



# National Institute of Standards & Technology

## Certificate

### Standard Reference Material 1969

Rubidium

Triple-Point Standard

Cell No. \_\_\_\_\_

39. \_\_\_\_\_  $\pm 0.010$  °C

International Temperature Scale of 1990

This Standard Reference Material (SRM) is to be used to calibrate thermometers near 39.30 °C. SRM 1969 consists of approximately 154 grams of 99.9+ % pure rubidium in an all-welded AISI 304 stainless-steel cell. The calibration temperature given above is the midpoint temperature of the plateau of the melting curve for this cell as determined by at least two of a set of six stable thermistor thermometers that are regularly calibrated against a Standard Platinum Resistance Thermometer (SPRT). A copy of the melting curve for this cell is Figure 1 of this certificate. The SPRT used for the calibration of the thermistor thermometers had been recently calibrated. The numerical value of the stated uncertainty,  $\pm 0.010$  °C, represents one-half of the total melting range for this cell. This is considerably greater than the irreproducibility of the midpoint temperature of the plateau of the melting curve.

SRM 1969 can be used to calibrate any thermometer that is smaller than 5 mm in diameter to an uncertainty of  $\pm 0.010$  °C. This uncertainty can be reduced to  $\pm 0.005$  °C if the entire melting curve is measured carefully and if the midpoint of the resulting plateau is selected as the calibration point. The assigned calibration temperature value given for this cell is the NIST measured midpoint temperature.

The rubidium metal used in SRM 1969 was obtained from Mine Safety Appliances Research Corporation, Evans City, Pennsylvania.

The design of this SRM and the technical measurements at NIST (formerly NBS) leading to certification were made by B.W. Mangum of the Temperature and Pressure Division of the Center for Basic Standards.

This certificate is a revision of the certificate dated January 16, 1984. The changes consist primarily of the conversion of temperatures on the IPTS-68 to those on the ITS-90 [1] by B.W. Mangum of the Process Measurements Division.

The technical and support aspects involved in the revision, update, and issuance of this Standard Reference Material were coordinated through Standard Reference Materials Program by J.C. Colbert. The original coordination of certification efforts was performed by R.W. Seward.

Gaithersburg, MD 20899  
March 11, 1991  
(Revision of certificate dated 1-16-84)

William P. Reed, Acting Chief  
Standard Reference Materials Program

**WARNING: DO NOT OPEN VALVE NOR REMOVE PLUG FROM TUBE END OF SRM 1969**

(over)

## Description of SRM 1969

A cross-sectional drawing of a cell is shown in figure 2. The all stainless-steel (AISI 304) cells were constructed and filled with 99.9 + % pure rubidium by Mine Safety Appliances Research Corp., Evans City, PA. Each cell was filled with approximately 154 grams of rubidium and the valve closed while the system was under vacuum. The rubidium in the tube between the valve and the tube end was removed, and a stainless steel plug was inserted into the tube end under an argon atmosphere.

**CAUTION:** Rubidium is a very reactive metal that ignites on contact with air and reacts violently with water, liberating hydrogen which burns simultaneously. Extreme caution is essential in handling rubidium. The valve on the SRM 1969 cell should never be opened nor should the plug on the end of the stainless steel tube be removed.

## Instructions for Use of SRM 1969

NBS Special Publication 260-87: SRM 1969, Rubidium Triple-Point Standard--A Temperature Reference Standard Near 39.30 °C, describes the preparation, certification, and use of this SRM. It provides information beyond that given in the Certificate, and serves as a technical manual for the most effective use of SRM 1969.

SRM 1969 should be used as a calibrant in a well-stirred, temperature-regulated fluid bath. Users should employ a low viscosity bath fluid with a low vapor pressure, e.g., a light purified mineral oil, to provide good thermal contact in the thermometer well of the cell and to provide a more uniform bath temperature. The thermometer to be calibrated should be inserted into the thermometer well so that the thermometer rests on the bottom of the well. The entire cell should be immersed in the bath fluid so that the plug on the end of the stainless-steel tube is approximately 2 cm below the surface of the bath fluid.

To reproduce the NIST obtained melting curve for this cell (figure 1), the bath fluid temperature should be controlled to 39.44 °C, and the cell should be supported in the plastic holder provided. This holder is similar to that shown on page 10 of NBS SP 260-87. Within 10 to 15 minutes, the thermometer should be within 0.01 °C of the temperature given on the Certificate. Additional thermometers may be calibrated in the cell as long as the temperature of the cell is at the plateau of the melting curve (figure 1). The duration of the melt, i.e., the length of time the temperature of the rubidium is at the plateau of the melting curve, and hence, the time available for calibration, depends on the bath temperature, see figure 3, and whether or not the cell is mounted in the cell holder. The curves of figure 3 were obtained with the cell mounted in a cell holder. Once melting begins, the duration of the plateau can be prolonged by setting the bath temperature to 39.\_\_\_\_\_°C, a temperature 0.03 °C above the rubidium melting point, and regulated at that point to  $\pm 0.03$  °C. The bath temperature can be checked by temporarily placing the thermometer directly into the bath fluid.

In addition to uncertainties associated with the SRM, the uncertainties associated with the scale (or readout) of the thermometers being calibrated must be considered. For example, if an SRM has a certified temperature of  $39.300 \pm 0.010$  °C and if the thermometer has a digital readout to the nearest 0.01 °C, it will indicate a temperature of 39.30 °C when the SRM temperature ranges from 39.295 °C to 39.304 °C. For thermometers with resistive sensing elements (e.g., thermistors and platinum resistors), self-heating caused by current through the elements is present. The magnitude of the self-heating depends on the local environment of the sensing element, as well as on the construction details of the thermometer. This effect will introduce uncertainties that must be considered. The instruction manual for the specific thermometer being calibrated should be consulted with regard to uncertainties both from the scale and the self-heating effect. The uncertainties normally associated with insufficient immersion can be eliminated if the thermometer to be calibrated is inserted to the bottom of the SRM well and if the SRM is immersed in the bath as specified in this Certificate.

Figure 1. Melting curves obtained for the SRM 1969 cell of this certificate in an oil bath regulated at a temperature of 39.440 °C.

## Reference:

- [1] H. Preston-Thomas, "The International Temperature Scale of 1990 (ITS-90)" *Metrologia* 27, 3-10 (1990).

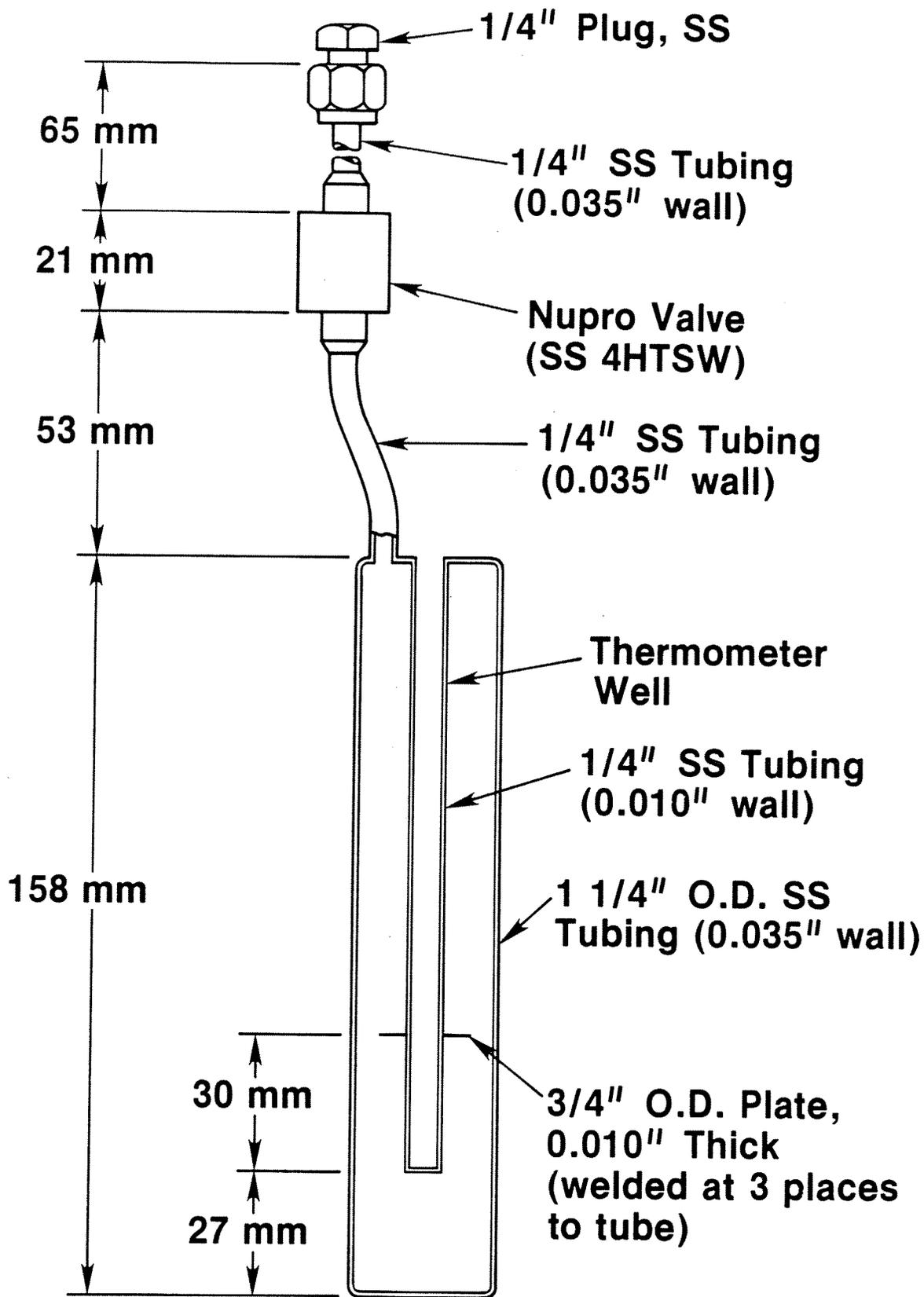


Figure 2. Cross-sectional drawing of SRM 1969, Rubidium Triple-Point Standard.

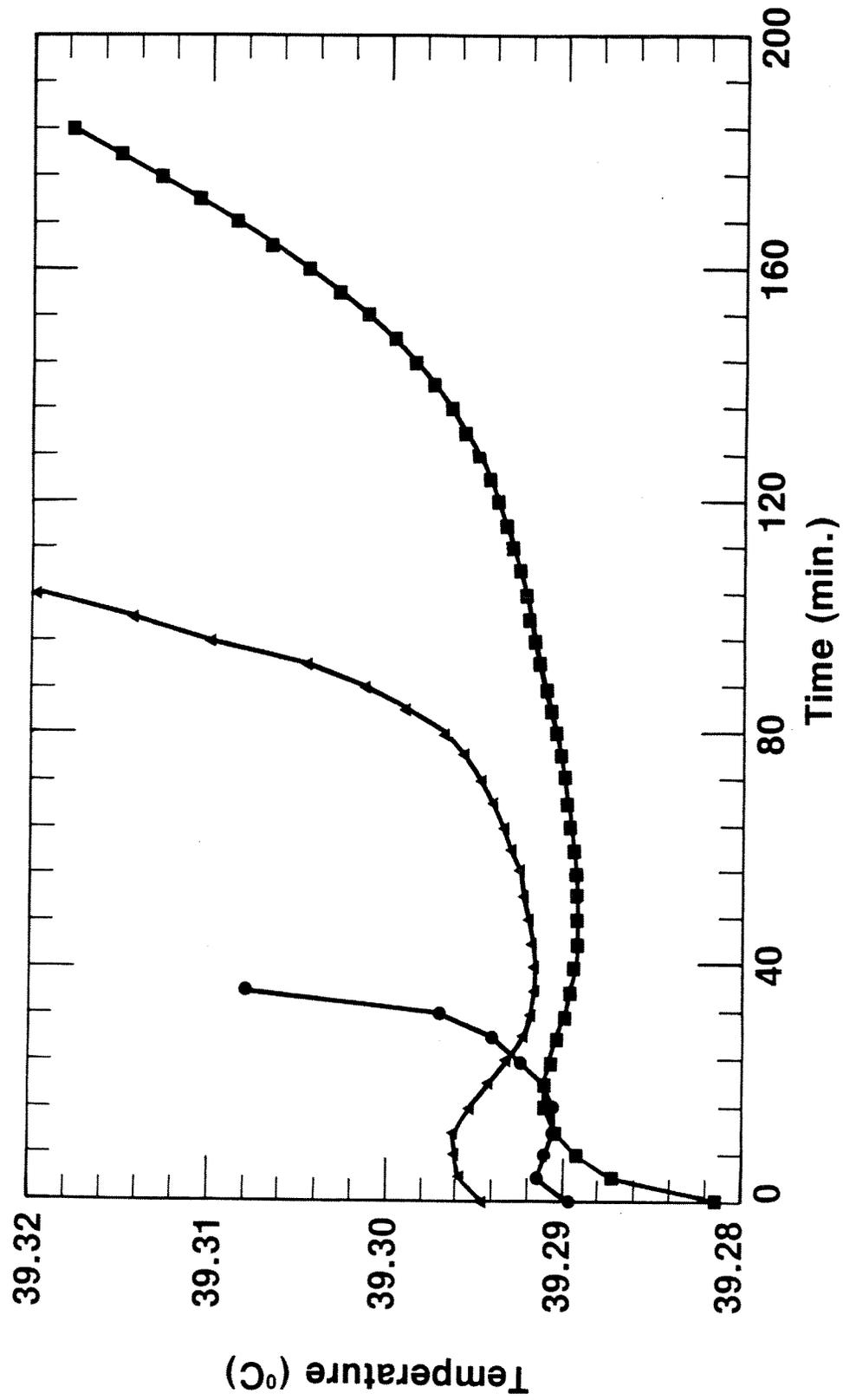


Figure 3. Typical melting curves of rubidium obtained with an SRM 1969 cell in baths at three difference temperatures. ■ represents data obtained in a bath at 39.400 °C; ▲ represents data obtained in a bath at 39.500 °C; ● represents data obtained in a bath at 39.700 °C. Temperatures indicated here are on the IPTS-68.