American National Standard

a guide for acquisition and documentation of reference power reactor physics measurements for nuclear analysis verification

REAFFIRMED
May 3, 2000
ANSI/ANS-19.4-1976 (R2000)

WITHDRAWN
May 3, 2010
ANSI/ANS-19.4-1976;R2000

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ANS-19.4
ANSI N652-1976

published by the
American Nuclear Society
244 East Ogden Avenue
Hinsdale, Illinois 60521, USA

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Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-19.4

Published by the
American Nuclear Society
244 East Ogden Avenue
Hinsdale, Illinois 60521

Approved June 10, 1976
by the
American National Standards Institute, Inc.

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Published by

American Nuclear Society
244 East Ogden Avenue, Hinsdale, Illinois 60521

Printed in the United States of America

Foreword

(This Foreword is not part of American National Standard A Guide for Acquisition and Documentation of Reference Power Reactor Physics Measurements for Nuclear Analysis Verification N652-1976/ANS-19.4)

It is the purpose of this Standard to specify criteria for performing and documenting measurements on light water power reactors which are to be used as reference measurements in the validation of reactor physics computational methods. Considerably more confidence is placed in nuclear analysis methods when they have been successfully used to calculate performance characteristics that have been carefully measured in an actual operating system. The existence of well-documented measurements made in a number of operating power reactors will fill a need on the part of the nuclear designer and reactor operator, and will permit the development of increased confidence in the design and performance analysis methods used to predict reactor performance. This Standard is not a guide for routine measurement of reactor physics parameters in an operating reactor. The objective of routine measurements carried out on an operating reactor is to satisfy specific operational, licensing, and contractual requirements. In many cases, however, measurements made on a routine basis are of sufficient quality to merit their use as reference measurements, and reporting these measurements in accordance with this guide is encouraged.

In addition, if time, personnel and instrumentation are available during the course of operation to perform additional measurements not normally required, reactor designers and operators are encouraged to specify, perform, document and report such measurements for use as reference power reactor physics measurements.

This Standard was developed primarily for application to measurements on reactors whose pertinent descriptions are available, or can be made available, to the technical community. This does not preclude its use on reactors for which some reactor information required to stimulate the measurement is proprietary. Since performance of reference measurements is not required on any system, application of this Standard is not related to the question of what reactor design information should, or should not, be publicly disseminated.

This Standard is an initial attempt to produce criteria for reference reactor physics measurements. As such it specifically considers only those types of reactor physics measurements that experience has shown to be practical and reproducible when carried out in large power reactors. The intended current application of the standard is confined to light water moderated and cooled power reactors. Inclusion of similar guidelines for measurements in High Temperature Gas Reactors (HTGRs) and Liquid Metal Fast Breeder Reactors (LMFBR's) is intended at a future date. In view of the lack of experience in applying such a standard to power reactor physics measurements, review and revision within a two-year period is recommended.

This Standard is intended primarily for measurements which can be performed at the reactor site; destructive analysis of the spent or partially spent fuel to determine isotopic composition, for example, is not covered. In the event such destructive analysis is carried out, however, its usefulness is increased if it is preceded by a series of reference quality measurements carried out in accordance with this Standard.

This Standard was developed by Working Group ANS 19.4 of the American Nuclear Society which had the following members at the time it prepared and approved this Standard:

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A Guide for Acquisition and Documentation of Reference Power Reactor Physics Measurements for Nuclear Analysis Verification

1. Introduction

Verification of the calculational system used to predict the nuclear performance characteristics of a power reactor is an essential prerequisite to establishing the reliability of that calculational system. The components of such a system, including the nuclear data sets, neutron spectra calculations, spatial homogenization procedures, and neutron transport models all involve approximations and uncertainties. Because of the inherent physical and geometric complexities of an operating reactor, the effects of these approximations and uncertainties on the accuracy of the results obtained with the calculational system are extremely difficult to evaluate. Experience has shown that a very useful technique for assessing the reliability of a calculational system in evaluating the performance characteristics of a reactor is to use it to calculate the same or similar characteristics in one or a number of similar reactors for which measurements are available. It is the intent of this Standard to establish criteria for the acquisition and documentation of measurements made for this purpose. For the most part, power reactor measurements are of an integral nature and as such could be most valuable in testing an overall result. There is also value in having measurements of the same type on several reactors in order to minimize systematic errors which might be attributable to a particular reactor.

It is recognized that the measurements program carried out in any single reactor will probably not produce reference quality data on all or even the majority of the specific measurements described in Section 6. Documentation of even a small part of an overall measurements program can, however, be a valuable contribution to the literature. A list of desirable power reactor measurements is given in Appendix A.

2. Scope

This Standard applies to measurements of reactor parameters in light water power reactors that are intended to serve as reference measurements to be used in evaluating reactor physics computational procedures. It includes: identification of the types of parameters of interest as reference measurements; a brief description of test conditions and experimental data required for such reference measurements; identification of problems and concerns which may affect the accuracy or interpretation of the data; and criteria to be used in documenting the results of reference measurements.

3. Definitions

differential measurement. A measurement which involves small changes in two operating parameters. In most differential measurements, one of these parameters is core reactivity.

fuel assembly. A grouping of fuel rods or pins which are mechanically or metallurgically joined together in a fixed geometrical arrangement. An assembly is not taken apart during its charging into or discharging from a reactor core. The reactor core is made up of an array of fuel assembly types.

fuel assembly type. All fuel assemblies which have the same external dimensions, design values for initial mass, compositions and spatial distribution of fuel, burnable poison, structural material and other materials which make up the fuel assembly.

reactor operating history. The reactor operating information accumulated or observed over the life of the reactor which defines the state of the reactor from the nuclear performance standpoint. This information includes the reactor operating parameters (thermal power level, system pressure, coolant temperatures, coolant flow rate, coolant soluble poison concentration, control rod postions), plus fueling and refueling patterns in successive cycles, and any other information required to establish the excess reactivity, power