

## 9. SUMMARY AND ANALYSIS OF RESULTS OF THE STUDY

Results of the theoretical and experimental programme performed on steam generator models form the basis necessary for the definition of safety conditions of both inverse steam generators MMISG as well as MISG, namely:

- the probability of burn-through of the target tube wall is very very low. Therefore the total water amount that may react with sodium is lower than that in traditional steam generators at similar leak conditions,
- the damaged area is concentrated to only one leaked tube,
- the probability of a large water into sodium leak in the inverse steam generator is hypothetical only,
- the hydrogen flow rate into the sodium buffer tank caused by a tube leak in the inverse steam generator is incomparably larger than that in the steam generator of the traditional concept at similar leak conditions,
- consequently, proved and simple leak detection methods may be used in surveillance systems of the MMISG and MISG, namely measurements of hydrogen concentrations in cover gas, pressure increase in sodium buffer tank and detection of hydrogen bubbles in the sodium outlet pipeline.

It was proved that the ratio of the MMISG total mass to its thermal power achieved a comparatively high value. Two

design ways contribute to the small value of the ratio mentioned above, namely:

- intensification of the heat transfer at the water side by efficient internals,
- using one macro module of the thermal power of 30 MW at least

TABLE XIV.  
COMPARISON OF FOUR STEAM GENERATORS TESTED AT BOR 60 REACTOR FROM THE VIEWPOINT OF THE RATIO MASS TO THERMAL POWER

STEAM GENERATOR	TOTAL MASS TO THERMAL POWER RATIO, kg/MW
MISG (module inverse steam generator)	345
Steam generator with serpentine shaped tubes in tube bundle (sodium at the shell side)	510
Micro module steam generator of traditional concept (sodium at the shell side)	700
Module steam generator of the BN 600 design (sodium at the shell side)	1200
MMISG (micro modular inverse steam generator)	1000

The MISG is an example. Thermohydraulic characteristics of the MISG measured at BOR 60 proved the design efficiency of the heat transfer intensifying internals used at the water/steam side of the economizer and the superheater regions.

Four steam generators are compared in Table XIV tested at BOR 60 reactor from the viewpoint of the ratio total mass to thermal power.

A long-term testing of the MMISG (more than 59,000 hours of operation) and MISG (more than 9,000 hours of operation) at BOR 60 reactor have proven very well their operational and safety characteristics as well as their reliability in all service situations with positive results.