



Standard Guide for Use of Melt Wire Temperature Monitors for Reactor Vessel Surveillance, E 706 (IIIE)¹

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1. Scope

1.1 This guide describes the application of melt wire temperature monitors and their use for reactor vessel surveillance of light-water power reactors as called for in Practice E 185.

1.2 The purpose of this guide is to recommend the selection and use of the common melt wire technique where the correspondence between melting temperature and composition of different alloys is used as a passive temperature monitor. Guidelines are provided for the selection and calibration of monitor materials; design, fabrication, and assembly of monitor and container; post-irradiation examinations; interpretation of the results; and estimation of uncertainties.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. (See Note 1.)*

2. Referenced Documents

2.1 ASTM Standards:

E 185 Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels, (IF)^{2,3}

E 706 Master Matrix for Light-Water Reactor Pressure Vessel Surveillance Standards³

E 794 Test Method for Melting and Crystallization Temperature by Thermal Analysis⁴

E 844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance, (IIC)^{2,3}

3. Significance and Use

3.1 Temperature monitors are used in surveillance capsules, in accordance with Practice E 185, to verify the estimated values of irradiation temperature of the surveillance specimens. Temperature monitors are needed to give evidence of overheating of surveillance specimens beyond the expected temperature. Since overheating causes a reduction in the amount of

radiation damage to the surveillance specimens, this overheating could result in a change in the measured properties of the surveillance specimens that would lead to an unconservative prediction of damage to the reactor vessel material.

3.2 The magnitude of the reduction of radiation damage with overheating depends on the composition of the material and time at temperature; there is not yet an accepted method for quantifying the effect. Because the evidence from melt wire monitors gives no indication of the duration of overheating above the expected temperature as indicated by melting of the monitor, the significance of overheating events cannot be quantified on the basis of thermal monitors alone. Indication of an overtemperature does serve to alert the user of the data to further evaluate the irradiation temperature exposure history of the surveillance capsule.

3.3 This guide is IIIE of Master Matrix E 706 that relates several standards used for irradiation surveillance of light water reactor vessel materials. It is intended primarily to amplify the requirements of Practice E 185. It may also be used in conjunction with Guide E 844.

4. Selection and Calibration of Monitor Materials

4.1 Selection of Monitor Materials:

4.1.1 Materials selected for thermal monitors shall possess unique melting temperatures. Since composition, and particularly the presence of impurities, strongly influence melting temperature, the fabricated monitor materials shall consist of either metals of purity 99.9 % or greater or eutectic alloys such that the measured melting temperature is within $\pm 3^\circ\text{C}$ of the recognized melting temperature. Transmutation-induced changes of the monitor materials suggested in 4.1.2 are not considered significant for fluences to 1×10^{20} n/cm² ($E > 1$ MeV) relative to the goal of these thermal monitors in flagging deviations from expected temperatures.

4.1.2 The monitor materials in Table 1 provide temperature indications in the range of 266 to 327°C. Other metals or alloys may be selected for the temperatures of interest provided the monitor materials meet the technical requirements of this guide.

4.1.3 The chosen monitor materials shall be carefully evaluated for radiological health hazards.

NOTE 1—It is beyond the scope of this guide to provide safety and health criteria, and the user is cautioned to seek further guidance.

¹ This guide is under the jurisdiction of ASTM Committee E-10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.02 on Behavior and Use of Metallic Materials in Nuclear Systems.

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² The reference Master Matrix designation in parentheses refers to Section 5, as well as Figs. 1 and 2 of Matrix E 706.

³ *Annual Book of ASTM Standards*, Vol 12.02.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.