DUKE POWER COMPANY - OCONEE NUCLEAR STATION
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TECHNICAL SPECIFICATIONS - BASES FOR OPERATING LIMITS

The proposed operating limitations for the initial two years of plant operation are based primarily on: (a) recent findings on thickness effect on the fracture toughness of heavy section ferritic steels, and (b) on the available fracture toughness data obtained from tests on the actual material of the reactor vessel.

Current ASME Section III Code rules permit that a vessel be pressurized only above a temperature equal to the sum of the Nil Ductility Transition (NDT) temperature and 60°F. The NDT temperature, according to paragraph N-331 of the Code, can be obtained by either the drop-weight test (DWT) or the Charpy V-notch (Cv) impact test. However, recent fracture toughness test data indicate that the current ASME Code rules are not always sufficiently conservative, and may not guarantee adequate fracture toughness of ferritic materials. While the Charpy V-notch tests continue to be useful in measuring the upper shelf fracture energy value, the Cv specimens, generally, do not predict correctly the NDT temperature.

The latter, therefore, must be obtained from other tests, such as the DWT test. Quite often, also, considerable difficulty exists in defining from the Cv test curves the transition temperature region in which fracture toughness of ferritic materials increases rapidly with temperature. In addition, this transition temperature region shifts to higher temperatures when the thickness of the specimen tested is increased (size effect).

The proposed heatup and cooldown limitations are based on the available fracture toughness test data for the reactor vessel material, and several assumptions. These assumptions relate primarily to the interpretation of the available Charpy V-notch test data, and are necessary because DWT test results, weld metal properties, or the Cv upper shelf fracture energy levels, were not required by the ASME Code rules. Specifically, the maximum initial NDT temperature for the materials of the reactor vessel (including welds) was assumed to be 50°F. To assure adequate fracture toughness level at the initial lowest pressurization temperature* (LPT), a temperature margin of 80° was added

*Lowest pressurization temperature of a component is the lowest temperature at which the pressure within the component exceeds 25 percent of the system normal operating pressure, or at which the rate of temperature change in the component material exceeds 50°F/hr. under normal operation, system hydrostatic tests, or transient conditions.

to the assumed NDT temperature of unirradiated material, plus a size effect of 80°F, obtained from the formula:

$$\text{size effect} = 27°F\sqrt{t} - 1/2,$$

where t is the maximum section thickness in inches.

The LPT for the unirradiated vessel was thus estimated to be 210°F. Using the estimated shift in the transition temperature, due to neutron irradiation, of 65°F, the LPT of 275°F has been specified for the first two years of plant operation. These operating limitations will require review, and probably revision, when the data are made available from the material surveillance program test results following the first capsule withdrawal.