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REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 2.3

QUALITY VERIFICATION FOR PLATE-TYPE URANIUM-ALUMINUM FUEL ELEMENTS FOR USE IN RESEARCH REACTORS

A. INTRODUCTION

Paragraph (a)(7) of Section 50.34, "Contents of Applications; Technical Information," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each applicant for a construction permit to build a production or utilization facility include in its preliminary safety analysis report a description of the quality assurance program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility. This guide describes a method acceptable to the NRC staff for establishing and executing a quality assurance program for verifying the quality of plate-type uranium-aluminum fuel elements used in research reactors.

B. DISCUSSION

Work Group ANS-15.2 of Subcommittee ANS-15, Research Reactors, of the American Nuclear Society Standards Committee has revised the American National Standards Institute (ANSI) Standard N8.[illegible]1967, "Quality Control for Plate-Type Uranium-Aluminum Fuel Elements." The revised standard provides guidelines for the establishment and execution of a program designed to verify the quality of plate-type uranium-aluminum fuel elements for use in research reactors. The revised standard was approved by the American National Standards Committee N17, Research Reactors, Reactor Physics and Radiation Shielding, and its Secretariat. It was subsequently approved and designated ANSI N398-1974 by ANSI on November 19, 1974.

It should be recognized that ANSI N398-1974 covers only one limited aspect of quality assurance. ANSI N402, "Quality Assurance Program Guidelines for Research Reactors," which is currently being developed under Subcommittee ANS-15, is expected to provide overall guidance for establishing quality assurance programs for research reactors.

C. REGULATORY POSITION

The guidance contained in ANSI N398-1974, "Quality Verification for Plate-Type Uranium-Aluminum Fuel Elements,"[1] is generally acceptable to the NRC staff and provides an adequate basis for complying with §50.34(a)(7) of 10 CFR Part 50 with respect to establishing and executing a quality assurance program for verifying the quality of plate-type uranium-aluminum fuel elements for use in research reactors, subject to the following:

Instead of the definition given in Section 1.4.9 of the standard, a research reactor should be defined as a nuclear reactor that is used for scientific, engineering, or training purposes and is designed to operate at a thermal power level of 1 megawatt or less or a level of 10 megawatts or less if it does not contain a circulating loop through the core in which fuel experiments are conducted, a liquid fuel loading, or an experimental facility in the core in excess of 16 square inches in cross section.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for utilizing this regulatory guide.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method described herein will be used by the NRC staff in the evaluation of submittals for construction permit or operating license applications for research reactors docketed after May 15, 1976.

[1] Copies may be obtained from the American Nuclear Society, 244 East Ogden Avenue, Hinsdale, Illinois 60521.

referred to the input for 4 μsec peaking times (the noise level varies inversely with the peaking time). The main amplifier should be a standard NIM[13] module.

At counting rates greater than ~10^4 cps, problems such as degradation of the energy resolution resulting in a loss of counts in the spectrum peaks begin to occur. These effects are due to the overlap of portions of two or more pulses in time and to baseline fluctuations. The magnitude of these effects can be minimized by the inclusion of the following features in the amplifier's design: (1) a baseline restorer (BLR) circuit at the amplifier output and (2) pole-zero cancelled coupling networks. The BLR circuit should be adjustable for both low and high counting rate conditions.[14]

5. Analog to Digital Converter (ADC)

(Systems I, II, III) The ADC should be capable of digitizing pulse amplitudes from the amplifier in the range of 0 to 10 volts in at least 4096 channels. The frequency of the internal clock should be at least 50 megahertz to handle high counting rates with nominal ADC dead time losses. The integral nonlinearity should be less than 0.15% over the top 95% of full scale and the differential nonlinearity should be less than 1.0% over the top 95% of full scale for semi-Gaussian pulses with peaking times of 1 to μsec. These linearity specifications are not stringent, but are adequate to enable identification of unknown peaks which may appear in a spectrum.

The short-term zero channel and gain drifts should be ⩽ .01%/°C and ⩽ .02%/°C, respectively (the percentage refers to full scale), in the temperature range from 0° to 50°C. For long term stability, the peak from a stable pulser should not shift by more than one channel over a 24-hour period for a line voltage of 115V ± 10%, 50-65 Hz, and at constant room temperature. (Note: The ADC drift and linearity specifications are closely related to the overall system stability and linearity operating specifications described in Section C.5.)

The ADC should be capable of being DC coupled to the main amplifier in order that BLR circuits can be used. A digital offset capability in the ADC is recommended. (Note: In some systems the ADC is an integral part of a multichannel analyzer, a unit which also performs the functions of data storage, display, and sometimes rudimentary analysis. These latter functions are taken up in Part 2 of this series. In multichannel analyzer systems, however, the ADC function is usually specified separately and can be compared with the above recommendations.)

(System I) For certain applications where energy resolution is definitely not critical, all the ADC specifications above are applicable with the exception that a 1024 channel capacity with a 1024 digital offset may be adequate to provide a sufficiently small energy interval per channel (keV/channel) to cover a limited energy range of interest. It should be emphasized, however, that this choice may restrict the effective use of the system for other applications.

6. Power Supplies

(Systems I, II, III) The system power supplies (detector high voltage, preamplifier, and NIM bin) should be capable of operating the system within the operating specifications listed in Section C.1 when supplied with 115 volts (± 10%) at 50 to 65 hertz (at constant room temperature). The detector bias power supply should have an adjustable output that is short circuit protected with automatic power restoration after removal of the short. The maximum output voltage is determined by detector requirements; 5 kilovolts is sufficient for most applications.

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[13] NIM-Nuclear Instrument Module, see USAEC Technical Information Document, Standard Nuclear Instrument Modules, Revision 3, TID-20893 (1969).

[14] For more details on BLR circuits see V. Radeka, "Effect of 'Baseline Restoration' on Signal-to-Noise Ratio in Pulse Amplitude Measurements," Rev. Sci. Instr. *38*, 1397 (1967).