American Nuclear Society

WITHDRAWN
January 13, 2011
ANSI/ANS-19.6.1-2005 (W2011)

reload startup physics tests for pressurized water reactors

an American National Standard

No longer being maintained as an American National Standard. This standard may contain outdated material or may have been superseded by another standard. Please contact the ANS Standards Administrator for details.

published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

ANSI/ANS-19.6.1-2005

ANSI/ANS-19.6.1-2005

American National Standard
Reload Startup Physics Tests for Pressurized Water Reactors

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-19.6.1

Published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

Approved November 29, 2005
by the
American National Standards Institute, Inc.

American National Standard

Designation of this document as an American National Standard attests that the principles of openness and due process have been followed in the approval procedure and that a consensus of those directly and materially affected by the standard has been achieved.

This standard was developed under procedures of the Standards Committee of the American Nuclear Society; these procedures are accredited by the American National Standards Institute, Inc., as meeting the criteria for American National Standards. The consensus committee that approved the standard was balanced to ensure that competent, concerned, and varied interests have had an opportunity to participate.

An American National Standard is intended to aid industry, consumers, governmental agencies, and general interest groups. Its use is entirely voluntary. The existence of an American National Standard, in and of itself, does not preclude anyone from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard.

By publication of this standard, the American Nuclear Society does not insure anyone utilizing the standard against liability allegedly arising from or after its use. The content of this standard reflects acceptable practice at the time of its approval and publication. Changes, if any, occurring through developments in the state of the art, may be considered at the time that the standard is subjected to periodic review. It may be reaffirmed, revised, or withdrawn at any time in accordance with established procedures. Users of this standard are cautioned to determine the validity of copies in their possession and to establish that they are of the latest issue.

The American Nuclear Society accepts no responsibility for interpretations of this standard made by any individual or by any ad hoc group of individuals. Requests for interpretation should be sent to the Standards Department at Society Headquarters. Action will be taken to provide appropriate response in accordance with established procedures that ensure consensus on the interpretation.

Comments on this standard are encouraged and should be sent to Society Headquarters.

Published by

American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

Printed in the United States of America

Foreword

(This Foreword is not a part of American National Standard "Reload Startup Physics Tests for Pressurized Water Reactors," ANSI/ANS-19.6.1-2005.)

It is the intent of this American National Standard to provide guidance for verifying the nuclear characteristics of a commercial pressurized water reactor core. This standard is intended to cover the physics tests that are performed following a refueling or other alteration of the reactor core for which nuclear design calculations are required. This standard provides the minimum acceptable startup physics test program; however, the standard recognizes that additional tests may be required by special design features for a particular core.

Compliance with the intent of this standard can be demonstrated by meeting the following requirements:

(1) Perform the physics tests described herein using one or more of the acceptable test methods;

(2) Determine if the test results agree with the predicted results within the previously established test criteria;

(3) Document the above in accordance with the requirements of Section 7 of this standard.

Suggestions for the improvement of this standard are welcome. They should be sent to the American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60526.

Following is a summary of changes that were made to the 1997 version:

(1) The differential boron worth test was removed from the minimum test program;

(2) The dynamic rod worth measurement method was added to the acceptable list of test methods;

(3) The rod symmetry measurement method was removed from the list of acceptable test methods;

(4) Several clarifications and editing changes were made.

This standard was developed by Working Group ANS-19.6.1 of the American Nuclear Society, which had the active participation of the following members in preparing the current version:

C. T. Rombough, Chairman, *CTR Technical Services, Inc.*

P. D. Adam, *Wolf Creek Nuclear Operating Corporation*
S. C. Ballard, *Duke Power Company*
R. J. Cacciapouti, *Framatome ANP*
L. R. Grobmyer, *Westinghouse Electric Corporation, LLC*
R. G. McAndrew, *Dominion Energy*
S. T. Robertson, *Framatome ANP*
P. C. Rohr, *Westinghouse Electric Corporation, LLC*
U. S. Shoop, *U.S. Nuclear Regulatory Commission*
F. J. Verbos, Jr., *Duke Power Company*
E. H. Young, *Exelon Nuclear*

The membership of Subcommittee ANS-19 at the time of its review and approval of this standard was as follows:

D. M. Cokinos, Chairman, *Brookhaven National Laboratory*
C. T. Rombough, Secretary, *CTR Technical Services, Inc.*

S. Baker, *Transware Enterprises, Inc.*
M. C. Brady Raap, *Pacific Northwest National Laboratory*

R. J. Cacciapouti, *Framatome ANP*
Y. A. Chao, *Westinghouse*
W. S. Charlton, *Texas A&M University*
R.-T. Chiang, *GE Nuclear Energy*
D. J. Diamond, *Brookhaven National Laboratory*
J. Katakura, *Japan Atomic Energy Research Institute*
R. Little, *Los Alamos National Laboratory*
L. Lois, *U.S. Nuclear Regulatory Commission*
R. D. McKnight, *Argonne National Laboratory*
R. D. Mosteller, *Los Alamos National Laboratory*
R. T. Perry, *Los Alamos National Laboratory*
B. Rouben, *Atomic Energy of Canada Limited*
A. Weitzberg, *Individual*

Consensus Committee N17, Research Reactors, Reactor Physics, Radiation Shielding, and Computational Methods, had the following membership at the time it reviewed and approved this standard:

T. M. Raby (Chair), *National Institute of Standards and Technology*
A. Weitzberg (Vice Chair) *Individual*

W. H. Bell, *American Institute of Chemical Engineers*
(Alt. R. D. Zimmerman, *American Institute of Chemical Engineers*)
R. E. Carter, *Individual*
D. Cokinos, *Brookhaven National Laboratory*
B. Dodd, *Health Physics Society*
W. A. Holt, *American Public Health Association*
W. C. Hopkins, *Individual*
L. I. Kopp, *Individual*
P. M. Madden, *U.S. Nuclear Regulatory Commission*
(Alt. A. Adams, *U.S. Nuclear Regulatory Commission*)
J. F. Miller, *Institute of Electrical and Electronics Engineers*
J. E. Olhoeft, *Individual*
W. J. Richards, *National Institute of Standards and Technology*
R. Seale, *University of Arizona*
T. R. Schmidt, *Sandia National Laboratories*
A. O. Smetana, *Savannah River National Laboratory*
E. G. Tourigny, *U.S. Department of Energy*
S. H. Weiss, *National Institute of Standards and Technology*
(Alt. T. J. Myers, *National Institute of Standards and Technology)*
W. L. Whittemore, *General Atomics*

Contents

Reload Startup Physics Tests for Pressurized Water Reactors

1 Introduction

In conjunction with each refueling shutdown or other significant reactor core alteration, nuclear design calculations are performed to ensure that the reactor physics characteristics of the new core will be consistent with the safety limits. Prior to return to normal operation, successful execution of a physics test program is required to determine if the operating characteristics of the core are consistent with the design predictions and to ensure that the core can be operated as designed.

This standard specifies the content of the minimum acceptable startup physics test program for commercial pressurized water reactors (PWRs) and describes acceptable methods for performing the individual tests.[1)]

Successful completion of the physics test program is demonstrated when the test results agree with the predicted results within predetermined test criteria. Successful completion of the physics test program and successful completion of other tests that are performed after each refueling or significant reactor core alteration provide assurance that the plant can be operated as designed.

2 Scope

This standard applies to the reactor physics tests that are performed following a refueling or other core alteration of a PWR for which nuclear design calculations are required. This standard does not address the physics test program for the initial core of a commercial PWR.

This standard specifies the minimum acceptable startup reactor physics test program and acceptable test methods to determine if the operating characteristics of the core are consistent with the design predictions, which provides assurance that the core can be operated as designed. This standard does not address surveillance of reactor physics parameters during operation or other required tests such as mechanical tests of system components (for example, the rod drop time test), visual verification requirements for fuel assembly loading, or the calibration of instrumentation or control systems (even though these tests are an integral part of an overall program to ensure that the core behaves as designed).

This standard assumes that the same previously accepted analytical methods are used for both the design of the reactor core and the startup test predictions. It also assumes that the expected operation of the core will fall within the historical database established for the plant and/or sister plants.

When major changes are made in the core design, the test program should be reviewed to determine if more extensive testing is needed. Typical changes that might fall in this category include the initial use of novel fuel cycle designs, significant changes in fuel enrichments, fuel assembly design changes, burnable absorber design changes, and cores resulting from unplanned short cycles. Changes such as these may lead to operation in regions outside of the plant's experience database and therefore may necessitate expanding the test program.

3 Definitions

3.1 Limitations

The following definitions are of a restricted nature for the purpose of this standard. Other specialized terms are defined in *Glossary of Terms in Nuclear Science and Technology* [1][2)] or in the definition sections of standards specified in this standard.

[1)] The Appendix to this standard is the User's Guide, which provides a set of guidelines, precautions, suggestions, and typical test criteria for each required test.

[2)] Numbers in brackets refer to corresponding numbers in Section 8, "References."