# SUMMARIES OF PRESENTATIONS
## (C. Luongo and J.R. Miller)

### Luca Bottura - "Validation Results for 3-D Quench Propagation"

The presentation focused on SARUMAN, a 3-dimensional quench simulation code developed as part of NET design activities. SARUMAN solves the 1-D helium channel flow problem by the finite elements method, coupled with a 3-D thermal conduction solution in the coil pack. The code can simulate not only a helium-driven quench, but also the turn-to-turn propagation of a normal zone by thermal conduction through insulation. The code also simulates current decay and pressure relief through manifolding/cryogenic system. In that sense, SARUMAN is a full-quench simulator, possibly the most complete simulation tool available today. By the same token, the code may be too complex to gain wide acceptance in the industry (it requires extensive computational facilities). Experimental validation results were also presented. Agreement with experimental data is very good, although the test coil was wound with an internally cooled monolithic conductor and not a CICC.

### Bob Wong - "Thermal Analysis of TPX Superconducting Magnets"

The presentation focused on the code CICC, a stability and quench code developed at LLNL. CICC solves the 1-D channel flow problem in conjunction with a 2-D axisymmetric thermal conduction problem. The numerical approach is that of finite differences using the method of lines (explicit predictor-corrector). For stability and quench simulation this code also requires significant computational capabilities. Results were presented of the use of CICC to model the temperature evolution inside the TPX coils subject to nuclear heating. Some experimental verification of operating regimes near the current sharing limit are under way.

### Chris Yeaw - "Preliminary Investigation of Radiation Effects upon ITER TF Coil Stability"

Yeaw has used Wong's CICC code to examine the stability of ITER-relevant conductors. In particular, the effects on materials properties of the ITER radiation environment were included using formalisms suggested in the literature. Yeaw simultaneously pointed out the importance of such formalisms in evaluating ITER magnet stability and the need to check their validity because of obvious inconsistencies. In general, Yeaw's work provided further evidence of the sensitivity of conductor performance to the detailed thermal properties of the constituent materials.

**Ali Shajii - "Analytical and Numerical Modeling of Quench in CICC"**

Two codes have been developed at MIT, Quencher and MacQuench. Quencher is a complete stability and quench model that like the other codes, requires extensive computer facilities. The code uses a finite difference approach with fully implicit solution in time, and a collocation method for the solution of the non-linear system at each time step. The code uses adjustable meshes that follow the normal front (to capture quench detail without carrying computational overhead where the gradients are small). A simplified quench simulator, MacQuench, has been developed. Also presented were analytical solutions to the 'piston-in-conduit' problem that represent an extension of Dresner's theory (inclusion of other effects). Work is in progress to analytically bound the conditions under which Thermal Hydraulic Quenchback (THQ) occurs.

**J. Winston Lue - "Normal Zone Propagation and Thermal Hydraulic Quenchback in Cable-in-Conduit Superconductor"**

The work at ORNL has fully confirmed the existence of THQ. Experimental results have been reconciled with theory. As predicted by earlier calculations, propagation by THQ is nearly sonic. The conditions at which THQ occurs are now better understood. The theory shows that indeed there is a 'threshold' behavior in the appearance of THQ.

**Cesar Luongo: - "Quench Studies for the SMES/CICC: Simulation and Experimental Verification"**

The presentation focused on the code HEDUMP, developed as part of SMES design efforts at Bechtel. The code is based on the method of lines, with an explicit time integrator. The model is not as complete as the other quench simulators, yet its intent is to capture some of the features specific to the SMES/CICC. The model accounts for the separation of helium into two zones, a peripheral cable space, and an unobstructed central tube. Experimental verification efforts are under way at the NHMFL. QUIPS (QUench Initiation and Propagation Study) will provide experimental data on a subscale conductor of the 'hybrid' type (CICC with segregated helium expulsion channel).

**Luca Bottura - "Criteria for Stability-Based Design of CICCs"**