Certified Reference Materials for Spectroscopy

Starna

2024

ilac-MRA

UKAS REFERENCE MATERIALS

UKAS CALIBRATION

Starna

Starna is the World's Leading Supplier of Certified Reference Materials (CRMs) for Spectroscopy

- **References for all wavelengths, from Deep UV to Mid Infrared**
- **References for Fluorescence, Life Science and Microvolume applications**
- **Liquid and vapour references permanently heat sealed into Starna cuvettes for stability, safety and durability**
- **Lifetime Guarantee on all CRMs**
- **Fast recalibration service**
- **Technical support and advice**

Why do we need Certified Reference Materials?

In a regulated environment, the onus of proof is on the user to justify and prove, by the qualification of the system, that the instrument is fit for it's intended purpose, providing data of the required accuracy and precision.

To qualify the performance of an analytical instrument, it is necessary to test (qualify) its performance against standards having known properties. Virtually all quality protocols require that any standards used can be shown to be **traceable** to nationally or internationally recognised primary references. Such standards are referred to as Certified Reference Materials or CRMs, which in turn must be manufactured and calibrated under closely controlled conditions. While it is possible for instrument users to prepare and calibrate their own CRMs, it is far more convenient to purchase them from a suitably Accredited Supplier such as Starna.

Instrument Qualification - DQ, IQ, OQ and PQ.

These abbreviations are used to describe the performance qualification of an analytical instrument. They are: **D**esign **Q**ualification, **I**nstallation **Q**ualification, **O**perational **Q**ualification and **P**erformance **Q**ualification. According to the US Pharmacopeia:

Operational Qualification (OQ) is the documented collection of activities necessary to demonstrate that an instrument will function according to its operational specification testing in the selected environment. OQ demonstrates fitness of purpose for the user's ways of working, and should reflect the contents of the DQ document.

Performance Qualification (PQ) is the documented collection of activities necessary to demonstrate that an instrument consistently performs according to the specifications defined by the user, and is appropriate for the intended use. The PQ verifies the fitness for purpose of the instrument under actual conditions of use. After IQ and OQ have been performed, the instrument's continued suitability for its intended use is demonstrated through continued performance qualification.

In a routine situation, only PQ will need to be performed on a regular basis. OQ is done less frequently, usually after maintenance or repair have been carried out on the instrument.

What is a CRM?

As defined by ISO/REMCO (the International Standards Organisation Committee on Reference Materials), a CRM is a "Reference Material, characterised by a metrologically valid procedure for one or more specified properties, accompanied by a certificate that provides the value of the specified property, its associated uncertainty, and a statement of metrological traceability."

CRMs - The Manufacturing Environment

To be a Reference Material Producer, manufacturers should be accredited to ISO 17034. This standard contains normative references to ISO/IEC 17025, so that certified value assignments can only be produced in calibration laboratories also accredited to this standard. Starna was the first CRM producer to be awarded accreditation to both Standards by UKAS, the UK Accreditation Service.

When assessing a reference material producer, it is important to consider the scope of their accreditation, as a supplier could claim accreditation to ISO 17034 or ISO/IEC 17025 based on just one type of reference material, which might not be the one required by the customer. References not included in the published scope may not be recognized for instrument qualification by regulatory bodies.

The scope of Starna's accreditations can be viewed at **www.starna.com/accreditations**

Liquid and Vapour Reference Materials

The ultimate measurement ability of a calibration laboratory is demonstrated by its Calibration and Measurement Capability (CMC), formerly known as Best Measurement Capability. While this may be stated in the laboratory's ISO/IEC 17025 accreditation schedule, the only absolute measure is the "Uncertainty" value given in the actual Calibration Certificate accompanying the reference material. Users should therefore compare the certificated uncertainty values of suppliers before purchase.

Starna consistently out-performs other suppliers in this respect. In the 1950s, the founders of Optiglass (the forerunner of Starna Scientific Ltd.) perfected the technique of fully fusing glass and silica cell components by heat alone, without distortion of optical surfaces. This technique also allowed the development and perfection by Starna Scientific Ltd. of permanently heat sealing cuvettes containing liquid or vapour phase reference materials, even when those materials are volatile or highly flammable, and contributes to the long-term stability of Starna reference materials and the unique LIFETIME GUARANTEE that accompanies all Starna CRMs. The potential hazards of handling volatile and toxic materials are also largely eliminated.

International Compliance Standards

Starna CRMs described in this catalogue comply with the requirements for instrument qualification of UV and visible spectrophotometers recommended by national and international regulatory authorities worldwide including:

United States Pharmacopeia	USP
American Society for Testing and Materials	ASTM
European Pharmacopoeia	EP (Ph. Eur)
Deutsches Arzneibuch (German Pharmacopoeia).	DAB
Therapeutic Goods Administration (Australia)	TGA
British Pharmacopoeia	BP
Japanese Pharmacopoeia	JP
Pharmacopoeia of the People's Republic of China	PPRC

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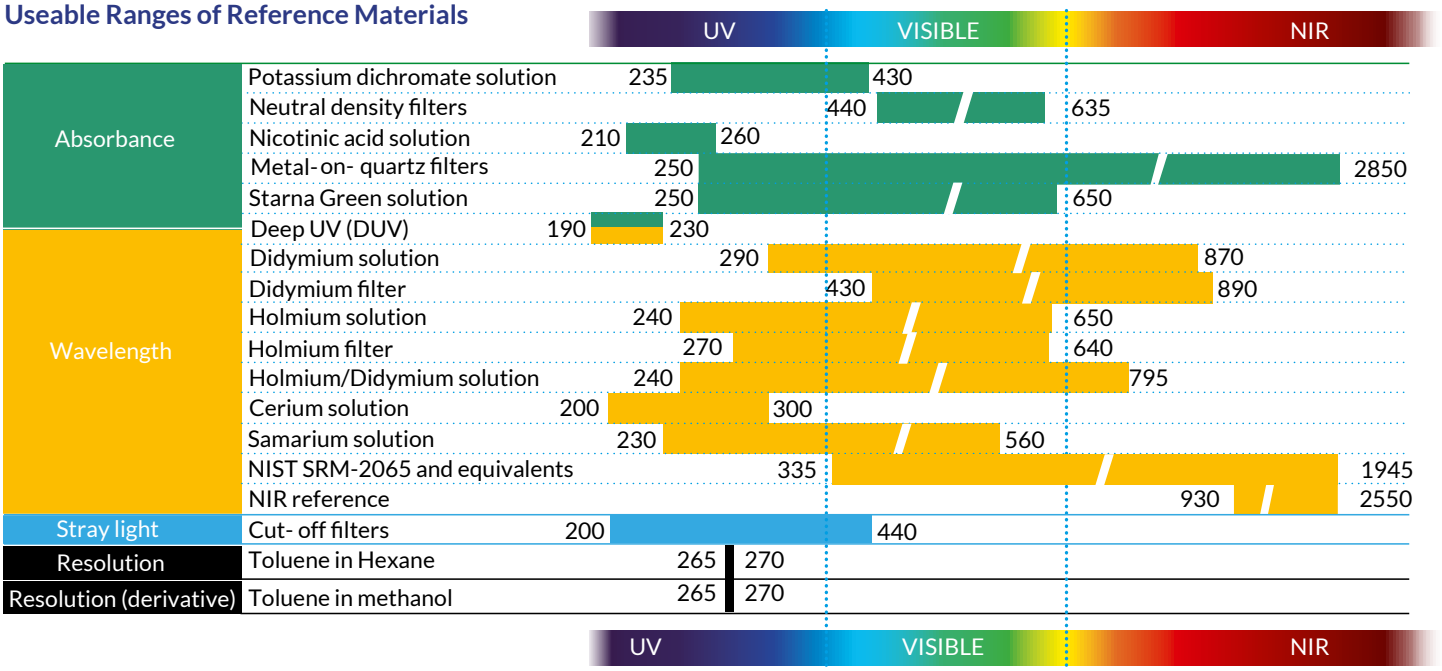
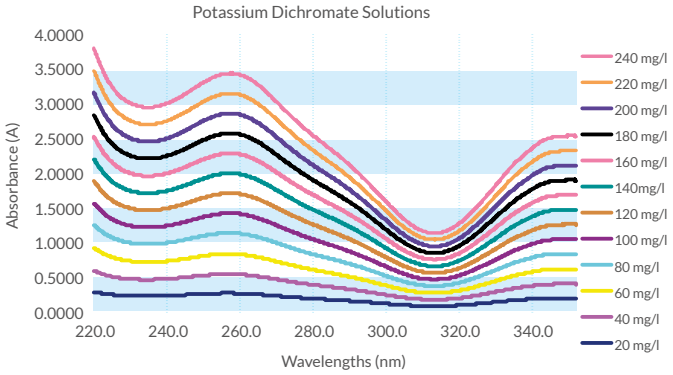


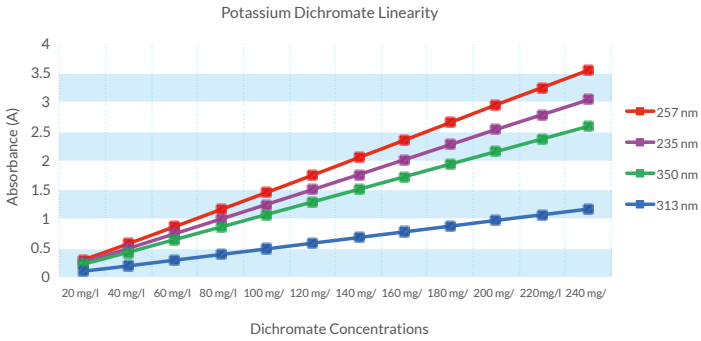
Starna Potassium Dichromate Solutions

The most widely used reference material for absorbance accuracy and linearity, covering wavelengths from 235 to 430 nm and absorbance values up to 3.5 A.

In this Certified Reference Material, potassium dichromate in 0.001 M perchloric acid is permanently heat sealed by heat fusion into 10 mm UV-quality quartz cells. Solutions are prepared from solid potassium dichromate, NIST SRM 935a.

The spectrum contains characteristic peaks at 257 nm and 350 nm, and troughs at 235 nm and 313 nm.





Within the concentration range 0 - 240 mg/l, if the absorbance scale of a spectrophotometer is linear, the measured absorbances at these wavelengths will be a linear function of concentration.

A 600 mg/l reference is also available, as recommended by the pharmacopoeias for instrument qualification at 430 nm.

To meet pharmacopoeia requirements, the instrument to be qualified should have a bandwidth of 1.6 nm (EP) or 2 nm (USP) or less. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.

UV and Visible Absorbance Accuracy and Linearity

0 – 3.5 A (235 - 350 nm and 430 nm)

These references are available in convenient sets covering different absorbance ranges:

	CATALOGUE NUMBER
Potassium Dichromate Linearity Set, 0.09 to 1.5 A 20, 40, 60, 80 & 100 mg/L & Blank Cell	**RM-0204060810**
As above, with additional 600mg/l reference for visible absorbance accuracy compliance	**RM-020406081060**
Potassium Dichromate Linearity Set, 1.5 to 3.5 A 120, 140, 160, 180 & 220 & 240 mg/l & Blank Cell	**RM-121416182224**
Potassium Dichromate Linearity Set, 0.19 to 3.5 A 40, 80, 120, 160, 200 & 240 mg/l & Blank Cell	**RM-040812162024**

References are also available individually. Catalogue numbers and nominal certified values are given below. Any combination of references can be ordered as a set by combining the catalogue numbers as in the examples above. A perchloric acid blank cell is supplied with each reference or set of references.

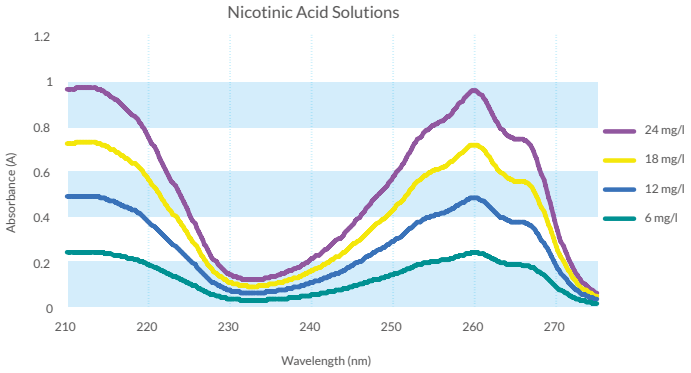
Concentration	Nominal Absorbance Values at Certified Wavelengths					CATALOGUE NUMBER
	235 nm	257 nm	313 nm	350 nm	430 nm	
20 mg/l	0.246	0.286	0.096	0.214		**RM-02**
40 mg/l	0.493	0.574	0.193	0.428		**RM-04**
60 mg/l	0.743	0.865	0.290	0.643		**RM-06**
80 mg/l	0.994	1.157	0.387	0.858		**RM-08**
100 mg/l	1.247	1.452	0.484	1.074		**RM-10**
120 mg/l	1.501	1.749	0.582	1.290		**RM-12**
140 mg/l	1.758	2.050	0.679	1.506		**RM-14**
160 mg/l	2.016	2.351	0.777	1.723		**RM-16**
180 mg/l	2.275	2.655	0.875	1.940		**RM-18**
200 mg/l	2.536	2.960	0.974	2.157		**RM-20**
220 mg/l	2.790	3.256	1.071	2.373		**RM-22**
240 mg/l	3.043	3.552	1.168	2.589		**RM-24**
600 mg/l					0.954	**RM-60**

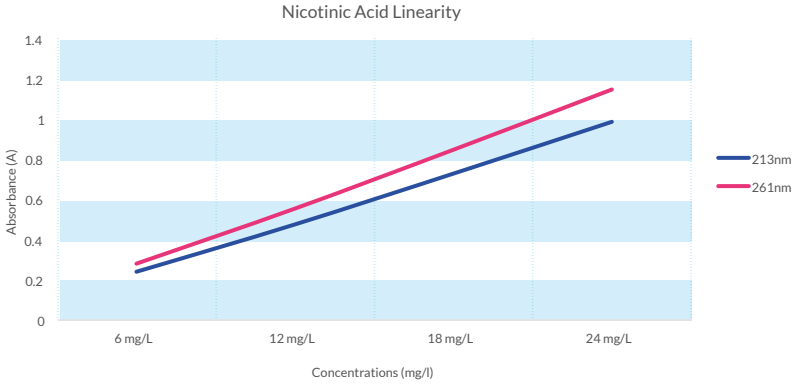
Starna Nicotinic Acid Solutions

Used for qualifying the absorbance scale and linearity in the Far UV region of the spectrum.

Solutions of four concentrations of nicotinic acid in dilute hydrochloric acid permanently sealed by heat fusion in to UV grade quartz cells. Supplied with hydrochloric acid blank cell. Complete with UKAS accredited ISO/IEC 17025 certificate of calibration and full instructions for use.

- The spectrum of nicotinic acid dissolved in dilute hydrochloric acid has peaks at 213 nm and 261 nm.
- A graph of measured absorbance against concentration of this reference will be linear if the absorbance scale of your instrument is linear.
- Instruments to be qualified should have a bandwidth of 2 nm or less. These references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.





These references are available in a convenient set containing all four concentrations and a hydrochloric acid blank cell:

	CATALOGUE NUMBER
Nicotinic Acid Linearity Set, 0.24 to 1.15 A 6, 12, 18 & 24 mg/l & Blank Cell	**RM-06A12A18A24A**

References are also available individually. Catalogue numbers and nominal certified values are given below. Any combination of references can be ordered as a set by combining the catalogue numbers as in the example above. A hydrochloric acid blank cell is supplied with each reference or set of references. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.

Concentration	Absorbance at Certified Wavelength		CATALOGUE NUMBER
	213 nm	261 nm	
6 mg/l	0.244	0.233	**RM-06A**
12 mg/l	0.489	0.466	**RM-12A**
18mg/l	0.727	0.694	**RM-18A**
24mg/l	0.968	0.924	**RM-24A**

Solutions are available at higher concentrations giving absorbance values up to 2.4A.
Starna do not recommend the use of Nicotinic Acid for linearity measurements above 1.0A

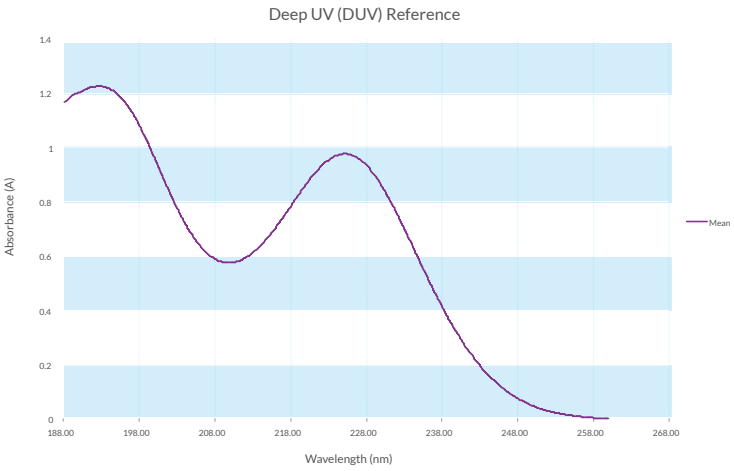
Starna TS8* Deep UV

This unique Certified Reference Material can be used to qualify the wavelength and absorbance scales of spectrophotometers in the deep ultra-violet region of the spectrum, between 190 nm and 230 nm.

Qualifying a UV spectrophotometer in the deep UV presents particular problems, both in identifying a suitable reference material and in accommodating the variability in transmittance characteristics of UV grade quartz below 200 nm. These problems have been overcome with this unique reference material by using innovative design and manufacturing protocols.

The Reference Material consists of a TS8* solution permanently sealed by heat fusion into a high quality UV quartz cell. Each reference is supplied with a matched solvent blank cell.

**TS8 is a proprietary matrix with the necessary spectral characteristics and stability to be used as a reference material.*



To allow users flexibility in use the reference is supplied with certified wavelength and absorbance values at two different bandwidths, 1.0 nm and 5.0 nm. Nominal values are given below.

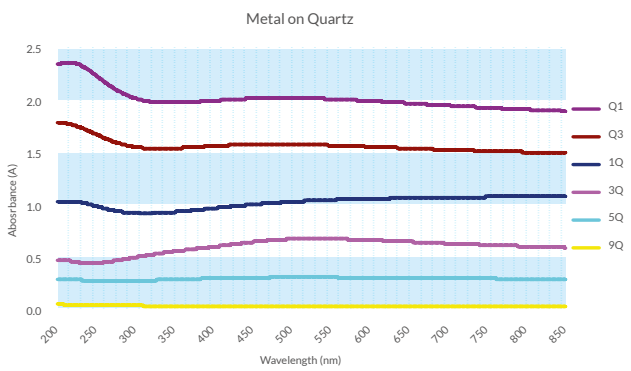
Nominal Wavelength and Absorbance Values			CATALOGUE NUMBER
191 nm	209 nm	226 nm	
1.2 A	0.6 A	1.0 A	**RM-DUV/195**

Starna Metal-on-Quartz filters

This Certified Reference Material can be used to qualify the Absorbance scale, in the ultra-violet and visible region of the spectrum (250 nm to 850 nm) of spectrophotometers with spectral bandwidths not exceeding 10 nm.

The transmission characteristics of the filter are determined by the thickness of a metallic coating deposited on a quartz plate. The metallic surface is overlaid by an optically bonded cover plate to protect it from oxidation, contamination, or physical degradation. The filters are mounted in stress-free black-anodized aluminium alloy holders, with front and rear sliding covers that protect the filters when not in use.

The spectrum of these filters is essentially flat from 250 nm to 850 nm. Absorbance and Transmittance values are certified at 250, 280, 340, 360, 400, 465, 500, 546.1, 590 and 635 nm. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.



Filters 1Q, 3Q and 9Q are equivalent to NIST SRM 2031a

Instruments to be qualified should have a bandwidth of 5 nm or less.

As these filters attenuate the incident radiation partly by reflection, inter-reflections could be generated within the sample compartments of some spectrophotometers. This could affect the accuracy of measurements, and it is recommended that potential purchasers contact the manufacturer of their instrument to check its compatibility with metal-on-quartz filters.

These references are available in a convenient set, equivalent to NIST SRM 2031a:

	CATALOGUE NUMBER
Metal-on-Quartz Filter set, NIST SRM 2031a 10, 30 & 92% T & blank filter holder	**RM-1Q3Q9Q**

The references are also available individually. Nominal certified transmission/absorbance values and catalogue number are given below. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request. Any combination of references can be ordered as a set by combining the catalogue numbers as in the example above. An empty filter holder is supplied with each reference or set of references to be used as a measurement blank.

Nominal Transmittance and Absorbance Values	CATALOGUE NUMBER
92% T (0.04 A)	**RM-9Q**
50% T (0.3 A)	**RM-5Q**
30% T (0.5 A)	**RM-3Q**
10% T (1.0 A)	**RM-1Q**
3% T (1.5 A)	**RM-Q3**
1% T (2.0A)	**RM-Q1**

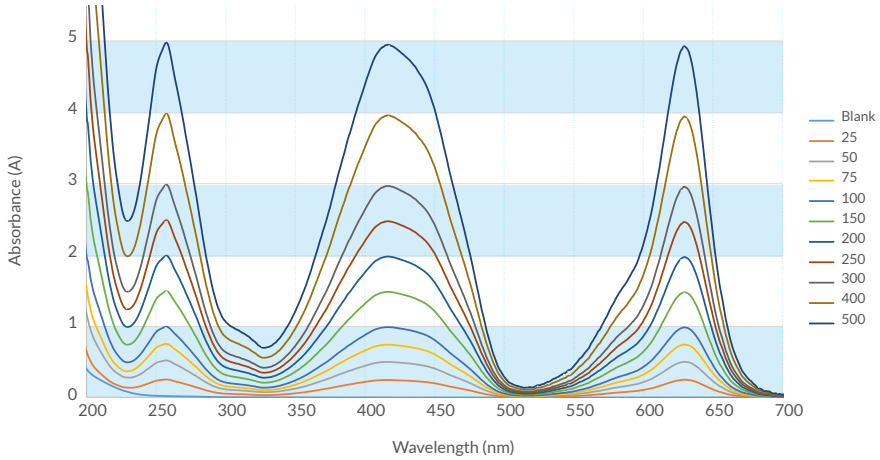
Starna Green Solutions

Unique general-purpose reference ideal for routinely testing spectrophotometer wavelength and absorbance accuracy and linearity (up to 5A) in the UV and visible regions of the spectrum. Also available specially packaged for testing microvolume and drop technology instrumentation (see p 28).

Starna Green solutions in dilute hydrochloric acid permanently sealed by heat fusion in to a UV grade quartz cell. Supplied with hydrochloric acid blank cell. Complete with UKAS accredited ISO/IEC 17025 certificate of calibration and full instructions for use.

Starna Green

- Starna Green is a specially formulated dye solution for testing spectrophotometers with bandwidths up to 20 nm. Three but well-defined peaks are certified for both wavelength and absorbance values at 258, 416 and 630 nm.
- A graph of measured absorbance against concentration of this reference will be linear if the absorbance scale of your instrument is linear, up to 5A.
- Starna Green is very stable, non-toxic and REACH compliant.



Starna Green References are calibrated at 1 and 5 nm bandwidths. Other bandwidths on request These references are available in a convenient set:

	CATALOGUE NUMBER
Starna Green Linearity Set 25, 50, 75 & 100 concentrations & blank	**RM-25G50G75G100G**

They are also available individually. Catalogue numbers and nominal values are given below. Any combination of references can be ordered as a set by combining the catalogue numbers as in the set above. A hydrochloric acid blank cell is supplied with each reference or set of references.

Nominal Concentration	Nominal Certified Wavelength and Absorbance Values			CATALOGUE NUMBER
	258 nm	416 nm	630 nm	
25	0.255	0.248	0.251	**RM-25G**
50	0.523	0.501	0.502	**RM-50G**
75	0.754	0.743	0.744	**RM-75G**
100	0.995	0.990	0.984	**RM-100G**
150	1.492	1.485	1.476	**RM-150G**
200	1.990	1.979	1.968	**RM-200G**
250	2.487	2.474	2.460	**RM-250G**
300	2.984	2.969	2.952	**RM-300G**
400	3.979	3.959	3.936	**RM-400G**
500	4.974	4.949	4.920	**RM-500G**

Starna Rare Earth Oxide Solution Cells

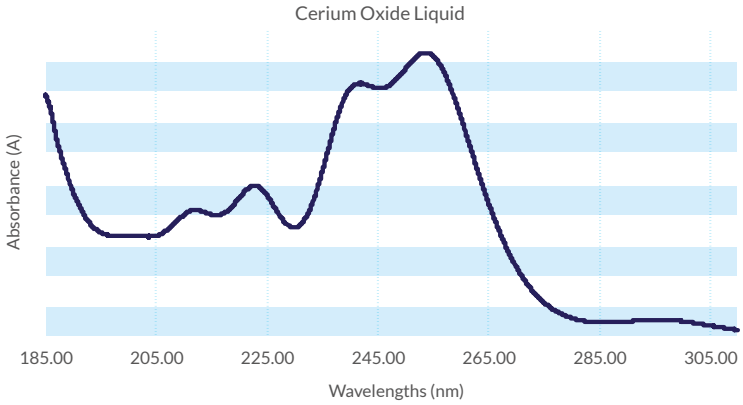
Rare Earth Oxides in acid solution have been the preferred wavelength references for UV spectrophotometry for many years. The unique range of liquid Certified Reference Materials from Starna covers wavelengths from the Deep UV to the visible. The solutions are permanently heat sealed into 10 mm far UV quartz cells.

Note: Nominal wavelength values given below are for guidance only. Because absorption bands are often asymmetric, measured values can be spectral bandwidth dependent. The Calibration Certificate accompanying each Starna reference gives actual values measured at bandwidths of 0.10, 0.25, 0.50, 1.00, 1.50, 2.00, 3.00, 4.00 and 5.00 nm. **Only the certified values should be used for instrument qualification.**

Far UV Reference (Cerium oxide in sulfuric acid) (200 – 270 nm)

This reference material is now recommended by the pharmacopoeias for wavelength qualification in the far UV and provides five peaks for wavelength qualification over the range 200 – 270 nm.

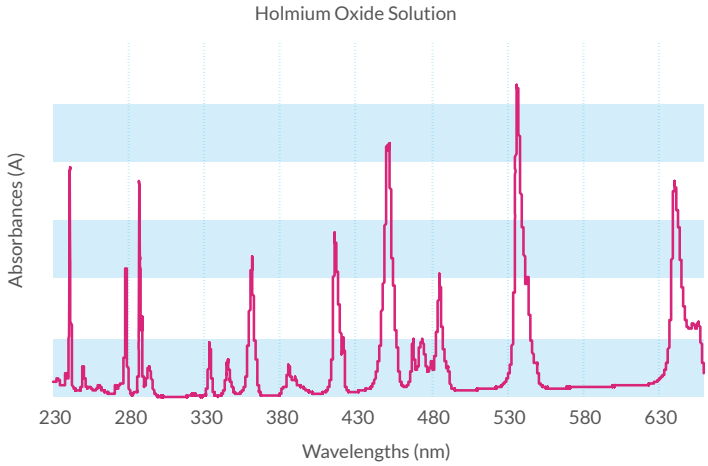
Nominal certified peak wavelengths (nm): 201, 212, 223, 240, 253



Holmium Oxide in perchloric acid (240 -650 nm)

4% m/v holmium oxide in 10% v/v perchloric acid. This is the most widely used reference for wavelength qualification and is accepted by all major pharmacopoeias and regulatory authorities. This reference gives a spectral scan containing a series of 14 sharp and well-defined peaks covering the wavelength range from 240 to 650 nm.

Nominal certified peak wavelength values (nm) are: 241, 250, 278, 288, 334, 346, 361, 385, 417, 451, 468, 485, 537, 641



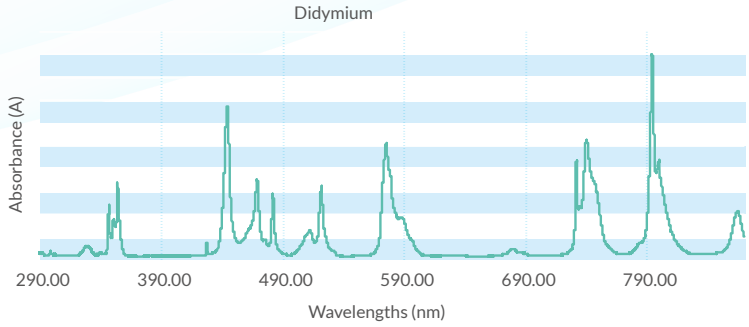
UV Wavelength Qualification

(200 – 870 nm)

Didymium Oxide in perchloric acid (290 – 870 nm)

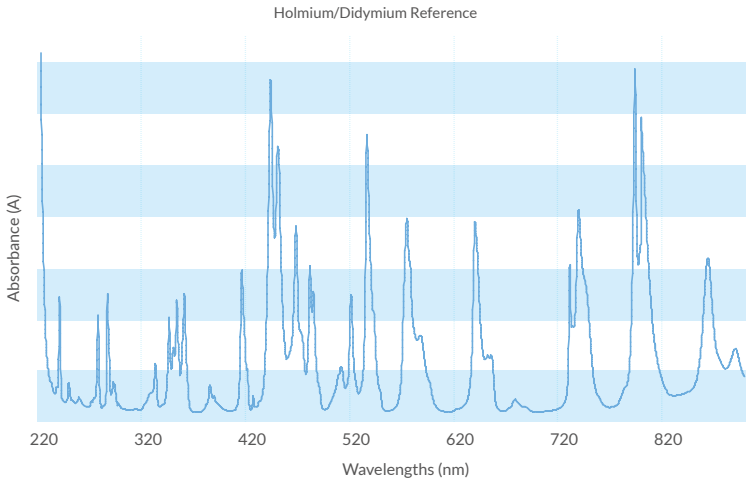
Didymium oxide is a mixture of neodymium & praseodymium oxides. This solution gives a series of 14 characteristic and well-defined peaks covering the wavelength range from 290 to 870 nm.

Nominal certified peak wavelength values (nm) are: 298, 329, 354, 444, 469, 482, 512, 522, 575, 732, 740, 794, 799, 864



Combined Holmium/Didymium Reference (240 -795 nm)

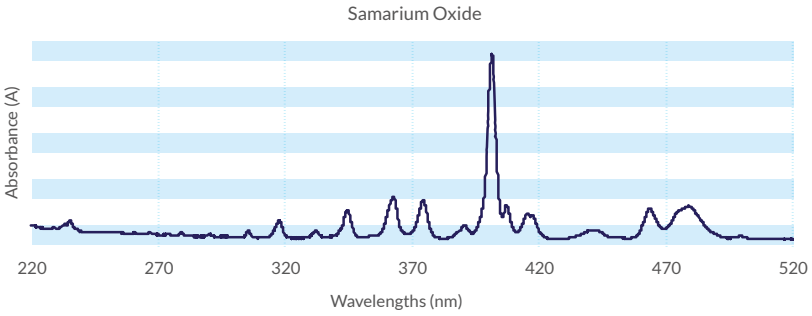
This unique combination reference has 14 well defined and useful certifiable peaks that are interference free and evenly distributed over its whole wavelength range, from 240 to 795 nm. The nominal peak wavelength values (nm) are: 241, 287, 361, 416, 444, 482, 485, 522, 537, 575, 641, 732, 740 and 794.



Samarium Oxide in perchloric acid (230 – 500 nm)

Samarium perchlorate is a particularly suitable reference material for checking the wavelength scale of a spectrophotometer over the commonly used range of 230 to 500 nm. Many of the peaks are very narrow, permitting accurate peak location and qualification..

Nominal certified peak wavelength values (nm) are: 235, 279, 290, 305, 318, 332, 344, 362, 374, 391, 401, 415, 464, 479



	CATALOGUE NUMBER
Cerium liquid cell	**RM-RE**
Holmium oxide liquid cell	**RM-HL**
Didymium oxide liquid cell	**RM-DL**
Holmium/Didymium liquid cell	**RM-HDL**
Samarium Oxide liquid cell	**RM-SL**

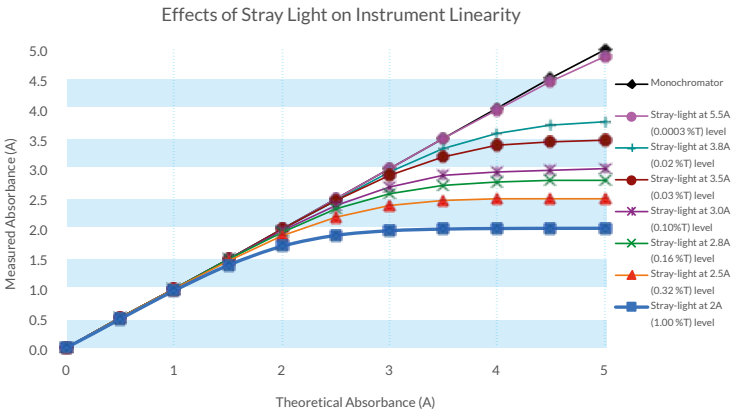
Note: other liquid reference materials suitable for UV wavelength qualification, and described elsewhere in this catalogue are:
Starna Deep UV Reference (wavelengths from 190-230 nm) See page 7.
Starna Green (250 nm – 650 nm, for instruments with wider bandwidths up to 20 nm). See page 9.

Liquid filters – Specified Wavelength method

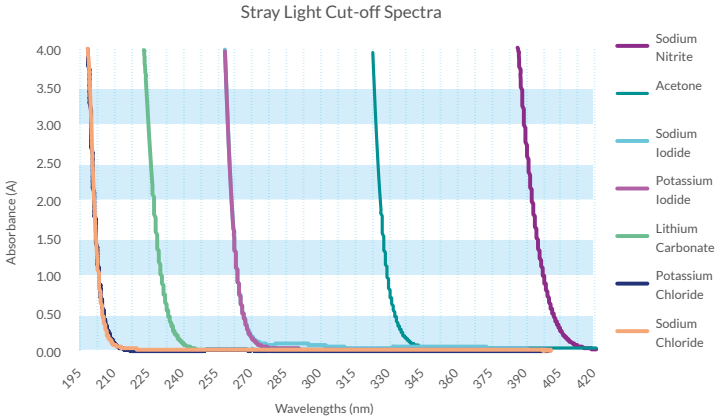
The Specified Wavelength method is approved by the European Pharmacopoeia, the US Pharmacopeia and most other regulatory bodies for qualifying the Stray Light of UV spectrophotometers. A range of liquid permanently sealed by heat fusion into Far UV quartz cells, covering the wavelength range from 175 nm to 385 nm.

Note: The US Pharmacopeia also recommends the Filter Ratio, or Mielenz method. Starna references for this method are described on pages 14 and 15.

Stray light, also called Stray Radiant Energy or Power, is any light reaching the spectrophotometer detector that is outside the Spectral bandwidth selected for analysis. This stray light is not absorbed even at high concentrations of the substance being determined, and this results in the reported concentration of the analyte being too low. Stray light is most noticeable when the energy throughput of the system is relatively low, for example in the far UV region. Any deterioration in the instrument optics or light source will exaggerate the apparent stray light, so checking it is an excellent way of monitoring the condition of the instrument optics.



The Specified Wavelength Method uses cut-off filters or solutions that cut off all light near the chosen analytical wavelength, and transmit at all higher wavelengths. The certified wavelength is that at which the spectrum, measured against a water blank, transitions 2.0 A. Below this wavelength, within the indicated usable range, any light transmission must be stray light.



UV Stray Light Qualification: EP and USP Compliance

(175-385 nm)

A range of materials allows stray light to be estimated at different wavelengths.

The USP and EP have different recommendations for the use of these materials.

Material	Concentration	Cut-off wavelength	
		USP <857>	EP 2.2.25
Potassium Chloride	12 g/l	≮ 2.0 A at 198 nm	≮ 2.0 A at 198 nm
Sodium Iodide	10 g/l	≮ 2.0 A at 220 nm	≮ 3.0 A at 220 nm
Potassium Iodide	10 g/l	≮ 2.0 A at 220 nm	≮ 3.0 A at 250 nm
Acetone	Spectroscopy grade	≮ 2.0 A at 300 nm	Not specified
Sodium Nitrite	50 g/l	≮ 2.0 A at 340 nm	≮ 3.0 A at 340 nm ≮ 3.0 A at 370 nm

Note: for USP compliance, either Sodium Iodide or Potassium Iodide may be used at 220 nm.

A convenient set of references, is available for this method, meeting both EP and USP requirements and covering a range of widely used wavelengths. The set includes the necessary blank cell.

Material	CATALOGUE NUMBER
Universal Stray Light reference set, EP and USP compliant	**RM-ACKCKISISN**

References may also be ordered individually:

Material	CATALOGUE NUMBER
Potassium Chloride solution & 10 mm water blank	**RM-KC**
Sodium Chloride solution & 10 mm water blank	**RM-SC**
Lithium Carbonate solution & 10 mm water blank	**RM-LC**
Potassium Iodide solution & 10 mm water blank	**RM -KI**
Sodium Iodide solution & 10 mm water blank	**RM-SI**
Acetone liquid & 10 mm water blank	**RM-AC**
Sodium Nitrite solution & 10 mm water blank	**RM-SN**

References can be ordered separately or in any combination simply by combining these catalogue numbers: for example **RM-KCSISN** would be a kit containing Potassium Chloride, Sodium Iodide and Sodium Nitrite references. A water blank is supplied with each reference or set of references.

Liquid filters – Filter Ratio (Mielenz) Method

The Filter Ratio method is approved by the US Pharmacopeia for qualifying the Stray Light of UV spectrophotometers. A range of liquid filters covers the wavelength range from 190 nm to 385 nm. It is particularly useful when testing high-performance instruments with very low stray light.

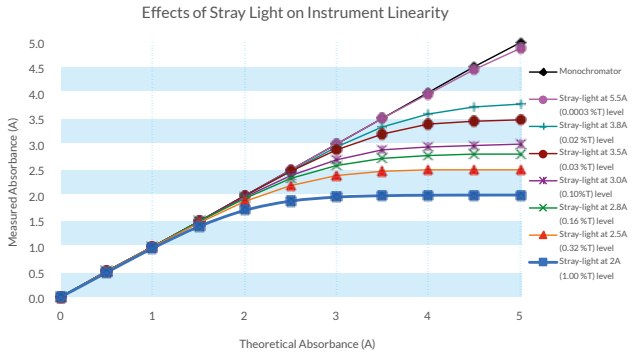
Note: The US Pharmacopeia and most other regulatory bodies also recommend the Specific Wavelength method. Starna references for this method are described on pages 12 and 13.

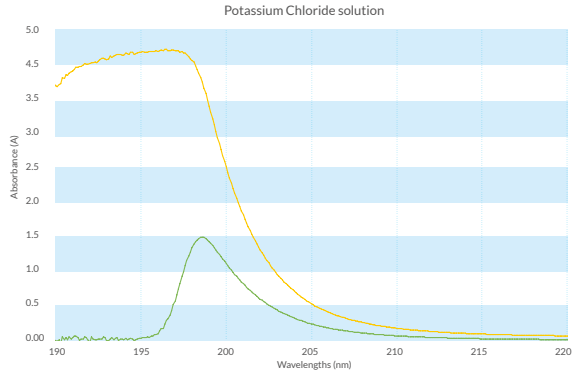
Stray light, also called Stray Radiant Energy or Power, is any light reaching the spectrophotometer detector that is outside the Spectral bandwidth selected for analysis. This stray light is not absorbed even at high concentrations of the substance being determined, and this results in the reported analyte concentration being too low. Stray light is most noticeable when the energy throughput of the system is relatively low, for example in the far UV region. Any deterioration in the instrument optics or light source will exaggerate the apparent stray light, so checking it is an excellent way of monitoring the condition of the instrument optics.

In this method the reference materials are measured in a 10 mm path length cell against a 5 mm path length cell containing the same solution. This has the effect of "real-time automatic attenuation" on the measured absorbance, resulting in a peak, as shown in these spectra obtained with Potassium Chloride solutions. This can simplify the measurement procedure, especially with high-performance instruments having very low stray light.

The differential absorbance value (ΔA) at the peak is related empirically to the Stray-Light level (s) by

$$s = 0.25 \times 10^{-2 * \Delta A}$$





The USP requires that at the peak, s is ≤ 0.01 and ΔA is ≥ 0.7

A range of materials allows stray light to be estimated at different wavelengths.

When choosing a Stray Light reference to qualify an instrument for a particular analysis, the analytical wavelength should lie within the usable range of the reference material.

Material	Concentration	Usable Range
Potassium Chloride	1.2% aqueous	190 - 210 nm
Potassium Iodide	1% aqueous	210 - 270 nm
Sodium Iodide	1% aqueous	210 - 270 nm
Acetone	Spectroscopy grade	250 - 330 nm
Sodium Nitrite	5% aqueous	300 - 400 nm

Potassium Iodide and Sodium Iodide may be regarded as interchangeable. Each reference is supplied in a permanently heat sealed 10 mm UV cell, with a 5mm cell of the same liquid to be used as measurement blank.

(190 - 385 nm)

A convenient set of references is available, suitable for this method and covering a range of commonly used wavelengths. The set includes the necessary blank cells.

Material	CATALOGUE NUMBER
Stray Light reference set, USP Filter Ratio method	**RM-ACKCSISN/5**

References may also be ordered individually:

Material	CATALOGUE NUMBER
Potassium Chloride, 10 mm & 5 mm cells	**RM-KC/5**
Potassium Iodide, 10 mm and 5 mm cells	**RM-KI/5**
Sodium Iodide, 10 mm and 5 mm cells	**RM-SI/5**
Acetone, 10 mm and 5 mm cells	**RM-AC/5**
Sodium Nitrite, 10 mm and 5 mm cells	**RM-SN/5**

References can be ordered in any combination by combining these catalogue numbers: for example **RM-KCSISN/5** would be a kit containing Potassium Chloride, Sodium Iodide and Sodium Nitrite references with 5 mm cells of each

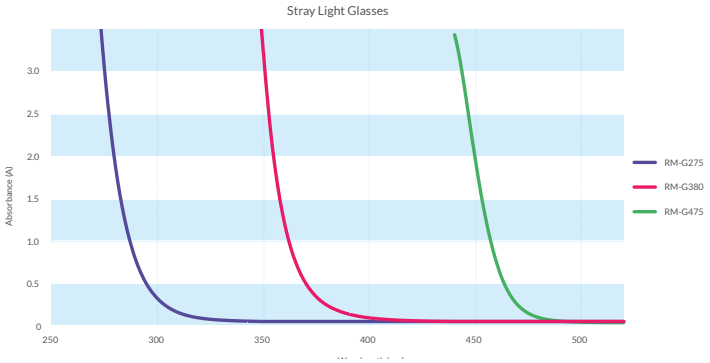
(210 – 440 nm)

Starna Stray Light Glasses

Used for testing Stray Light (Stray Radiant Energy) in the UV and Visible regions of the spectrum.

These glass filters contain inorganic materials whose spectra exhibit sharp cut-offs in the UV and visible regions

- An explanation of stray light and its effect on analytical results is given in p14 of this catalogue.
- These reference materials allow you to detect the presence of stray light in your instrument.
- Each material cuts off all light below the certified wavelength. The certified wavelength is that at which the absorbance, measured against air, exceeds 2.0 A. Any light detected by the instrument below that wavelength, within the usable range, must, by definition, be stray light.



MATERIAL	CUT-OFF (NM)	USABLE RANGE (NM)	CATALOGUE NUMBER
WG275	280	210 - 270	RM-G275
GG380	355	270 - 350	RM-G380
GG475	450	350 - 440	RM-G475

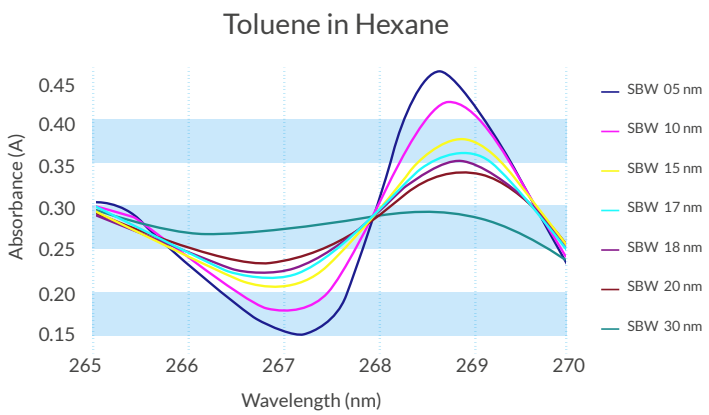
Note: Variations from melt to melt of the glass can cause variation in these wavelengths, up to ± 10 nm, so each Starna filter is individually certified.

Starna Toluene in Hexane Reference

Toluene in hexane is widely used to qualify the spectral bandwidth (resolution) of UV spectrophotometers, and is accepted for this purpose by most Pharmacopoeias and standardisation bodies. This reference comprises of two Far UV quartz cells permanently sealed by heat fusion, one containing 0.020% v/v toluene in hexane and the other a hexane blank.

Resolution is the ability of the instrument to discriminate between two adjacent absorbance bands. This is usually expressed as the Spectral bandwidth (SBW) of the instrument, which describes the range of wavelengths coming from the exit slit of the monochromator. The accuracy of the measured absorbance will depend on the ratio of the SBW to the natural bandwidth (NBW) of the absorbing substance. **To comply with Pharmacopoeia requirements, the instrument to be tested should have a spectral bandwidth not exceeding 1.8 nm (EP), or 2.0 nm (USP).**

The UV spectrum of toluene in hexane shows a maximum absorbance at 269 nm and a minimum at 267 nm:



The ratio of the peak maximum at 269 nm to the minimum at 267 nm gives a measure of the bandwidth of the instrument. Typical ratios for different bandwidths (at 20°C) are:

Spectral Bandwidth (nm)	0.5	1.0	1.5	2.0	3.0
Ratio	2.4 – 2.5	2.0 - 2.1	1.6 – 1.7	1.3 – 1.4	1.0 – 1.1

Note: These values are for guidance only. Actual values are given in the calibration certificate.

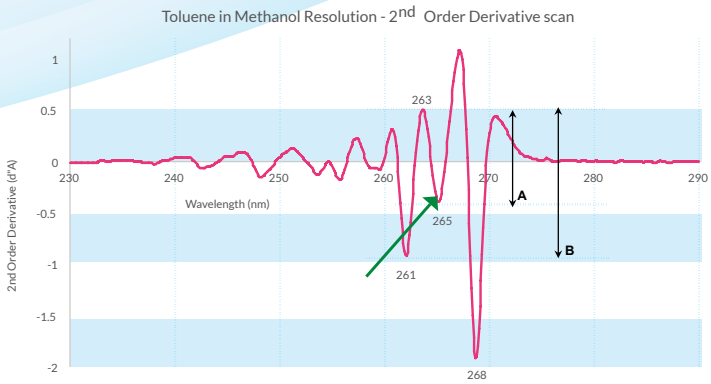
	CATALOGUE NUMBER
Toluene in hexane cell with hexane blank cell	**RM-TX**

Toluene in Methanol Reference for Derivative Spectroscopy (EP)

This reference is described in earlier versions of the European Pharmacopoeia as a resolution test for use in derivative spectroscopy. It comprises a 0.020% v/v solution of toluene in methanol, permanently heat sealed by heat fusion into a far UV quartz cell, with a methanol blank.

The 2nd derivative spectrum shows a small negative extremum (⟶) at 265 nm between two larger negative extrema at 261 nm and 268 nm.

If the instrument is functioning correctly, the ratio A/B should be greater than 0.2

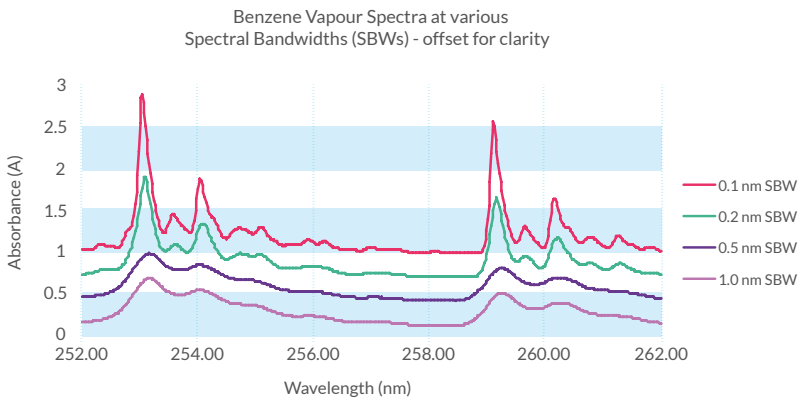


Benzene Vapour Reference – Bandwidths less than 1 nm

This reference is useful as a resolution check for instruments with spectral bandwidths less than 1 nm. 0.01 ml benzene liquid is sealed by heat fusion into a UV grade quartz cell. At room temperatures, the benzene is in the vapour phase.

The benzene vapour spectrum contains characteristic features that may or may not be resolved, dependent upon the spectrophotometer SBW. This is illustrated in the following spectra:

Note: Benzene vapour may not work well with all photodiode array spectro(photo)meters, as the resolution may be limited by the diode spacing of the array.



	CATALOGUE NUMBER
Toluene in methanol cell with methanol blank cell	RM-TM
Benzene vapour cell	RM-BZ

Starna Neutral Density Glass References

Schott NG type glass filters, from which a wide range of transmission and absorbance can be produced, have been available for over forty years. All Starna neutral density filters are manufactured and certified in accordance with the 'Technical Specification for Certification of Spectrophotometric NIST Traceable Reference Materials' (NIST Special Publication 260-140). This recommends calibration at 440 nm, 465 nm 546.1 nm, 590 nm and 635 nm, and Starna filters are certified at these wavelengths. Starna absorbance references are calibrated at a bandwidth of 1 nm, however other bandwidths are available on request They can also be certified at other wavelengths to suit customer requirements with the provision that the 440 nm, 546.1 nm and 635 nm wavelengths are included for traceability.

NIST Equivalent SRM Sets

Three specifications for neutral density filter Standard Reference Materials (SRMs) are listed by NIST: SRM 930e, SRM 1930 and SRM 2930. For those users wishing to work to these specifications, sets of filters equivalent to these SRMs are available:

	CATALOGUE NUMBER
SRM 930e equivalent set: 10, 20 & 30 %T (1.0, 0,7 & 0.5 A) and blank holder	**RM-1N2N3N**
SRM 1930 equivalent set 1, 3 & 50 %T (2.0, 1.5 & 0.3 A) and blank holder	**RM-N1N35N**
SRM 2930 equivalent set 0.1, 0.3 & 92 %T (3.0, 2.5 & 0.04 A) and blank holder	**RM-D1D39N**
NIST SRM Set Set of all 9 above filters and blank holder	**RM-SRM9ND**

Visible Spectrophotometer Qualification Set

This is a convenient way of qualifying a visible spectrophotometer for photometric accuracy, linearity and wavelength accuracy.

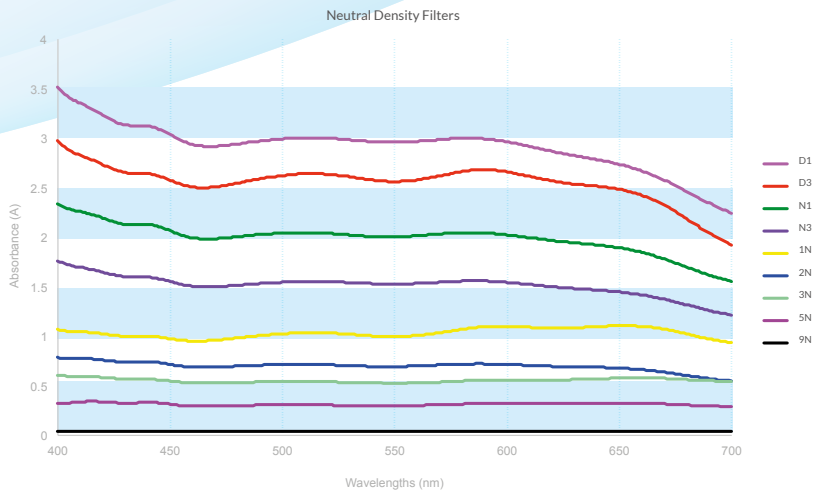
		CATALOGUE NUMBER
	Starna Transmission/Absorbance and Wavelength Set Neutral Density Filters: 1.00 ,0.50 &0.25 A (10, 30 & 52 %T) and blank holder & Holmium Glass Filter: **(see page 20 for full details)**	**1N3N5DHG**

The glass filters are mounted NIST pattern 'stress free' in an anodised aluminium holder.

The spectrum of these filters is essentially flat over the range of calibration.

A range of nineteen Neutral Density Filters is available in the standard format covering absorbance values from approximately 0.04 to 3.5 A.

These filters are also available in other dimensions 50 x 50 mm, 50 mm diameter and 25 mm diameter.



Starna selected sets and individual filters:

Any combination of references can be ordered as a set by combining the single filter catalogue numbers.

Nominal % Transmittance	Nominal Absorbance	CATALOGUE NUMBER			
		RM-4ND	RM-6ND	RM-9ND	Single filter
92	0.04			•	**RM-9N**
79.4	0.10				**RM-8N**
73	0.14			•	**RM-7N**
60	0.22			•	**RM-6N**
56.5	0.25	•	•		**RM-5D**
50	0.30				**RM-5N**
40	0.40				**RM-4N**
30	0.52	•	•	•	**RM-3N**
25	0.60				**RM-2D**
20	0.70				**RM-2N**
10	1.00	•	•	•	**RM-1N**
6	1.22				**RM-N6**
3	1.52		•	•	**RM-N3**
1.5	1.82				**RM-1D**
1	2.00	•	•	•	**RM-N1**
0.3	2.52			•	**RM-D3**
0.1	3.00		•	•	**RM-D1**
0.06	3.22				**RM-H6**
0.03	3.52				**RM-H3**

Rare Earth Glasses

These filters are useful as a limited wavelength check, however it should be noted that they are not accepted by all Pharmacopoeias.

Glass wavelength filters are made from different melts of glass. Users should therefore be aware that in some instances the actual peak positions and the availability of some defined peaks may vary from melt to melt.

This means that the certified values will also vary from melt to melt accordingly.

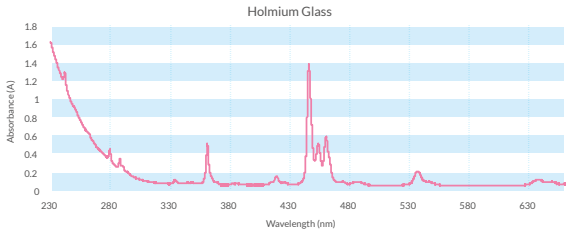
Glass filters containing rare earth oxides, mounted stress free in an anodised aluminium holder. Sliding window covers protect the surface from damage when not in use.

Holmium glass filter

The Holmium (neodymium & praseodymium) glass spectrum shows 11 characteristic and well-defined peaks from 240 nm to 640 nm.

Nominal peak wavelength values (in nm) are:

242, 279, 288, 334, 361, 419, 446, 454, 460, 537, 638
Also available in microscope slide format.

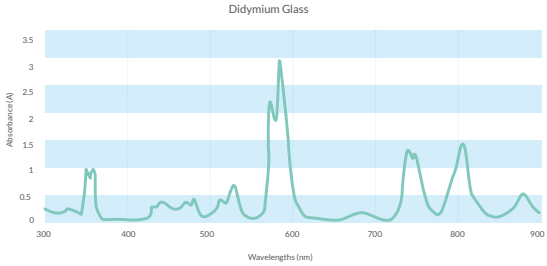


Didymium glass filter

Didymium glass has 11 peaks covering the wavelength range from 430 nm to 890 nm.

Nominal peak wavelength values (in nm) are:

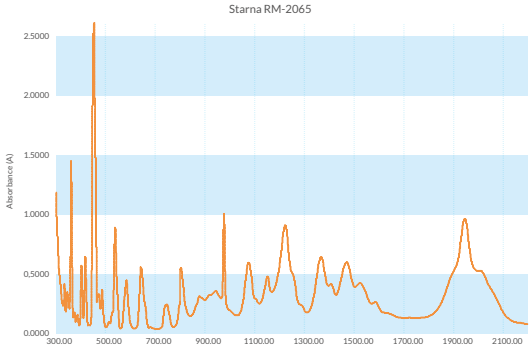
431, 473, 513, 529, 573, 585, 685, 741, 749, 807, 879.
Also available in microscope slide format



Starna Wide-Range Wavelength Reference

This exceptionally wide-range filter contains a mixture of rare earth oxides and provides 20 peaks for wavelength calibration between 335 nm in the UV and 1945 nm in the NIR. It is equivalent to NIST SRM 2065. Nominal peak wavelength values (in nm) are:

335, 345, 361, 375, 386, 402, 418, 485, 538, 583, 642, 748, 804, 976, 1076, 1151, 1222, 1366, 1469, 1945



	CATALOGUE NUMBER
Holmium glass filter	RM-HG
Didymium glass filter	RM-DG
Set of Holmium and Didymium filters	RM - HGDG
Wide range wavelength reference	RM-2065
Holmium filter (microscope slide)	RMM-HG
Didymium filter (microscope slide)	RMM-DG

Starna Rare Earth/Neutral Density Combination Filters

These unique combination wavelength/absorption filters have been purposely developed by Starna to provide a true certifiable way of routinely checking the wavelength and absorbance accuracy of a spectro(photo)meter with a single reference.

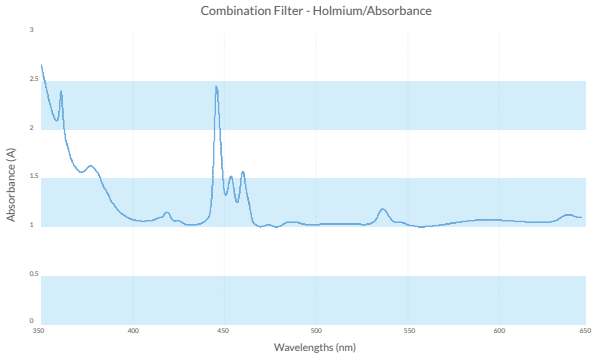
Glass filters containing holmium or didymium (neodymium & praseodymium) oxide, optically bonded to a 1 A (nominal) neutral density filter. The combined filter is mounted stress free in an anodised aluminium holder and sliding window covers protect the surface from damage when not in use.

Holmium/Neutral Density Combination Filter

The holmium spectrum is superimposed on an approximately constant 1 A background.

7 peak wavelengths are certified at nominal values of 361, 419, 446, 454, 460, 537 and 638 nm.

The absorbance values, nominally 1 A, are certified at suitable interference-free wavelengths between the holmium peaks, at 431, 516, 557, 594 and 623 nm. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.

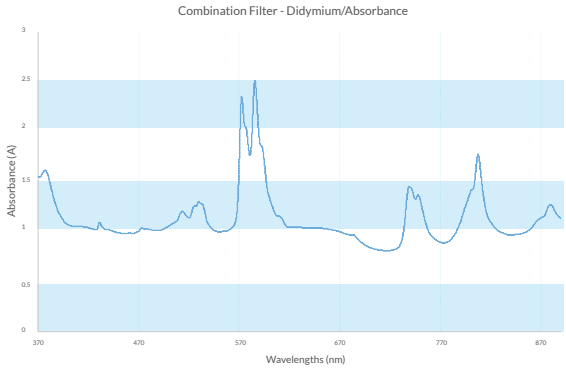


Didymium/Neutral Density Combination Filter

The didymium spectrum is superimposed on an approximately constant 1 A background.

9 peak wavelengths are certified at nominal values of 473, 514, 530, 572, 586, 739, 748, 807 and 879 nm.

The absorbance values, nominally 1 A, are certified at suitable interference-free wavelengths between the didymium peaks, at 410, 455, 550, 637 and 773 nm. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.

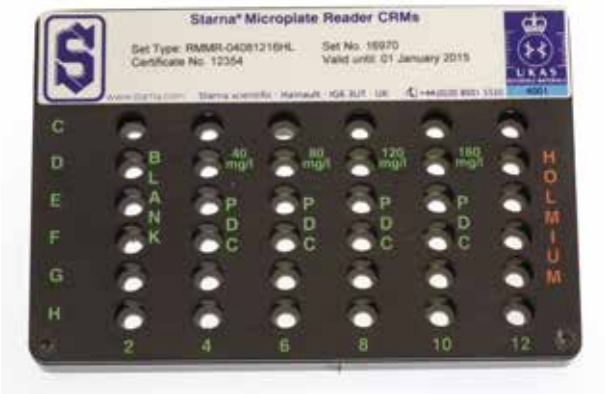


	CATALOGUE NUMBER
Holmium /Neutral Density combination filter	RM-HG/1ND
Didymium /Neutral Density combination filter	RM-DG/1ND
Set of Holmium & Didymium /Neutral Density combination filters	RM-HGDG/1ND

Starna Sealed Cell UV Plate Reader Reference

This reference uses Starna's proven and universally accepted UV reference materials for the qualification of 96-well plate readers. It contains six Starna liquid CRMs permanently sealed by heat fusion into Starna Far UV quartz cells, which are retained in a black anodised aluminium microplate, manufactured to the Society of Biomolecular Screening (SBS) dimensional standards for a 96-well plate.

The permanently heat sealed, liquid filled cell format utilises 5 mm path length cells that have a Starna patented bubble trap to minimise measurement errors. Potassium dichromate solution is used as an absorbance reference, and holmium oxide solution as a wavelength reference. These references are accepted by



Pharmacopoeias and Standardisation Bodies as evidence of instrument qualification. Full technical details and spectra of the individual reference materials may be found in the appropriate Starna data sheets.

www.starna.com/sealed-cell-microplate-reference

The standard product has the following configuration of reference position and CRM:

POSITION	REFERENCE
C2 - H2	Potassium dichromate 0.001 M perchloric acid blank
C4 - H4	Potassium dichromate 40mg/l in 0.001 M perchloric acid
C6 - H6	Potassium dichromate 80mg/l in 0.001 M perchloric acid
C8 - H8	Potassium dichromate 120mg/l in 0.001 M perchloric acid
C10 - H10	Potassium dichromate 160mg/l in 0.001 M perchloric acid
C12 - H12	Holmium oxide (8%) in 10% perchloric acid

Absorbance values for the potassium dichromate references are certified at 235, 257, 313, & 350nm and range from approximately 0.1 A to 1.0 A. The Holmium solution has 14 certified peak values from 240 nm to 640 nm.

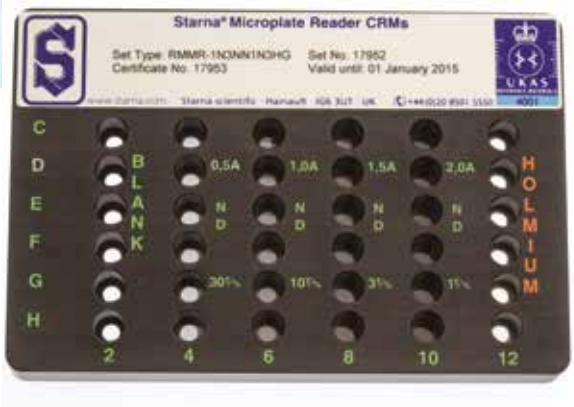
Any standard format Starna sealed liquid CRM is available in the Starna microplate format. These include references for wavelength accuracy, absorbance accuracy, stray light and resolution. Please contact Starna for more information.

	CATALOGUE NUMBER
Starna Sealed Cell UV Plate Reader Reference	**RMMR-04081216HL**

Starna Filter Visible Plate Reader Reference

Similar to the Liquid Filter reference plate, but using glass filter CRMs. Neutral density filters are used to qualify the absorbance scale and holmium oxide glass for wavelength. Full technical details and spectra of the individual reference materials may be found in the appropriate Starna data sheets.

www.starna.com/filter-microplate-reference



The standard product has the following configuration of reference position and CRM:

POSITION	REFERENCE
C2 - H2	Air blank
C4 - H4	Neutral Density Glass - 30 %T (0.5 Absorbance)
C6 - H6	Neutral Density Glass - 10 %T (1.0 Absorbance)
C8 - H8	Neutral Density Glass - 3 %T (1.5 Absorbance)
C10 - H10	Neutral Density Glass - 1 %T (2.0 Absorbance)
C12 - H12	Holmium Glass

Absorbance values are certified at 440, 465, 546.1, 590 and 635 nm for the neutral density filters.

The holmium filter has 11 certified peak values between 240 nm to 640 nm.

Any standard format Starna solid filter CRM is available in the Starna microplate format.

Starna Microplate Adapter

This convenient patented devise allows Starna standard format liquid cell or glass filter CRMs to be used to qualify 96-well microplate readers. Manufactured in a black ridged molded material, the device conforms to Society of Biomolecular Screening (SBS) dimensional standards for a 96-well plate and can accommodate any six standard format Starna cell- or filter-based CRMs. For users own test solutions, screw-cap 10 mm cells can be supplied.

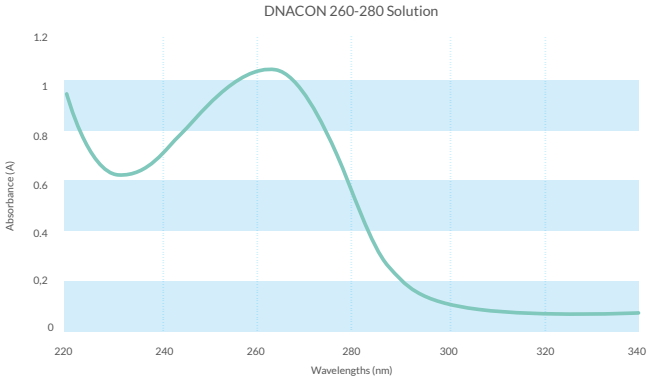
	CATALOGUE NUMBER
Starna Filter Visible Plate Reader Reference	RMMR-1N3NN1N3HG
Starna Microplate Adapter	SCP-96-8R
10 mm Quartz Cell with PTFE screw-cap	1.35/ST/Q/10

Starna DNACON Cell

This Certified Reference Material can be used for quality control and assurance of nucleic acid purity. The ratio of the UV absorbance values at 260 nm and 280 nm is an indication of the purity of nucleic acid preparations. Pure DNA and RNA solutions will have ratios of ≥ 1.8 and ≥ 2.0, respectively.

Reliable reference materials using DNA solutions are difficult to produce, are inherently unstable, and the materials themselves are often difficult to characterize, handle, package, store and certify.

The DNACON reference from Starna was developed as a reliable, stable and traceable reference material for the validation of this method. The reference consists of a solution of a synthetic material whose spectral characteristics closely mimic those of DNA, permanently sealed by heat fusion into a in a Far-UV quartz cell. By replicating an actual DNA sample, DNACON gives a reliable direct indication of the quality of the overall measurement process.



Absorbance values are certified at 260 nm, 280 nm and 330 nm at spectral bandwidths of 1.0, 2.0, 3.0, 4.0 and 5.0 nm . The value at 330 nm is used as a "background" correction, as in the normal methodology. From these values a corrected 260/280 ratio is calculated for each bandwidth using the formula:

$$\text{Ratio} = \frac{(A_{260} - A_{330})}{(A_{280} - A_{330})}$$

The nominal calculated ratio is 1.9

	CATALOGUE NUMBER
Starna DNACON 260/280 Reference	**RM-DNA**

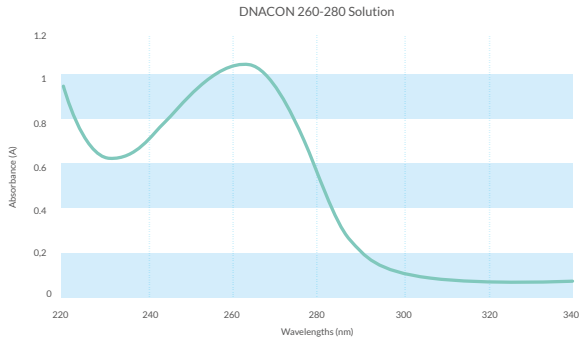
NOTE: This Reference Material is also available for use with dedicated microvolume instruments, see page 25

Starna DNACON

DNACON was specially developed by Starna for the validation of DNA purity using the 260/280 ratio method. These specially packaged versions of this reference are designed for the qualification of microvolume instruments, commonly used for this application. They are also ideal for qualifying conventional instruments used with ultra-low volume cells such as the Starna DMV - Bio cell.

More information about DNACON is given on page 24 of this catalogue.

The references are supplied in vials with screw-cap closure for ease of handling, from which it is easy to transfer them to the instrument under test using a micropipette or syringe. Two concentrations are available in vial format: the 5x concentration is suitable for the NanoDrop™ instrument and will give an absorbance value of approximately 0.5 at 260 nm while the 10x concentration is suitable for micro drop systems and will give an absorbance value of approximately 1.0 at 260 nm



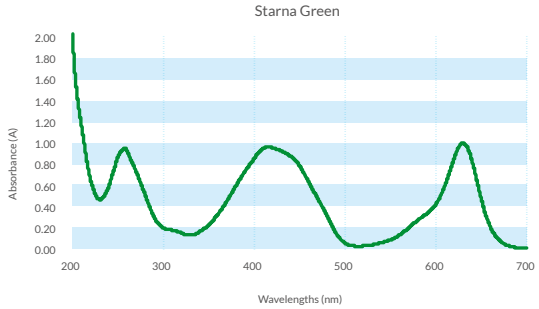
	CATALOGUE NUMBER
Starna Microvolume DNACON Reference, 5X concentration : 1 x 1,5ml vial	**DNACON5X-SC1**
2 x 1.5 ml vials	**DNACON5X-SC2**
4 x 1.5 ml vials	**DNACON5X-SC4**
Starna Microvolume DNACON Reference, 10X concentration :1 x 1,5ml vial	**DNACON10X-SC1**
2 x 1.5 ml vials	**DNACON10X-SC2**
4 x 1.5 ml vials	**DNACON10X-SC4**

Starna Green Wavelength and Absorbance Qualification

Not all microvolume instruments are used for nucleic acid measurements, and these specially packaged versions of the Starna Green reference can be used to qualify these instruments for general spectrophotometric measurements. More information on Starna Green will be found on page 9 of this catalogue.

This reference is formulated to give a nominal absorbance of 1A at each of the certified wavelengths, 258, 416 and 630 nm, at a path length of 1 mm.

The references are supplied in vials with screw-cap closure for ease of handling, from which it is easy to transfer them to the instrument under test using a micropipette or syringe. Each vial contains 1.5 ml of Starna Green solution.

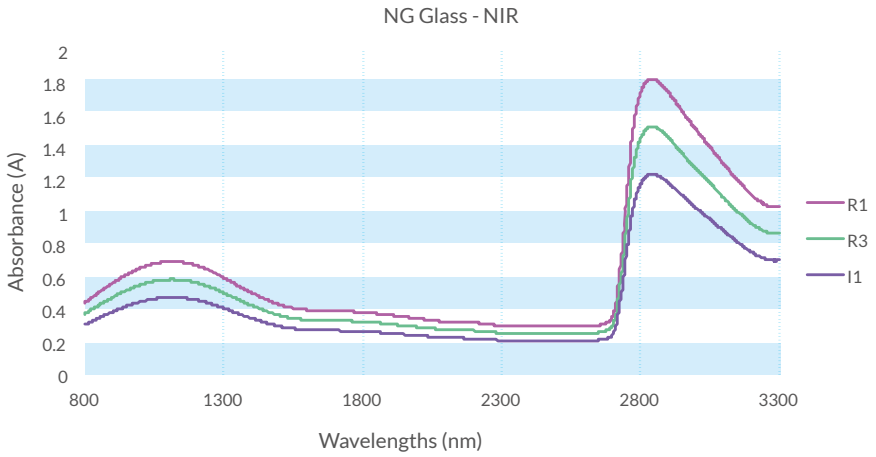


	CATALOGUE NUMBER
Starna Green Microvolume reference, 1 x 1.5 ml vial	**RM-1000G-SC1**
Starna Green Microvolume reference, 2 x 1.5 ml vials	**RM-1000G-SC2**
Starna Green Microvolume reference, 4 x 1.5 ml vials	**RM-1000G-SC4**

Starna NIR Neutral Density Glass References

These references can be used to qualify the absorbance accuracy and linearity of near-infrared spectrophotometers with a spectral bandwidth of 6.5 nm or less, over the wavelength range 800 nm - 3200 nm. The glass filters are mounted 'stress free' in an anodised aluminium holder.

The spectrum of these filters is relatively flat over most of the range of calibration, but with significant deviation above 2700 nm.



Calibration values (in % Transmission and Absorbance) are certified at 1100, 1700, 2210, 2500 and 2850 nm. Three filters are available, designated R1, R3 and I1. Nominal values are:

Nominal values at certified wavelengths										CATALOGUE NUMBER
1100 nm		1700 nm		2210 nm		2500 nm		2850 nm		
%T	A	%T	A	%T	A	%T	A	%T	A	
20	0.70	40	0.40	47	0.32	49	0.31	2	1.83	RM-R1
25	0.59	46	0.34	53	0.28	55	0.26	3	1.54	RM-R3
33	0.48	53	0.28	59	0.23	60	0.22	6	1.25	RM-I1
Set of all 3 filters as above										RM-R1R3I1

Starna Metal-on-Quartz filters

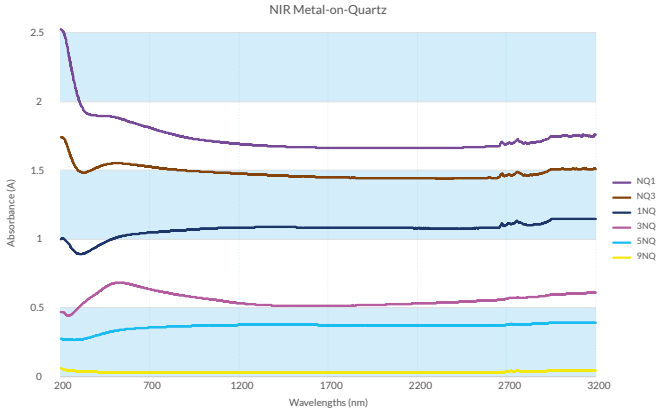
This Reference Material can be used to qualify the Absorbance scale of spectrophotometers in the ultra-violet, visible and near-infrared regions of the spectrum (250 nm to 3200 nm.)

The transmission characteristics of the filter are determined by the thickness of a metallic coating deposited on a quartz plate. The metallic surface is overlaid by an optically bonded cover plate, to protect it from oxidation, contamination, or physical degradation.

The filters are mounted in stress-free black-anodized aluminium alloy holders, with front and rear sliding covers that protect the filters when not in use. All individual references and sets are supplied with an empty filter holder for use as a measurement reference.

The spectrum of these filters is essentially flat from 250 nm to 3200 nm.

Absorbance and Transmittance values are certified at 250.0, 360.0, 465.0, 546.1, 635, 1100, 1700, 2210, 2500, and 2800 nm. Starna absorbance references are calibrated at a bandwidth of 1 nm. Other bandwidths may be available on request.



They are available in sets:

	CATALOGUE NUMBER
Metal on Quartz NIR Reference Set: 3 & 50 %T (1.5 & 0.3 A) & Blank Holder	**RM-NQ35NQ**
Metal on Quartz NIR Reference Set: 10, 30 & 92 %T (1.0, 0.5 & 0.04 A) & Blank Holder	**RM-1NQ3NQ9NQ**
Metal on Quartz NIR Reference Set: 1, 3 & 50 %T (2.0, 1.5 & 0.3 A) & Blank Holder	**RM-NQ1NQ35NQ**

Or as individual filters:

Nominal Values		CATALOGUE NUMBER
% Transmittance	Absorbance	
92	0.04	RM-9NQ
50	0.3	RM-5NQ
30	0.5	RM-3NQ
10	1.0	RM-1NQ
3	1.5	RM-NQ3
1	2.0	RM-NQ1

Any combination of filters can be ordered as a set by combining the catalogue numbers as in the examples above. A blank filter holder is supplied with each reference or set of references.

Starna NIR Solution References

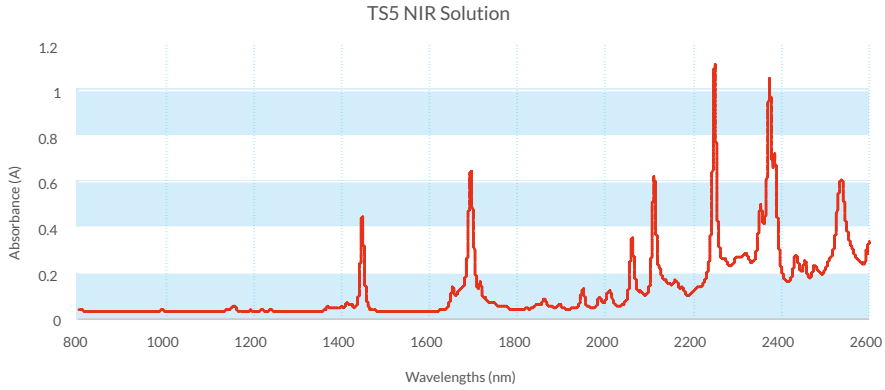
This Certified Reference Material can be used to qualify the wavelength calibration of near-infrared spectrophotometers from 900 nm to 2600 nm. It consists of a proprietary organic matrix (TS5), permanently sealed by heat fusion in a high quality quartz cell

It is available in two formats: either as in 10 mm cell, or in a 5 mm mirror-coated cell. The 10 mm cell is used in transmission mode in conventional NIR spectrophotometers. The 5 mm cell has four polished windows: when used in the 5 mm (mirror) orientation, it simulates reflectance measurements with an effective path length of 10 mm, in the other orientation it becomes a transmittance reference with an effective 10 mm path length.

14 certified peaks are available for wavelength qualification purposes.

Nominal peak wavelength values (in nm) are:

991, 1155, 1447,1652, 1693, 1861, 1948, 2060, 2111, 2248, 2353, 2373, 2385, 2536



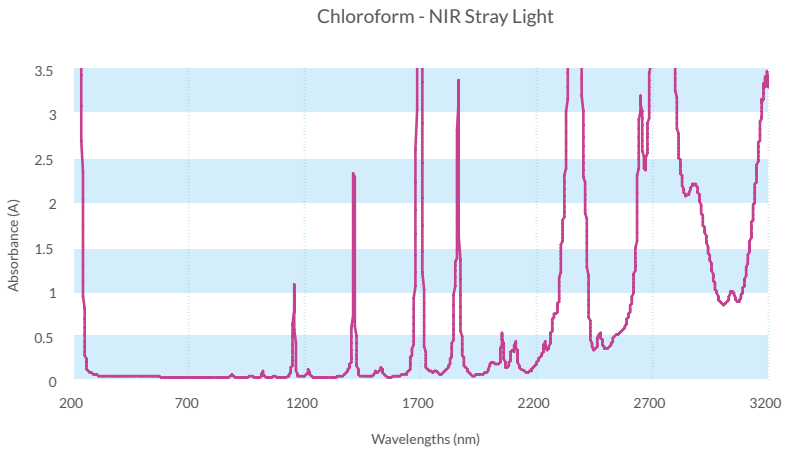
	CATALOGUE NUMBER
Starna Near Infrared Wavelength Reference Cell.	**RM-NIR**
Starna Near Infrared Transflectance Wavelength Reference Cell.	**RM-NIR/T**

Starna Chloroform Stray Light Cell

This Reference Material can be used to estimate the Stray Light (Stray Radiant Energy) of near-infrared spectrophotometers at approximately 2365 nm. Spectroscopic grade chloroform is permanently sealed by heat fusion in a high quality quartz cell. Heat sealing the cell in this way eliminates the risks associated with handling this volatile, hazardous substance.

The spectrum shows a cut - off (i.e. Absorbance >2.0A) at approximately 2365 nm. Any light detected within ± 20 nm of this wavelength will be stray light. The certified cut-off wavelength is the wavelength at which the absorbance value exceeds 2.00 A

Note: The spectral bandwidth of the instrument at 2365 nm should not exceed ±20 nm otherwise the stray light will be over-estimated.



	CATALOGUE NUMBER
Starna Chloroform Stray Light Cell	**RM-CHCL3**

Starna Polystyrene NIR References

Polystyrene film has been a recognised wavelength reference in infrared spectroscopy for many years. **The Starna polystyrene references are the only references traceable to NIST, via an ISO/IEC 17025 Certificate**.

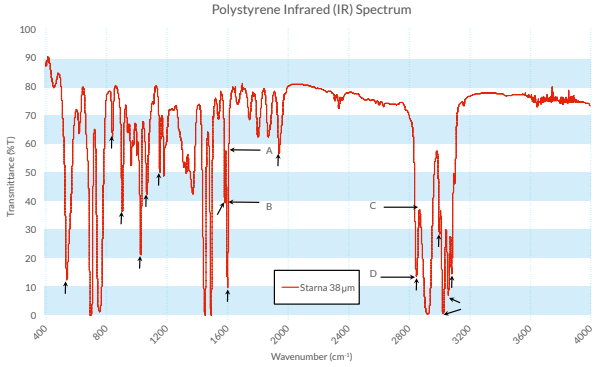
Polystyrene is now accepted by pharmacopoeias as a wavelength and resolution reference

14 certified peaks (arrowed in spectrum below) are available for wavelength qualification purposes. The calibration values are traceable to NIST SRM 1921b and this material is now accepted for wavelength qualification by some pharmacopoeias.

Approximate peak wavelength values (in cm^{-1}) are:

539, 842, 907, 1028, 1069, 1155, 1583,1601, 1943, 2849, 3001, 3026, 3060, and 3082

The absorption minima and maxima at A and B, C and D can be



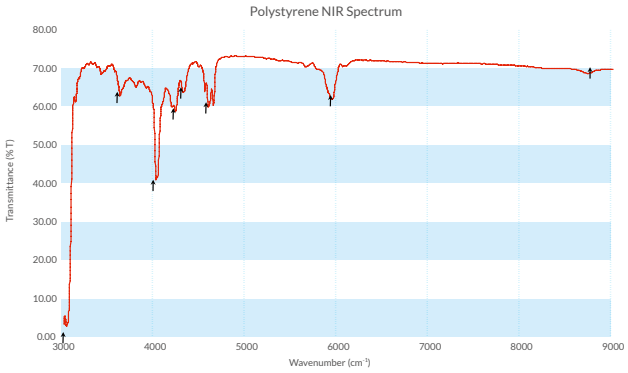
used to qualify instrument resolution according to pharmacopoeia requirements (EP/JP/USP).

The alternative version has a film thickness of 65 µm and also has certified peaks in the Near-Infrared, covering wavelengths from 3000 cm^{-1} to 9.000 cm^{-1} (3.3 to 1.1 µm).

Eight peaks are available for wavelength qualification purposes in the NIR. In this case the calibration values are traceable to NIST SRM 2065.

Nominal peak values are:

In cm^{-1} : 3064, 3647, 4039, 4250, 4335, 4608, 5952, 8749
In nm: 3264, 2742, 2476, 2353, 2307, 2170, 1680, 1143



The 38 µm film can also be supplied in a format suitable for qualifying ATR (Attenuated Total Reflectance) instruments according to EP 2.2.24.

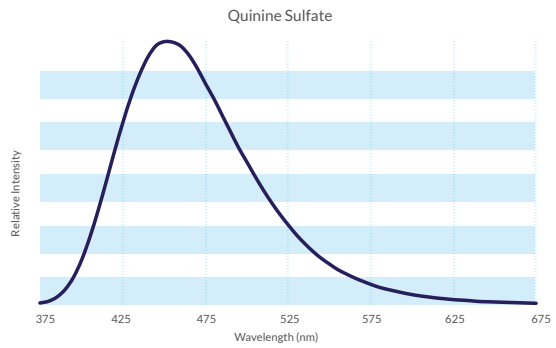
	CATALOGUE NUMBER
Starna Mid IR-FTIR Polystyrene Reference, 38 µm	RM-1921/38
Starna Mid IR-FTIR/NIR Polystyrene Reference, 65 µm	RM-1921/65
Starna Mid IR-FTIR Polystyrene Reference for ATR, 38µm	RM-1921/38/ATR

Starna Quinine Sulfate References

Quinine sulfate dihydrate in perchloric acid was one of the first reference materials developed for use in fluorescence spectroscopy, and is designated SRM 936a by NIST. It can be used to qualify the spectral response of a spectrofluorometer over the range 375 nm to 675 nm. It can also, over a limited concentration range, be used as a linearity check.

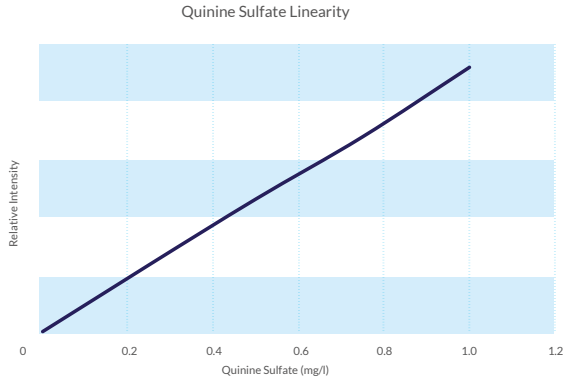
10mm far UV quartz fluorometer cuvettes with polished faces at 90° containing quinine sulphate solution, permanently sealed by heat fusion. The reference can be supplied with or without a perchloric acid blank. It is also available as a set of four solutions with concentrations up to 1.0 mg/l for use as a linearity check.

The data supplied with the reference is based on its corrected fluorescence emission spectrum using an excitation wavelength of 347.5 nm:



In the Calibration Certificate supplied, the relative emission intensity is tabulated at 5 nm intervals.

From this data it is simple to calculate intensity correction factors for the instrument under test, and hence the corrections to be applied to sample measurements made on that instrument.



At low concentrations (up to 1 mg/l, this material can be used to check the linearity of response of a spectrofluorometer, and a set of references with concentrations 0.25, 0.5, 0.75 and 1 mg/l is available for this purpose.

	CATALOGUE NUMBER
Quinine Sulfate Spectral Response & Linearity Set 0.25, 0.5, 0.75 and 1 mg/l Quinine Sulfate in perchloric acid + perchloric acid blank cell	**RM-4QS00**
Quinine Sulfate Spectral Response & Linearity Set (2 concentrations) 0.5 and 1 mg/l Quinine Sulfate in perchloric acid + perchloric acid blank cell	**RM-2QS00**
Quinine Sulfate Spectral Response Cell 0.5 µg/ml Quinine Sulfate in perchloric acid	**RM-QS**
Quinine Sulfate Spectral Response Cell + Blank As above with perchloric acid blank cell	**RM-QS00**

Ultra High Purity Water Reference

This Certified Reference Material can be used to qualify the Signal to Noise Ratio of a spectrofluorometer near the limit of detection and hence indicate its ultimate sensitivity.

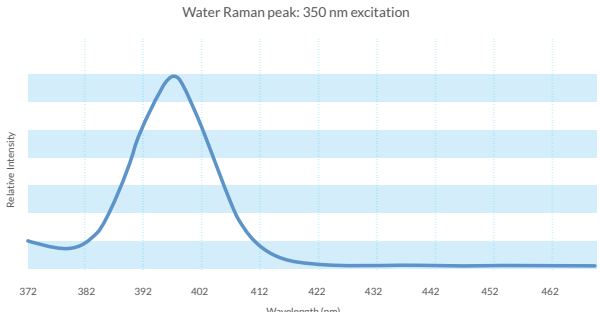
Traditionally, the performance of spectrofluorometers has been tested using dilute solutions of known fluorophores such as quinine sulfate or rhodamine to determine spectral response factors. Near the detection limit of a high-performance instrument however, this is impractical because the necessary sample concentrations are so low that sample preparation becomes difficult and error-prone and there is high potential for sample contamination.

An alternative approach, employed in this reference, is to use the phenomenon of Raman scattering. When excited at appropriate wavelengths, pure water exhibits a Raman shift spectrum analogous to fluorescence. This spectrum can be used to evaluate the signal-to-noise ratio of a fluorescence spectrophotometer near the detection limit.

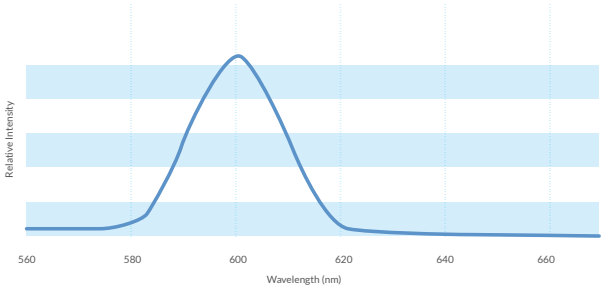
10 mm far UV quartz fluorometer cuvette with polished faces at 90° containing ultra-high purity water, permanently sealed by heat fusion.

Typical emission spectra are provided with excitation at 350nm and 500nm :

Peak at 350 nm Excitation



Peak at 500 nm Excitation



The signal –to-noise ratio for a given excitation wavelength may be calculated using the instrument software.

Note that the calculated ratio will depend on the calculation protocol employed by the instrument manufacturer and therefore 'compliance to specification' limits will be specific to the spectrofluorometer type under test.

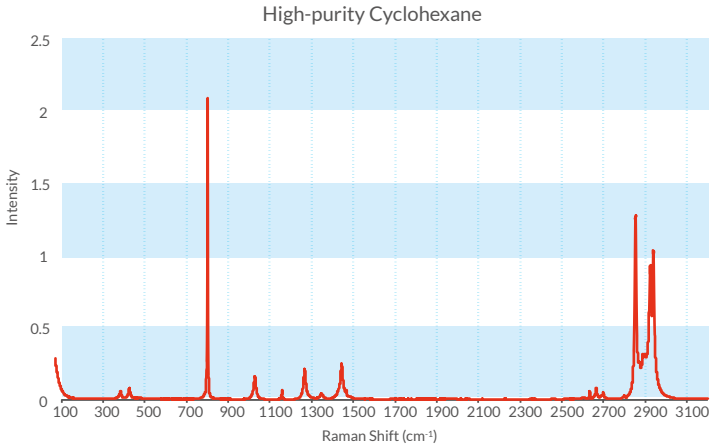
	CATALOGUE NUMBER
Ultra high purity water reference	**RM-H2O**

Cyclohexane Raman Reference

This reference material can be used to qualify the wavelength scale of Raman spectrometers between 380 cm^{-1} and 3000 cm^{-1}. It is cited for this purpose in ASTM E1840 - 96(2014).

Reagent grade cyclohexane is permanently sealed by heat fusion into a 10 mm quartz cuvette. The permanently sealed cuvette eliminates the hazards associated with handling this volatile, toxic and highly flammable material.

Compared to atomic emission lines, Raman shift standards offer an easier-to-use alternative for qualifying the wavelength scale of Raman Spectrometers. They are also independent of laser frequency. The Raman shift values for cyclohexane have been accurately measured and it is widely used as a reference material. Using an excitation wavelength of 514.5 nm, 11 shift values covering a range from 384.1 to 2938.3 cm^{-1} can be identified.



	CATALOGUE NUMBER
Starna Cyclohexane Cell	**RM-C6H12**

References for Pharmacopoeia Compliance

The Regulations

The regulations for ultraviolet and visible spectroscopy were recently updated by the US and European pharmacopoeias. The revised **US Pharmacopeia (USP) Chapter <857>** became mandatory on 1st December 2019. **European Pharmacopoeia 10.0 (EP) Chapter 2.2.25** became mandatory on 1st January 2020. Earlier versions of the pharmacopoeias described a limited set of generic tests to qualify an instrument for wavelength, absorbance, stray light and resolution (spectral bandwidth). If the instrument passed these tests, in could be described as 'pharmacopoeia compliant'. This is no longer the case: these limited tests no longer qualify an instrument for the variety of measurements encountered in the modern pharmaceutical laboratory. Users must now demonstrate '**fitness for purpose**', i.e. that the instrument has the capability to perform the actual analysis to the required accuracy and precision. The qualification measurements must therefore be made at parameter values that match or '**bracket**' those used in the analysis. This means that it is no longer possible to specify 'kits' that can qualify instruments for all applications. Both standards now require absorbance linearity to be qualified. The Basic Qualification Kits described below will meet the routine needs of many laboratories and can be supplemented with additional references if required. Starna CRM kits offer cost savings when compared to the purchase of individual references.

Basic Qualification Kits

The kits below will allow instrument qualification over the stated wavelength and absorbance ranges for compliance with EP 2.2.25 and USP <857>. References are provided to qualify wavelength accuracy, absorbance accuracy and 3-point linearity, stray light and resolution/bandwidth. The stray light references for USP compliance are for Chapter <857> Method B.

These kits have been designed to qualify UV-visible spectrophotometers over the wavelength and absorbance ranges commonly used in pharmaceutical analysis. If your operating parameters fall outside these ranges, Starna offers the world's biggest range of spectroscopy CRMs as illustrated elsewhere in this catalogue and will be pleased to recommend additional or alternative references to meet individual requirements. Please contact sales@starna.com for advice and information.

Basic Kit for EP2.2.25 compliance

Catalogue number: RM-EP20
[Kit Identity: RM-020610HLKISISNTX]

REFERENCE	TO QUALIFY	WAVELENGTH RANGE
Holmium cell	Wavelength accuracy	240 - 650 nm
Potassium Dichromate 20, 60 & 100 mg/l & blank cell.	Absorbance accuracy and linearity, 0-1 A	235 – 350 nm
Sodium Iodide	Stray light, 220 nm	220 -370 nm
Potassium Iodide	Stray light, 250 nm	
Sodium Nitrite	Stray light, 340, 370 nm	
Toluene in Hexane	Resolution (bandwidth), 265-270nm	265-270 nm

Basic Kit for USP Chapter <857> compliance

Catalogue number: RM-USP20
[Kit Identity: RM-020610HLACKISNTX]

REFERENCE	TO QUALIFY	WAVELENGTH RANGE
Holmium cell	Wavelength accuracy	240 - 650 nm
Potassium Dichromate 20, 60 & 100 mg/l & blank cell.	Absorbance accuracy and linearity, 0-1 A	235 – 350 nm
Potassium dichromate	Absorbance accuracy, 1 A	430 nm
Potassium Iodide	Stray light, 220 nm	220 -370 nm
Acetone	Stray light, 300 nm	
Sodium Nitrite	Stray light, 340 nm	
Toluene in Hexane	Resolution (bandwidth), 265-270nm	265-270 nm

Basic Combination kit for EP and USP compliance

Catalogue number: RM-USPEP20
[Kit Identity: RM-020610HLACKISISNTX]

REFERENCE	TO QUALIFY	WAVELENGTH RANGE
Holmium cell	Wavelength accuracy	240 - 650 nm
Potassium Dichromate 20, 60 & 100 mg/l & blank cell.	Absorbance accuracy and linearity, 0-1 A	235 – 350 nm
Potassium dichromate	Absorbance accuracy, 1 A (USP)	430 nm
Sodium Iodide	Stray light, 220 nm (EP)	220 -370 nm
Potassium Iodide	Stray light, 220 nm (USP), 250nm (EP)	
Acetone	Stray light, 300 nm (USP)	
Sodium Nitrite	Stray light, 340 nm (EP & USP), 370 nm (EP)	
Toluene in Hexane	Resolution (bandwidth), 265-270nm	265-270 nm

Far UV extension kit – EP and USP compliance

Catalogue number: RM-06A12A24AREKC

REFERENCE	TO QUALIFY	WAVELENGTH RANGE
Cerium cell	Wavelength accuracy	200 -270 nm
Nicotinic acid 6, 12 & 24 mg/l	Absorbance accuracy and linearity, 0-1 A	210 - 270 nm
Potassium Chloride	Stray light, 200 nm	200 nm

Starna Calibration Services

Experience & Accreditation

Starna has over forty-five years' experience in the production and calibration of both glass filters and liquid reference materials for spectrophotometry, and offers a unique range of reference materials covering the complete spectrum from Deep UV to Mid Infrared.

Calibration accreditation through UKAS to ISO/IEC17025 was achieved in 2001. This was followed in 2006 by Starna also achieving ISO Guide 34 as a Reference Material Producer. Starna was the first CRM producer to be awarded accreditation to both Standards by UKAS, the UK Accreditation Service.

In November 2016, ISO Guide 34 was revised and became ISO 17034.

Calibration Services

The Starna Calibration and Recalibration Laboratory offers a calibration and re-calibration service to ISO/IEC 17025, which is the highest level of accreditation currently available. Calibration is carried out on one of five fully qualified reference spectrophotometers.

This calibration service is not only available for reference materials manufactured by Starna, but also for similar materials manufactured by third parties, such as NIST and other commercial organizations.

Starna is also able to extend the service to cover a wide range of optical products within the UV-Visible-NIR range. We welcome enquiries for all types of similar products, even though in some instances they may not have been produced in the first instance as certified references.

Among the many products that Starna Scientific certify are a wide variety of reference plates for plate reader instruments from a number of manufacturers.

Certification is normally completed within five working days from receipt of the references at the Starna Calibration Laboratory. In urgent situations this time may be reduced.

Calibration of third party products.

Starna welcomes enquiries from users, NMIs and reputable commercial operations to calibrate or recalibrate suitable materials eg Neutral density filters, Metal-on-quartz filters and glasses.

Certification in USB Electronic Format

As a result of increased customer requests for certificates and associated data to be supplied in electronic format, from 2013 Starna certificates have been provided in electronic format (USB Stick).

It is now easy to input calibration data directly into users' own databases, facilitating retrieval of historical records and the circulation of calibration data. Useful technical information on Certified Reference Materials is also provided on the stick.

For customers whose security protocols do not allow the transfer of data by USB stick, printed/soft copy can be provided on request at no additional cost.

Certified Values and Uncertainty Budgets

The certificate values given for any CRM are not absolute, but the result of a calibration process that will itself be subject to any variability of the calibration instrument. This means that there is a small uncertainty surrounding the certified value, the "uncertainty budget" of the CRM. The "expanded uncertainty budget" stated in the calibration certificate is the uncertainty to be expected in the measured parameter during the two year validity of the certificate, and is stated with a 95% confidence level (k=2).

When a CRM is used to qualify an instrument, the total allowed tolerance is the sum of the certificate uncertainty and the manufacturer's specified accuracy of the instrument, as in the following example:

	Wavelength	Absorbance
Certificate uncertainty budget	±0.10 nm	±0.0049 A
Instrument specification	±0.30 nm	±0.0050 A
Total tolerance	±0.40 nm	±0.0099 A

If the difference between the measured value and the certified value is less than the total tolerance, the instrument can be judged to be compliant. The difference should also be less than the error permitted by the quality regime prevailing in the laboratory and/or the requirement of the analytical method in use.

Note that because absorption bands are often asymmetric, measured values can be spectral bandwidth dependent. Starna Calibration Certificates always quote the bandwidths at which the certified values were obtained. Only these certified values should be used for instrument qualification, and many reference materials have a maximum usable bandwidth limit.

Traceability

Traceability is another very important concept in the qualification process, defined in ISO/IEC Guide 99:2007 as the **"property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty"**

Starna CRMs are certified using a number of reference spectrophotometers, all qualified using Standard Reference Materials certified by the National Institute of Standards and Technology (NIST) in the NIST in the USA, other NMI laboratories where applicable or against primary physical references such as elemental emission lines. The references used are universally recognised, and are named on the certificates that accompany all Starna CRMs.

Recertification

As agreed with the accreditation authority (UKAS) the validity of Starna certificates expires after a period of **TWO YEARS** from the date of issue unless otherwise stated. Reference materials may be recalibrated at shorter intervals depending on the protocol under which they are being used, some periods being as short as six months.

Recertification is normally completed within five working days from receipt of the references at the Starna Calibration Laboratory. In urgent situations this time may be reduced. Transportation time to and from the calibration laboratory should be allowed for to minimize disruption to continuity of compliance.

On receipt by Starna Scientific the references are measured "As received", before cleaning under the re-certification procedure. "As received" data is available on request.

Regulated laboratories are encouraged to hold two sets of references, purchased twelve months apart, to ensure total continuity of compliance whilst references are returned for revalidation. This is also an insurance against accidental breakage or damage.

Technical Support

Starna technical staff are available to assist with any queries on the selection or use of reference materials. Please send enquiries to: **sales@starna.com**.

Terms & Conditions

Product Warranty

Starna Certified Reference Materials are manufactured with extreme care under closely controlled conditions. Similar care should be exercised in their storage and use.

All reference materials are certified and supplied in a useable condition. There is no warranty for fitness beyond receipt by the customer. Starna does, however offer a conditional Lifetime Guarantee on all Starna reference materials, unless otherwise stated, such that any reference material which moves outside its published uncertainty budget will be replaced free of charge. This guarantee is subject to the reference materials being re-certified at least every two years and to the references having been used and stored as prescribed in the Starna literature and provided that they have not been physically, thermally or optically abused.

World Leader in UV, Visible and NIR/MIR Certified Reference Materials

ISO 17034 Reference Material Producer

ISO/IEC 17025 Calibration

Lifetime Guarantee

Fast Recalibration Service

Technical Support

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