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Nuclear energy — Light water reactors — Decay heat power in non-recycled nuclear fuels

Énergie nucléaire — Réacteurs à eau légère — Puissance résiduelle des combustibles nucléaires non recyclés

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national Standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 6, *Reactor technology*.

This second edition cancels and replaces the first edition (ISO 10645:1992), which has been technically revised.

The main changes compared to the previous edition are as follows:

— The decay heat curves for ^{235}U, ^{238}U, ^{239}Pu, and ^{241}Pu are revised using data adopted from the American National Standard ANS-5.1-2014[1].

— These curves are based on fits to experimental spectroscopic and calorimetric measurements of fission product decay heat at short cooling times less than ~10^5 seconds, and on measurements and simulations for longer times[2].

— Nuclear data constants are updated to reflect modern evaluated values.

— The range of initial ^{235}U enrichment is extended beyond 4,1 % (mass fraction) to 5 %.

— Burnup range is extended to 62 GWd/t, an increase from 52 GWd/t in the previous 1992 edition.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The decay heat power of nuclear fuels is the thermal power produced by radioactive decay of fission and activation products of the nuclear fuel. Decay heat is one of the contributors to the total heat emitted from the nuclear fuel during the reactor operation, representing about <7 % of the total heat. As decay heat continues to be released after shutdown of a nuclear reactor, it is an important physical quantity for the design of systems in which the decay heat power should be taken into consideration as a heat source.

This document provides an alternative to dedicated and validated calculation codes, as it provides values for the local generation of decay heat power as a function of the thermal fuel power during operation. The values for the fission product component of decay heat are based on fits to measured data for short cooling times less than ~10^5 s[2], and on measurements and computational simulations for longer times. Values for other components of decay heat are developed to provide conservative estimates. Therefore, at longer cooling times where fission products represent an increasingly smaller relative contribution to total decay heat, this document becomes increasing conservative, and alternative methods such as dedicated computer codes may provide more accurate estimates. The spatial distribution of the energy conversion into heat, e.g. γ-radiation, is not considered. If required, evaluation of this is left to the user.

The calculation procedure used has the advantage of enabling the estimation of the decay heat power without the need for a validated dedicated calculation code. Nevertheless, the calculation requires the fission fractions of each fissile isotope. These values are not given in this document but can be obtained from literature[3][4] or computer codes.

The power generated by residual fission induced by delayed neutrons after shutdown and activated structural materials is not considered in this document. Delayed neutrons are generally negligible several minutes after core shutdown, and the activated structural materials generally have a minor effect on the global decay heat. Analyses of delayed neutron heating is configuration specific and may require more detailed models. Similarly, analysis of structural activation heating requires separate evaluations.