Development of an expert system VEHA

Svetlin Philipov, Risk Engineering, Ltd
svetlin.philipov@riskeng.bg
Kaliopa Mancheva, Risk Engineering, Ltd
kaliopa.mancheva@riskeng.bg

10 Vihren Str, Pavlovo, Sofia 1618, Bulgaria

Abstract

Severe accidents in NPP are still the most complicated compilation of phenomena that is difficult to assess. From the beginning of the SA assessment a lot of models and codes are developed. The project VEHA is focused mainly on calculation results assessment and implementing techniques for hydrogen phenomena analyses.

The system VEHA (Visual Environment for Hydrogen Assessment) is data base platform that includes mainly visual components. It has graphical part where user can select control volumes and get their data from MELCOR calculation. The nodalization scheme is done through external additional tool for visual design of control volumes. VEHA system is foreseen to allow water level tracking in control volumes, gas species monitoring and assessment of the flammability of the gas mixture in a given control volume. VEHA system is designed to work with data from MELCOR as and EDF reader.

Key words: severe accident, NPP, hydrogen, MELCOR, post calculation, VEHA.

Severe accidents in NPP are still the most complicated compilation of phenomena that is difficult to assess. To a great extend the complex manner is defined by uncertainty in modeling phenomena themselves. Target to provide better safety requires more efficient ways to predict and model processes that are significant (not only for severe accidents). In the time of severe accident progression some phenomena are not possible to be assessed in a detailed manner. Computer analyses codes are using phenomena effects to consider that phenomena. To some degree this increases uncertainty. So this is the place where post calculation tools are useful in the assessment stage. Such tools must be in help of the specialists and users. It is very important to construct reasonable and pure code with ability to model physical phenomena and in the resent years such codes are fast developing. These codes, models and results must be given a user friendly form so specialist can appreciate code's abilities.

Severe accident management relies on sets of measures forming so called strategies. Containment conditions control is a strategy of a highest level contribution to environment protection from radiological consequences. In the time of nuclear power development number of challenges are recognized concerning containment integrity.

The ambition for increasing nuclear safety is a reasonable cause for development of new complex methods and codes for severe accident analyses. Means used for nuclear plant assessment include (when it is possible) experimental examples also. In cases when it is not possible, that is the basic, computer codes are used to present a given phenomena with a predefined degree of uncertainty.

From the beginning of the severe accident assessment a lot of models and codes are developed. The project VEHA is focused mainly on post calculation results assessment and implementing techniques for hydrogen phenomena analyses.

The system VEHA (Visual Environment for Hydrogen Assessment) is data base platform that includes mainly visual components. It has graphical part where user can select control volumes and get their data from MELCOR calculation. The nodalization scheme is done through external additional tool for visual design of control volumes. VEHA system is foreseen to allow water level tracking in control volumes, gas species monitoring and assessment of the flammability of the gas mixture in a given control volume. VEHA system is designed to work with data from MELCOR as and EDF reader. In the future this can be cone simultaneously during MELCOR calculation.

The idea is users to have possibility to assess mainly atmosphere conditions in containment. The system is designed in a way that allows any nodalization scheme to be assessed. This means that the system do not recognize containment volumes. The user is the one who can define what and where to visualize. The module that is used to define control volume objects is simple but allows different forms to represent one control volume. On Figure 1 type of objects and links are shown. In fact this is the nodalization scheme. Each object is a unique and so there is no chance for wrong and repeated nodes construction. Each link represents flow path is defined by source and target. The main feature is the property that points if the flow path is linked to a control volume and to which one both for source and target sides.

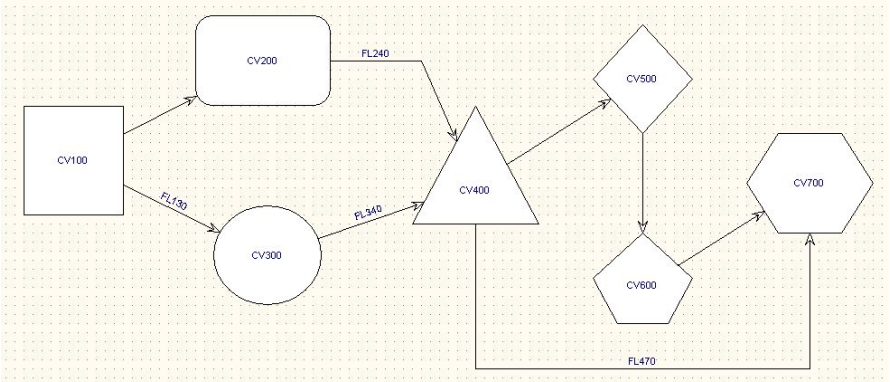

Figure 1 – Control volume types and links

For all control volumes data files are supposed to be loaded. Flow path information is foreseen to be added. VEHA environment is separated into two zones – graph zone and controls tab zone. All numerical data is shown and accessible through controls tab. It is possible to select certain objects for which data will be shown. Below is a picture of a control volume that is analyzed taking into account water level in it and calculated hydrogen concentration at a given time of the calculation scenario.

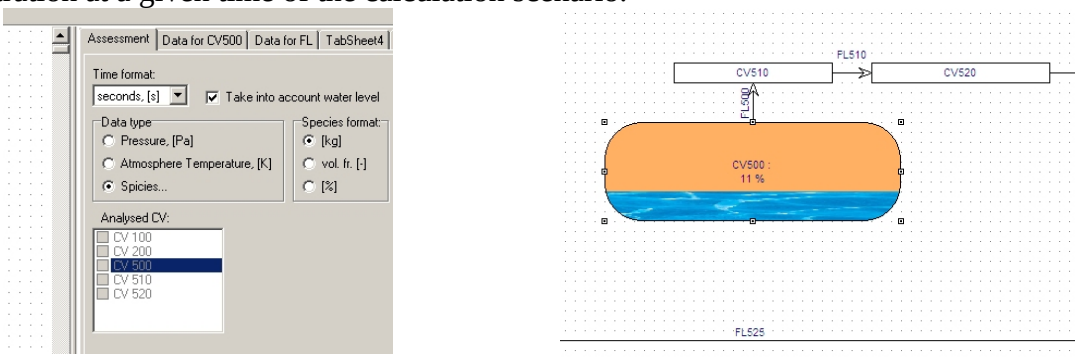

Figure 2 – Control volume types and links

The system is equipped with track bar that allows the users to trace along the time and to see dynamically the changes in the defined control volumes.

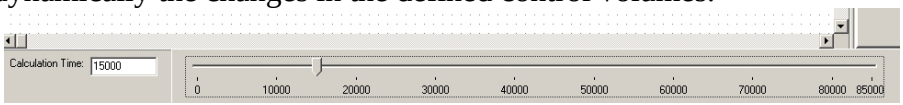

Figure 3 – Control volume types and links

One of the main parts of the VEHA system is the module that is used for hydrogen analyzes. Using Chapman-Jouguet theory this module translates MELCOR results for species concentration to form that suits using flammability conditions. Analyzing Shapiro diagram the user is able to give an expert assessment to the conditions in the containment. The form is visual and is easy to recognize possible burning regime.

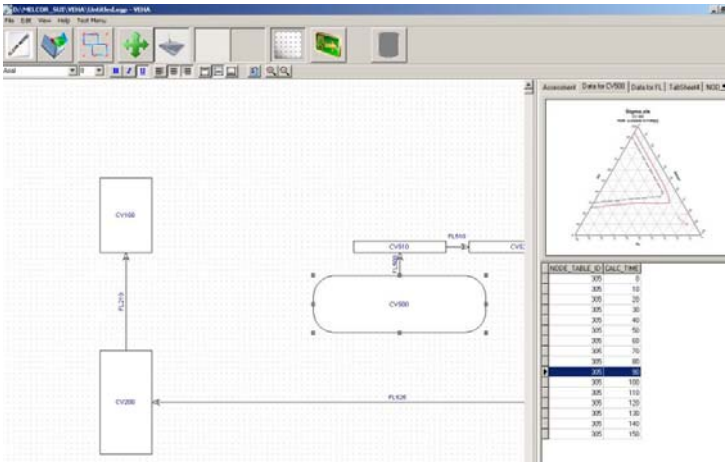

Figure 4 – Control volume types and links

Development of such kind of tools is in help not only for post calculation analyzes but for codes developer also. Visual form of the results can help developers improve ability of their codes and design better tools.

References

1. Bradfute J. O., M. P. Paulsen, *Hydrogen Flammability Model Based on Present Data*, Proceedings of the Workshop on the Impact of Hydrogen on Water Reactor Safety, Volume III, 1981
2. Dorofeev S. B., A. S. Kochurko, A. A. Efimenko, B. B. Chaivanov, *Evaluation of the hydrogen explosion hazard*, Nuclear Engineering and Design 148, pp. 305-316, 1994
3. *Flame Acceleration and Deflagration-to-Detonation Transition in Nuclear Safety* (SOAR), NEA/CSNI/R(2000)7
4. Kumar R. K., G. W. Koroll, M. Heitsh, E. Studer, *Carbon Monoxide – Hydrogen Combustion Characteristics in Severe Accident Containment Conditions*, Nuclear Energy Agency, Report NEA/CSNI/R(2000)10, March 2000
5. *MELCOR – Computer Code Manual and Reference Guide*, Sandia National Laboratories