Models and calculations about the accidental activity emission to the environment of the NPP Paks

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INTRODUCTION

The nuclear power plants in operation, necessarily produce radioactive materials that may cause a potential threat to the environment. The plants have a multi- barrier protection to prevent environmental release. In an emergency condition the primary circuit can be damaged, in this case the containment is the final barrier to the environment. To determine the amount and composition of the radioactive materials leaving the plant in this case we must use computer codes.

RESULTS

This work is about modelling the possible activity emission in a case of a LOCA (Loss Of Coolant Accident) in the Paks NPP. I made calculations and physical models for this purpose.

I used the program called HERMET for this work. As studied the program I learnt the working of the safety systems of the Paks NPP, and the theoretical and experimental works in this field. I used the HERMET code for different LOCA and I analysed the results of the calculations.

I examined and developed the psychical models found in the HERMET program:

- I changed the HERMET program steam-water-air state calculating algorithm to a new one and I checked it with the help of CONTAIN calculations.
- I added a volume-work calculation algorithm for the HERMET program and I compared it to CONTAIN calculation successfully.
- I made new wall heat convection model for the HERMET code, the new model is much simpler than the old one, and it gives more detailed simulation of the heat conduction, it works with two phases and considers radiation heat transfer as well.

Emission to the environment is possible from the hermetic rooms though other rooms of the NPP at a LOCA, if there internal pressure is higher than the atmospheric. To calculate this emission I made a new reactor hall model and I made several different analyses considering different LOCA scenarios. I made these calculations for the three most important isotopes from radiation protection point of view

I used the new reactor hall model to examine of the effect of the different fuel failure starting time to the emission. I made this study from 0 s fuel damage delay to 60 s delay. I

present these results in detail in graphic and table form, and I compared to the earlier calculations.

Theses

1. I determined the calculation accuracy of some models of the HERMET code. I found that the parameters describing the state of the nodes and the wall heat model must be developed further.
2. Developed an algorithm to calculate the air-steam-water state parameters in the nodes by appropriate precision.
3. I integrated the volume of work to integral calculation of node state.
4. New wall heat transfer model was created. It proved that the modified model can be used for long term LOCA simulation.
5. I have created a new model for the reactor hall. Dilution, filtration and retention is simulated, and follows the path of the radionuclide towards the environment.
6. I used the new reactor model to calculate the impact of the different fuel damage starting times on the emission through the chimney.

Related publications

Papers:

Attila Nagy, Zoltán Hózer, János Sebestyén Jánosy: **Modelling of VVER-440/213 hermetic rooms in training simulator**, Annals of Nuclear Energy Volume 55, May 2013, Pages 272–278

Attila Nagy, Sándor Deme, Zoltán Hózer: **Activity emission model for VVER 440/213 reactor LOCA**, Annals of Nuclear Energy, Volume 62, December 2013, Pages 413–420

Presentations:

Attila Madaras, Sándor Deme, Zoltán Hózer, Edit Láng, István Németh, Tamás Pázmándi and Péter Szántó: **A new simulation code for analizing loss of coolant accidents in VVER-440/213 reactors concerning activity transport**, Proceedings of the 17th International Conference on Nuclear Engineering ICONE17 July 12-16, 2009, Brussels, Belgium, ICONE17-75306

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Nagy A., Balásházy I., Hofmann W., and Lőrinc M. (1999) Quantification of expiratory deposition patterns of radioaerosols in the upper human airways. IRPA Regional Congress on Radiation Protection in Central Europe, Budapest, Hungary, August 22-27. Book of Abstracts 127.

Balásházy I., Hegedűs Cs., Vértes P., Szabó P.P., Lőrinc M., Andrási A., Nagy A., Láng E. and Hofmann W. (1999) Quantification of local particle deposition patterns of inhaled aerosols in the human lung. KFKI Atomic Energy Research Institute, Progress Report on Research Activities in 1999. Budapest, March 2000, 61.

Nagy A., Hegedűs Cs., Vértes P., Láng E., Lőrinc M. and Szabó P.P (1999) Characterisation of expiratory aerosol deposition patterns in human airway bifurcations. J. Aerosol Sci. 30, S1, 725-726.

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