ATTACHMENT A

DEMONSTRATION OF THE CONFORMANCE

OF

EXXON NUCLEAR COMPANY FUEL

TO THE

WESTINGHOUSE K(Z) OPERATING ENVELOPE

FOR THE

PRAIRIE ISLAND NUCLEAR POWER PLANT

Westinghouse Electric Corporation

Nuclear Technology Division

Nuclear Safety Department

Safeguards Engineering and Development

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I. Introduction

This document reports the results of an analysis that was performed in order to demonstrate conformance of Exxon Nuclear Company nuclear fuel in the Prairie Island nuclear power plant to the Westinghouse K(z) operating envelope. The results of this analysis of top-skewed (8 ft. and 10.5 ft.) and chopped cosine (6 ft. peak) power shapes meet the requirements of Appendix K and 10CFR50.46 acceptance criteria.

II. Method of Analysis

The analysis was performed using the SATAN, WREFLOOD, COCO and LOCTA computer codes of the Westinghouse 1981 Large Break LOCA Evaluation Model (WEM) to calculate the PCT for Exxon fuel for three power shapes. The power shapes investigated were peaked at 6.0 ft., 8.0 ft., and at 10.5 ft. The power shapes used in the LOCA analyses are shown in Figures 1-3. The peak power of each power shape is limited by the Westinghouse K(z) envelope for the Prairie Island (NSP/NRP) power plant. This analysis is based on a full core of Exxon 14X14 "TOPROD" fuel with a maximum total peaking factor of 2.32 and a hot channel enthalpy rise factor (F-delta-h) of 1.60.

The study incorporates the new upper internals design package scheduled for installation in the first quarter of 1986. The new upper internals configuration contains an inverted top hat upper support plate. The inverted top hat upper support plate displaces upper plenum free water

volume and leaves less water volume available for core flooding during blowdown. This factor establishes the new upper internal configuration as a bounding case for either upper internals package. Thus the results of this analysis are applicable to both the new and old upper internals designs.

The fuel design parameters for these LOCA analyses were prepared by the Westinghouse Nuclear Fuel Division using NRC approved Westinghouse methodology and fuel performance models, modified to accurately describe measured Exxon fuel operating performance data with detailed operating fuel rod power histories. The similarity of Exxon and Westinghouse fuel cladding as-built and irradiated mechanical properties further supports the validity of the model development. The LOCA fuel design parameters calculated by Westinghouse with these modified and verified fuel performance models were then compared with LOCA fuel parameters used by Exxon in the previous cycle LOCA evaluations. This comparison showed good agreement on the fuel temperatures and stored energy and, as expected, somewhat lower fuel rod internal pressures as a function of fuel rod linear power. To assure that the new LOCA fuel performance parameters conservatively bound the values used by Exxon in the prior cycle analysis, the fuel temperature and rod internal pressure results calculated with the Westinghouse models were adjusted upward to match the prior cycle limiting values. The fuel parameters, calculated with those finalized calculational models, which included fuel pellet temperatures and fuel rod internal pressures were then used as input in each of the SATAN, WREFLOOD and LOCTA calculations. The results of the 1981 Evaluation Model calculation are summarized in the following table:

Comparison of Exxon Fuel Peak Cladding Temperatures

Power Shape Peak	PCT	PCT Elevation	PCT Time
6.0	2034 F	7.5 ft	207.0 s
8.0	1688 F	8.0 ft	5.3 s
10.5	1679 F	10.5 ft	180.8 s

These results demonstrate that for Prairie Island, the chopped cosine power shape (i.e. 6.0 ft. peaked shape) generates the most limiting peak clad temperature. Figures 4-6 show the clad temperature response for the peak node for the 6.0, 8.0, and 10.5 ft. power shapes respectively. A comparison of the peak clad temperatures during the blowdown and reflood phases for each of these power shapes provides a conclusive demonstration that the chopped cosine power shape produces the most limiting LOCA results with a wide margin between the chopped cosine shape and the top-skewed power shapes. In addition to showing that the chopped cosine power shape is the "worst" power shape for a LOCA analysis of Prairie Island with Exxon fuel, it also demonstrates a large margin to the 2200 deg-F limit for the top-skewed shapes for this plant.

III. Conclusions

The Westinghouse Large Break LOCA 1981 Evaluation Model was used to analyze Exxon fuel for three power shapes. The results confirmed that the power shape peaked at the center of the core produces the highest peak cladding temperature. This result for the Exxon fuel is consistent with power shape studies performed by Westinghouse with the same computer codes for Westinghouse fuel. The results of this study demonstrate that the Exxon fuel in the Prairie Island nuclear power plant conforms to the current operating K(z) envelope for top-skewed power shapes.

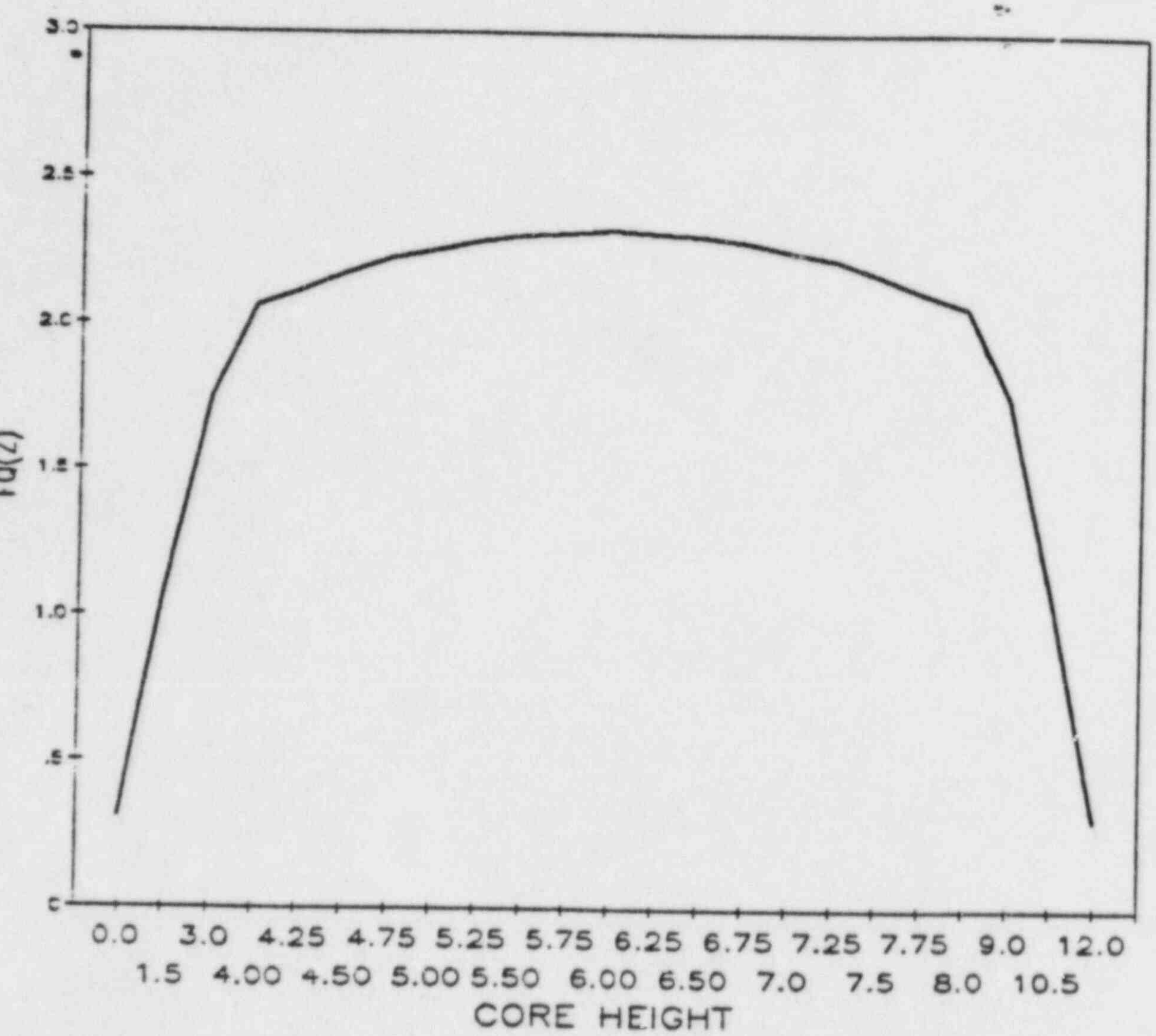

Figure 1. Axial Power Shape Peaked at 6.0 ft.

(Chopped Cosine Power Shape)

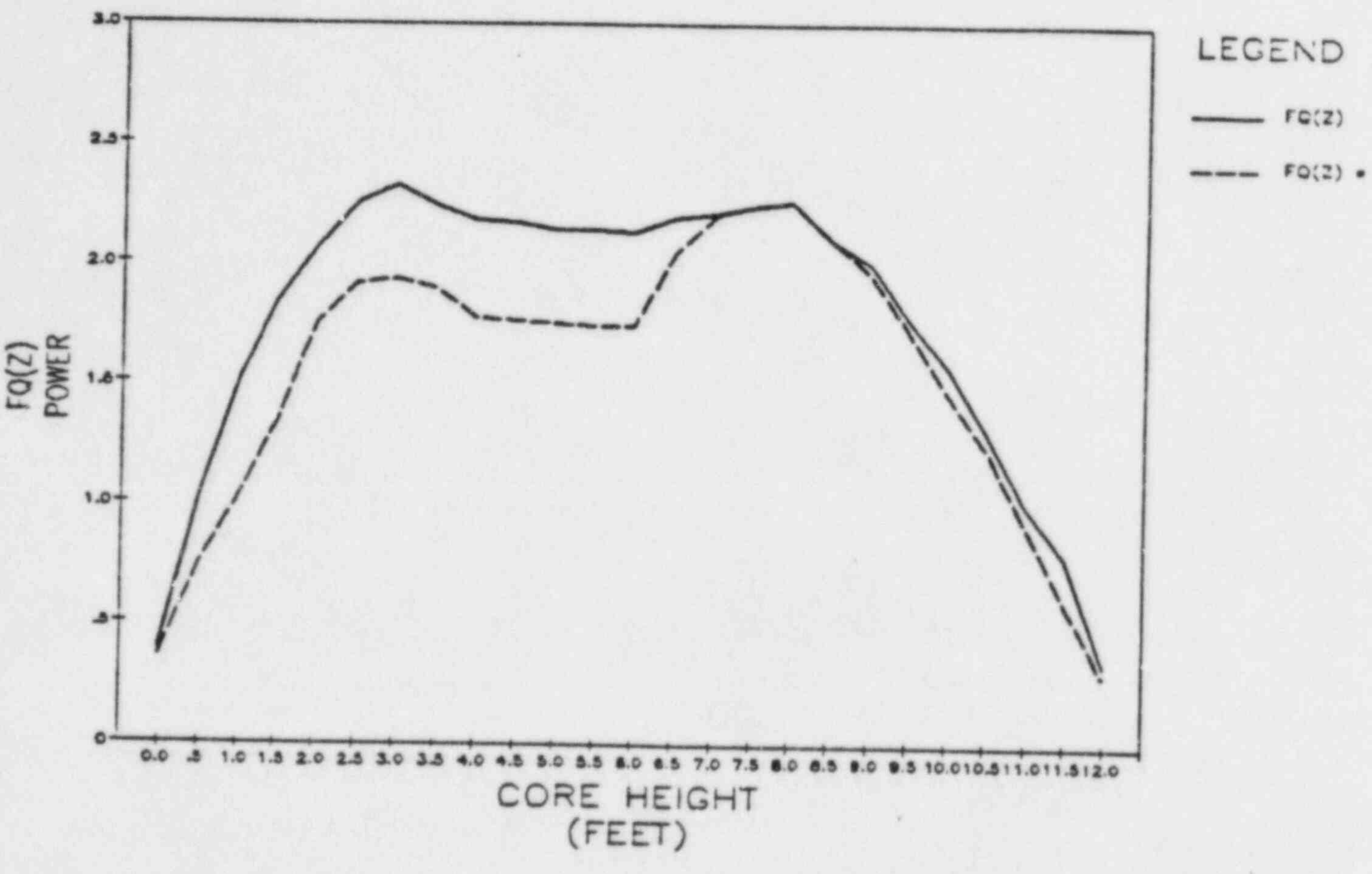

Figure 2. Axial Power Shape Peaked at 8.0 ft.

NOTE: FQ(z) indicates a base (overpower) axial power shape
FQ(z)* indicates axial power shape adjusted to correct power

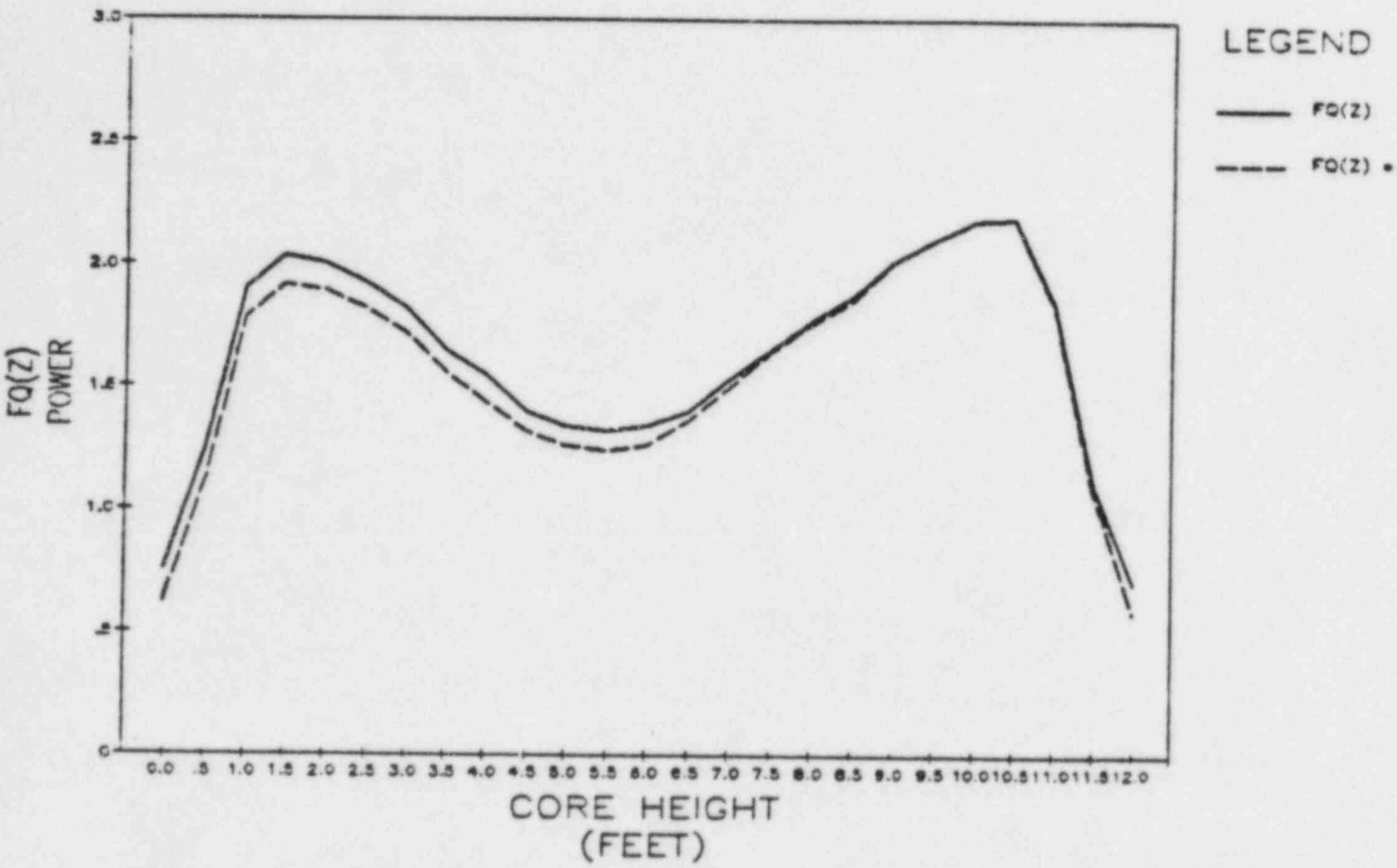

Figure 3. Axial Power Shape Peaked at 10.5 ft.

NOTE: FQ(z) indicates a base (overpower) axial power shape
FQ(z)* indicates axial power shape adjusted to correct power

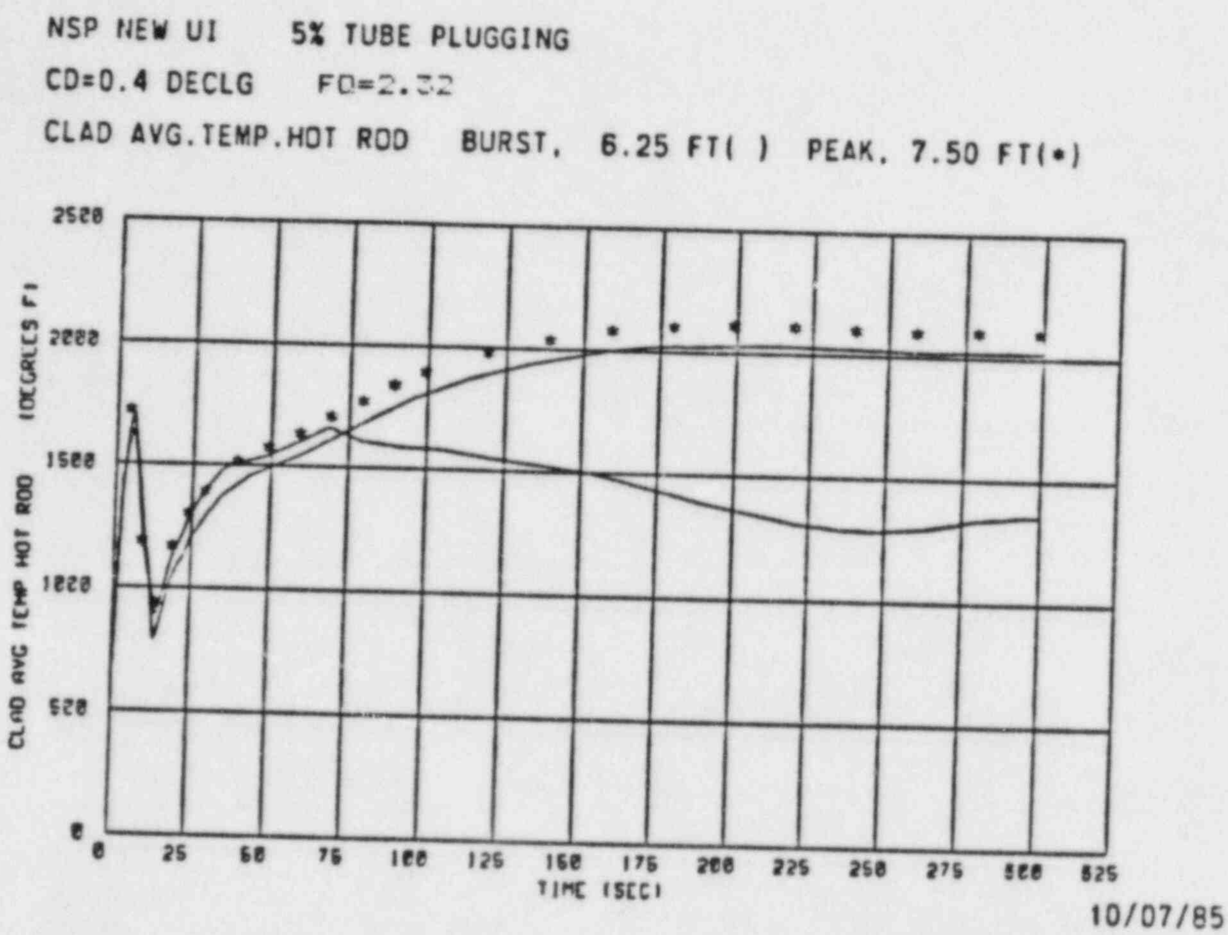

Figure 4. Clad Temperature Response for PCT Location for the 6.0 ft. Power Shape.

NOTE: Asterisks (*) do <u>not</u> represent a separate curve, but provide a tracer to identify the curve representing clad avg. temperature at the peak temperature node. Where the peak and burst nodes coincide, only one curve (with asterisk tracer) will be seen.

NSP NEW UI   5% TUBE PLUGGING

CD=0.4 DECLG   FQ=2.32   14X14 ENC TOPROD

CLAD AVG.TEMP.HOT ROD   BURST, 7.25 FT( ) PEAK, 7.25 FT(*)

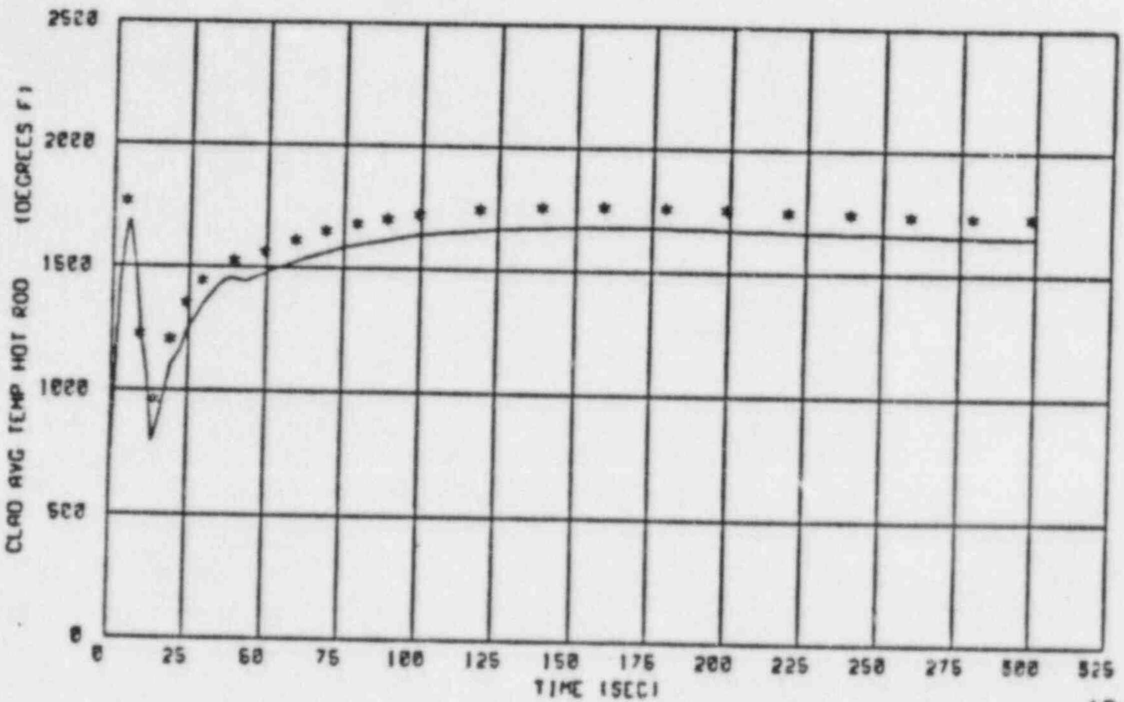

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Figure 5. Clad Temperature Response for PCT Location for 8.0 ft. Power Shape

NOTE: Asterisks (*) do <u>not</u> represent a separate curve, but provide a tracer to identify the curve representing clad avg. temperature at the peak temperature node. Where the peak and burst nodes coincide, only one curve (with asterisk tracer) will be seen.

NSP NEW UI 5% TUBE PLUGGING

CD=0.4 DECLG FQ=2.32

CLAD AVG.TEMP.HOT ROD BURST, 10.50 FT( ) PEAK,10.50 FT(*)

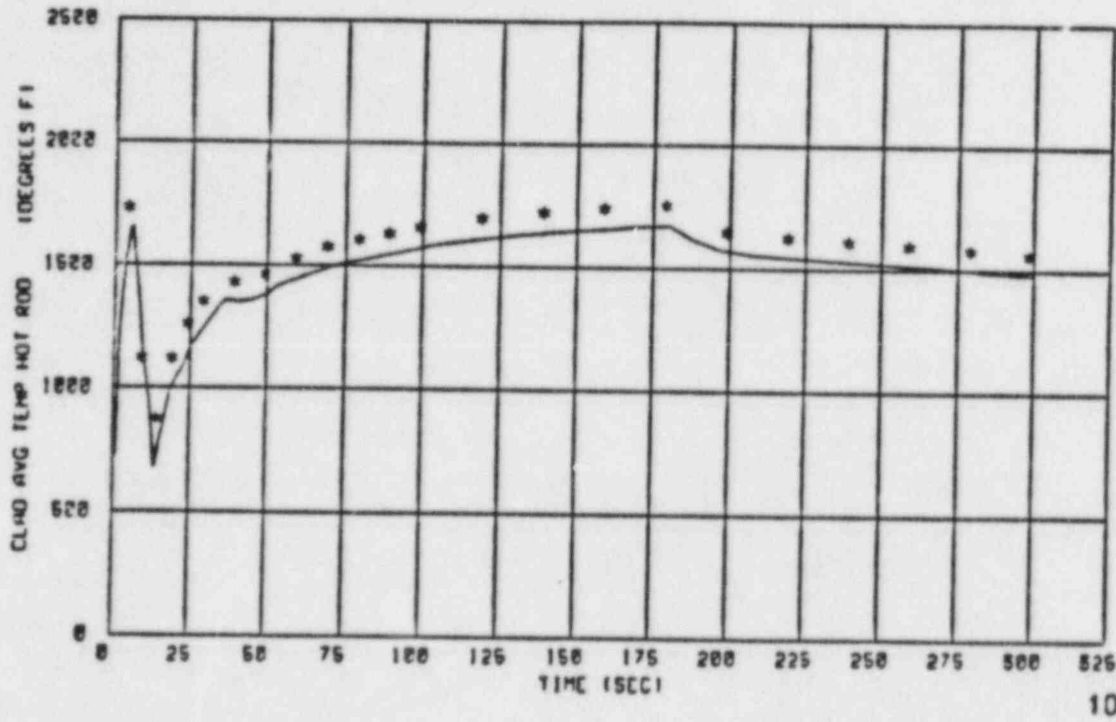

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Figure 6. Clad Temperature Response for PCT Location for the 10.5 ft. Power Shape

NOTE: Asterisks (*) do not represent a separate curve, but provide a tracer to identify the curve representing clad avg. temperature at the peak temperature node. Where the peak and burst nodes coincide, only one curve (with asterisk tracer) will be seen.