Methodology and Application for Instrumentation," provides a detailed description of the statistical treatment of uncertainty.

To estimate the total uncertainty in an instrument or measurement, the applicant algebraically combined various random and bias errors. The applicant combined random errors using the square root of the sum of the squares (SRSS) method, and summed bias errors together, before combining the sum with the SRSS result. Similar treatment of the uncertainties was applied to the previously certified System 80+ design.

Thermal-hydraulic instability does not occur during normal operations or AOOs for the APR1400 due to the inherent thermal-hydraulic characteristics of PWRs as indicated in NUREG-1462. NUREG-1462 states that the expected pressures and flows are sufficiently large to suppress fluctuations that could cause flow instability.

To ensure that required net positive suction head (NPSH) is available to the reactor coolant pumps (RCP) under all operating conditions, an operating curve that gives acceptable RCS pressure as a function of temperature is used. The applicant stated that the APR1400 does not allow for power operation with inoperative pumps. Additionally, DCD Tier 2 Chapter 16, TS B 3.4 "REACTOR COOLANT SYSTEM," specifically requires two RCS loops for Modes 1 and 2 with both RCPs in operation in each loop.

The applicant calculated core coolant flow distribution based on flow test programs with geometrically scaled models performed for the System 80 and the Hanbit Nuclear Power Plant Units 3 and 4. Flow blockage in the vessel core is assumed to occur in the determination of the core DNBR limits. This assumption of blockage helps address the effect of crud buildup in the primary coolant system. Furthermore, the calculation of hydraulic loads account for pressure losses due to core crud.

The applicant stated that a licensee will continuously monitor the flux tilt, that is, the azimuthal imbalance of the radial power distribution in the core, using the COLSS during operation. ~~The COLSS analyzes the flux tilt using the TORC code and a simplified version of it, CETOP.~~ The azimuthal power tilt is also determined by the COLSS and it is included in the COLSS determination of core margin. Protection limit setpoints allow a certain amount of flux tilt. The operator will monitor these margins and take corrective action if the limits are approached.

CPCS

The APR1400 design uses the COLSS and ~~RPS~~ to help ensure that the design basis limits are not exceeded for the DNBR and fuel temperature. The applicant precluded fuel melting by limiting the LPD. These limits are maintained by LCO, which are provided in DCD Tier 2, Chapter 16.

APR1400 thermal-hydraulic-related instrumentation includes CEA position indication, ex-core neutron flux detectors, and reactor coolant flow indicators for determination of thermal-hydraulic conditions. In-core instrumentation assemblies permit three-dimensional flux mapping of the core and include core-exit thermocouples. The ex-core neutron flux monitoring system measures reactor power level from startup levels to 200 percent of full power.

The inadequate core cooling monitoring system monitors hot and cold leg temperatures, pressurizer pressure, core exit temperature, and reactor vessel water level, to identify inadequate core cooling conditions.