SUMMARY REPORT OF FUEL ROD ANOMALIES AND THEIR IMPACT ON THE OPERATION OF INDIAN POINT UNIT NO. 2 DURING 50% TESTING OPERATIONS

AUGUST 17, 1972

1. INTRODUCTION

As a result of recent inspections during outages at several other nuclear plants, anomalies in some fuel rods at these plants were discovered. In certain respects, the fuel rods for Indian Point Unit No. 2 are similar to those in which anomalies were found after operation. For this reason, a detailed review of these anomalies has been conducted by Con Edison and Westinghouse, and this report discusses their impact and safety significance relating to the planned 50% testing operations at Indian Point Unit No. 2.

2. DESCRIPTION OF ANOMALIES

The review of the data from the operating plants in which anomalies were discovered revealed four anomalies: fuel densification, fuel rod cladding collapse, rod bowing in the cold condition, and hydriding of the clad.

The fuel which exhibited these anomalies contained Zircaloy clad, was not internally pressurized, had pellet density of 90-94% of maximum theoretical and stainless steel control rod thimbles.

Fuel densification is the result of the in-pile sintering of the UO_2 fuel from the densities existing at the beginning-of-life. This leads to shrinkage of the UO_2 fuel pellets. The net result is a reduction in the height of the fuel pellet stack, which can cause an increase in kw/ft, and the formation of axial gaps in the pellet stack which in turn would cause local power peaks.

Later in core life, after several thousand equivalent full power hours of operation, the Zircaloy cladding creeps down on the fuel. Given a sufficient axial pellet gap, (as a result of densification), and resultant unsupported length of clad, continued cladding creep after additional irradiation, results in increased ovality and eventual instability leading to clad collapse into the axial gap.

Fuel rod bowing in the cold condition is the result of radiation-induced Zircaloy growth and differential thermal expansion between the Zircaloy clad fuel rods and the stainless steel control rod thimbles. The stainless steel thimble thermally contracts (and expands) to a greater extent than the Zircaloy clad fuel rods causing the clearance between the top of the fuel rod and the top fuel assembly nozzle to be a minimum in the cold shutdown condition. During irradiation, the Zircaloy clad is expected to exhibit growth, such that upon subsequent cooldown to the cold condition, some rod bowing can occur due to material thermal contraction causing rod-nozzle gap closure.

In two of the eleven fuel regions examined by Westinghouse, areas of local clad hydriding were found. This was caused by excess moisture in the UO_2 pellets, which led to the formation of local areas of zirconium hydride. These areas of zirconium hydride, being less ductile than the surrounding Zircaloy clad, led to the leakage of some fuel rods.

3. SAFETY SIGNIFICANCE OF FUEL ROD ANOMALIES DURING 50% TESTING OPERATIONS

Some fuel densification would be expected to occur during 50% testing operations for Indian Point Unit No. 2. The direct result of fuel densification is an increase in flux peaking and a slightly altered axial flux shape due to the gap and change in pellet stack height.

The effects of fuel densification on the consequences of accidents and anticipated transients affected by fuel performance were evaluated. For the power level which will be limited to 50% of full power under the testing license, safety requirements would be satisfied.

Specifically, the effect of fuel densification on the analysis of the consequences of the loss-of-coolant accident was conservatively evaluated in accordance with the requirements of the Interim Acceptance criteria. The calculated peak cladding temperature with densification at 50% power was 1115°F, as compared with the value of 1140°F at 50% power without densification, previously reported in response to the Atomic Safety and Licensing Board's question (Tr. 4166, December 14, 1971). In addition, all of the other requirements of the Interim Acceptance Criteria, including Criterion 3, would be satisfied.

On the basis of fuel rod inspection results the onset of fuel rod cladding collapse is not expected to occur prior to approximately 6000 equivalent full power hours (~8000 MWD/MTU) of operation. Since the 50% testing operations for Indian Point Unit No. 2 are conservatively estimated not to exceed approximately 1500 equivalent full power hours of operation, and probably will not exceed 900 equivalent full power hours of operation, there is considerable margin to the onset of cladding collapse and it is not expected to occur.

Design evaluations have been performed for Indian Point Unit No. 2 based on the observed data on fuel rod bowing in the cold condition, to provide assurance of satisfactory performance during testing operation and the subsequent cold shutdown. Since the time required for Zircaloy growth sufficient to cause rod bowing in the cold condition is approximately one fuel cycle, much longer than the 50% testing operations, no fuel rod bowing is expected to occur.

Hydriding of the clad and fuel rod leakage, as mentioned before, resulted from excess moisture content in the fuel pellets during fabrication; not from fuel densification and cladding collapse. Fuel, including the Indian Point Unit No. 2 fuel, fabricated after the fuel that exhibited hydriding,was manufactured to preclude such excess moisture. Fuel leakages resulting from hydriding have not been experienced, in reactors in which such fuel has been employed even though the cores have passed well beyond the point in operating lifetime where the previously-mentioned fuel exhibited leakge. There is confidence, therefore, that this problem is not expected to occur at Indian Point Unit No. 2.

4. SUMMARY AND CONCLUSIONS

The investigation and evaluation of the fuel rod anomalies disclosed recently at several other plants, as they relate to the operation of Indian Point Unit No. 2 during the period of 50% testing operations, has been completed.

Of the anomalies disclosed, only fuel densification is expected to occur, but it will not limit or affect operation under the testing license. For the power level which will be limited to 50% of full power under the testing license, safety requirements would be satisfied. All of the requirements of the Interim Acceptance Criteria, including Criterion 3, would be satisiied.

It is concluded, therefore, that the fuel rod anomalies disclosed at certain other reactors will not adversely affect the safety of Indian Point Unit No. 2 during the period of the 50% testing operations.

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