Starna®

Certified Reference Materials for UV and Visible Spectroscopy

Starna®

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Introduction

UV and Visible Spectrophotometry is one of the most common techniques used in analytical science. Procedures using this methodology are found in analytical, clinical and research laboratories, and find extensive use in a Quality Assurance environment. The technique is fundamentally both accurate and precise, but it is essential to check instrument performance on a regular basis to ensure that it is within satisfactory parameters i.e. “under control”, and to allow for corrective action to be taken when found to be outside these limits.

With an increasing requirement for laboratories to be accredited to at least one of the internationally recognised standards of GLP, ISO/IEC 17025 or ISO 9001, this “evidence of control” has become an absolute necessity. As has the use of Certified Reference Materials with a defined traceable path to national or internationally recognised primary materials or procedures.

Optiglass has over thirty years experience in the development and production of Starna® liquid-filled, heat sealed quartz cells which possess the good long-term stability and optical properties needed to evaluate performance of UV-Visible spectrophotometers. The range also includes solid glass filter materials for both absorbance and wavelength measurements. The full range of Certified Reference Materials established traceable to the USA National Institute of Standards and Technology (NIST) currently available are described in detail in the following pages, together with the necessary information for ordering a set to meet your exact requirements.

The ability to customise your requirements is unique to Starna®, and allows for the compilation of a certified set from available reference materials.

Qualification of the reference spectrophotometer is consistent with the most exacting requirements of any regulated environment, and is documented as appropriate on each supplied certificate. In addition to the measured values, certificates also detail how to use, clean, and store the Certified Reference Material.

To ensure the on-going quality of the calibration validation process, recertification of these Certified Reference Materials is an essential requirement, and this process is also documented in the following pages.

Stored, handled, and used correctly Starna® Certified Reference Materials have a long working life in providing that essential evidence of control for your spectrophotometer.

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Frequently asked questions

We are often asked the two primary questions:

1. What is traceability?

2. How is this traceability achieved with the Starna® range of Certified Reference Materials?

Before answering these questions, we must establish what is meant by “Calibration”, and why is it important?

- ### What is calibration?

  Calibration is the process of establishing how the response of a measuring device varies with respect to the instrument parameter being measured. The usual way to perform calibration is to measure the parameter (e.g. using a reference material) and monitor the instrument response.

- ### Why is it important?

  Place any equipment in the environment of choice, and immediately the chosen environment will begin to act on that equipment causing change; and ultimately degradation in performance. This so called drift, causes your results to become unreliable and no longer “fit for their intended purpose”. Whilst drift cannot be eliminated it can be detected and contained hrough the process of calibration. In the p[harma-ceutical industry, a system where drift has occurred to an unacceptable level is deemed to be “out of control”.

  By inference, this same environment will also act on your Certified Reference Materials to a greater or lesser degree, be depending on how they are stored, etc. and these materials must checked/re-certified to ensure that the values on which you are depending have not also significantly changed.

What is traceability?

National Standards Laboratories (NIST, NPL, etc.) work together to agree a common definition for measurement units. These then make up the International System of units, SI. e.g. kilogram, second, metre, ampere, candela, and the Standards Laboratories will then "realise" units from internationally agreed SI definitions to establish primary national measurement scales.

Traceability is defined in the "International Vocabulary of Basic and General Terms in Metrology (ISO, 1993)" as the…*"property of the result of a measurement of the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties."*

How is this traceability achieved with Starna® materials?

Where appropriate, calibration certificates are issued where the certification process has established traceable links to a USA National Institute for Standards and Technology (NIST) Standard Reference Material (SRM) to determine the appropriate filter parameters.

Using procedures consistent with the operation within an ISO/IEC 17025 environment, all certification measurements are bracketed by use of an appropriate NIST primary SRM. In addition the fundamental characteristic of the reference spectrophotometer are periodically established using physical references. For example, wavelength calibration is verified using line spectra from a mercury emission source.

What does traceability achieve?

Measurements are made against a consistent set of units and there is international equivalence of national measurement scales. It also means that compatible measurements are made across national borders, resulting in unambiguous and reliable communication of specifications.

What does ISO/IEC 17025 accreditation achieve?

It provides an independent third party technical audit on all processes and procedures performed within the Calibration Laboratory. Through the International Laboratory Accreditation Corporation (ILAC), accreditation to the ISO/IEC 17025 standard is recognised on a world-wide basis.

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Absorbance/Transmission

For the measurement of this fundamental parameter, Starna® offers you the choice of either sealed cell, or filter materials. Please note that your selection process should not only include the wavelength(s) required, but also the spectral bandwidth (SBW) of your spectrophotometer. Use of the reference materials outside the SBW range detailed is not excluded, but variations from the certified values may be observed.

Potassium Dichromate – UV Absorbance and Linearity

Description: Potassium dichromate from NIST (SRM 935a) in 0.001M perchloric acid.
Primary Usage: Testing absorbance scale and linearity in the UV region.
Useable range: 235 nm to 350 nm, instruments with a SBW of 2 nm or less.
Physical Configuration: UV quartz cells that have been permanently heat sealed.

Potassium Dichromate – UV Absorbance and Linearity

Product Description:

The use of potassium dichromate solvated in dilute perchloric acid is an established and well recognised method for the validation of the absorbance scale and linearity of a spectrophotometer in the UV region.

When prepared in 0.001M perchloric acid, potassium dichromate gives a spectral scan containing characteristic peaks at 257 nm and 350 nm, and troughs at 235 nm and 313 nm. Within the concentration range 20-100 mg/l, if the absorbance scale of a narrow SBW (< 2 nm) spectrophotometer is linear, the apparent absorbances of a series of concentrations will be a linear function of concentration.

RM-0204060810 set:

Consists of one blank (0.001M perchloric acid) and five increasing concentrations, with nominal values of 20 mg/l, 40 mg/l, 60 mg/l, 80 mg/l, and 100 mg/l.

Typical values obtained:

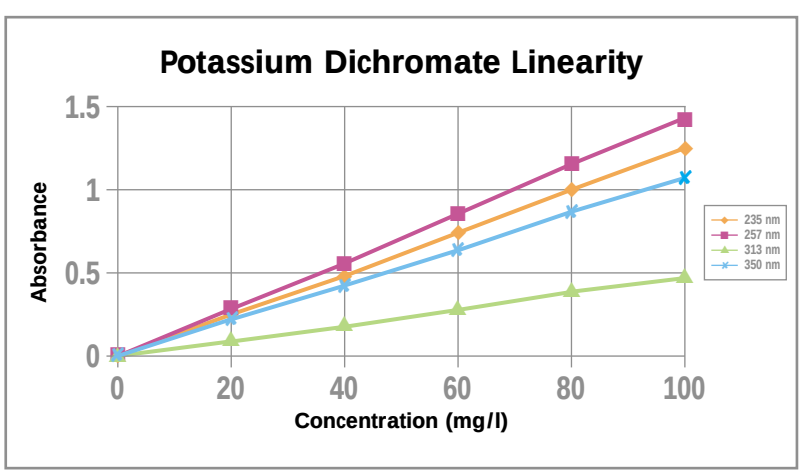
	Wavelengths			
	235 nm	257 nm	313 nm	350 nm
20 mg/l	0.240	0.281	0.095	0.211
40 mg/l	0.477	0.556	0.186	0.415
60 mg/l	0.730	0.849	0.284	0.631
80 mg/l	0.988	1.149	0.384	0.852
100 mg/l	1.229	1.433	0.477	1.061

All Starna® potassium dichromate cells are prepared using the solid NIST primary material (SRM 935a), prepared at the solution concentrations described in NIST Special Publication 260-54. After filling under controlled conditions, the cells are then permanently sealed by heat fusion and the values certified by the procedure described below.

Calibration procedure:

Traceability:

- All Starna® potassium dichromate cells are prepared using the solid NIST primary material (SRM 935a), prepared at the solution concentrations described in "Certification and Use of Acidic Potassium Dichromate Solutions as an Ultraviolet Absorbance Standard – SRM 935" (NIST Special Publication 260-54).
- Primary instrumental linearity is established using the Double Aperture method.
- Additional traceability links to NIST primary materials are established using SRM 930e and SRM 1930 neutral density glass filters.



Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.

Neutral Density Filter – Visible Absorbance and Linearity

Neutral Density Filter – Visible Absorbance and Linearity

Description: Neutral Density Filter Set.
Primary Usage: Routine verification of the visible photometric scale.
Useable range: 440 nm to 635 nm, instruments with SBW of less than 6.5 nm.
Physical Configuration: Glass filters 'stress free' mounted in anodised aluminium holder.

Product Description:

Schott NG-type glasses have been used for over thirty years for the validation of the absorbance scale and linearity of a spectrophotometer in the visible region.

When manufactured to a specific thickness, filters with a range of transmission and absorbance values can be produced. Whilst the spectral scan of these materials is essentially flat, NIST SRM 930e and SRM 1930 certify these glass filters at 440.0 nm, 465.0 nm, 546.1 nm, 590.0 nm, and 635.0 nm. These sets consist of three filters of varying transmission together with an empty aluminium holder, to be used as a blank.

RM-1N2N3N set:

Consists of one blank holder and three filters with nominal values of 10 %T, 20 %T, and 30 %T.

Typical values obtained:

	Wavelengths	440.0 nm	465.0 nm	546.1 nm	590.0 nm	635.0 nm
	SBW	2.2 nm	2.7 nm	4.0 nm	4.0 nm	4.0 nm
10% Filter	Absorbance (approx.)	1.1811	1.0975	1.1278	1.1746	1.1152
20% Filter	Absorbance (approx.)	0.7474	0.6940	0.7140	0.7459	0.7106
30% Filter	Absorbance (approx.)	0.5438	0.4963	0.5083	0.5386	0.5245

RM-N1N35N set:

Consists of one blank holder and three filters with nominal values of 1 %T, 3 %T, and 50 %T.

Typical values obtained:

	Wavelengths	440.0 nm	465.0 nm	546.1 nm	590.0 nm	635.0 nm
	SBW	2.2 nm	2.7 nm	4.0 nm	4.0 nm	4.0 nm
1% Filter	Absorbance (approx.)	2.1610	2.0210	2.0620	2.0930	1.9730
3% Filter	Absorbance (approx.)	1.5930	1.4770	1.5040	1.5350	1.4410
50% Filter	Absorbance (approx.)	0.3010	0.2720	0.2770	0.3000	0.3080

All Starna® neutral density filters are manufactured and certified in accordance with the "Technical Specification for Certification of Spectrophotometric NTRMs" (NIST Special Publication 260-140).

Filters in the range.
92%T-0.1%T (0.035-3.0A) are available on request. These are held in stock at 17 discrete values across this range.

Calibration procedure:

Traceability:

- Primary instrumental linearity is established using the Double Aperture method.
- Fundamental traceability links to NIST primary materials are established using SRM 930e and SRM 1930 neutral density glass filters as appropriate.

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.

Far UV Absorbance/Transmission

For the measurement of this fundamental parameter, Starna® offers you the choice of sealed cell materials. Please note that your selection process should not only include the wavelength(s) required, but also the spectral bandwidth (SBW) of your spectrophotometer. Use of the reference materials outside the SBW range detailed is not excluded, but variations from the certified values may be observed.

Nicotinic Acid –
UV Absorbance and Linearity

Description: Nicotinic acid in 0.1M hydrochloric acid.
Primary Usage: Testing absorbance scale and linearity in the UV region.
Useable range: 210nm to 270nm, instruments with a SBW of 2 nm or less.
Physical Configuration: UV quartz cells that have been permanently heat sealed.

Nicotinic acid – UV Absorbance and Linearity

Product Description:

The use of nicotinic acid solvated in dilute hydrochloric acid is a well documented method for the validation of the absorbance scale and linearity of a spectrophotometer in the Far UV region.

When prepared in 0.1M hydrochloric acid, nicotinic acid gives a spectral scan containing characteristic peaks at approx. 210nm and 260nm. Within the concentration range 5-25 mg/l, if the absorbance scale of a narrow SBW (≥ 2 nm) spectrophotometer is linear, the apparent absorbances of a series of concentrations will be a linear function of concentration, at a specified SBW.

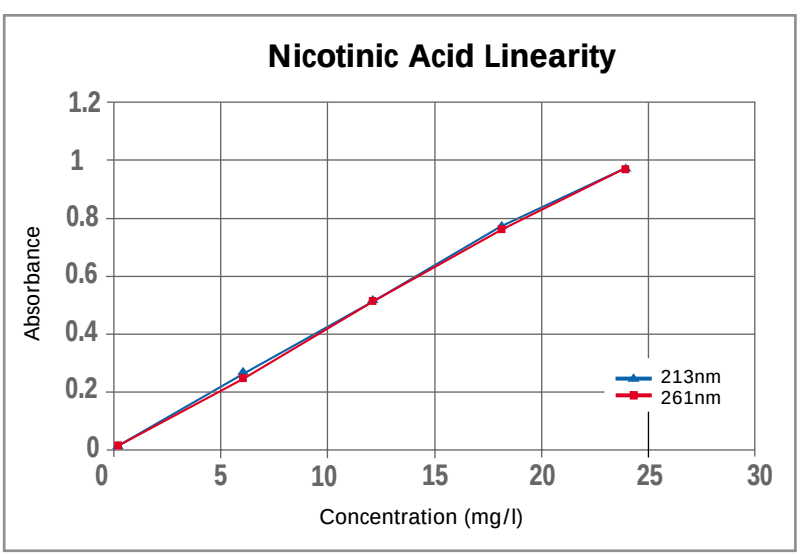
RM-UVA (1A2A3A4A) set:

Consists of one blank (0.1M hydrochloric acid) and four increasing concentrations, with nominal values of 6mg/l, 12mg/l, 18mg/l and 24mg/l.

Typical values obtained:

	Wavelengths	
	213nm	261nm
6mg/l	0.244	0.240
12mg/l	0.489	0.482
18mg/l	0.728	0.717
24mg/l	0.969	0.954

All Starna® nicotinic cells are prepared using AR grade chemicals. After filling under controlled conditions, the cells are then permanently sealed by heat fusion and the values certified by the procedure described below, at the specified SBW. (1.0nm as default)



Calibration procedure:

Traceability:

- Primary instrumental linearity is established using the Double Aperture method.
- Additional traceability links to NIST primary materials are established using SRM 935a potassium dichromate, SRM 930e and SRM 1930 neutral density glass filters.

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.

Wavelength

For the measurement of this fundamental parameter, Starna® offers you the choice of either sealed cell, or filter materials. Please note that your selection process should not only include the wavelength(s) required, but also the spectral bandwidth (SBW) of your spectrophotometer. Use of the reference materials outside the SBW range detailed is not excluded, but at higher spectral bandwidths some of the certified peaks may not be resolved from the overall background spectrum.

Holmium Oxide – UV and Visible Wavelength

Product Description:

The use of holmium oxide solvated in perchloric acid is an established and well recognised method for the validation of the wavelength scale of a spectrophotometer in the UV and visible regions. When prepared in perchloric acid, holmium oxide gives a spectral scan containing a series of characteristic peaks. However, these values are dependent and will vary with the spectral bandwidth of the measuring instrument (NIST Special Publication 260-120)

RM-HL:

Consists of one sealed cell, with certified peak at spectral bandwidth values of 0.10 nm, 0.25 nm, 0.50 nm, 1.00 nm, 1.50 nm, 2.00 nm and 3.00 nm.

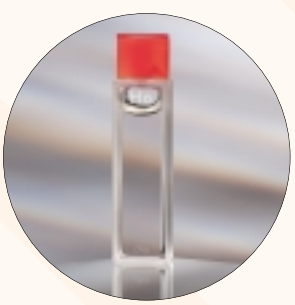
Holmium Oxide – UV and Visible Wavelength

Description: Holmium oxide (4% m/v) in 10% v/v perchloric acid.
Primary Usage: Assessment of wavelength scale accuracy in both UV and visible regions.
Useable range: 240 nm to 650 nm, instruments with spectral bandwidth of less than 3 nm.
Physical Configuration: Far UV quartz cells that have been permanently heat sealed.

Typical values obtained:

SBW	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
0.10	640.54	536.47	485.26	467.88	452.13	416.16	385.55	361.43	345.60	333.52	287.10	278.29	249.85	241.07
0.25	640.52	536.52	485.29	467.84	452.12	416.16	385.48	361.42	345.46	333.56	287.12	278.26	249.88	241.09
0.50	640.52	536.55	485.31	467.90	451.99	416.19	385.61	361.39	345.54	333.61	287.19	278.29	249.94	241.16
1.00	640.65	536.85	485.37	467.93	451.38	416.58	385.90	361.18	345.56	333.64	287.66	278.28	250.14	241.33
1.50	640.58	536.66	485.31	467.88	451.37	416.40	385.78	361.41	345.53	333.58	287.39	278.27	250.00	241.30
2.00	640.85	537.01	485.29	468.00	451.42	416.73	385.90	361.13	345.66	333.62	287.78	278.25	250.25	241.34
3.00	641.29	537.50	485.28	468.14	451.45	417.04	386.17	361.11	345.67	333.74	287.91	278.30	250.38	241.34

All Starna® holmium oxide cells are prepared in accordance with “Holmium Oxide Solution Wavelength Standard From 240 to 640 nm – SRM 2034” (NIST Special Publication 260-54). After filling under controlled conditions, the cells are then permanently sealed by heat fusion and the values certified by the procedure described below.



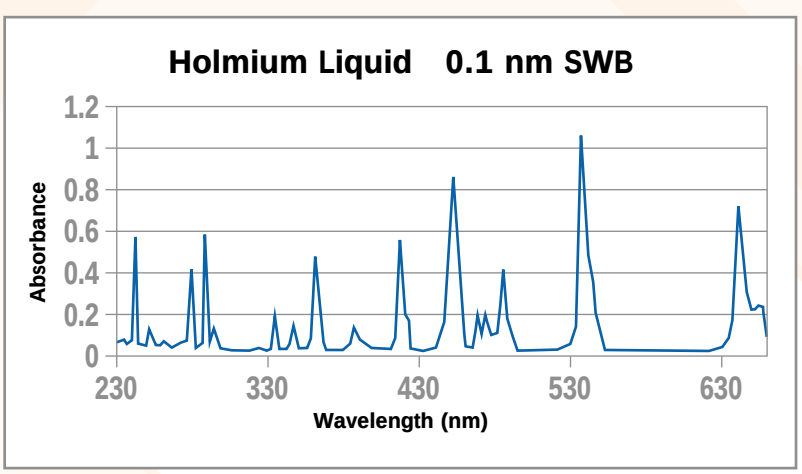
Calibration procedure:

Traceability:

- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v).

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.



Didymium – UV and Visible Wavelength

Description: Didymium (neodymium & praesodymium) in perchloric acid.
Primary Usage: Assessment of wavelength scale accuracy in both UV and visible regions.
Useable range: 290 nm to 870 nm, instruments with SBW of less than 5 nm.
Physical Configuration: Far UV quartz cells that have been permanently heat sealed.

Didymium – UV and Visible Wavelength

Product Description:

Didymium glass has been used for many years as a high wavelength visible reference material. When prepared in perchloric acid, didymium gives a spectral scan containing a series of sharp characteristic peaks that extend well above the useable range of the holmium into the near NIR (680-900 nm). Again, like holmium, these values are dependent and will vary with the spectral bandwidth of the measuring instrument.

RM-DL:

Consists of one sealed cell, with certified peak at spectral bandwidth values of 0.10 nm, 0.25 nm, 0.50 nm, 1.00 nm, 1.50 nm, 2.00 nm and 3.00 nm.

Typical values obtained:

SBW	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
0.10	864.35	799.18	794.13	740.06	731.57	575.19	521.82	511.81	481.65	468.78	444.05	353.83	328.92	298.24
0.25	864.32	799.63	794.16	740.08	731.57	575.14	521.81	511.83	481.64	468.80	444.06	353.82	328.99	298.25
0.50	864.32	799.63	794.12	740.02	731.56	575.12	521.76	511.85	481.63	468.76	444.04	353.81	328.74	298.24
1.00	864.40	798.99	794.08	740.04	731.63	575.04	521.56	511.87	481.67	468.66	444.01	353.80	328.78	298.29
1.50	864.34	799.83	794.09	740.02	731.74	574.87	521.38	511.90	481.70	468.61	443.96	353.82	328.79	298.51
2.00	864.37	799.63	794.09	740.17	731.92	574.87	521.38	511.90	481.70	468.48	443.88	353.83	328.82	298.52
3.00	864.37	799.63	794.09	740.34	732.48	574.98	521.38	511.57	481.64	468.25	443.73	353.53	328.84	298.79

All Starna® didymium Certified Reference Materials are manufactured using procedures similar to those used in the preparation of our Holmium Oxide Reference Material (RM-HL). After filling under controlled conditions, the cells are then permanently sealed by heat fusion and the values certified by the procedure described below.

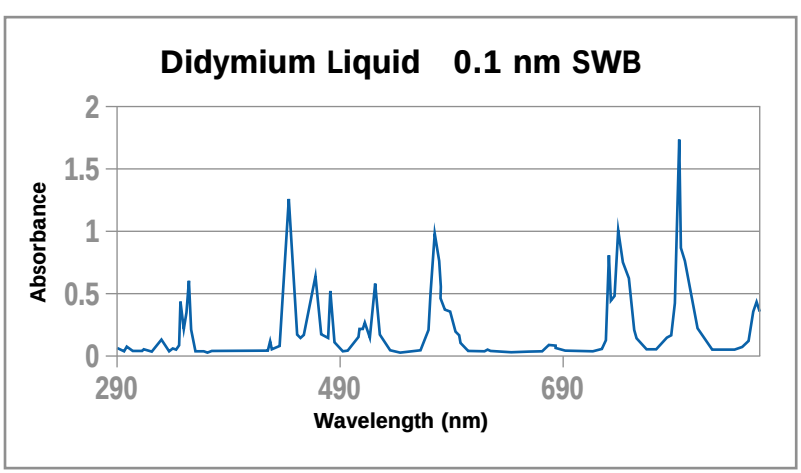
Calibration procedure:

Traceability:

- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v).

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.



Samarium – UV and Visible Wavelength

Samarium – UV and Visible Wavelength

Description: Samarium (III) oxide in perchloric acid.
Primary Usage: Assessment of wavelength scale accuracy in both UV and visible regions.
Useable range: 230 nm to 560 nm, instruments with SBW of less than 5 nm.
Physical Configuration: Far UV quartz cells that have been permanently heat sealed.

Product Description:

Samarium perchlorate is a particularly suitable reference material for checking the wavelength scale of a spectrophotometer over the most commonly used range of 200 to 500 nm, as it has peaks throughout this region. Many of the peaks are very narrow, providing very accurate location of the peak wavelengths. With a half bandwidth of as little as 5 nm, some peaks provide a very convenient way of checking instrument resolution also. Shown below is this effect observed on the peak couple at 233-235 nm.

RM-SL:

Consists of one sealed cell, with certified peak at spectral bandwidth values of 0.10 nm, 0.25 nm, 0.50 nm, 1.00 nm, 1.50 nm, 2.00 nm and 3.00 nm.

Typical values obtained:

SBW	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
0.10	479.18	463.49	415.20	401.45	390.60	374.27	362.36	346.96	332.09	317.59	305.28	290.24	278.99	235.27
0.25	479.17	463.48	415.33	401.41	390.68	374.24	362.55	344.61	331.94	317.71	305.30	290.29	279.07	235.18
0.50	479.12	463.44	415.32	401.40	390.51	374.32	362.42	344.61	331.94	317.60	305.38	290.19	278.96	235.16
1.00	478.99	463.53	415.44	401.36	390.61	374.31	362.46	344.51	332.05	317.58	305.23	290.22	279.10	235.21
1.50	479.07	463.60	415.65	401.28	390.55	374.31	362.53	344.48	332.14	317.49	305.32	290.20	279.10	235.21
2.00	478.86	463.71	415.99	401.27	390.54	374.22	362.32	344.57	332.09	317.52	305.56	290.20	279.10	235.03
3.00	478.57	463.77	415.99	401.18	390.65	374.08	362.11	344.50	332.00	317.50	305.43	290.50	279.07	234.60

All Starna® samarium Certified Reference Materials are manufactured using procedures similar to those used in the preparation of our Holmium Oxide Reference Material (RM-HL). After filling under controlled conditions, the cells are then permanently sealed by heat fusion and the values certified by the procedure described below.

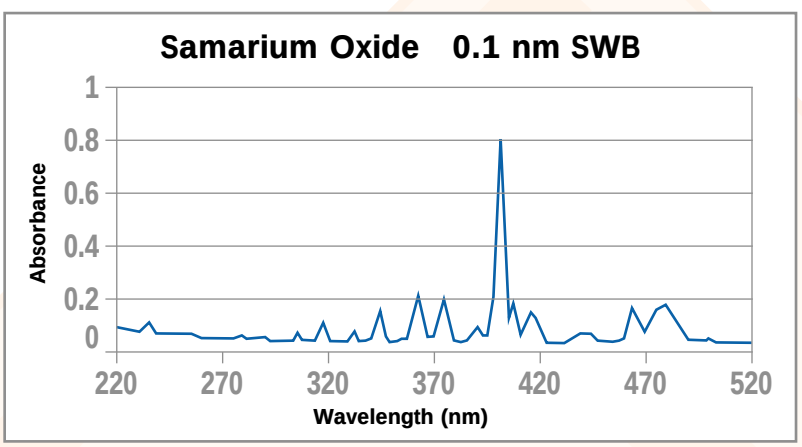
Calibration procedure:

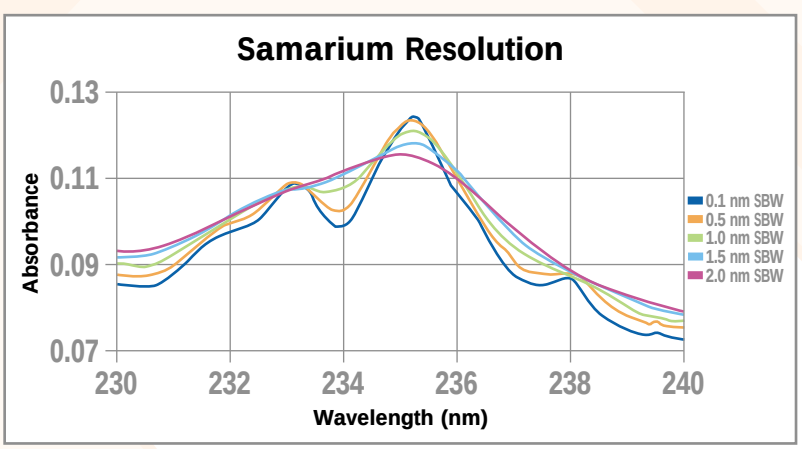
Traceability:

- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v).

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.





Holmium Glass – UV and Visible Wavelength

Description: Holmium glass filter.
Primary Usage: Assessment of wavelength scale accuracy in the UV and visible regions.
Useable range: 270 nm to 640 nm, instruments with SBW of less than 10 nm.
Physical Configuration: Glass filters 'stress free' mounted in anodised aluminium holder.

Holmium Glass – UV and Visible Wavelength

Product Description:

Like its liquid counterpart, the holmium glass filter produces characteristic peaks that make it suitable for use as a wavelength reference material. As a solid material it is physically more robust than the liquid cell, and can therefore be used in a more demanding environment, providing care is still taken to avoid scratching the surface of the filter. By individually certifying each Starna® filter, uncertainty caused by variations in peak positions (observed from melt to melt of the glass) is significantly reduced to acceptable levels (± 0.2 nm).

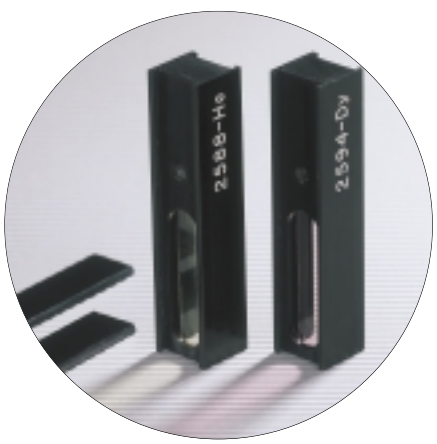
RM-HG:

Consists of one filter, 'stress free' mounted in a proprietary NIST design, with certified peak at spectral bandwidth values of 0.10 nm, 0.25 nm, 0.50 nm, 1.00 nm, 1.50 nm, 2.00 nm, and 3.00 nm.

Typical values obtained:

SBW	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
0.10	637.53	536.43	460.33	453.69	445.71	418.93	360.98	333.87	287.62	279.40	241.66
0.25	637.58	536.36	460.30	453.68	445.70	418.66	360.98	333.86	287.62	279.40	241.69
0.50	637.68	536.37	460.28	453.70	445.71	418.73	360.97	333.90	287.60	279.40	241.70
1.00	637.54	536.64	460.23	453.69	445.73	418.73	360.90	333.90	287.65	279.45	241.65
1.50	637.60	536.59	460.21	453.65	445.82	418.73	360.94	333.91	287.72	279.33	241.58
2.00	637.55	536.63	460.22	453.69	445.97	418.71	360.92	333.92	287.74	279.28	xxx.xx
3.00	637.51	536.87	460.42	453.58	446.21	418.86	360.94	333.95	287.82	278.82	xxx.xx

Note: xxx.xx This peak cannot be resolved at this SBW.



All Starna® filter Certified Reference Materials are manufactured to the same optical tolerances required by the primary National Physical Reference Laboratories around the World. After assembly under controlled conditions, the filters are then certified by the procedure described below.

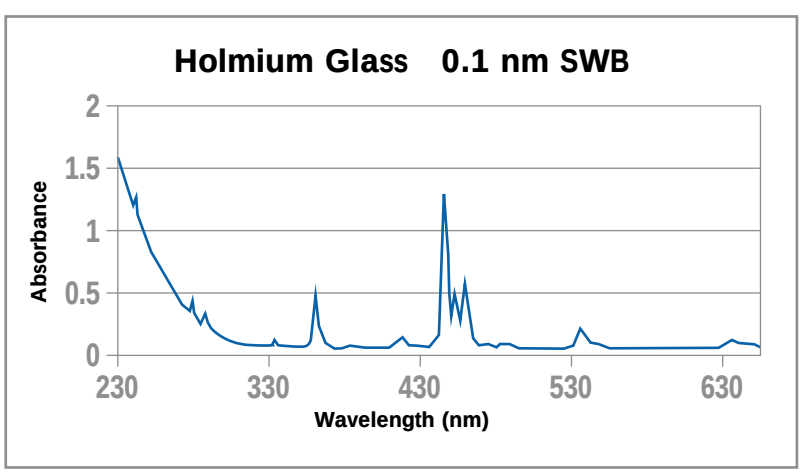
Calibration procedure:

Traceability:

- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v).

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.



Didymium Glass – UV and Visible Wavelength

Didymium Glass – UV and Visible Wavelength

Description: Didymium glass filter.
Primary Usage: Assessment of wavelength scale accuracy in the visible/near NIR region.
Useable range: 430 nm to 890 nm, instruments with SBW of less than 10 nm.
Physical Configuration: Glass filters 'stress free' mounted in anodised aluminium holder.

Product Description:

Like its liquid counterpart, the didymium glass filter produces characteristic peaks that make it suitable for use as a wavelength reference material in the high end visible/near NIR region. As a solid material it is physically more robust than the liquid cell, and can therefore be used in a more demanding environment, providing care is still taken to avoid scratching the surface of the filter. By individually certifying each Starna® filter, uncertainty caused by variations in peak positions (observed from melt to melt of the glass) is significantly reduced to acceptable levels (± 0.2 nm).

RM-DG:

Consists of one filter, "stress free" mounted in a proprietary NIST design, with certified peak at spectral bandwidth values of 0.10 nm, 0.25 nm, 0.50 nm, 1.00 nm, 1.50 nm, 2.00 nm, and 3.00 nm.

Typical values obtained:

SBW	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
0.10	879.40	805.40	748.82	741.63	684.62	587.44	574.35	528.93	513.35	481.13	440.30
0.25	879.40	805.36	748.52	741.05	684.59	587.06	573.09	528.93	513.47	481.08	440.40
0.50	879.30	805.74	748.62	741.15	684.47	587.01	573.03	528.91	513.36	480.99	440.50
1.00	879.36	805.48	748.54	741.07	684.53	587.39	573.07	528.99	513.51	480.99	440.38
1.50	879.44	805.52	748.58	740.70	684.62	587.16	573.19	528.95	513.37	480.92	440.50
2.00	879.44	805.46	748.59	740.46	684.55	587.34	573.32	528.92	513.51	480.75	440.41
3.00	879.36	805.48	748.54	741.07	684.53	587.39	573.07	528.99	513.51	480.99	440.38

All Starna® filter Certified Reference Materials are manufactured to the same optical tolerances required by the primary National Physical Reference Laboratories around the World. After assembly under controlled conditions, the filters are then certified by the procedure described below.

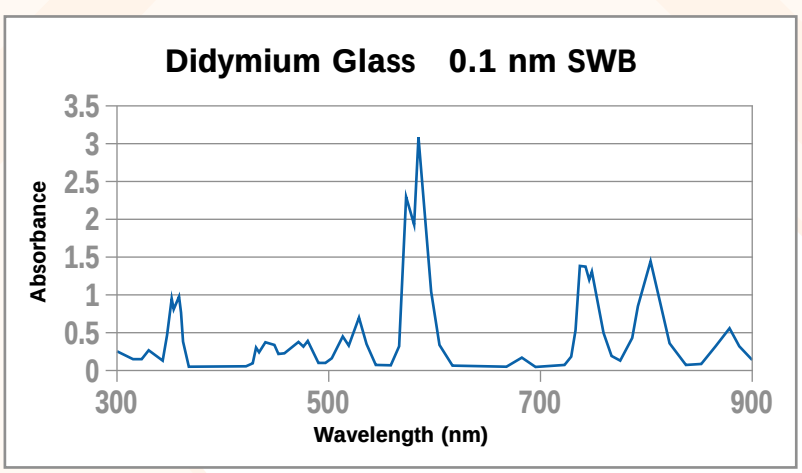
Calibration procedure:

Traceability:

- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v).

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.



Far UV Wavelength

For the measurement of this fundamental parameter, Starna® offers you sealed cell materials. Please note that your selection process should not only include the wavelength(s) required, but also the spectral bandwidth (SBW) of your spectrophotometer. Use of the reference materials outside the SBW range detailed is not excluded, but at higher spectral bandwidths some of the certified peaks may not be resolved from the overall background spectrum.

Rare Earth Oxide – UV Wavelength

Description: Rare earth oxide in dilute sulphuric acid.
Primary Usage: Assessment of wavelength scale accuracy in the UV region.
Useable range: 200nm to 300nm, instruments with spectral bandwidth of less than 5nm.
Physical Configuration: Far UV quartz cells that have been permanently heat sealed.

Rare Earth Oxide – UV Wavelength

Product Description:

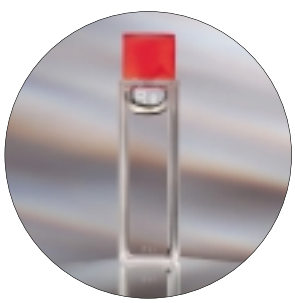
The use of rare earth oxides solvated in acid is an established and well recognised method for the validation of the wavelength scale of a spectrophotometer in the UV and visible regions. When prepared in sulphuric acid, this rare earth gives a spectral scan containing a series of characteristic peaks that extend into the Far UV region.

RM-RE:

Consists of one sealed cell, with certified peak at spectral bandpass values of 0.1nm, 0.2nm, 0.5nm, 1.0nm, 1.5nm, 2.0nm and 3.0nm.

Typical values obtained:

SBW	nm	nm	nm	nm	nm
0.10	201.14	211.76	222.92	240.00	253.56
0.25	201.16	211.96	222.82	240.44	253.80
0.50	200.98	212.00	222.86	240.26	253.58
1.00	201.44	211.72	223.02	240.48	253.74
1.50	201.34	211.96	222.86	240.38	253.58
2.00	201.34	212.00	223.02	240.72	253.52
3.00	201.34	211.96	222.86	240.72	253.64

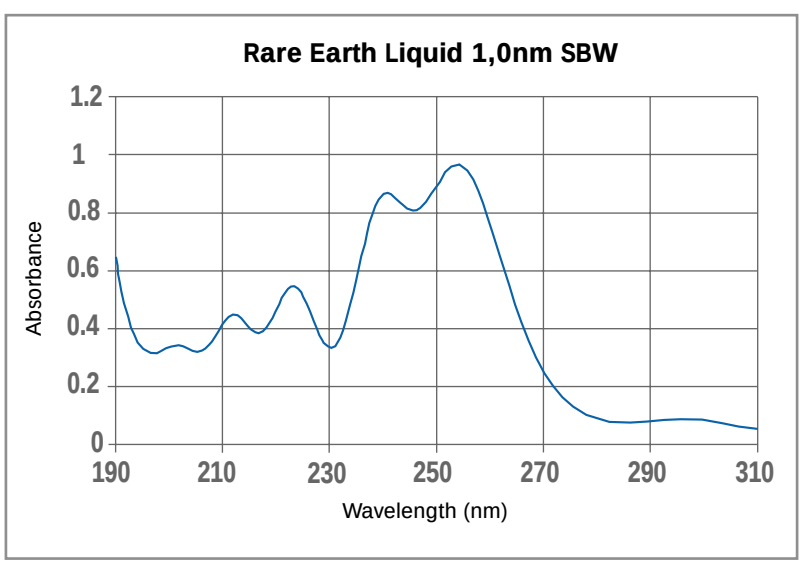


All Starna® Far UV cells are filled under controlled conditions, the cells are then permanently sealed by heat fusion and the values certified by the procedure described below.

Calibration procedure:

Traceability:

- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v).



Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.

Stray light

Stray light can be described as an indication by the instrument of transmitted light at wavelength the monochromator is set to, when in reality there is no light being transmitted through the sample. This apparent transmission is caused by light of other wavelengths than that established by the monochromator being sensed by the detector, and usually results in non-linearity of an absorbance to concentration relationship. The poorer the stray light performance of an instrument the lower the absorbance value at which this correlation begins to deviate from a straight line. Stray light can be a problem at any wavelength but energy throughput of an instrument decreases, for example as you move into the UV region apparent stray light will become an increasing problem.

For the measurement of this fundamental parameter, Starna® offers you the choice of a range of materials in sealed cells.

Inorganic cut-off filters – UV Stray light

Product Description:

Starna® stray light Certified Reference Materials have very sharp transitional (cut-off) spectra, giving excellent filtering characteristics. Hence, below the specified "cut-off" wavelength, any indication of light transmission must be stray light. The test for stray light is important even if the spectrophotometer is not used below 260 nm, because it is an excellent indication of the overall performance of the instrument optics, grating, and deuterium lamp.

Material	Cat. No.	Cut-off	Concentration
Sodium Nitrite	RM-SN	390 nm	5% aqueous
Potassium Iodide	RM-KI	260 nm	1% aqueous
Sodium Iodide	RM-SI	260 nm	1% aqueous
Lithium Carbonate	RM-LC	227 nm	Saturated aqueous
Sodium Chloride	RM-SC	205 nm	1% aqueous
Potassium Chloride	RM-KC	200 nm	1.2% aqueous

Inorganic cut-off filters – UV Stray light

Description: Materials with sharp cut-offs in transmission at specified wavelengths.
Primary Usage: Detection of stray light in the UV region.
Useable range: 200 nm to 260 nm, depending on the material.
Physical Configuration: Far UV quartz cells that have been permanently heat sealed.

All Starna® alkali halide stray light Certified Reference Materials are prepared in accordance with ASTM E-387. These materials, together with the saturated lithium carbonate cell are then filled under controlled conditions, the cells permanently sealed by heat fusion and the values certified by the procedure described below.

Suggestions for Use:

Stray light determinations are run against a water blank supplied with each Certified Reference Material, and the procedure is similar for all materials.

- Set the spectrophotometer wavelength 20 nm above the cut-off wavelength – for example when using potassium iodide set the start wavelength to 280 nm.
- Scan down into the UV region, and record the "peak absorbance" observed below the cut-off wavelength. This is the Instrument Stray Light (ISL) reading for the instrument.

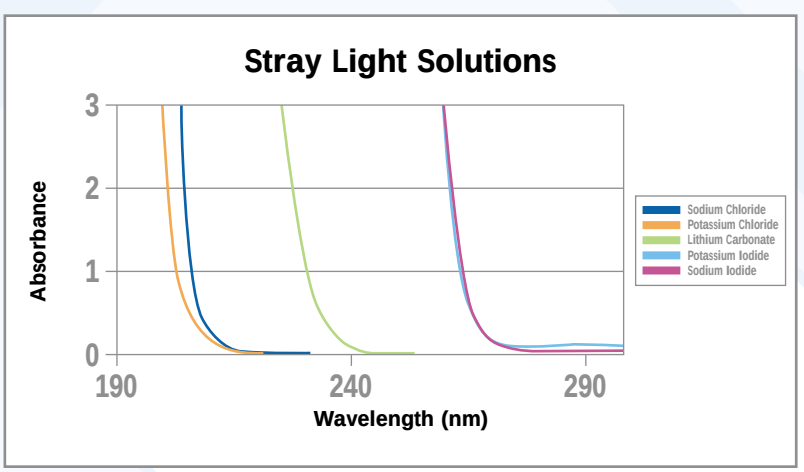
Calibration procedure:

Traceability:

- Primary instrumental linearity is established using the Double Aperture method.
- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v), SRM 930e and SRM 1930 neutral density glass filters.

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.



Resolution

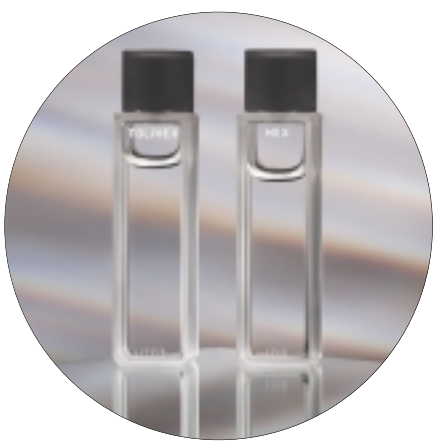
Accurate absorbance and wavelength measurements can only be achieved if due consideration is given to the resolution of the monochromator in use. In modern instruments with grating monochromators, the resolution relates directly to the slitwidth chosen. The smaller the slit and associated spectral bandwidth, the greater the resolution, but the corresponding reduction in energy means the signal-to-noise ratio falls. When measuring an absorbance band in a high-resolution instrument, it is recommended that the spectral bandwidth (SBW) should not exceed 10% of the natural bandwidth (NBW) of the band.

Therefore, simple checks on the resolution power of a spectrophotometer will ensure, for example that adjacent peaks will be fully resolved and not be blended into a combination peak with the associated wavelength, and absorbance errors.

For the measurement and checking of this fundamental parameter, Starna® offers you the choice of either a sealed liquid cell (0.02% v/v solution of toluene in hexane), or a sealed benzene vapour cell.

Toluene in Hexane

Description: 0.020% v/v solution of toluene in hexane.
Primary Usage: Determination of spectral bandwidth (SBW) in the UV region.
Useable range: 265 nm to 270 nm, instruments with a SBW of less than 3 nm.
Physical Configuration: Far UV quartz cells that have been permanently sealed.



Toluene in Hexane

Product Description RM-TX:

This formulation is described and used in the European Pharmacopoeia where the ratio of the peak maximum at 269 nm to the minimum at 266 nm gives a measure of the resolution of the instrument.

Ratio table:

SBW (nm):	0.5	1.0	1.5	2.0	3.0
Ratio:	2.5	2.1	1.6	1.4	1.0

Suggestions for Use:

Resolution determinations are run against the hexane blank supplied with each Certified Reference Material, and the procedure is similar for all spectral bandwidths.

- Scan the 265-270 nm region, and calculate the peak maxima and minima.
- Calculate the peak/trough ratio and compare to the reference values.

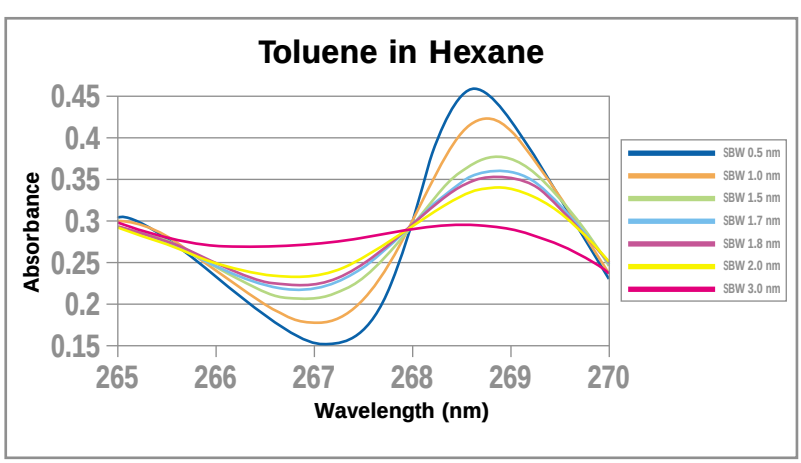
Calibration procedure:

Traceability:

- Primary instrumental linearity is established using the Double Aperture method.
- Primary instrumental wavelength calibration is established using the emission lines from mercury and deuterium sources.
- Additional traceability links to NIST primary materials are established using SRM 2034 holmium oxide (4% m/v) in perchloric acid (10% v/v), SRM 930e and SRM 1930 neutral density glass filters.

Use:

- All appropriate fundamental parameters and procedures relating to measurement, handling and storage are fully documented on the certificate supplied with each Certified Reference Material.



Benzene Vapour

Product Description UR-BZ:

At spectral bandwidths less than 1 nm, the benzene vapour spectrum provides a useful reference that has characteristic features that may or may not be displayed – dependent upon the current spectrophotometer SBW.

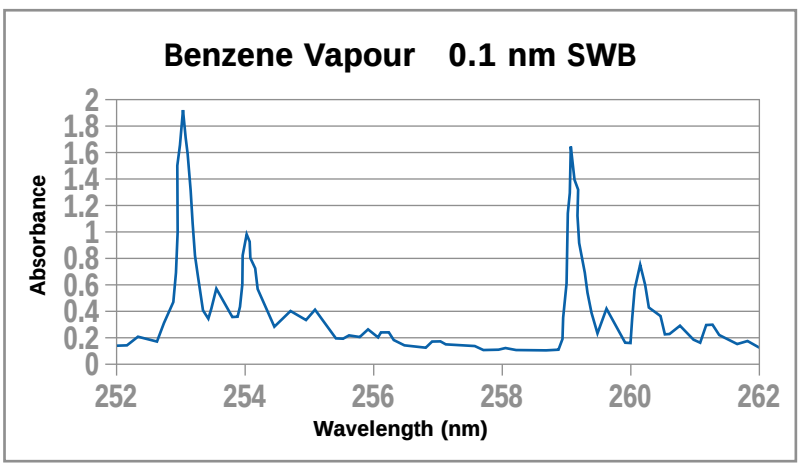
Benzene vapour will not work well with a photodiode array spectrophotometer as this instrument type does not measure a continuum and the peaks will not be resolved well enough to be useable.

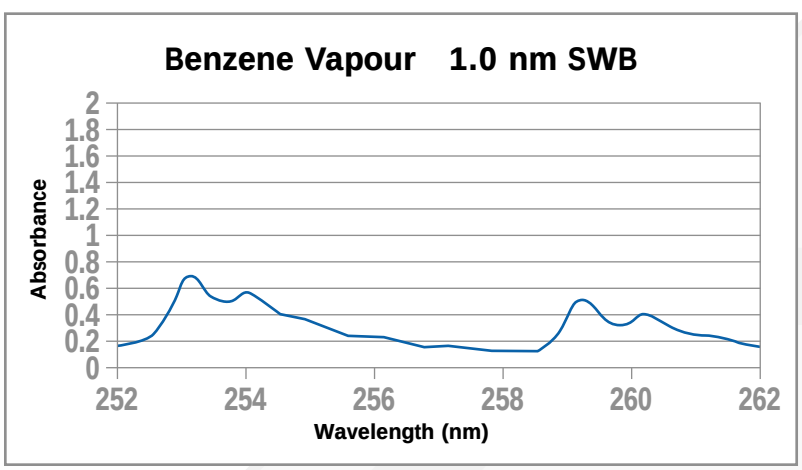
Suggestions for Use:

- Scan the 252-262 nm region, and observe the spectral changes with SBW.
- The 253.49 nm and 259.56 nm peaks should be visible at a SBW of 0.2 nm or less.

Benzene Vapour

Description: 0.1 ml benzene in the vapour state.
Primary Usage: Determination of spectral bandwidth (SBW) in the UV region.
Useable range: 230 nm to 270 nm, instruments with a SBW of less than 1 nm.
Physical Configuration: Far UV quartz cells that have been permanently heat sealed.





How to order

Step by Step:

1. Select whether the set must be traceable to NIST or not.
NIST traceability required so it's an RM set: **RM**

2. Select the Absorbance/Transmission RMs.
20, 40, 60 mg/l potassium dichromates required: **RM-020406**

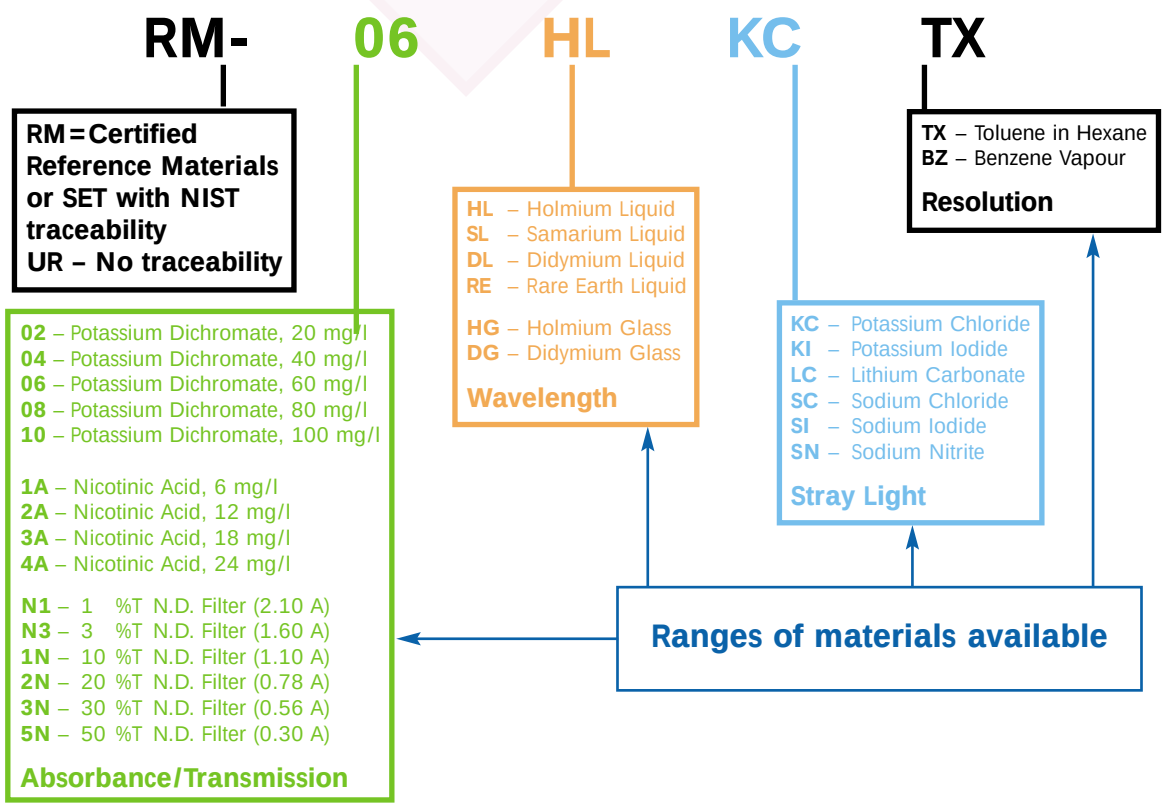
3. Select the Wavelength Material RM.
Holmium Oxide required: **RM-020406HL**

4. Select the Stray Light Material RMs.
Potassium Chloride and Sodium Iodide required: **RM-020406HLKCSI**

5. Select the Resolution Material RM.
Toluene in Hexane required: **RM-020406HLKCSITX**

The chart shown below details all the materials currently available and the syntax that is used to construct the definitive Certified Reference Material sets. This list should not be seen to be exhaustive or unlikely to change, as new materials are becoming available all the time – contact your local Starna® representative for the latest information.

One example of a typical Traceable Set RM-06HLKCTX:



Note: With all Certified Reference Material (RM) Potassium Dichromates, Stray Light Solutions and Toluene in Hexane, appropriate blank solutions are provided. Untraceable Reference Materials do not include a liquid blank and are intended for use with an air blank.

Certified Reference Material (RM) Sets

The Certified Reference Material sets have been assembled to make your verification task easier, and meet specific regulatory requirements. In addition, set prices do offer price savings over the purchase of individual Certified Reference Materials.
So where possible use the general syntax rules to construct your own set, even if it is simply an absorbance and wavelength set.
For example, a 60 mg/l potassium dichromate, together with a holmium oxide solution can be ordered under the part number RM-06HL.

Primary Requirement	Catalogue Number	Construction Parameter	Material	Wavelength
Full specification verification	**RM-06HLKCSITX**	Absorbance Wavelength Stray light Resolution	Potassium dichromate 60 mg/l, blank Holmium oxide Potassium chloride, sodium iodide, blank Toluene in Hexane	235 to 350 nm 240 to 650 nm 200 & 260 nm 265 to 270 nm
Photometric linearity	**RM-0204060810**	Absorbance	Potassium dichromate 20, 40, 60, 80, 100 mg/l, 0.001M perchloric acid blank	235 to 350 nm
Pharmacopoeia compliance	**RM-06HLKCTX**	Absorbance Wavelength Stray light Resolution	Potassium dichromate 60 mg/l, blank Holmium oxide Potassium chloride, blank Toluene in Hexane	235 to 350 nm 240 to 650 nm 200 nm 265 to 270 nm
Similarity to NIST (USA) SRMs	**RM-06HLKI**	Absorbance Wavelength Stray light	Potassium dichromate 60 mg/l, blank Holmium oxide Potassium iodide, blank	235 to 350 nm 240 to 650 nm 260 nm
Similarity to NIST (USA) SRMs	**RM-1N2N3N**	Visible Absorbance	N.D. glass 1.10, 0.78, 0.56 A., blank	440 to 635 nm
Similarity to NIST (USA) SRMs	**RM-N1N35N**	Visible Absorbance	N.D. glass 2.10, 1.60, 0.30 A., blank	440 to 635 nm
High end visible wavelength	**RM-06DLKI**	Absorbance Wavelength Stray light	Potassium dichromate 60 mg/l, blank Didymium Potassium iodide, blank	235 to 350 nm 290 to 870 nm 260 nm

To order contact:
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Email: starnabrand@optiglass.co.uk

Compliance references

Material	Test	Range	USP	Ph. Eur.	BP	ASTM	TGA
Potassium Dichromate	Absorbance	UV/Visible	✔	✔	✔	✔	✔
Neutral Density Filters	Absorbance	Visible	✔	✔	✔	✔	✔
Holmium Oxide	Wavelength	UV/Visible	✔	✔	✔	✔	✔
Potassium Chloride	Stray Light	UV	✔	✔	✔	✔	✔
Potassium Iodide	Stray Light	UV	✔			✔	
Sodium Iodide	Stray Light	UV		✔	✔	✔	✔
Toluene in Hexane	Resolution	UV		✔	✔		✔

Recertification

How often do I need to recertify my Certified Reference Material?

To ensure the validity of the calibration values of reference materials it is essential that they be recertified at regular intervals. The period between recertification is under the control of the user, and is specifically related to the laboratory environment where the certified reference materials are used.

Where the certified reference material stability has been established in the controlled environment of our certification laboratory, a maximum period of two years between recertification is recommended. This duration also assumes an environment where use, storage and care is in a good quality laboratory environment and obviously because of this requirement there is no warranty for fitness beyond initial receipt by the customer.

Ideally, this environment should be temperature controlled, where temperature extremes outside the range 15 - 30 °C are not experienced, have a relative humidity not exceeding 70% and be 'dust free'. All stated 'Instructions for Use' and 'Storage and Care' are adhered to.

In an environment where the above criteria cannot be met, and the users are interested in the highest possible Quality Assurance (QA), it is suggested that the following procedure be adopted. A suitable protocol has to be established as only a statistical process can be used for determining the recertification interval. The certified reference material in question needs be recertified at least every twelve months for the first three years of use. Review of this data, in conjunction with the laboratory control limits, will enable the acceptable recertification time interval to be established. This process should be incorporated in any formal control of the QA system, and any major changes in the laboratory environment should be evaluated with respect to their impact on the calibration of the certified reference materials.

Should you wish to participate in such a Quality Assurance program, please contact your Starna representative about our 'Starna Assisted Recertification'- 'STAR' service.

In the first instance contact the organisation at:

Starna® Products
Sales & Technical Assistanc
Tel: +44 (0)20 8501 5550 · Fax: +44 (0)20 8501 1118 · Email: starna@optiglass.co.uk

Care and handling of Certified Reference Materials (RMs)

- Always store the reference(s) in the box when not in use. Handle with extreme care, like any fragile component. Remove dust from the optical faces by blowing dry air on to the surface.
- Only use a dry optical tissue to remove other contamination. Breakage, scratching of the optical faces, or cracking voids the certification.
- Insert and remove cell based Certified Reference Materials from the instrument cell holder using the circular top, and make sure not to place side loads or twist on the cell.

References

Glossary:

Absorbance	Negative logarithm (base 10) of the transmittance.
Certified Reference Material	A certified reference material issued by Starna® where the traceability has been established to appropriate NIST Standard Reference Materials (SRMs).
Double Aperture	The implicit standard methodology used to calibrate the detector linearity of national reference spectrophotometers.
Far UV	Radiation at the shortwave end of the UV region. Generally accepted to be the region between 190 and 250 nm.
GLP	Good Laboratory Practice.
ISO 9001	International Standard for quality management and quality assurance.
ISO/IEC 17025	International Standard for the accreditation of Testing or Calibration Laboratories, formally ISO/IEC Guide 25.
SBW	Spectral Bandwidth, also known as Spectral slit width (SSW), spectral bandpass, and instrument function; a measure of the monochromaticity of the light of a given spectrophotometer.
Transmission	The process by which radiation passes through material. It therefore represents radiation that is not absorbed, scattered or otherwise dispersed by the material.
UV-Visible spectrophotometer	An instrument designed to operate through the UV and visible regions, i.e. from 180 to 800 nm.

Standards:

ASTM E275-01Standard Practice for Describing and Measuring Performance of Ultraviolet, Visible, and Near-Infrared Spectrophotometers

ASTM E387-84 Standard Test Method for Estimating Stray Radiant Power Ratio of Spectrophotometers by the Opaque Filter Method

Bibliography:

Standards and Best Practice in Absorption Spectrometry
Edited by Chris Burgess and Tom Frost UVSG. ISBN 0-632-05313-5 Blackwell Science
http://www.blackwell-science.com

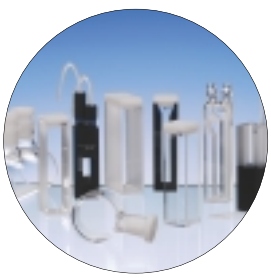
NIST Special Publication 260-54
Standard Reference Materials:
Certification and use of Acidic Potassium Dichromate Solutions as an Ultraviolet Absorbance Standard – SRM 935

NIST Special Publication 260-116
Standard Reference Materials:
Glass Filters as a Standard Reference Material for Spectrophotometry – Selection, Preparation, Certification, and Use of SRM 930 and SRM 1930

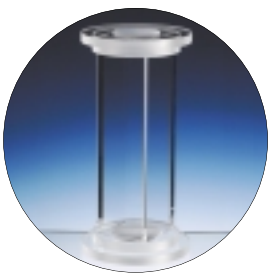
NIST Special Publication 260-102
Standard Reference Materials:
Holmium Oxide Solution Wavelength Standard From 240 to 640 nm – SRM 2034

NIST Special Publication 260-140
Standard Reference Materials:
Technical Specifications for Certification of Spectrophotometric NTRMs

Starna® accessories



• Spectrophotometer Cells



• UHV Cells

• Flow Cells

• Fluorescence Reference Materials

• Fluorescence Cells

For further information, contact your local Starna® representative.

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