52-003

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Dr. Gene Rhee
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Dear Gene:

This is a letter summarizing my feelings about the acceptability of the ROSA IV facility for an integral, large scale for the AP-600 reactor system.

These are really two issues that have to be addressed in the test program for the AP-600 system. They are:

1) Are there any surprises that the new system has which would not have become apparent in the separate effects tests?
2) Will going to full scale so change the system (in dimensionless parameter terms) that the extrapolation of system behavior from small scale tests will be inadequate?

I think these two issues can be adequately addressed with two separate experiments one of which, item 2) above, could be addressed in the ROSA IV facility. Let me expand on this point.

There are lots of geometric differences between the proposed AP-600 and the proposed altered ROSA IV facility. ROSA IV is, however, full pressure almost full height and is not much smaller, in its largest pipes, than the AP-600. It does lack the 2x4 arrangement of the AP-600 and doesn't match the number of loops in the primary. I think the fact that it is almost full size in the major primary pipes and the high pressure capabilities are ROSA IV's major advantages. These, combined with a smaller scale system that better matches the

geometric detail of the AP-600, makes the use of ROSA IV an attractive possibility. I doubt you could get an apparatus close to the size or pressure of ROSA IV for the 5 million dollars that a program on the altered ROSA IV facility would cost.

Though we didn't spend much time on the scenarios of interest at the December 31 meeting we did mention the accidents of concern. These are:

Large Break Loss Of Coolant Accident
Small Break Loss Of Coolant Accident
Steam Generator Tube Rupture

Of the three transients listed above the LB LOCA is of the least interest. I think the AP-600 has a low enough power density and the primary system is similar enough to current reactors so that the existing codes are quite capable of calculating this transient. No system effect test is required for a LB LOCA.

The SB LOCA is probably the most important. A few seconds into this transient the reactor has scrammed and we are at decay heat levels with the system depressurizing due to both the leak and the operation of the automatic depressurization system. I think many of the details of the depressurization process,though beyond calculation,are not very important as long as the core is covered. A small scale experiment will show if the various parts of the emergency core cooling system will perform as expected. Much of the early, high pressure stage of the blowdown could be simulated on ROSA IV. Once the water level in the vessel drops below the top of the hot and cold legs, the steam generators will drain and the processes will become quite predictable. This stage of the blowdown is sensitive to geometry and ROSA IV is probably not adequate. All the water in the primary will be in the lower part of the vessel. The only important question at this point is can the ECCS deliver enough water, in a predictable fashion, to keep the core covered? A small scale system effect test to uncover surprises combined with a large scale test on ROSA I think is sufficient.

I am unable to evaluate the steam generator tube rupture accident without knowing more about the scenario. I'm less familiar with this accident than the others.

At this time we don't know what we'll find in a system effects test. As testing proceeds, however, it is likely that we'll find some phenomena for which we wish we had a larger scale system to investigate. This is an additional role that ROSA IV can play.

Another role that ROSA IV can play is the role similar to the role MIST played in the combined UMCP-MIST program for B and W reactors. A variety of phenomena were uncovered in both these experiments. These phenomena were, to a large extent, similar for both experiments. MIST was large scale but lacked the geometric complexity of the B and W plant. The UMCP experiment was small scale and low pressure but retained much of the geometric complexity of the B and W plant. The similar behavior displayed by these two experiments made me confident that no surprises are awaiting us on the B and W reactors.

One might ask what surprises we might expect in a new system like the AP-600. If I knew, of course, I'd tell you and we wouldn't need to run any experiments. But I don't. I have some ideas however. These are flow oscillations during refill, stratification, and steam bubble collapse induced water hammer.

A natural circulation delivery system for the ECC such as the AP-600 has is characterized by cold water entering a steam filled or partially steam filled system, a system which is at a rather low pressure, 100 psia more or less. Our data base for this combination of conditions is small. I could imagine oscillations similar to the familiar reflood oscillations in cores (though in this case they may occur in pipes) or oscillations similar to the cold leg oscillations observed in the CREARE experiments several years ago. These are both system effect phenomena which have their own scaling laws. These could happen in hot piping like the hot leg, in the ECC injection line if it voids, or in the surge line as it drains into the hot leg. They could occur in both horizontal or vertical pipes.

Stratification is certainly a smaller, and may be a negligible concern, in a low pressure system such as the AP-600 after blow down. I'm almost sure PTS due to stratification is not a concern. However, pipes with a single phase stratified flow in them can bow enough to cause a loop seal and may give rise to unacceptable stress levels. Experiments will show whether stratification is a concern.

Steam bubble collapse induced water hammer could occur in any steam filled horizontal line as the system refills with cold water. In addition it could occur in the surge line as it drains, and at the entrance of the ECC line into the pressure vessel (as occurred in some W steam generators a number of years ago when the auxiliary feed came on). It could also occur where steam could be trapped during refill with cold ECC, particularly in the cold leg as we observed in our little rig (Jacobek and Griffith) several years ago. This was also observed in the UMCP rig recently.

I'm confident most of the possibilities I've mentioned above are not real. I'm almost sure I've forgotten something too. I'm most reassured that a system is safe and that there are no surprises waiting to happen if a variety of experiments, designed according to different scaling rationales are run and yet their behavior is similar. ROSA IV is full pressure and as big as we'll ever be able to afford. Combined with one or more small, perhaps low pressure experiments and separate effects tests as needed, I believe we can construct an unassailable case that the AP-600 is a safe reactor.

The AP-600 represents a substantial advance over current designs and can be constructed to be a predictable, reliable, safe machine. The ROSA IV test facility provides, along with analysis and small scale integral tests, the answer to the question - what will happen at high pressure or if the size is increased?

Sincerely,

Peter Griffith
Consultant

cc: Marcos Ortiz