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USING SSC/MINET

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Analysis of the CRBRP Part Load Conditions
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By G.J. Van Tuyle and J.G. Guppy

The part load plant conditions for the Clinch River Breeder Reactor Plant (CRBRP), as calculated by the CRBRP Project Office, are presented in Section 5.7 of the CRBRP Preliminary Safety Analysis Report (PSAR)¹. The Super System Code (SSC)², coupled with the MINET (Momentum Integral Network) Code³, was used to determine the plausibility of these postulated plant conditions, particularly with regard to whether the heat exchangers have sufficient heat transfer area for these conditions to prevail.

The SSC/MINET representation of the Clinch River Plant used for the part load study is shown in Figure 1. SSC was used to analyze the reactor, the primary loop, and most of the intermediate loop. MINET was used for the rest of the CRBRP system, as indicated in Figure 1. The analysis relies primarily on energy balances (SSC), an established package of heat transfer correlations (SSC & MINET), and two steady state momentum integral network solvers (MINET).^{2,3}

Values for thirteen plant parameters, evaluated between 40% and 100% of rated power, were digitized (±1%) from figures in the CRBRP PSAR. Part load values were determined for the reactor power, the primary loop hot and cold leg, intermediate loop hot and cold leg, turbine, evaporator inlet, and feedwater temperatures, as well as the primary loop, intermediate loop, feedwater, re-circulation loop, and steam drum drain line (to topping heater) mass flow rates.

The part load conditions were analyzed for seven cases, spanning the 40% to 100% load follow power range covered in the PSAR. In order to match the plant conditions as indicated in the PSAR, it was necessary to apply correction factors to the design heat transfer area in the three heat exchanger types, i.e., the intermediate heat exchanger (IHX), the evaporator (Evap), and the superheater (Suph). This factoring of the heat transfer area is equivalent to adding or subtracting tubes to/from the units.

The area correction factors used for each of the three heat exchanger types, at each of the power levels, are given in Table 1. The fact that none of these factors exceed 1.0 indicates that the heat transfer area is sufficient to provide the plant conditions indicated in the PSAR.

Table 1. Fraction of Available Heat Transfer Area Utilized

<u>Power</u>	<u>f_{IHX}</u>	<u>f_{Evap}</u>	<u>f_{Suph}</u>
40%	.81	.65	.95
50%	.86	.67	.84
60%	.88	.67	.84
70%	.88	.70	.85
80%	.87	.71	.81
90%	.84	.73	.81
100%	.86	.73	.78

It is stated in Section 5.5.3.5 of the PSAR that the CRBR heat exchanger designs include a 10% margin for fouling of the heat transfer. Thus, the equivalent of Table 1, as calculated by the CRBRP Project Office, would contain values of 0.9. Taking into account errors of data digitization, etc., the results of the SSC/MINET analysis essentially confirm this margin for

the IHX and superheater. Regarding the evaporator, SSC/MINET analysis indicates that a somewhat higher design margin actually exists, but the difference is within the error range generally associated with boiling heat transfer correlations. Trends in the area correction factor over the various power levels are merely an indication of different heat transfer correlations, e.g., a correlation employed in SSC/MINET may have a stronger mass flow rate dependence than the equivalent correlation used to obtain the conditions given in the PSAR.

Furthermore, it was determined that the area correction factors for the IHX and superheater are highly responsive to changes in temperature. Thus, the plant is likely to operate with slightly lower temperatures in the primary and intermediate loops. The evaporator area correction factor is relatively insensitive to temperature changes, and a higher re-circulation loop mass flow rate is likely.

In summary, the CRBRP part load conditions have been confirmed using SSC/MINET. The results indicate that any errors are conservative, i.e., there is more than sufficient heat transfer capacity, and actual operating reactor temperatures should be slightly lower than those cited in the PSAR.

References

1. Clinch River Breeder Reactor Project, Preliminary Safety Analysis Report, Project Management Corporation, 1975.
2. J.G. Guppy, et al., "Super System Code (SSC-L, Rev. 2), An Advanced Thermohydraulic Simulation Code for Transients in LMFBRs", Brookhaven National Laboratory, (to be published, 1982).
3. G.J. Van Tuyle, "Analysis of CRBRP Station Blackout Using SSC/MINET", 2nd Joint ASME/ANS Nuclear Engineering Conference, Portland, OR, ASME Paper No. 82-NE-19, BNL-NUREG-31110. July 1982.

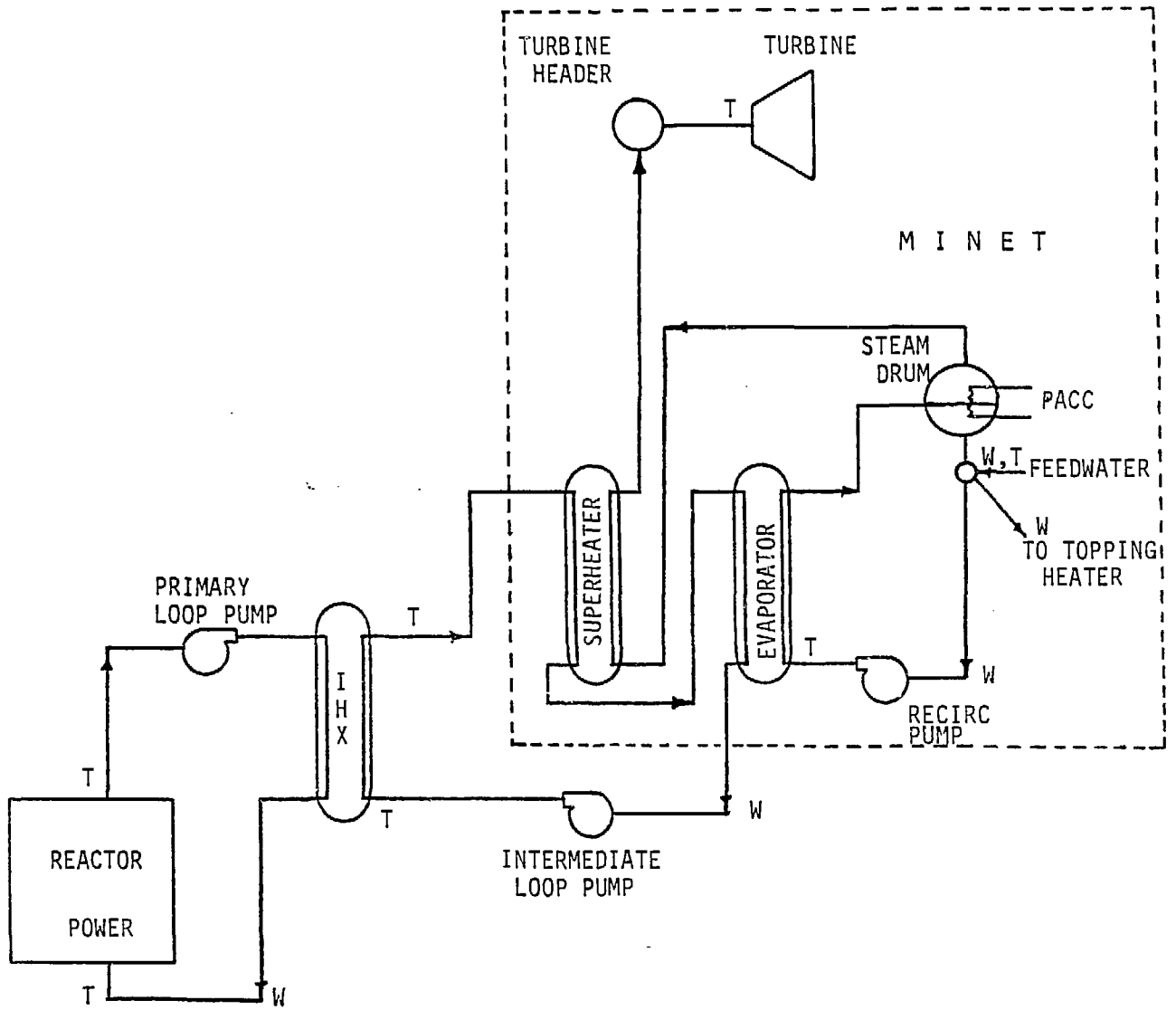


Fig. 1 SSC/MINET REPRESENTATION OF CRBRP FOR PART LOAD STUDY