GDCS

A STANDARD OF THE ASSOCIATION FOR INTELLIGENT DIAMOND INTERNATIONAL

GDCS TESTING STANDARD

GDCS Synthetic Gemstone Testing and Grading Standard

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Foreword

This standard is drafted in accordance with the rules given in GB/T 1.1—2020 Directives for standardization — Part 1: Rules for the structure and drafting of standardizing documents.

This standard was proposed by, and is under the jurisdiction of, the GDCS Technical Committee.

The subject of this standard is limited to synthetic ruby, synthetic sapphire and synthetic emerald, including loose stones and, where applicable, mounted samples. Natural ruby, natural sapphire and natural emerald serve only as controlled natural reference materials, used to compare differences in growth history, inclusions, and chemical or spectroscopic characteristics; natural gemstones shall not be quality-graded under the colour, clarity, cut or optical performance clauses of this document. The subject of GB/T 32862—2016, GB/T 32863—2016 and GB/T 34545—2017 is in each case natural gemstones; only their method structure, observation logic and quality-control experience may be referred to. Their scope shall not be extended, nor shall clauses in them that apply only to natural materials be transplanted directly to synthetic materials.

This standard makes explicit that refractive index, density, a single spectral peak, a single inclusion type, a single growth line or a single chemical signal shall not on its own make a binary determination of "natural or synthetic"; that a Pantone FHI TPG colour number shall not automatically determine a colour grade; and that no instrument parameter exceeding a preset threshold shall automatically determine enhancement. All high-risk conclusions shall rest on mutually separate and traceable chains of evidence for identity, growth method, enhancement, colour, clarity, cut and optical performance.

This standard uses Pantone FHI TPG as a tool for candidate colour retrieval, communication and supplementary expression. Pantone FHI TPG is not a gemstone colour standard, is not a statutory or official gemstone grade reference system, and is not equivalent to CIELAB coordinates. Colour grades shall be defined by approved controlled synthetic master colour stones; Pantone FHI TPG is used only to record the closest candidate number, and that number must be physically approved.

Because the controlled master stones have not yet completed verification of cross-batch and cross-laboratory consistency and of durability, this document shall currently be used as a "draft trial-run text". Until the master stones are approved, measurement-condition trials and personnel reproducibility trials are completed and trial-run data have been produced, laboratories shall not claim to have achieved fully unified colour grades that are interchangeable across institutions.

1 Scope

1.1 This standard specifies requirements for the testing, quality grading, certificates, quality control, method validation, uncertainty, complaints and re-examination, and dispute arbitration of synthetic ruby, synthetic sapphire and synthetic emerald.

1.2 This standard applies to synthetic ruby, synthetic sapphire and synthetic emerald. Unless otherwise stated, "sample" in this standard means a synthetic ruby, synthetic sapphire or synthetic emerald.

1.3 This standard does not apply to the quality grading of natural ruby, natural sapphire, natural emerald, imitations, assembled stones, or coated or composite products. The materials above may be identified in accordance with GB/T 16553—2017, with identification results issued in accordance with the applicable standard, only where this has been agreed in advance and there is a sufficient basis for identification. For natural

materials, the grading conclusions of this document shall not be used in place of a natural gemstone grading certificate.

1.4 In this standard, "quality grading" means the grading or description of quality factors such as colour, clarity, cut and optical performance. It does not indicate the commercial value, origin, rarity or investment return of the sample.

2 Normative References

The contents of the following documents, through normative reference in the text, constitute indispensable provisions of this standard. For dated references, only the edition corresponding to that date applies to this standard; for undated references, the latest edition (including all amendments) applies to this standard.

- GB/T 16552 Gems — Nomenclature
- GB/T 16553 Gems — Testing
- GB/T 32862—2016 Sapphire grading
- GB/T 32863—2016 Ruby grading
- GB/T 34545—2017 Emerald grading
- GB/T 1.1—2020 Directives for standardization — Part 1: Rules for the structure and drafting of standardizing documents

Note 1: As of 21 September 2026, the National Public Service Platform for Standards Information records that GB/T 16552—2017 was reviewed on 22 May 2026 and entered the revision plan. Laboratories shall monitor for a change of edition and assess all referenced clauses before the new edition is implemented.

Note 2: As of 21 September 2026, the National Public Service Platform for Standards Information records that GB/T 32862—2016 was reviewed on 22 May 2026 and entered the revision plan; this standard refers only to its grading method for natural sapphire and does not carry over its subject of application.

Note 3: The scope of GB/T 32863—2016 is stated explicitly as "natural, unmounted, faceted and polished ruby that is unenhanced or heat-treated"; GB/T 32862—2016 is stated explicitly to cover natural sapphire, and GB/T 34545—2017 natural emerald. These shall not be used as grounds for changing the "natural" scope to "synthetic".

3 Terms, Definitions and Abbreviations

3.1 Terms and Definitions

The terms and definitions given in GB/T 16552, GB/T 16553, GB/T 32862—2016, GB/T 32863—2016 and GB/T 34545—2017 apply to this standard.

3.1.1 Synthetic gem

A crystalline or amorphous solid material made wholly or partly by artificial means, for which a known counterpart exists in nature. In this standard it refers only to synthetic ruby, synthetic sapphire and synthetic emerald.

3.1.2 Controlled synthetic master colour stone

A physical synthetic gemstone, approved by the GDCS Colour Committee, that is of established identity, has a recorded growth method, has a stable surface condition, can be kept long-term, and has been colour-compared independently by two people with an approval record produced. It is used to define colour grade boundaries; it need not be a commercial sample and carries no implication of origin or value.

3.1.3 Pantone FHI TPG colour number

A paper-based coated colour chip code within the Pantone Fashion, Home + Interiors (FHI) system, written as six digits, a hyphen and the suffix "TPG". TPG denotes only the "Textile Paper—Green" paper-based carrier; it does not represent gemstones, natural materials or the grades of this standard.

3.1.4 TPG candidate number

The closest colour number, recorded after physical visual approval, within the current Pantone product edition. A candidate number is not a grade, not a CIELAB coordinate, and not a permanent commitment.

3.1.5 Evidence of identity

Evidence of material category proving that the sample is a synthetic ruby, synthetic sapphire or synthetic emerald, comprising a combined judgement of crystallographic, chemical composition, microstructural, optical and spectroscopic information.

3.1.6 Growth-method evidence

Information derived from the features left by growth techniques such as the flame-fusion, Czochralski (pulling), flux and hydrothermal methods. The growth method is only a clue to the material's history; it is not a quality grade, nor a substitute for a conclusion on synthetic identity.

3.1.7 Enhancement

A treatment applied after the material has formed in order to change its appearance, clarity, stability or other quality factors. In this document the crystal growth process itself is not called "treatment". Where there is no independent, traceable evidence, the statement "no clear evidence attributable to enhancement observed" shall be made; treatment shall not be determined directly merely because of high clarity, unusual colour or a single instrument signal.

3.1.8 Level of evidence

The classification of observation or measurement results by reliability, independence, reviewability and dependence on conditions, comprising Class A decisive evidence, Class B strong supporting evidence, Class C auxiliary clues and Class D information for explanation only.

3.1.9 Colour grade

The Light, Medium, Intense, Vivid or Deep level arrived at by comparing the overall colour of the sample with the boundaries set by controlled master stones under controlled observation conditions. TPG candidate numbers do not enter this determination algorithm.

3.1.10 Clarity characteristic

A feature observable inside or on the outside of the sample, including solid inclusions, gas–liquid inclusions, fissures, growth structures, abrasion, damage, polishing residues and other anomalies affecting appearance.

3.1.11 Six-axis clarity evaluation

Recording and evaluating clarity characteristics by type, quantity, size, position, visibility and impact; "not visible to the naked eye" or "not visible under a 10× loupe" shall not be used as the sole criterion.

3.1.12 Cut

The style, proportions, symmetry and polish of a finished gemstone. The evaluation of cut shall not be mixed with the evaluation of colour lightness or darkness, clarity, brightness, fire or optical phenomena.

3.1.13 Brightness

The appearance of brightness, viewed face-up, produced jointly by reflection, internal reflection and light leakage.

3.1.14 Fire

Visible flashes of colour formed by the dispersion of white light.

3.1.15 Scintillation

Changes in light and dark and in colour produced by relative movement of the sample, the observer and the lighting.

3.1.16 Transparency

The degree to which light passing through the sample forms a discernible image.

3.1.17 Optical phenomenon

Repeatable optical behaviour that differs from ordinary colour, such as asterism, chatoyancy, colour change and colour-change fluorescence. The conditions, directions, illumination and recording requirements for identifying it shall be specified separately.

3.1.18 CIE standard illuminant D65

A relative spectral power distribution representing average daylight, with a nominal correlated colour temperature of approximately 6500 K; it is not an ordinary "6500 K lamp". A light booth, LED or integrating sphere realising D65 must be verified through chromaticity coordinates, spectral power distribution and a checking procedure.

3.2 Abbreviations

The following abbreviations apply to this standard.

Abbreviation	Full form or meaning
TPG	Textile Paper—Green; Pantone FHI paper-based colour chips
TCX	Textile Cotton Extended; Pantone FHI cotton colour chips
TPX	Former Pantone FHI paper-based format, now discontinued
CIELAB	CIE 1976 L*a*b* colour space
D65	CIE standard illuminant D65
FTIR	Fourier transform infrared spectroscopy
UV-Vis-NIR	Ultraviolet–visible–near-infrared spectroscopy
PL	Photoluminescence spectroscopy

Abbreviation	Full form or meaning
CL	Cathodoluminescence
XRF	X-ray fluorescence spectroscopy
Raman	Raman spectroscopy
GDCS	Name of the technical committee of the body issuing this standard

4 Basic Principles

4.1 This standard follows the principles of separation of evidence, non-destructive priority, physical priority, physical re-checking, escalation with risk, traceability and certificate minimisation.

4.2 Identity, growth method, enhancement, colour, clarity, cut and optical performance shall each have their own evidence, records and conclusions. No conclusion shall be treated as a sufficient condition for any other conclusion.

4.3 Identification shall give priority to methods that do not damage the sample. Where a destructive, near-destructive or irreversible method is genuinely needed, written authorisation shall be obtained from the client, and the necessity, risk, location and extent shall be recorded.

4.4 Colour grading shall use, in order: first, controlled synthetic master colour stones; second, the current Pantone FHI TPG physical colour chips; third, CIELAB or spectral data. The third tier shall not override the physical boundaries of the first tier, nor shall it automatically generate a grade.

4.5 For decisive conclusions that may affect trade, insurance, judicial proceedings or high-value transactions, the laboratory shall apply independent review, retention of original records and an escalation mechanism for anomalies.

4.6 In the text of this standard, "shall" indicates a requirement; "shall not" indicates a prohibition; "should" indicates a recommendation; "may" indicates a permission; and "can" indicates an objective capability. Unverified specific instrument thresholds, physical property ranges, fixed TPG-to-grade mappings or commercial colour promises shall not be written into the mandatory clauses of this standard.

5 Sample Acceptance, Contract Review and Status Codes

5.1 At acceptance, the laboratory shall check the requested items, sample identity, mounting status, declarations of known treatment, photographs, mass, quantity, client risk and delivery deadline.

5.2 Items that cannot be completed, items that may damage the sample, items for which the sample's condition is unsuitable for grading, and items outside the scope of this document shall be stated explicitly in the contract; the laboratory shall not accept them and then implicitly promise completion.

5.3 Each sample shall be given a unique acceptance number, and its girdle features, facet abrasion, fissures, repairs, obstruction by the mounting and condition before submission shall be recorded by photography or description.

5.4 Sample status shall be recorded in accordance with Table 1. Where a sample has several statuses at once, they may be marked side by side; where an "S4" or "S7" risk exists, the laboratory shall suspend or limit the

relevant conclusions.

Table 1 Sample Status Codes (Normative)

Code	Status	Permission or restriction
S0	Normal condition; can be fully tested and graded	All items may be carried out
S1	Loose stone	The corresponding loose-stone procedure applies
S2	Mounted, body visible	May be tested; obstructed items shall be marked "not observed"
S3	Mounted, base or pavilion not visible	Conclusions on clarity, proportions and cut shall be restricted
S4	Body has fissures, chips, repairs or high-risk damage	Non-destructiveness and instrument risk shall be assessed first
S5	Declared or strongly suspected to contain an unstable treatment	Shall not be exposed to light, heat, vacuum or strong laser that may accelerate change
S6	Insufficiently clean	Shall be cleaned under an approved procedure with the client's consent, and recorded
S7	Sample condition inconsistent with the submission information	Testing shall be suspended and confirmation obtained in writing
S8	Identification only, no grading	Only identity and applicable treatment conclusions are issued

5.5 Sample handover, storage, packaging, transport, return and retained samples shall be recorded. Samples shall not be kept together with master stones, chemical reagents, polishing materials or other objects that may cause cross-contamination.

5.6 Where the client requests "a synthetic certificate only", "a colour grade only" or "no clarity record", the laboratory shall make clear that its selective conclusions do not mean that the items not tested are free of anomalies; the certificate shall state the scope of testing.

6 Equipment, D65 Checks and Observation Conditions

6.1 General Requirements

6.1.1 The laboratory shall be equipped with, and maintain, the following: a gemstone microscope with suitable illumination, a standard colour-matching light booth, an electronic balance, gauges or imaging angle-measurement equipment, FTIR, UV-Vis-NIR, Raman or PL, XRF, a standard white tile, standard colour tiles, an illuminance meter, equipment for checking chromaticity coordinates or spectra, sample photography equipment, sample storage facilities and a records system.

6.1.2 Not every test requires all of the equipment. Methods shall be chosen according to the sample, the risk and the intended use; where equipment is lacking, results shall not be guessed, and the item shall instead be reported as "not tested" or subcontracted to a competent laboratory.

6.1.3 All key equipment affecting results shall have a unique number, a stated purpose, operating instructions, a status label, a maintenance plan, a checking plan, fault-handling records and metrological traceability records.

6.2 The Correct Meaning of D65 and Its Checking

6.2.1 D65 is a relative spectral power distribution defined by the CIE; it is not an ordinary "6500 K lamp". A correlated colour temperature of approximately 6500 K shows only that the colour temperature is close; it does not prove that a light booth realises D65.

6.2.2 For each lighting workstation, the following shall be recorded: the illuminant, how it is realised, measured chromaticity coordinates, measured correlated colour temperature, colour rendering performance, spectral power distribution, illuminance at the viewing surface, uniformity, hours of use, date of the last check and date of the next check.

6.2.3 A re-check shall be made after new installation, repair, lamp replacement or ageing of filters, or when continuous use reaches the interval set by the laboratory. Where data do not meet the approval requirements, the workstation shall be marked "not to be used" and the related results shall be quarantined.

6.2.4 This standard does not preset uniform fixed values for chromaticity tolerance, illuminance tolerance or colour rendering index. The laboratory shall establish control limits in method validation, based on task risk, equipment capability and historical data, and verify them in the trial run. Until control limits are established, the light booth shall not be used to decide colour boundaries.

6.3 Colour Observation Conditions

6.3.1 Colour shall be assessed at the specified D65 workstation. Where necessary, another agreed illuminant may be used for supplementary description, but the conditions must be stated alongside, and a supplementary condition shall not replace the D65 conclusion.

6.3.2 The following seven items of observation metadata shall be recorded; where any is missing, completion of standard colour comparison shall not be claimed:

- a) the illuminant and the state of its realisation;
- b) the illumination geometry, e.g. 45°:0°, 0°:45° or light-booth diffuse conditions;
- c) the observation geometry, including the angle between the observation axis and the normal to the sample's table;
- d) the material, colour value and gloss of the neutral background;
- e) the observation distance;
- f) the identity of the observer and their corrected colour-vision status;
- g) whether tweezers, a tray, a liquid cell or light-shielding accessories are used.

6.3.3 The sample shall be placed on a neutral background free of strong specular reflection and fluorescence interference. The body colour shall first be observed with the sample static, and the sample then rotated slightly through a controlled angle. Rotation shall be used only to average out windowing, light leakage and colour range; the most favourable angle shall not be selected in place of the overall colour.

6.3.4 The observation distance shall be set according to the physical size of the sample and the workstation. The certificate may record a distance range; the same fixed distance shall not be applied to all sizes. Where colour is observed with a microscope, it shall be made clear that "microscope observation" is not the default mode of face-up colour comparison in this standard.

6.3.5 Observers shall be persons with colour vision corrected to normal who are not in a state of abnormal chromatic adaptation, fatigue or under the influence of medication. Each sample shall be colour-compared

independently by two authorised observers who are independent of each other. Boundary samples shall be decided by a third person or by the Colour Committee.

6.3.6 Before colour observation, the observer shall adapt in the light booth for a specified time. The specific adaptation time is determined by method validation; until validation is complete, an unvalidated uniform number of seconds shall not be used as a hard requirement.

7 Non-Destructive Identification and Levels of Evidence

7.1 General Requirements

7.1.1 Identity conclusions shall be proved directly by Class A decisive evidence, or supported by cross-corroboration from several kinds of Class B evidence. Class C clues may be used to form hypotheses, choose methods and explain anomalies; they shall not on their own form a binary "natural/synthetic" conclusion.

7.1.2 The laboratory shall establish controlled reference spectral libraries and microscopic image libraries of synthetic ruby, synthetic sapphire, synthetic emerald, their natural counterparts, imitations and commonly treated materials. Each reference entered in a library shall record the material's source, preparation, test method, instrument parameters, personnel, date, validity and review status.

7.1.3 Where different methods give inconsistent results for the same sample, sample position, polarisation, orientation, focus, illumination, instrument status, references and interpretation model shall be investigated first; averaging shall not be used to remove a fundamental conflict.

7.2 Classification of Evidence

Table 2 Levels of Evidence and Authority of Conclusions (Normative)

Level	Meaning	Permitted conclusion
A	Decisive evidence formed from controlled references, traceable instrument data or irreversible structural features	May directly support identity or a definite treatment conclusion
B	Strong evidence jointly supported by several independent observations or measurements	May form a decisive conclusion together with Class A, or form a "supports" conclusion
C	Auxiliary clues such as morphology, growth lines, colour distribution, a single peak position or a single trace element	Used only to form hypotheses, choose methods and assist interpretation; shall not settle a case on its own
D	Commercial descriptions, client declarations, digital images, old certificates, uncalibrated display colours	Only as leads or background material; shall not enter factual conclusions

7.2.1 Refractive index, birefringence, density, thermal conductivity, a particular absorption peak, a particular fluorescence peak, gas bubbles, curved striae, platinum platelets, flux residues or chemical element signals shall none of them be written as a sole deciding condition for "natural/synthetic".

7.2.2 Where results meet only Class C, the certificate shall state "no clear natural features sufficient to negate synthetic identity observed", "features consistent with clues to a particular growth technique" or "other explanations cannot be excluded on this observation alone", and shall not state an absolute binary conclusion.

7.3 Identity and Enhancement Shall Be Kept Separate

7.3.1 Identity answers "which kind of synthetic material the sample is"; enhancement answers "whether an identifiable artificial change was applied after formation". Neither shall substitute for the other.

7.3.2 Enhancement conclusions shall distinguish at least:

- a) no clear evidence of treatment observed;
- b) clues possibly related to treatment observed, but evidence insufficient;
- c) Class B or higher evidence supports a particular treatment;
- d) Class A evidence supports a definite treatment;
- e) not tested, or the sample's condition does not permit evaluation.

7.3.3 An instrument parameter outside the laboratory's validated range indicates only "deviation from the validated model" or "escalated review required". Unless a quantitative method has been developed and validated in advance for that instrument, sample form and specific treatment, treatment shall not be determined directly on that basis.

7.4 Limits on the Use of Instrumental Evidence

7.4.1 FTIR should be used to identify structural groups, hydroxyl, organic fillers, polymers or particular growth-related differences, but absorption is affected by orientation, polished surface, particle size and instrument accessories; the measurement mode and sample orientation shall be recorded.

7.4.2 UV-Vis-NIR should be used to study chromophore ions, charge transfer, colour centres and specific absorptions, but sample thickness, crystal axis, polarisation and instrument bandwidth change the shape of the spectrum; a single peak cannot serve as the sole basis for identity or treatment.

7.4.3 Raman should be used to identify phases, the phases of inclusions and some fillers; strong fluorescence, thermal effects and the risk of laser damage shall be controlled through power, spot size, integration time and reference scans.

7.4.4 XRF should be used to screen near-surface major elements and some trace elements; light elements, depth distribution, sample form and matrix effects all limit the results, and "element detected" does not mean that the element is present in the form of a treatment.

7.4.5 PL, CL, UV fluorescence and phosphorescence may provide auxiliary information on growth zoning, defects or certain treatments, but the excitation conditions, temperature, orientation and detection window must be recorded.

7.4.6 This standard does not specify general fixed peak positions, intensity ratios or content thresholds for the above methods. The laboratory shall carry out method validation for its specific instruments, samples and intended uses, and establish the validated range.

8 Colour Grading and Pantone FHI TPG Approval

8.1 Physical Priority Principle

8.1.1 The first object of comparison for colour grades is the controlled synthetic master colour stone, not screen colour, printed colour, a digital photograph or a single CIELAB value.

8.1.2 The five-level framework is uniformly Light, Medium, Intense, Vivid, Deep. Each grade must be defined by at least one controlled physical boundary stone; where a boundary stone covers a range, it shall be made clear whether it is the upper boundary, the centre stone or the lower boundary of that grade.

8.1.3 Physical boundaries shall be established for each grade by gem type. The same boundary name shall not be used across ruby, sapphire and emerald without verification; independent boundary sets shall likewise be established within the same hue category.

8.1.4 Before the trial run, laboratories may use only "candidate grades" or "candidate boundaries"; formal grades may be used only after the master stones have been approved and two-person and multi-laboratory consistency trials have been completed.

8.2 Boundary Rules of the Five-Level Framework

8.2.1 The five levels are not five equal divisions of colour space, nor a ranking of commercial value. Boundaries shall be defined by physical master stones, and review bands are permitted at the boundaries between adjacent grades.

8.2.2 Where the colour of a sample falls between two boundary stones, the sample shall be assigned to the corresponding grade on the basis of the closest body colour; where the colour lies clearly within a review band, the boundary status shall be recorded and decided by a third person.

8.2.3 Where the body colour of a sample clearly lies beyond the highest or lowest approved boundary, it may be stated as "beyond the currently approved boundaries" or recorded as an extended description of the adjacent boundary; an unapproved new grade shall not be invented.

8.2.4 Where colour is uneven, the certificate shall describe the body colour, the distribution pattern and whether it affects the grade. The specific weighting method shall be documented after the trial run; a single brightest, darkest or smallest-window view shall not be used in place of overall observation.

8.3 Limits on the Use of Pantone FHI TPG

8.3.1 TPG is used to retrieve the closest candidate number, to communicate colour impressions and to assist review. A TPG candidate number shall not automatically determine a grade, shall not override controlled physical boundaries, shall not replace physical colour comparison under D65, and shall not be used as a statement of CIELAB equivalence.

8.3.2 For the same TPG number, the paper, ink, batch, surface wear and observation conditions may all vary. A candidate number is valid only for a specific physical colour chip, edition and condition.

8.3.3 TCX may be used as a colour communication tool on another material carrier, but it must be marked "cotton carrier, not a gemstone standard", and it shall not be claimed that TPG and TCX are absolutely the same colour within this system. TPX is a discontinued format and may be used only as a historical record; old TPX numbers shall not be converted directly into current grade conclusions without physical approval.

8.3.4 Pantone FHI's official public pages currently state that TPG is a paper-based coated colour chip, suited to hard-surface products, home goods and similar uses. The "2 800" or "2 801" colours found in market channels come from editions that include different expansion packs, and are not a standard set by Pantone for gemstone grades. The laboratory shall rely on the physical edition and approval records, and shall not claim that the 2 800/2 801 colours, or any specific colour number, are an "official gemstone grade reference".

8.4 Physical Approval Procedure for TPG Candidate Numbers

8.4.1 Each approval comprises at least six steps: candidate selection, physical comparison, recording of conditions, approval, edition binding and historical traceability.

8.4.2 At the candidate stage, the search shall not be confined to screen images; the current physical Pantone FHI TPG guide shall be at hand, and adjacent candidate numbers shall be selected and compared together.

8.4.3 At least two authorised persons shall independently compare the physical controlled synthetic gemstone with the physical colour chip at the same D65 workstation, against the same background, at the same observation distance and under the same illumination geometry.

8.4.4 During comparison, highlights, facet edges, windows, shadows or specular reflections shall not be allowed to stand in for the body colour. A neutral mask may be used where necessary, but must be recorded.

8.4.5 The approval record shall be entered in Annex A. A candidate number may enter a certificate only when "candidate number — physical boundary — observation conditions — approver — validity period" is complete.

8.4.6 A TPG colour chip shall be withdrawn from use if it shows fading, contamination, scratches, warping, ink migration, loss of its page number or an unidentifiable edition. Even if the number is legible, a chip whose physical condition has failed shall not continue to be used for approval.

8.5 CIELAB and Spectral Aids

8.5.1 Instrumental measurement may serve only as an auxiliary record. The laboratory shall state whether the CIE 1931 standard colorimetric observer or the CIE 1964 standard colorimetric observer is used, whether the 2° or the 10° standard observer is used, and the measurement geometry, aperture, background, sample orientation, traceability of the white standard, integration time or number of scans, and version of the calculation software.

8.5.2 Monitor colour values, raw camera colour values or uncalibrated photograph colour values shall not be written as CIELAB certificate data.

8.5.3 Colour measurement uncertainty shall be evaluated taking into account the realisation of the illumination, geometry, sample anisotropy, background, instrument repeatability, traceability of the white standard and observer differences. The specific budget model is established by method validation.

8.5.4 Where instrument results are inconsistent with physical boundaries, the approved first-order physical boundaries shall prevail, but the difference shall be recorded, the instrument status reviewed and the illumination re-checked; the physical grade shall not be altered directly to fit the instrument figures.

9 Synthetic Ruby

9.1 Identification of synthetic ruby shall be based on its identity as corundum, its chromium-induced red colour, and its differences from natural ruby, red spinel, red glass and similar materials. Synthetic identity shall not be established solely on subjective impressions such as "colour too vivid", "too uniform" or "no inclusions".

9.2 The flame-fusion, Czochralski (pulling), flux and high-temperature solution methods serve only as growth-method clues. Curved striae, elongated gas bubbles, unmelted powder, seed crystals, platinum platelets or flux residues may all be affected by cutting, observation direction and process improvements; there is also overlap between methods, and the growth method shall not be named from a single feature.

9.3 Enhancement shall be evaluated separately. "Synthetic", "heating", "diffusion" and "filling" shall not be conflated; treatment shall not be determined automatically because infrared, UV-visible or element data deviate from an unverified range.

9.4 The red body colour shall be described separately from purplish, orangey and other modifying colours. Colour number, TPG candidate number and grade are different fields and shall not substitute for one another.

9.5 For high-chromium or strongly fluorescent samples, the excitation, observation window and illumination time shall be recorded, to avoid fluorescence being mixed into the transmitted body colour.

10 Synthetic Sapphire

10.1 Synthetic sapphire means only blue synthetic corundum. Corundum of other colours, such as yellow, pink, green, white and purple, is outside the scope of this standard; where the laboratory has the capability and has separately approved a method, an identification result may be issued in accordance with GB/T 16553—2017, but the colour grades of this standard shall not be applied.

10.2 For the blue body colour, the main blue and any purplish, greenish or other modifying colours shall be recorded. Depth of colour is part of the colour grade and shall not be confused with clarity or transparency.

10.3 The flame-fusion, Czochralski (pulling), flux and hydrothermal methods and other growth techniques serve only as growth-method clues. Curved striae, parallel striae, gas bubbles, wavy patterns, seed crystals, metallic inclusions or residues shall not on their own be used to name the growth method.

10.4 Heat treatment, diffusion treatment, beryllium diffusion, dyeing, filling or other post-growth treatments shall not be determined on the basis of a single parameter or a single microscopic feature. Where a treatment cannot be excluded, it shall be stated that "clues to a certain treatment are present; evidence is insufficient; no definite treatment conclusion has been made".

10.5 Identification of titanium-induced colour, iron–titanium charge transfer, cobalt-induced colour or other colouring systems shall be based on several complementary pieces of evidence; a single peak position or the detection of a single element shall not be conclusive.

11 Synthetic Emerald

11.1 Synthetic emerald belongs to the beryl group. Identification shall first confirm that it is an emerald material coloured by chromium or by chromium and vanadium, and distinguish it from natural emerald, green beryl, glass, assembled stones and other green imitations.

11.2 The hydrothermal and flux methods are common growth clues, but different commercial sources and process improvements produce overlaps. Seed crystals, growth lines, particular inclusions, residues, and hydroxyl or water-molecule features may serve only as evidence and shall not on their own determine the method.

11.3 Clarity enhancement, coating, dyeing, filling, fissure healing and other treatments shall be evaluated separately. For emerald it shall be stated specifically that high clarity, particular hydroxyl signals, particular infrared absorptions or particular combinations of inclusions do not constitute direct proof of "untreated".

11.4 For the green body colour, yellowish, bluish and other modifying colours shall be recorded. Transparency, brightness, fire and scintillation shall be listed as separate fields.

11.5 For oil, resin, polymer or other fissure-filling materials, a definite treatment name may be used only when identifiable characteristics of the substance have been measured and it has been confirmed that the substance lies within fissures and is not incidental contamination. The test location shall be recorded, to avoid extending local evidence into a conclusion about the whole stone.

12 Clarity Evaluation

12.1 Six-Axis Framework

12.1.1 Clarity shall be recorded on six axes: type, quantity, size, position, visibility and impact. All six shall be filled in; where an axis is not applicable or cannot be observed, the reason shall be stated explicitly, and it shall not be left blank and then interpreted as "no characteristics".

Table 3 Six-Axis Clarity Recording Framework (Normative)

Axis	Content to be recorded
Type	Solid inclusions, gas–liquid inclusions, fissures, growth structures, cavities, surface abrasion, damage, repairs, polish lines, etc.
Quantity	Exact number, order of magnitude, or too many to count; record the magnification and field of view
Size	Maximum size, proportion, or size relative to the sample; unfounded micrometre estimates shall not replace actual measurement
Position	Under the table, crown, pavilion, girdle, base, near-surface, penetrating, obstructed areas, etc.
Visibility	Visibility to the naked eye, under 10× magnification or under other agreed conditions
Impact	Impact on brightness, transparency, stability, durability, appearance and optical performance

12.1.2 A clarity grade shall be formed only after all six items have been fully recorded. High clarity in a synthetic material is only an attribute; it does not constitute a conclusion on growth method, identity or value.

12.1.3 Fissures, fillings, repairs or features affecting durability shall be listed with a separate risk notice even if they do not affect appearance; they shall not be omitted merely because they are not visible.

12.2 Description Rules

12.2.1 Clarity descriptions shall avoid using the fixed grades of the national standards for natural gemstones to evaluate synthetic samples directly. This document does not preset clarity grade names that are uniform across gem types; until the laboratory has established controlled grades in the trial run, six-axis text descriptions shall be used.

12.2.2 If, on completing the trial run, the laboratory decides to set grades, it shall separately produce a "clarity grade validation report" including at least: physical specimens defining the grades, boundary rules, observation distance, magnification conditions, personnel consistency, cross-batch verification, and appeals and review.

12.2.3 Annex C is the clarity record form. The certificate excerpts only the conclusion and key features; the complete original images, videos and observation records shall be kept with the technical file.

13 Cut, Brightness, Fire, Scintillation and Optical Phenomena

13.1 Cut

13.1.1 Cut shall be recorded for style, outline, proportions, symmetry and polish. Facet type serves only for classification and does not indicate a cut grade.

13.1.2 Proportion and angle records shall use calibrated gauges or a validated imaging method. Measurement positions, calculation definitions and sources of uncertainty shall be traceable.

13.1.3 Symmetry evaluation shall record separately: outline deviation, off-centre table, variation in girdle thickness, off-centre culet or base, facet alignment, missing facets and misshapen facets.

13.1.4 Polish evaluation shall record surface lines, scratches, damage, extra facets, burn marks, orange peel, abrasion and other anomalies. The direction of microscope illumination shall be recorded, because darkfield or brightfield illumination changes the visibility of the surface.

13.1.5 Colour lightness or darkness, internal clarity, brightness, fire, scintillation and optical phenomena shall not be counted in the cut grade.

13.2 Brightness, Fire and Scintillation

13.2.1 Brightness, fire and scintillation shall each be evaluated separately. For the standard round brilliant, relative area and visibility descriptions may be used; for non-standard, small, dark, strongly fluorescent, high-clarity or fancy-shaped stones, area percentages shall not be applied directly without verification.

13.2.2 Rotational observation shall use a controlled range. The specific angles and number of rotations are set by the laboratory's method validation; without verification, they shall not be fixed as a percentage threshold common to all gemstones.

13.2.3 Face-up brightness, windowing, extinction, dark areas and light leakage shall each be recorded separately; a single "good fire" shall not be used in their place.

13.2.4 Fire records shall distinguish dispersive flashes, surface-reflected colour, contamination by ambient colour and instrument-excited luminescence.

13.3 Transparency and Optical Phenomena

13.3.1 Transparency shall be described according to the physically observed state, such as transparent, translucent, slightly translucent or opaque. Hazy areas, areas of dense fissures, colour banding, absorption and irregular internal reflection may affect transparency and shall be recorded item by item.

13.3.2 Asterism, chatoyancy, colour change, colour-change fluorescence, play of colour or other optical phenomena may be recorded only when they can be observed repeatably under the excitation, direction and review conditions specified in this standard.

13.3.3 For mounted samples, metal obstruction, reflections from the mounting and closed backs may create or mask optical phenomena; the limitation shall be stated explicitly.

13.3.4 This document does not preset commercial grades for optical phenomena. A controlled evaluation may be formed only after the laboratory has established an independent validation document through the trial run.

14 Determination and Certificates

14.1 Determination Rules

14.1.1 It shall first be determined whether the sample falls within the scope of this document; where it does not, only identification or referral shall be carried out, and a synthetic quality-grading certificate shall not then be issued.

14.1.2 Conclusions on identity, growth-method clues, enhancement, colour, clarity, cut and optical performance shall each be formed separately. Where the evidence for any item is insufficient, it shall be marked "not detected", "not evaluated" or "insufficient evidence"; no inference shall be made.

14.1.3 Colour grades may be determined only by approved controlled master stones. TPG candidate numbers enter only the "colour communication information" field and shall not be used as a basis for grading.

14.1.4 Synthetic ruby, synthetic sapphire and synthetic emerald shall be dealt with under Chapters 9 to 11 respectively. The same set of boundary stones, TPG candidate set or treatment rules shall not be used for all three on the grounds that they are all "synthetic gemstones".

14.1.5 The certificate shall not state "natural", "natural, untreated" or any other natural gemstone quality-grading conclusion. Natural references may be mentioned only in explanations of method or evidence.

14.2 Certificate Fields

The certificate shall contain at least:

- a) the certificate title and document number;
- b) the name, address and contact details of the issuing body;
- c) the sample acceptance number and unique identifier;
- d) the test date, report date and test location;
- e) the testing basis, including the number, version and status of this standard;
- f) the sample description, photographs, mass, dimensions and status code;
- g) the identification result, including the basic name of the material;
- h) growth-method evidence and the definite growth-method conclusion;
- i) the enhancement conclusion and its level of evidence;
- j) the overall colour description, colour grade, TPG candidate number, TPG edition and approval date;
- k) the six-axis clarity summary and grade or description;
- l) cut, brightness, fire, scintillation, transparency and optical phenomena;
- m) items not tested, not evaluated or obstructed;
- n) the important limitation statement;
- o) the reviewer, approver and issuer, with electronic or handwritten signatures;
- p) how to make enquiries, and information on complaints, re-examination and arbitration.

14.3 Prohibited Certificate Provisions

14.3.1 A TPG candidate number shall not be written as an "official gemstone grade colour number".

14.3.2 CIELAB, screen colour or photograph colour values shall not be written as the sole basis of a grade.

14.3.3 "Curved striae", "gas bubbles", "single spectral peak", "refractive index" or "density" shall not be written as automatic determination rules for natural or synthetic.

14.3.4 An instrument parameter exceeding a threshold shall not be written as an automatic determination of treatment.

14.3.5 Growth method, synthetic manufacturer, origin or commercial value shall not be stated as unsubstantiated conclusions.

14.3.6 Until the controlled master stones have been approved, formal colour grades shall not be used; only "candidate" or a limitation statement may be used.

14.4 Certificate Template

Table 4 GDCS Synthetic Gemstone Testing and Grading Certificate Template (Normative)

Field	Content to be recorded
Certificate title	GDCS Synthetic Gemstone Testing and Grading Certificate (Pantone FHI TPG revised edition)
Document number	GDCS-G-_____
Sample number/acceptance number	_____
Issuing body	_____
Test date	____-__-__
Report date	____-__-__
Test location	_____
Testing basis	GDCS Synthetic Gemstone Testing and Grading Standard (Pantone FHI TPG revised edition); version: draft trial-run edition; publication date: ____-__-__
Sample photographs	Front, back and side views as necessary; description of obstructed areas: _____
Sample description	Synthetic ruby / synthetic sapphire / synthetic emerald; loose/mounted; shape; dimensions; mass
Sample status code	☐S0 ☐S1 ☐S2 ☐S3 ☐S4 ☐S5 ☐S6 ☐S7 ☐S8; status note: _____
Identity conclusion	Material: _____; level of evidence: ☐A ☐B ☐C; evidence summary: _____
Growth-method clues	Structural or material clues observed: _____; growth-method conclusion: _____; not to be determined from a single feature alone: yes/no
Enhancement	Conclusion: ☐no clear evidence observed ☐clues present but evidence insufficient ☐Class B support ☐Class A definite; treatment category: _____; location: _____
Overall colour description	Main colour: _____; modifying colour: _____; uniformity: _____

Field	Content to be recorded
Colour grade	☐Light ☐Medium ☐Intense ☐Vivid ☐Deep; boundary approval number: _____; grade status: ☐candidate ☐formal
TPG candidate number	_____ TPG; edition/batch/page: _____; approval date: _____; approver: _____; for communication only: yes/no
CIELAB auxiliary data	Instrument: _____; illuminant: _____; observer: _____; geometry: _____; L*:____ a*:____ b*:____; use: auxiliary, shall not determine the grade
Clarity: type	_____
Clarity: quantity	_____
Clarity: size	_____
Clarity: position	_____
Clarity: visibility	_____
Clarity: impact	_____
Clarity conclusion	Grade/description: _____; boundary or standard note: _____
Cut	Style: _____; proportions: _____; symmetry: _____; polish: _____
Brightness	_____
Fire	_____
Scintillation	_____
Transparency	_____
Optical phenomena	_____
Items not tested/not evaluated	_____
Important limitation statement	This certificate does not grade natural gemstones; TPG candidate numbers do not constitute an official gemstone grade reference; until the controlled master stones are approved, colour grades are candidate conclusions only; enhancement conclusions are limited by the scope of observation and the items tested.
Reviewer	_____
Approver	_____
Issuer	_____
Enquiries/complaints	Website: _____; telephone: _____; complaint time limit: _____

15 Quality Control

15.1 The laboratory shall establish a technical records system ensuring that samples, instruments, personnel, methods, raw data, images, conclusions and versions are all traceable.

15.2 Key roles shall include at least: sample reception officer, tester, colour grader, reviewer, approver, equipment manager, quality manager and complaints handler. Roles may be combined, but the reviewer shall not be the same person as the initial examiner.

15.3 Before taking up their posts, personnel shall pass assessment in theory, physical specimens, instruments, evidence classification, certificates and the handling of anomalies. After absence from post beyond the specified time, a change of method, a major error or consecutive anomalies, their competence shall be re-confirmed.

15.4 The laboratory shall carry out at least the following quality-control activities:

- a) checks of the standard colour-matching light booth;
- b) routine instrument checks;
- c) blank, negative, positive and physical reference checks;
- d) independent two-person colour comparison;
- e) review of anomalous results;
- f) spot checks of technical records;
- g) management of retained samples;
- h) complaints and corrective actions;
- i) internal audits and management reviews;
- j) proficiency testing, measurement audits or approved inter-laboratory comparisons (where feasible).

15.5 Quality-control rules shall be set out in controlled documents and shall not be replaced by verbal custom. When control is lost, the related items shall be stopped immediately, potentially affected results quarantined and the cause investigated, and work shall resume only after verification.

15.6 Images, videos, instrument data and electronic certificates shall have tamper protection, backup, access control and version records. Changes to original records shall be made by retaining the original value, with signature, date and reason; records shall not be overwritten.

16 Method Validation and Measurement Uncertainty

16.1 Method validation shall be carried out in all of the following cases: non-standard methods, methods developed by the laboratory itself, standard methods used outside their intended scope, modified standard methods, and where a referenced standard is replaced by a new edition or equipment changes significantly.

16.2 Validation shall cover at least applicability, selectivity, sensitivity or detection capability, repeatability, reproducibility, robustness, the influence of matrix or sample form, the influence of personnel, measuring range and uncertainty. Qualitative methods need not mechanically apply quantitative parameters, but their reliability shall be demonstrated.

16.3 Validation of colour grading shall include at least: consistency of physical boundaries, stability under different observation distances and backgrounds, differences between observers, differences between lighting

equipment, the influence of TPG paper chip batches, the auxiliary relationship of instrument data, and reproducibility for boundary samples.

16.4 Instrument thresholds may be used as clues to a specific treatment or growth method only after the full chain "sample — instrument — parameters — reference — decision rule — uncertainty" has been verified. Unvalidated uniform thresholds shall not be written into certificates.

16.5 Measurement uncertainty shall be evaluated according to the validated model. Where subjective observation is involved in colour, clarity, cut and optical performance, differences between personnel, between observation conditions and in sample orientation shall enter the model; overall uncertainty shall not be claimed after calculating instrument repeatability alone.

16.6 Method validation data, trial-run reports and validation validity periods shall be archived. Validation items not completed may be used only for research or candidate conclusions and shall not be published externally as formal methods.

17 Anomalous Results, Complaints, Re-examination and Dispute Arbitration

17.1 Anomalous Results

17.1.1 Anomalous results include instrument anomalies, disputes over boundary samples, inconsistent results between several people, inconsistency between images and the physical sample, risk of sample damage, suspected substitution, failure of references, and significant conflict with known declarations.

17.1.2 When an anomaly is found, the initial examiner shall record the original condition and stop any operation that may increase the risk. The laboratory shall arrange for technical staff to review it and, where necessary, change the equipment, personnel and observation conditions.

17.1.3 If an anomaly may result from a change in the sample, the submission photographs, status codes and sealing records shall be compared; the original conclusion shall not be deemed wrong without first excluding a difference in the sample.

17.2 Complaints and Re-examination

17.2.1 The certificate shall state the channel for receiving complaints, the materials required, the time limit and the principles for fees. The complaint time limit is set by the laboratory's policy and shall not be shorter than the period specified by applicable law or by contract.

17.2.2 The complainant shall provide the original certificate or its electronic number, the sample, and materials capable of proving that the sample has not been replaced or treated. Where it cannot be proved that the sample is the same, the laboratory may accept an enquiry, but shall not promise an item-by-item re-examination against the original certificate.

17.2.3 Re-examination shall be carried out by personnel other than those who performed the initial examination, using as far as possible the same or equivalent equipment, references and observation conditions. The original data and original images shall be retained and included in the comparison.

17.2.4 Where the re-examination conclusion differs from the original conclusion, independent adjudication, review of retained samples and, where necessary, third-party testing shall be initiated; the complainant shall not

choose the result unilaterally.

17.3 Independent Re-examination and Dispute Arbitration

17.3.1 An independent re-examination body shall have the corresponding competence to test synthetic gemstones. Before the work starts, the laboratory shall define the test items, methods, sample condition, report format, allocation of costs, use of data and effect of the results.

17.3.2 Before arbitration, the sample's seal, images, weight, girdle features and packaging chain shall be checked to verify that it is the same sample. Where the sample's condition has changed or the chain of evidence is broken, the arbitration conclusion can apply only to the present sample and cannot negate the entire content of the original report.

17.3.3 Arbitration shall be carried out by a competent body unrelated to the original laboratory. Where no single candidate body can be settled on, the two parties may choose one at random from an approved list, or one may be designated by the agreed arbitration institution.

17.3.4 The arbitration report shall state the differences from the original conclusion, the scope of testing, the methods used and the levels of evidence. The final disposal rules are determined by the contract, trading platform rules, legal provisions or the arbitration institution; this standard specifies only the technical procedure and does not take the place of legal effect.

18 Version Management

18.1 This standard uses the version code "major version.method version.data version" or an approved equivalent. A change of major version indicates a change in structure or major requirements; a change of method version indicates a change in procedures or conditions; a change of data version indicates an update of master stones, TPG edition, reference spectral library or instrument model.

18.2 Each release shall be accompanied by version notes, including the effective date, amended clauses, linkage with records under the previous version, master stone status, TPG edition, method validation status and transition period.

18.3 The edition, print batch, purchase date, expiry date, chip images, place of use and person responsible for the Pantone FHI TPG guide shall be entered in Annex A. Old-edition TPG colour numbers shall not be carried over directly to a new edition; they shall be physically re-approved.

18.4 When a master stone is replaced, a comparison of the old and new physical boundaries, an approval record and a transitional observation period shall be carried out. If the new boundary is incompatible with the original boundary, a version change shall be published; the stone shall not be replaced silently.

18.5 When a referenced national standard is replaced by a new edition, the laboratory shall evaluate its scope, terms, methods and certificate fields. GB/T 16552—2017 has entered the revision plan; this standard does not undertake to keep using that edition permanently.

18.6 Electronic, printed and archived versions shall be bound to a version number and checksum information. Only authorised released versions may be used externally; the draft trial-run edition shall be marked prominently, and its limitation statements shall not be removed.

Annex A (Normative) Pantone FHI TPG Approval Record Form

Table A.1 TPG Candidate Number Approval Record Form

Field	Content to be recorded
Approval record number	GDCS-TPG-_____
Sample number/boundary stone number	_____
Gem type	☐Synthetic ruby ☐Synthetic sapphire ☐Synthetic emerald
Colour grade status	☐Candidate ☐Formal
Corresponding physical boundary stone	Number: _____; approval date: _____; upper/lower boundary: _____
Candidate TPG number	_____ TPG
Pantone product name and edition	_____
Pantone batch/print identifier	_____
Page number and chip position	_____
Adjacent candidate numbers	_____
Illuminant and how it is realised	D65; equipment number: _____; check record: _____
Illumination geometry/observation geometry	_____
Background	Material: _____; colour value: _____; gloss: _____
Observation distance	_____
Observer 1	Name: _____; colour-vision status: _____; conclusion: _____
Observer 2	Name: _____; colour-vision status: _____; conclusion: _____
Independent observation	☐Yes ☐No
Comparison limitations	Paper/gemstone difference: _____; highlight control: _____; fluorescence: _____
Photographs of physical items	One set each of gemstone and chip side by side and photographed separately; screen colour alone is prohibited
Approval date	____-__-__
Approver	_____
Valid until	____-__-__
Conditions for invalidation	Chip fading, contamination or scratches; edition discontinued; new version of the boundary stone; change of personnel or method
Link to previous versions	Old record number: _____; reason for replacement: _____
Statement that automatic grading is not permitted	Confirmed: ☐Yes ☐No

Annex B (Normative) Controlled Synthetic Gemstone Master Stone Management Form

Table B.1 Master Stone Management Form

Field	Content to be recorded
Master stone number	GDCS-M-_____
Gem type and material	☐Synthetic ruby ☐Synthetic sapphire ☐Synthetic emerald
Growth-method record	_____; method used as a basis for identity: ☐No
Source and traceability documents	_____
Colour grade defined	☐Light ☐Medium ☐Intense ☐Vivid ☐Deep
Boundary role	☐Upper boundary ☐Centre stone ☐Lower boundary; adjacent grade: _____
Hue category	_____
Size/mass	_____
Clarity and visible features	_____
Stability assessment	Records of exposure to light, heat, humidity and chemicals, and of observation: _____
Storage container	UV protection, abrasion protection, constant temperature and humidity, or equivalent measures: _____
Authorisation for use	Restricted to personnel approved by the Colour Committee
Calibration/consistency record	Date of last check: _____; participants: _____; result: _____
Damage and replacement	Status: ☐Normal ☐Restricted use ☐Withdrawn; replacement record: _____
Version status	☐Candidate boundary ☐Approved boundary; approval meeting number: _____
Effective date/expiry date	_____

Annex C (Normative) Clarity Record Form

Table C.1 Six-Axis Clarity Record Form

Feature no.	Type	Quantity	Size	Position	Visibility	Impact	Image/video no.	Observation conditions
C-01								
C-02								
C-03								
Clarity conclusion								
Level of evidence	☐A ☐B ☐C ☐D	Limitation note		Reviewer		Date		

Annex D (Normative) Instrument Check and Evidence Record Form

Table D.1 Instrument Check and Evidence Record Form

Instrument no.	Purpose	Check item	Check method	Source of control limits	Last check	Status	Operator
Test record no.	Instrument/method	Sample position and orientation	Parameters	Raw file no.	Level of evidence	Conclusion supported or refuted	Limitations

Annex E (Informative) Quick Reference Table of Status Codes

Code	Meaning	Grading restriction
S0	Normal	Can be carried out in full
S1	Loose stone	Loose-stone procedure applies
S2	Mounted, body visible	Obstructed items restricted
S3	Pavilion not visible	Clarity/cut restricted
S4	High-risk damage	Non-destructiveness reviewed
S5	Risk of unstable treatment	Light, heat and vacuum restricted
S6	Insufficiently clean	Cleaning with authorisation
S7	Status inconsistent	Suspend
S8	Identification only	No grading conclusion issued

Annex F (Informative) Example Certificate Limitation Statements

1. This certificate applies only to synthetic ruby, synthetic sapphire or synthetic emerald, and is not used for the quality grading of natural gemstones.
2. Pantone FHI TPG candidate numbers are used only for retrieval, communication and supplementary expression, and shall not automatically determine the colour grade.
3. TPG is not a gemstone colour standard; the 2 800 or 2 801 colours and any related specific colour numbers do not constitute an official Pantone gemstone grade reference.
4. Until the controlled master stones and method validation are completed, colour grades are candidate conclusions.
5. Natural materials serve only as controlled references; a single inclusion, a single spectral peak, refractive index, density, growth lines or element signals shall not automatically determine natural/synthetic or enhancement.
6. Mounting, cleanliness, sample damage, obstruction of the base or limits on the requested items all affect the scope of the conclusions.

7. Certificate conclusions are limited by the condition of the sample at submission, the items tested, equipment capability and personnel judgement, and do not represent commercial value, origin, rarity or permanence.

Annex G (Informative) Trial-Run Verification Checklist

G.1 Have the controlled synthetic physical boundary stones been purchased or prepared, with traceable identity, and are they stable? Yes/No.

G.2 Have the boundaries of each of Light, Medium, Intense, Vivid and Deep been defined? Yes/No.

G.3 Have at least two observers completed two rounds of independent colour comparison? Yes/No.

G.4 Have trials been completed on the effects of different TPG chip batches, lighting equipment and observation distances? Yes/No.

G.5 Have the review bands for samples at adjacent boundaries and the rules for decision by a third person been recorded? Yes/No.

G.6 Have candidate TPG approval forms been established separately for ruby, sapphire and emerald? Yes/No.

G.7 Have the D65 light booth, background and observation geometry been verified? Yes/No.

G.8 Have method validation, the uncertainty budget and anomaly procedures been completed? Yes/No.

G.9 Have personnel assessment and mock certificate review been completed? Yes/No.

G.10 Is the "candidate" label used under the limiting conditions? Yes/No.

If any of the above items is "No", this standard shall not be claimed externally to be a fully implementable version.

Sources

- [1] https://std.samr.gov.cn/gb/search/gbDetailedCNF?id=A24AF19F41445C2EE05397BE0A0A5E0D — GB/T 1.1-2020 Directives for standardization — Part 1: Rules for the structure and drafting of standardizing documents; published 2020-03-31, implemented 2020-10-01, replacing GB/T 1.1-2009 in its entirety.
- [2] https://std.samr.gov.cn/gb/search/gbDetailed?id=71F772D81FC9D3A7E05397BE0A0AB82A — GB/T 16552—2017 Gems — Nomenclature was published on 2017-10-14 and implemented on 2018-05-01; the review of 2026-05-22 concluded that it be revised.
- [3] https://www.ndls.org.cn/standard/detail/e9c82f8e3a972e2363eeb0d1500b1644 — GB/T 16553—2017 Gems — Testing specifies the terms and definitions, testing methods, selection of test items and identification characteristics for gems, and applies to the identification of gems.
- [4] https://std.samr.gov.cn/gb/search/gbDetailed?id=sHOyH4EL7MI=&mode=p — GB/T 32862—2016 Sapphire grading was published on 2016-08-29 and implemented on 2017-03-01; the review of 2026-05-22 concluded that it be revised.
- [5] https://www.chn-njtc.com/upload/2018-12-04/89f71bf3-66c1-44e2-a066-237cb657bf76.pdf — GB/T 32863—2016 Ruby grading sets out grading rules for natural, unmounted, faceted and polished ruby that is unenhanced or heat-treated.
- [6] https://www.chn-njtc.com/upload/2018-12-04/6b3af89c-6732-44b0-bca0-80b2846edbac.pdf — GB/T 34545—2017 Emerald grading sets out grading rules for natural, unmounted, faceted and polished emerald

that is unenhanced or clarity-enhanced.

- [7] https://cie.co.at/eilvterm/17-23-021 — CIE standard illuminant D65 is a relative spectral distribution representing a phase of daylight with a correlated colour temperature of approximately 6 500 K.
- [8] https://cie.co.at/publications/colorimetry-part-4-cie-1976-lab-colour-space-1 — ISO/CIE 11664-4:2019 specifies a method of calculating the coordinates of the CIE 1976 L*a*b* colour space.
- [9] https://www.pantonecn.com/articles/product-spotlight/tcx-and-tpg — TPG is a lacquer coating on paper, while TCX is dye on cotton; 2 625 colours are presented in the current TPG guidance described on the official China page.
- [10] https://www.pantone.com/ — Pantone official home identifies Fashion, Home + Interiors as a separate colour system from Graphics + Digital.
- [11] https://cie.co.at/eilvterm/17-23-076 — The CIE 1976 L*a*b* colour space is a three-dimensional, approximately uniform colour space with coordinates L*, a* and b*.
- [12] https://www.ngtc.com.cn/Uploads/201706/593656497b432.pdf — GB/T 16553—2017 added composition analysis methods (non-destructive and near-non-destructive) and added identification characteristics and spectral data for the main gems.
- [13] https://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=55CAF3D8E6AD61F4133F4C26D363DB47 — GB/T 34545—2017 divides emerald fire into four grades, B1, B2, B3 and B4, and requires grading to be done independently by two to three people under specified conditions, reaching agreement.
- [14] https://www.cmes.org/cmes/upload/2025/04-08/12-56-410119265831117.pdf — GB/T 1.1—2020 requires documents to set out clear, accurate and unambiguous provisions that are easy to understand and apply for professionals who did not take part in drafting them.