Chapter 7

Conclusions

MATSTAB is a new computer code, able to predict global and regional power-void oscillations in a boiling water reactor. The predictions of the code are validated against stability measurements in all three reactors in Forsmark and in Oskarshamn as well as against the Leibstadt reactor in Switzerland. The predictions are normally very accurate for global oscillations and are comparable with the results of state-of-the art transient codes.

The MATSTAB model is based on RAMONA 3B (thermal-hydraulics, thermal conduction) and POLCA 4 (neutronics). The thermal-hydraulic part is one dimensional but multichannel, with full radial resolution (each fuel assembly is modeled independently). The neutronic part is three dimensional with 25 nodes for each fuel assembly. The good agreement between prediction and measurement justify the chosen model. However, it seems that the model is more complex than necessary. Most thermal-hydraulic equations were copied from RAMONA in a one-to-one manner. Since RAMONA was designed for general transient calculations, several equations could be simplified for stability calculations. The same is true for the thermal conduction model. Especially the nodalization of the pellet and cladding could be replaced by an analytical approach. This would reduce the number of equations in the system matrix substantially. At the moment, nearly half of the equations originate from the nodalization of the fuel. Nevertheless, the gain for the solution algorithm would be only moderate, since the structure of the fuel equations is simple and allows a fast numerical solution despite its size.

MATSTAB linearizes the set of equations and takes full advantage of sparse matrix technology and frequency-domain methods. With this combination, it is possible to overcome the high memory and CPU requirements of the detailed model. Within ten minutes (with a standard PC), it is possible to predict global oscillations and in another five minutes the decay ratio of the regional oscillation can be predicted. The fast solution of MATSTAB is certainly an advantage in the daily use, but also other codes like RAMONA-5 improved significantly in speed since the development of MATSTAB. Therefore, the real benefit lies in the fact, that MATSTAB calculates more information about the stability behavior of a BWR reactor than just the plain decay ratio. Especially the decay ratio of the regional oscillation and the information available from the eigenvectors are of big interest.

Using the information available from the right and left eigenvectors, a new method is introduced to analyze the contribution of specific model sections, fuel assemblies, variables or equations to the eigenvalue (decay ratio). The method is promising and some first, simple examples are explored. An in-depth analysis of the numerous possibilities remains to be done.

Putting all pieces together, the new approach chosen in MATSTAB proved to be successful. The goals for accuracy, ease of use and speed could be met, while new ways to explore BWR stability have been opened.

Proposals for Future Work

The following topics are good candidates for future work:

- Further development of the new method to analyze the contributions of different parts of the model to the eigenvalue.
- Regional analysis for Ringhals
- Two-group model for the neutronics
- Simplification of the fuel model