representations of the output.
5. Plant independent features working with any RETRAN input, mimics, and plant database.
6. General interface structure (easily portable to other system codes)

The first application of this tool has been made for Kori 1 & 2 NPP. The user's feedback from the first application is taken into account for improvement of ViRRE. Future developments will concentrate on interactive control features to simulate the user's action during transient simulations.

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