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Virgil E. Schrock
258 Orchard Road
Orinda, CA 94563

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To: Dr. Ivan Catton, ACRS
Chairman, Subcommittee on Thermal Hydraulic Phenomena

From: Virgil Schrock, Consultant

Re: Visit to OSU to witness NRC sponsored Test in APEX Facility, July 19, 1995

As requested, I visited the OSU-APEX facility to witness the NRC test conducted on July 19, 1995. Since I was not present for the subcommittee tour of the facility (in 1994, I think), this was also my first look at the facility. I was very impressed by the high quality of the design, instrumentation, data acquisition system and construction of the facility. In fact I found the quality to be at least as good and probably better than any major integral facility I have seen, including those at INEL, ROSA and MIST. The operating staff also appeared to be very sharp and well qualified for the task.

Dr. Jose Reyes brought a copy of the Test Plan/ Check List to my motel the evening before the test and we discussed the background then and in the morning just prior the test. Since the document is sketchy and largely an operating check-off list, I asked for drawings showing the facility as used for the test, some written material covering the information leading to the chosen initial conditions and copies of preliminary results of the test. All of this was provided promptly the week following the test and is included as an appendix to this report.

The test was said to be the first "on-the-fly" type test, that is, the facility was to be conditioned to pick up the simulation at the time of actuation of the first ADS valve. It was designated NRC-14 and was a SBLOCA, a 1" break located at the bottom of cold leg # 3 of the AP600. The test was intended to be a "real pressure" (as opposed to "scaled pressure") simulation for that part of the AP600 response. The test is a counterpart to the ROSA AP-CL-03 test and could be used to extend the results into long term sump recirculation cooling. Initial conditions for the test NRC-14 were taken from this ROSA test and were reasonably confirmed by RELAP-5 calculations done at INEL. The test also was a repetition of the June 29; 1995 APEX test NRC-6 (except that one ADS-4 valve was assumed to fail in NRC-14 whereas all were functional in NRC-6). Test NRC-6 was flawed due leakage of mainsteam valve MS-1, causing asymmetric depressurization of the steam generators. The objective of NRC-14 was to "quantify the differences between pressure similitude and pressure scaled depressuration behavior".

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Both types of scaling are claimed to have 1/2 the AP600 time scale but APEX pressure is interpreted as 1/3 AP600 for "pressure scaled" and equal to AP600 for "Pressure similitude". Evidently the facility is considered capable of both, the only difference being the use of different orifice sizes. For "full pressure" tests all break areas and ADS valve sizes are 1/96 of AP600. For "scaled pressure" break and ADS 1 & 2 areas are sized 1/38 of AP600 while ADS 3 & 4 are 1/96 (for 2" breaks and larger they would be 1/38). I do not recall the rationale for this scaling argument. As an aside, I understood from Paul Boehnert that ACRS is expecting additional material on the APEX scaling. When I asked Dr. Reyes about this he indicated that he had provided everything requested through Westinghouse. Evidently some clarification is needed.

The test required that the CMT's be hot at the start of the test and this was accomplished by allowing recirculation to occur until their temperature stabilized. The pressurizer was drained and a target primary coolant reduced inventory were obtained by opening the LOCA valve prior to the initiation of the test, during which time the pressure was manually controlled by adjusting core power. The programmed decay heat power controller was actuated at the beginning of the test. To avoid the problem of the leaking MS-1 the steam generator # 01 was isolated using the downstream valve MS-3.

Core power is displayed on the control panel in two roughly equal segments (gangs of rods). During startup I noticed that manual control of pressure via heater control was difficult and large power over and undershoots resulted. The two banks of heaters were not kept synchronized and each had changes of up to a factor of two every few seconds. In spite of these power variations, the pressure at the start of test was close to the desired level. The initiation of CMT draining occurred at a lower than expected core collapsed liquid level. In these test conditions draining is initiated by flashing at the top of the CMT's and would be sensitive to the amount of superheat there. The data provided do not allow ready assessment of the comparative superheats (APEX vs. ROSA).

The test was judged to pass the acceptance criteria. Preliminary data provided by Dr. Reyes are in the form of 78 graph of measured presssures, temperatures, liquid levels and flowrates. As observed in the test, pressure measured in the pressurizer and upper head appeared to drop-off smoothly with de pressurization complete in less than 1000 s. Large variations in the accumulator and CMT injection rates occurred during this . Nothing very surprising appears in the data although comparison with the other tests will have to be made to determine what important information is provided by the test. I presume that Bessett and DiMarzo will use the scheme to evaluate the results.

A newly mounted video camera was positioned to show the discharge through an arm of the quencher in the IRWST. Dr. Reyes indicated that this was a matter of curiosity rather than an attempt to resolve a problem. The IRWST tank dynamics are not scaled in the APEX facility and Dr. Reyes is not familiar with the large scale tests done in Cassacia, Italy for Westinghouse. The video showed a burst of large bubbles completely obscuring the quencher following the firing of ADS-1 and this diminished rapidly. After a few minutes the steam bubbles were small (like twice the orifice diameter) and were collapsed near the quencher.

In summary the test appeared to be successful and without any major surprises. Comparison of the data with those of other tests will be needed to judge whether the test objective has been met. A RELAP-5 preprediction of the test, done by one of Reyes' colleagues, showed a significant pressure recovery in the latter stages of depressurization. This feature was not observed in the test.

Dr. Reyes indicated that the next test would be a steam generator tube rupture. For this test the break will be created by placing a tee in a tube (two locations are planned). I pointed out that this will be still a third geometry -- 1. a severed tube in AP600 with two critical flow paths each driven by different stagnation states (pressures and enthalpies)-- 2. a single flow path from the hot plenum of the ROSA SG -- and 3. the APEX geometry in which the fluids coming from the two plena have to pass together through the tee without complete mixing. I am concerned that these are likely to produce different results. I have yet to learn why this issue is not of concern to the staff. It was first raised at the meeting in Idaho Falls more than two years ago.