TERA

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUL 0 2 1980

Mr. A. E. Scherer 9438-1922
Director of Nuclear Engineering
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Dear Mr. Scherer:

SUBJECT: REVIEW OF COMBUSTION ENGINEERING TOPICAL REPORT CENPD-153-P/ CENPD-153-P (REVISION 1), "EVALUATION OF UNCERTAINTY IN THE NUCLEAR POWER PEAKING MEASURED BY THE SELF-POWERED, FIXED IN-CORE DETECTOR SYSTEM"

We have completed our review of the Combustion Engineering (CE) proprietary topical report CENPD-153-P (Revision 1) entitled "Evaluation of Uncertainty in the Nuclear Power Peaking Measured by the Self-Powered, Fixed In-Core Detector System," and the non-proprietary version CENPD-153 (Revision 1) having the same title. The report describes the method used by CE for the analysis used to establish the overall measurement uncertainty of core power distribution components.

Based on our review, we conclude that this topical report, as revised, is acceptable for reference in license applications. As described in the enclosed staff evaluation, our review included evaluating the statistical methods, the reactor physics methods, and the experimental data used by CE. We find these acceptable to be applied, through the INCA/CECOR system of codes, in evaluating the overall measurement uncertainties. These uncertainties are acceptable to CE reactors employing Rhodium, self-powered, fixed in-core detectors in 4 or 5-detector strings, placed in Mark V fuel, and operated within the control rod insertion limits.

The staff does not intend to repeat its review of CENPD-153-P and CENPD-153-P (Revision 1) when the reports appear as references in specific license applications, except to assure that the reports are applicable to the specific plants involved.

Should the NRC criteria or regulations change such that our conclusions as to the acceptability of the report maybe invalidated, CE and/or the referencing applicants will be expected to revise and resubmit the topical report and the referencing document or submit justification for the continued effective applicability of the topical report without revision.

In accordance with the established procedure, it is requested that CE issue revised versions of CENPD-153-P and CENPD-153 to include any supplementary information provided for our review of the report, this acceptance letter, and the enclosed staff evaluation.

Sincerely,

James R. Miller, Chief
Standardization & Special
Projects Branch
Division of Licensing

Enclosure:
Topical Report Evaluation

EVALUATION OF COMBUSTION ENGINEERING TOPICAL REPORT

Report No.: CENPD-153-P, Rev. 1-P (Proprietary)
CENPD-153, Rev. 1 (Non-proprietary)
Report Title: Evaluation of Uncertainty In the Nuclear Power Peaking Measured By The Self-Powered, Fixed In-Core Detector System
Report Date: May 1980
Originating Organization: Combustion Engineering
Reviewed By: Core Performance Branch

1. Summary of Report

The subject document describes the method used by Combustion Engineering, Inc. (CE) for the analysis used to establish the overall measurement uncertainty of core power distribution components.

The document is organized into three parts. Part I contains a description of the in-core instrument system and the methods used to assess the uncertainty associated with the measurement of assembly average power in instrumented locations. Part II describes the methods used to assess the synthesis dependent uncertainties in expanding assembly average power in instrumented locations to three-dimensional core power distributions. Part III describes the methods used to combine the instrument uncertainty with the synthesis uncertainties to obtain the overall measurement uncertainties. The overall measurement uncertainties at the one-sided 95/95 probability/confidence level are:

Total peaking factor uncertainty	=	6.2%
Planar radial peaking factor uncertainty	=	5.3%
Integrated radial peaking factor uncertainty	=	6.0%

2. Summary of Review

We have reviewed the information presented with regard to the analytical methods, the core physics methods and the statistical methods. We have examined the data base used to establish the comparison between measurement and calculations in determining the basic measurement uncertainty.

The in-core instrument system consists of analog components and analog-digital converters. Digitized signals are fed to either a data-logger or to the plant computer. A complete scan of the in-core detectors can be accomplished in about 20 seconds.

The uncertainty attributed to the measurement of fuel assembly average power is obtained by comparing detailed calculations of the assembly average power with those obtained from in-core measurements with the INCA system. The resulting deviations contain the effect of instrument calibration, depletion, background, and calculational uncertainty in the process of obtaining fuel assembly average power from in-core detector readings. Comparisons were made for 5 reactors with a total of 11 cycles covering 170 time points, with 30 to 40 instrumented fuel assemblies at each time point.

The INCA/CECOR system provides a method of synthesizing detailed three-dimensional assembly and peak-pin power distributions, using signals from the self-powered, fixed in-core detectors. The fuel assembly box powers are obtained from in-core measurements with INCA. The synthesis of three-dimensional power distributions is carried out in CECOR. This is done by using power to signal ratios to obtain the power in instrumented assemblies at each detector level. The power in uninstrumented assemblies is then calculated through the use of coupling coefficients which relate the power in an assembly to the power in its neighbors. The axial power distribution in each assembly is then obtained by using a few mode Fourier expansion. The uncertainties associated with the CECOR synthesis are evaluated by using a computer simulation over three cycles in which signals are taken from three-dimensional calculations. The resulting power distributions are then compared with calculated power distributions to obtain the synthesis uncertainties.

Statistical methods are used to combine the measurement uncertainties and the synthesis uncertainties. A one-sided lower tolerance limit is constructed and the INCA/CECOR overall measurement uncertainties are such that there is a 95% probability that at least 95% of the time Fq, Fxy, and Fr values will be less than the value derived from the INCA/CECOR measurement within accuracies of 6.2%, 5.3%, and 6.0%, respectively.

3. Evaluation Procedure

We have reviewed the report within the guidelines provided by Section 4.3 of the Standard Review Plan. Included in our review was the description of the experimental data base, the calculations performed, and the methods used to determine the components of uncertainty and the combination of these components into overall uncertainties.

4. Regulatory Position

We have reviewed the statistical methods, the reactor physics methods, and the experimental data used by CE. We find these acceptable to be applied, through the INCA/CECOR system of codes, in evaluating the overall measurement uncertainties. The overall measurement uncertainties at the one-sided 95/95 probability/confidence level are:

Total Peaking Factor Uncertainty	= 6.2%
Planar Radial Peaking Factor Uncertainty	= 5.3%
Integrated Radial Peaking Factor Uncertainty	= 6.0%

These uncertainties are applicable to CE reactors employing Rhodium, self-powered, fixed in-core detectors in 4 or 5-detector strings, placed in Mark V fuel, and operated within the control rod insertion limits.