National Institute of Advanced Industrial Science and Technology
National Metrology Institute of Japan

Reference Material Certificate

NMIJ CRM 4057-a
No. +++
1,4-Dioxane

This certified reference material (CRM) was produced in accordance with the NMIJ’s management system, and in compliance with ISO GUIDE 34:2009 and ISO/IEC 17025:2005. It is primarily intended for use in the calibration of analytical instruments, quality control of analytical instruments, and validation of analytical techniques and instruments.

Certified Values
The certified values are purities in the amount-of-substance fraction and in the mass fraction, given in the table below. The uncertainty of the certified value is the half-width of the expanded uncertainty interval calculated using a coverage factor \( k \) of 2, which gives a level of confidence of approximately 95%.

<table>
<thead>
<tr>
<th>Substance</th>
<th>CAS No.</th>
<th>Certified Value, Amount-of-substance Fraction (mol/mol)</th>
<th>Expanded Uncertainty, Amount-of-substance Fraction (mol/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,4-Dioxane</td>
<td>123-91-1</td>
<td>0.9993</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substance</th>
<th>CAS No.</th>
<th>Certified Value, Mass Fraction (kg/kg)</th>
<th>Expanded Uncertainty, Mass Fraction (kg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,4-Dioxane</td>
<td>123-91-1</td>
<td>0.9999</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Analysis
Purity in the amount-of-substance fraction was determined by the freezing point depression method with an adiabatic calorimeter by using a fractional melting method. Combined standard uncertainty of the purity in the amount-of-substance fraction was estimated by the combination of standard uncertainties due to the purity determination, homogeneity test and stability test. Purity in the mass fraction was converted from the purity in the amount-of-substance fraction by using the molecular weight of 1,4-dioxane and concentrations of impurities. Combined standard uncertainty of the purity in the mass fraction was estimated by combination of standard uncertainties due to the molecular weight of 1,4-dioxane, average molecular weight of impurities and the purity in the amount-of-substance fraction.

Metrological Traceability
The purity in the amount-of-substance fraction was determined by the freezing point depression method with adiabatic calorimeters. Temperature (platinum resistance thermometer), voltage (digital multi-meter), resistance (standard resistor) and heating duration (universal counter) of the adiabatic calorimeters were calibrated and they were traceable to the SI. The purity in the mass fraction was converted from the purity in the amount-of-substance fraction based on the results of an impurity analysis with a gas chromatograph with the flame ionization detector calibrated with standard solutions prepared by NMIJ and a validated Karl-Fischer titrimeter. Therefore, the certified values are traceable to the SI.

Expiration of Certification
This certificate is valid for one year after the date of shipment, provided that the material remains unopened and stored in accordance with the instructions given in this certificate.
Sample Form
This CRM is in the form of a colorless and clear liquid at room temperature. This CRM is sealed in an amber glass ampoule with argon gas. The net amount is 15 mL for each ampoule.

Homogeneity
Ten ampoules were sampled from 200 subdivided ampoules with almost same intervals in order of subdivision for homogeneity tests by gas chromatography and Karl-Fischer titrimetry. Area percentages of 1,4-dioxane by gas chromatography and water content by Karl-Fischer titrimetry were measured and evaluated as homogeneity tests. The evaluated variation of purity between the ampoules due to inhomogeneity was taken into account for the uncertainty of the certified values. Thus, this CRM is homogeneous within the range of the uncertainty of the certified values.

Instructions for Storage
This CRM should be stored at 2 °C to 8 °C and shielded from lights.

Instructions for Use
This CRM is for laboratory use only. The ampoules of this CRM should be allowed to warm to room temperature and then shaken well before opening. This CRM is hygroscopic and should be used promptly once an ampoule is opened.

Precautions for Handling
Keep away from heat and ignition sources. Wear personal protective equipment such as safety glasses, safety mask and safety gloves when handling. Handle the CRM according to the Safety Data Sheet (SDS) on this CRM.

Preparation Method
This CRM was subdivided by KANTO CHEMICAL CO., INC. Fifteen milliliters each of 1,4-dioxane was filled into an amber glass ampoule in an argon atmosphere.

Information
This CRM contains dibutylhydroxytoluene (BHT) as a stabilizer.

NMIJ Analysts
The technical manager for this CRM is M. Numata. The production manager is Y. Shimizu and the analysts are Y. Shimizu, Y. Kitamaki, and E. Yoshimura.

Technical Information
Customer registration on the NMIJ Website (given below) will facilitate notification of any revision of the information given above. Technical reports regarding this CRM can be obtained from the contact details given below.

Reproduction of Certificate
In reproducing this certificate, it should be clearly indicated that the document is a copy.

April 1, 2015

Ryoji Chubachi
President
National Institute of Advanced Industrial Science and Technology
If you have any questions about this CRM, please contact:
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National Metrology Institute of Japan,
Center for Quality Management of Metrology, Reference Materials Office,
1-1-1 Umezono, Tsukuba, Ibaraki 305-8563, Japan
Phone: +81-29-861-4059; Fax: +81-29-861-4009, https://www.nmij.jp/english/service/C/

Revision history
April 1, 2015: “Metrology Management Center” was renamed to “Center for Quality Management of Metrology.”
November 12, 2015: The description in “Expiration of Certification” was changed to “one year after the date of shipment.”