measurex

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Mr. Robert D. Funderburg
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Reference: Docket Number 90988-1856

Subject: ANSI CLASSIFICATIONS FOR MEASUREX SENSORS

Dear Mr. Funderburg:

In response to your letter dated 12 March, Measurex has evaluated its sensors against the ANSI N538-1979 standards. The results of these evaluations are given below.

USE CONDITIONS: HIGH TEMPERATURE

Rating: 4

All safety features of Measurex thickness gauges are fully functional at temperatures exceeding 185 degrees F.

This classification and the low temperature classification are based on actual performance at customer sites. The observed effects of temperature on the function of the various interlocks and other safety features present on Measurex sensors is consistent with their design.

USE CONDITION: LOW TEMPERATURE

Rating: 3

USE CONDITION: STRAY RADIATION AT 5 CM

Shutter Open Rating: 2 Shutter Closed Rating: 5

This rating and those for stray radiation at 30 and 100 cm are based on worst-case measurements made using the instruments and methods described in License No. 1663-43. All dose rates measured using an ion chamber with a window thickness of 300 mg/sq-cm or less are within the specified limits of the indicated rating. Dose rates measured with an ion chamber window thickness of 7 mg/sq-cm do not exceed six times the applicable value in the ANSI classification table for each category (per ANSI N538-1979 Section 7.3.3.1).

USE CONDITION: STRAY RADIATION AT 30 CM

Shutter Open Rating: 5 Shutter Closed Rating: 6

USE CONDITION: STRAY RADIATION AT 100 CM

Shutter Open Rating: 5 Shutter Closed Rating: 5

ACCIDENT CONDITION: FIRE

Rating: 2

Measurex classifies its sensors at the at the Class 2 level for shielding/source leakage under fire accident conditions based on a combination of measurements and calculations (per ANSI N538-1979 Section 6.1). These measurements and calculations are described below.

Measurements: A Measurex source holder assembly containing a "dummy" radioactive source capsule was placed in an oven at 500 degrees F. (The "dummy" capsule is an empty and windowless capsule made of the same materials and to the same dimensions as the Kr-85 capsules used by Measurex. It is very similar to the Sr-90 and other solid source capsules used by Measurex.) The oven air temperature and the temperature inside the source capsule were monitored using calibrated thermocouples. These temperatures were recorded at 1 minute intervals for a period of about 50 minutes.

The data obtained from these measurements are shown on the attached graph. The measured capsule temperatures are indicated by the black plus (+) symbols. The initial capsule temperature was room temperature, in this case 77 degrees F.

Calculations: The heating curve for a thermal mass can be represented by the following equation:

1. $$T(t) = T(t=0) + \{1 - \exp[- t/c]\} * \{T(max) - T(t=0)\}$$

where: T(t) is the temperature at the point of interest within the thermal mass as a function of time (t)

c is the thermal time constant for the thermal mass (time required for the temperature at the point of interest within the thermal mass to increase by about 63% of the total temperature difference)

T(max) is the temperature that would be reached at the point of interest in the thermal mass in equilibrium with its surroundings (oven temperature)

If a curve of the form given by Equation 1 is fit to the data from the capsule temperature measurements made at 500 degrees F, a thermal time constant of about 23 minutes is obtained for the Measurex source holder assembly. The curve from this model is shown on the attached graph. The curve fit thermal time constant was confirmed to be reasonable by using it in Equation 1 and comparing the resulting curve to a second set of capsule temperature measurements made in using an oven temperature of about 350 degrees F.

Using a time constant of 23 minutes and Equation 1, the heating curve for the capsule within a source holder assembly in a 1000 degrees F environment can be modeled. The results are shown in the upper curve on the attached graph.

Application and conclusions: To satisfy the criteria for a classification of 2 in the fire accident condition category, a sensor must be able to withstand 5 minutes at 1000 degrees F without:

- loss of source from the source housing
- leakage or dispersal of radioactive material

Escape of the sealed source capsule from the shielded source holder assembly after 5 minutes of exposure to 500 degrees F is not possible. All components critical to containing the capsule are made of a tungsten alloy which does not begin to soften until it reaches temperatures of about 1800 degrees F.

The tests and calculations described above indicate that after 5 minutes at 1000 degrees F the capsule temperature would reach about 250 degrees F. All source capsules used by Measurex for distribution in generally licensed thickness gauges are ANSI-classified as being capable of withstanding a minimum of one hour at 356 degrees F without leakage of radioactive material. Thus the thermal insulation provided by the source holder assembly alone is sufficient to insure that the capsule integrity will be maintained.

It should be noted that the conclusion that the sensor satisfies the requirements for the 2 rating is conservative since it does not take into account:

- between 500 degrees and 1000 degrees F the thermal conductivity of tungsten decreases (by about 14%) so that the temperature reached inside the source capsule after 5 minutes in a 1000 degrees F environment would be lower than the 250 degrees F shown by the model curve.
- the substantial thermal insulation and heat sink that would be provided by the sensor head in which the source holder assembly is mounted.

I am very much looking forward to completing this license renewal. I'm sure you share that feeling.

Sincerely,
MEASUREX CORPORATION

Elsa Nimmo

Elsa Nimmo
Radiation Safety Officer

Attachment: Capsule Temperature Rise in Fire Accident

CC: Jerry Raffel
Steve Van Elswyk
Radiation Safety Committee

Capsule Temperature Rise in Fire Accident