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INTRODUCTION TO

GONIOSCOPY ESSENTIALS

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A concise guide to understanding the anterior chamber angle and mastering gonioscopy for improved patient care.

CORNEA

ANGLE

TRABECULAR MESHWORK

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GONIOSCOPY

A High-Yield PG Review — Optics, Technique, Grading & Clinical Decision-Making

Based on: Kanski's Clinical Ophthalmology • AAO BCSC Glaucoma Section

1. The Clinical Analogy — Why You Can't Just 'Look' at the Angle

Imagine standing inside a brightly lit aquarium, trying to see a narrow service tunnel that runs around the base of the glass tank, just below the waterline, hidden behind the curved glass wall. If you look straight through the glass at a steep angle, the glass-air interface acts like a mirror — you see your own reflection of the room, not the tunnel. The light rays coming from the tunnel hit the glass-air boundary at an angle steeper than the 'critical angle' and undergo **total internal reflection (TIR)**, bouncing back into the water instead of escaping to your eye. To actually see the tunnel, you need to either place another piece of glass (with matching refractive index) directly against the tank wall to abolish that interface, or use a mirror angled cleverly to redirect the escaping light toward you.

This is exactly the optical problem at the corneoscleral limbus. Light reflected from the anterior chamber (AC) angle strikes the cornea-air interface at roughly 46° (greater than the critical angle for the cornea-air interface, calculated from Snell's law using corneal index ~1.376 vs air 1.0), so it undergoes TIR and never reaches the observer's eye directly. A **gonioscopy lens** either (a) replaces the cornea-air interface with a cornea-lens interface of similar refractive index, eliminating TIR (direct gonioscopy), or (b) uses an internal mirror to redirect the escaping rays toward the examiner (indirect gonioscopy).

2. Optical Principles & Classification of Gonioscopy

2.1 Direct Gonioscopy

Uses a **Koeppe lens** (steep, contact, plano-convex/biconvex dome) placed on the cornea with viscous coupling fluid. The lens has a higher refractive index/curvature that allows light from the angle to pass directly into the lens without TIR, producing an erect, real image of the angle viewed with a separate hand-held binocular microscope and light source. Performed with the **patient supine** (operating microscope/portable slit lamp) — ideal for examination under anesthesia (EUA) in children and for comparative bilateral simultaneous viewing.

2.2 Indirect Gonioscopy

Uses a lens with an internal **mirror** angled at ~59-64° that reflects the obliquely-traveling rays from the opposite angle back to the examiner at the slit lamp. Because the mirror images the **opposite** angle (180° away), a mirror placed superiorly shows the inferior angle, and so on. Performed with the patient **upright** at the slit lamp — the standard clinic technique (Goldmann and Zeiss/Posner-type lenses).

Table 1 — Comparison of Gonioscopy Lenses (Exam Favourite)

Feature	Koeppe (Direct)	Goldmann 1/2/3-mirror (Indirect)	Zeiss/Posner 4-mirror (Indirect)
Patient position	Supine	Sitting, slit lamp	Sitting, slit lamp
Coupling fluid	Required (methylcellulose)	Required (viscous gel)	Usually not required (corneal tear film suffices)
Corneal contact diameter	Large flange	Large flange (12 mm)	Small (steeper radius than cornea, ~9 mm)

Table 1 — Comparison of Gonioscopy Lenses (Exam Favourite)

Feature	Koeppe (Direct)	Goldmann 1/2/3-mirror (Indirect)	Zeiss/Posner 4-mirror (Indirect)
Indentation/dynamic gonioscopy	Not possible	Difficult (large flange compresses sclera)	**Excellent** – can perform compression/indentation gonioscopy
Field of view per mirror	Wide, panoramic (with extra lens)	Narrow, needs rotation for 360°	Narrow, but 4 mirrors give 360° without much rotation
Typical clinical use	EUA, congenital glaucoma, research/photography	Routine OPD examination, laser (with flat haptic - stable for SLT/ALT/PI)	Rapid screening + dynamic gonioscopy to break appositional closure
Image orientation	Erect, non-reversed	Inverted/reversed (mirror image)	Inverted/reversed (mirror image)

Viva Pearl: The Zeiss/Posner 4-mirror lens has a **smaller radius of curvature than the cornea**, creating a tear-film optical gap that allows it to rest without coupling fluid and permits gentle posterior pressure on the central cornea to be transmitted to the angle (**indentation/dynamic gonioscopy**) — this is the key reason it is preferred for differentiating appositional from synechial angle closure.

3. Angle Anatomy — Landmarks From Apex to Base (Kanski Fig. Angle Anatomy)

On gonioscopy, the angle is examined from the corneal side (anterior) toward the iris root (posterior). The five key landmarks, in order, are:

Table 2 — Angle Landmarks, Identification & Clinical Correlates

Landmark	Identifying Features / Tips	Clinical Correlate
1. Schwalbe's line	Termination of corneal endothelium/Descemet's membrane; often appears as a fine, glistening, slightly opaque line. Identify using the **corneal wedge sign** (parallelepiped technique) – the apex of the wedge formed by two light beams (one off the corneal surface, one off the endothelium) points to Schwalbe's line	Site of pigment deposition – **Sampaolesi's line** in PXF/PDS (scalloped, anterior to or at Schwalbe's line)
2. Trabecular meshwork (TM)	Band between Schwalbe's line and scleral spur. Anterior (non-pigmented, non-filtering, corresponds to Schwalbe's-adjacent CTM) vs Posterior (pigmented, filtering, overlies Schwalbe's canal)	Site of laser trabeculoplasty (SLT/ALT) – aim at junction of pigmented/non-pigmented TM; angle recession – widened ciliary body band posterior to TM
3. Scleral spur	Most anterior projection of the sclera; appears as a bright white line just posterior to pigmented TM – the most consistent and reliable landmark	Landmark for trabeculectomy ostium placement; reference point for Spaeth grading (iris insertion site)
4. Ciliary body band (CBB)	Grey-brown/pink band posterior to scleral spur; width varies with iris insertion	Widened/torn CBB = **angle recession** (blunt trauma) – risk of late traumatic glaucoma

Table 2 — Angle Landmarks, Identification & Clinical Correlates

Landmark	Identifying Features / Tips	Clinical Correlate
5. Iris root	Most peripheral, posterior iris insertion onto the angle wall; insertion level varies (anterior, mid, posterior to spur)	Iris processes (normal variant, fine strands to TM) vs PAS (broad, tent-shaped adhesions obscuring angle structures)

Mnemonic (anterior to posterior): "Some Tribes Take Cigarettes In" → Schwalbe's line, Trabecular meshwork, sclerai spur (Spur), Ciliary body band, Iris root.

4. Technique – Static vs Dynamic (Indentation) Gonioscopy

Table 3 — Static vs Dynamic Gonioscopy

Parameter	Static Gonioscopy	Dynamic / Indentation (Compression) Gonioscopy
Lens used	Goldmann (large flange) or Zeiss 4-mirror without pressure	Zeiss/Posner 4-mirror (small flange, no coupling fluid)
Mechanism	Passive viewing of angle as it naturally appears	Gentle pressure on central cornea displaces aqueous peripherally, pushing iris root posteriorly → opens an appositionally closed angle if no adhesions present
Purpose	Document baseline angle width & grade	**Differentiate appositional closure (opens with indentation) from synechial closure / PAS (does not open)**; unmask angle recession; identify the true angle in plateau iris
Pitfall	May under- or over-estimate true angle if pressure inadvertently applied	Excess pressure can cause corneal folds (Descemet's striae) that distort the view, or falsely 'open' a narrow angle – should always be combined with static assessment first

General Technique Tips

- Perform in a **dim room** with a **short, narrow slit beam** (avoid shining light across the pupil – this constricts the pupil and artificially widens the angle, or pulls the iris away from the angle).
- Use a low-power, oblique beam first to avoid eliciting accommodative miosis.
- Always examine **all four quadrants** (superior, inferior, nasal, temporal) – the superior angle is physiologically the narrowest (eyelid pressure on the globe over time) and most often missed if only one quadrant is checked.
- Tilt technique: if a structure is borderline visible, ask the patient to look toward the mirror (e.g., looking down when examining the superior angle with an inferior mirror) – this 'unfolds' a narrow angle and may convert an apparently closed angle into an open one (important pitfall when grading).

5. Grading Systems – The Exam Core

5.1 Shaffer Grading System (most widely used; based on the angle between iris and TM, estimated by the examiner)

Table 4 — Shaffer Grading System

Grade	Angle Width (degrees)	Structures Visible	Clinical Significance
Grade 4	35–45°	All structures including ciliary body band easily visible	Wide open; angle closure essentially impossible
Grade 3	20–35°	Scleral spur visible (CBB may not be)	Open angle; closure unlikely
Grade 2	20°	Only trabecular meshwork visible (spur not seen)	Angle closure possible
Grade 1	10° (slit-like)	Only Schwalbe's line, possibly top of TM	Angle closure likely – high risk
Grade 0	0° (closed, iridocorneal contact)	No angle structures visible	Angle closure present

5.2 Scheie Classification (based on extent of structures obscured – reverse logic, less commonly used now but classic exam question)

Table 5 — Scheie Classification

Grade	Description
Wide (Grade 0)	All structures visible – normal wide-open angle
Grade I	Slightly narrowed; CBB not visible
Grade II	Posterior trabeculum not visible
Grade III	Only anterior trabeculum and Schwalbe's line visible
Grade IV (Narrow)	Schwalbe's line not visible – closed angle

5.3 Spaeth Grading System (most comprehensive – describes 3 parameters; favoured for research and detailed documentation)

Table 6 — Spaeth Grading System (Three-Parameter Notation)

Parameter	Categories
1. Angular width of the angle recess	Estimated in degrees (0° to 40°), similar concept to Shaffer but measured as the angle between a line tangential to the TM/corneal endothelium and a line tangential to the anterior iris surface
2. Configuration of peripheral iris	**b** = posterior bowing (myopic/post-iridotomy); **f** = flat; **p** = anterior bowing/convex (plateau iris configuration)
3. Site of iris insertion (relative to landmarks)	Graded A (anterior to TM), B (behind Schwalbe's line, i.e., at TM), C (at scleral spur), D (deep – into the ciliary body band), E (extremely deep – at or behind the iris root recess)

Viva Pearl: A Spaeth notation of **D 40 f** describes a wide-open, deep angle with flat iris – essentially the safest configuration. A notation like **B 10 p** describes a very narrow angle with anteriorly-bowed (plateau-type) iris insertion close to Schwalbe's line – high closure risk and a strong indicator for laser peripheral iridotomy (LPI) +/- iridoplasty.

6. Van Herick Technique – The Screening Correlate

A slit-lamp screening method performed **without a gonioscopy lens** – useful when gonioscopy is not immediately available, or to decide whether dilation is safe. A narrow slit beam is shone at roughly 60° onto the peripheral cornea near the limbus; the peripheral AC depth (corneal optical section thickness, 'CT') is compared to the adjacent peripheral iris thickness:

Table 7 — Van Herick Grading and Correlation with Shaffer Grade

Van Herick Grade	AC Depth : Corneal Thickness Ratio	Correlation with Shaffer Grade
Grade 4	≥1 : 1	Grade 3–4 (open)
Grade 3	1/2 : 1 to 1 : 1	Grade 2–3
Grade 2	1/4 : 1 to 1/2 : 1	Grade 1–2 (occludable risk)
Grade 1	<1/4 : 1	Grade 0–1 (high closure risk – gonioscopy mandatory before dilation)
Grade 0	Slit-like / flat AC, no visible space	Closed angle – refer urgently

Caveat: Van Herick is a peripheral AC depth estimate, NOT a substitute for gonioscopy – it correlates well but cannot detect PAS, plateau iris, or differentiate appositional vs synechial closure. Always confirm with gonioscopy before management decisions.

7. Clinical Applications – Pattern Recognition on Gonioscopy

Table 8 — Pattern Recognition: Disease-Specific Gonioscopic Findings

Condition	Gonioscopic Findings	Clinical Significance / Mechanism
Primary angle closure (PAC/PACG)	Narrow or closed angle (Shaffer 0–1); may show PAS in advanced disease; iris bombe configuration with pupillary block	Relative pupillary block → anterior bowing of peripheral iris → appositional then synechial closure
Plateau iris	Deceptively deep central AC but very narrow angle with flat/anteriorly placed peripheral iris ('double hump sign' on indentation – central iris flattens but peripheral roll persists); anteriorly positioned ciliary processes push the iris root forward	LPI alone insufficient – often needs argon laser peripheral iridoplasty (ALPI) since mechanism is not pupillary block
Pigment dispersion syndrome (PDS)/Pigmentary glaucoma	Dense, homogeneous pigmentation of TM (often concentrated inferiorly), **Sampaolesi's line** (scalloped pigment line anterior to Schwalbe's line), concave (posteriorly bowed) iris configuration	Iridozonular touch → mechanical rubbing releases pigment → clogs TM → elevated IOP, classically in young myopic males
Pseudoexfoliation (PXF/PEX)	Patchy, often non-homogeneous pigmentation with increased pigmentation anterior to Schwalbe's line (Sampaolesi's line), fluffy white exfoliative material may be seen on angle structures and zonules	Asymmetric, often unilateral initially; high risk of IOP spikes, zonular weakness (phacodonesis) – relevant for cataract surgery planning
Angle recession (post-traumatic)	Widened ciliary body band, torn iris processes, irregular widening of angle recess, often with iris root tears or sphincter tears	Late-onset traumatic glaucoma can occur years after blunt trauma due to TM scarring/dysfunction – lifelong IOP monitoring needed

Table 8 — Pattern Recognition: Disease-Specific Gonioscopic Findings

Condition	Gonioscopic Findings	Clinical Significance / Mechanism
Neovascular glaucoma (NVG)	Fine, fibrovascular tufts crossing the scleral spur from the iris root onto the TM (**NVA – neovascularization of the angle**), often preceding visible NVI; progresses to PAS and angle closure	Seen in PDR, CRVO (90-day glaucoma), OIS – anti-VEGF + PRP urgent; gonioscopy should be performed gently to avoid hyphema from fragile vessels
Angle dysgenesis (Axenfeld-Rieger spectrum, Peters anomaly)	Prominent, anteriorly displaced Schwalbe's line (posterior embryotoxon), iris strands bridging to the line, high iris insertion	Congenital/developmental glaucoma; associated systemic features (dental, facial) in Axenfeld-Rieger syndrome
Iridocorneal endothelial (ICE) syndrome	High PAS extending anterior to Schwalbe's line, fine endothelial membrane visible over angle on specular reflection	Unilateral, abnormal corneal endothelium proliferates and migrates over angle/iris → secondary angle closure glaucoma
Cyclodialysis cleft	Visible gap/cleft between ciliary body and scleral spur with direct communication to suprachoroidal space	Causes hypotony; gonioscopy with indentation or UBM may be needed if not clearly seen

8. Indications, Pre-procedural Relevance & Surgical Correlations

8.1 Key Indications for Gonioscopy

- Every newly diagnosed glaucoma or glaucoma-suspect patient (baseline angle assessment – mandatory by AAO Preferred Practice Pattern for glaucoma).
- Before pupillary dilation in any patient with shallow AC on slit lamp / Van Herick grade ≤2.
- Annual/periodic re-assessment in chronic angle closure (angle configuration can change with lens growth, cataract progression).
- Post-trauma (to assess for angle recession, cyclodialysis, hyphema clearance).
- Pre-operative assessment before cataract surgery in PXF/PDS (zonular status correlates with angle pigmentation), before glaucoma surgery (trabeculectomy site selection, MIGS device candidacy – e.g., iStent/Hydrus require an open, visible nasal angle).
- Suspected neovascular or inflammatory glaucoma (look for NVA/PAS before performing mydriasis which can precipitate angle closure).
- Post-laser PI to confirm patency and re-grade the angle (document angle widening).

8.2 Surgical/Anatomical Correlations

For **trabeculectomy**, the scleral spur is the key reference – the sclerostomy/internal ostium should straddle the trabecular meshwork just anterior to the scleral spur (entering posterior to Schwalbe's line but anterior to the ciliary body, to avoid cyclodialysis and hyphema from ciliary body vessels). For **goniotomy/trabeculotomy** (congenital glaucoma), direct visualization of the TM via a Koeppe/Barkan lens under anesthesia guides the blade/probe into Schlemm's canal. For **angle-based MIGS** (iStent, Hydrus, Kahook Dual Blade, gonioscopy-assisted transluminal trabeculotomy – GATT), **intra-operative gonioscopy** using a surgical gonioprism with the microscope and patient head tilted ~30° away and the surgeon's view angled toward the nasal angle is essential – poor visualization (corneal striae/haze) is a major cause of misplacement and surgical failure.

9. Imaging Correlation – Gonioscopy vs UBM vs AS-OCT

Table 9 — Gonioscopy vs UBM vs AS-OCT

Modality	What It Shows	Advantages	Limitations
Gonioscopy	Direct visualization of angle structures, pigmentation, PAS, NVA – gold standard for structural identification and dynamic (indentation) assessment	Real-time, dynamic, allows differentiation of appositional vs synechial closure; inexpensive	Operator-dependent; requires corneal contact (risk in infections/abrasions); light from slit lamp can alter angle width during exam
Ultrasound Biomicroscopy (UBM)	Cross-sectional image of angle, ciliary body, posterior chamber structures (can image behind iris – e.g., plateau iris ciliary processes, cyclodialysis cleft, tumors)	Visualizes structures gonioscopy cannot (behind iris); useful in corneal opacity	Requires contact/immersion, operator-dependent, time-consuming
Anterior Segment OCT (AS-OCT)	Non-contact cross-sectional imaging of angle recess, AC depth, iris-trabecular contact (ITC), angle opening distance (AOD), trabecular-iris space area (TISA)	Rapid, non-contact, reproducible, good for screening & longitudinal monitoring (e.g., post-LPI changes)	Cannot visualize structures posterior to iris pigment epithelium (lower penetration than UBM); cannot assess pigmentation/NVA directly

10. Landmark Trials & Evolving Concepts

- **ZAP Study (Zhongshan Angle-Closure Prevention Trial, 2019, Lancet):** Prophylactic LPI in primary angle closure suspects (PACS) reduced progression to PAC/acute angle closure over 6 years but the absolute risk reduction was modest (~goes from 4.19% to 1.49%), reigniting debate on universal prophylactic LPI for occludable angles found on gonioscopy.
- **EAGLE Study (Effectiveness in Angle-closure Glaucoma of Lens Extraction, 2016, Lancet):** Early clear lens extraction was more effective and cost-effective than LPI + medical therapy in primary angle closure with raised IOP – reshaping the surgical decision tree once gonioscopy confirms a closed/occludable angle with a visually significant lens.
- **AS-OCT-based automated angle assessment** (deep learning algorithms for AOD/TISA quantification) is emerging as an adjunct/screening tool but has not replaced gonioscopy as the diagnostic standard.
- **Goniopuncture and intra-operative endoscopic gonioscopy** for MIGS device placement are expanding the procedural role of angle visualization beyond diagnosis into real-time surgical navigation.

11. Consultant-Level MCQ Traps

Q1. A 4-mirror Zeiss/Posner lens is preferred over a Goldmann 3-mirror lens for dynamic indentation gonioscopy primarily because:

A) It has a larger flange providing more stability

B) Its radius of curvature is smaller than the cornea, allowing pressure transmission without scleral indentation

C) It requires coupling fluid for clearer optics

D) It provides magnification superior to the slit lamp's own optics

Answer: B. The small-flange, steeper-than-cornea design of the Zeiss/Posner lens means it does not require coupling fluid and does NOT rest on the sclera (unlike the large Goldmann flange, which compresses the sclera and falsely opens/distorts the angle). This allows isolated, controlled pressure on the cornea to be transmitted to the angle – the essence of dynamic gonioscopy.

Q2. On gonioscopy, a patient is noted to have a deep central anterior chamber but a very narrow angle on all four quadrants, with a 'double hump' sign on indentation. The most likely diagnosis and best initial management is:

A) Pupillary block PACG – LPI alone

B) Plateau iris configuration – LPI followed by reassessment, +/- argon laser peripheral iridoplasty

C) Phacomorphic glaucoma – immediate cataract extraction

D) Pigment dispersion syndrome – topical pilocarpine

Answer: B. A deep central AC with narrow peripheral angle and the 'double hump' sign (central iris flattens on indentation but peripheral iris roll persists due to anteriorly positioned ciliary processes) is classic for plateau iris. LPI is still performed first (to rule out/treat any coexisting pupillary block component), but if the angle remains narrow post-LPI, ALPI is the next step since the mechanism is non-pupillary-block.

Q3. A Sampaolesi's line seen on gonioscopy as a scalloped pigmented line anterior to Schwalbe's line is most characteristically associated with:

A) Angle recession

B) Pseudoexfoliation syndrome and pigment dispersion syndrome

C) Iridocorneal endothelial syndrome

D) Axenfeld-Rieger syndrome

Answer: B. Sampaolesi's line represents pigment deposition anterior to (or along) Schwalbe's line and is a hallmark of both PXF and PDS – though the pattern of TM pigmentation differs (homogeneous/dense in PDS vs patchy in PXF), the Sampaolesi's line itself is a shared finding tested frequently in vivas.

Q4. During gonioscopy, the examiner notes fine new vessels crossing the scleral spur from the iris root onto the trabecular meshwork in a diabetic patient with no visible rubeosis on slit-lamp examination of the iris. The most appropriate immediate next step is:

A) Reassure – angle vessels without iris involvement are insignificant

B) Proceed with routine cataract surgery as planned

C) Urgent fundus evaluation, consider PRP/anti-VEGF – angle neovascularization often precedes visible NVI

D) Start pilocarpine to constrict the pupil and 'hide' the vessels

Answer: C. NVA can precede clinically visible NVI and signals impending neovascular glaucoma. It mandates urgent fundus assessment (likely PDR/ischemia) and consideration of anti-VEGF + PRP before progression to PAS and intractable angle-closure glaucoma. Gonioscopy in such eyes should be gentle (minimal indentation) to avoid precipitating hyphema from fragile NVA vessels.

12. Rapid-Fire Viva Questions

- Why does shining a wide slit beam through the pupil during gonioscopy give a falsely reassuring (wide) angle assessment? — *Light through the pupil causes pupillary constriction, which pulls the peripheral iris away from the angle, artificially widening it; always use a short, off-axis (non-pupil-crossing) beam.*
- Why is the superior angle typically the narrowest quadrant and most prone to PAS formation? — *Chronic mechanical pressure from the upper eyelid over years gradually narrows the superior angle relative to other quadrants – hence the superior angle is the most sensitive location to detect early angle closure and should never be skipped.*
- How do you differentiate iris processes from peripheral anterior synechiae (PAS) on gonioscopy? — *Iris processes are fine, lacy, often symmetric strands that arise from the iris collarette/root and extend to the TM with visible angle recess in between; PAS are broader, tent-shaped/triangular adhesions that obliterate the angle recess and pull the iris root anteriorly – PAS do not open on indentation, iris processes are not relevant to gonioscopic grading.*
- What is the embryological basis of the corneal wedge sign used to identify Schwalbe's line? — *Schwalbe's line marks the peripheral termination of Descemet's membrane and corneal endothelium (derived from neural crest mesenchyme); the two light reflections (epithelial surface beam and endothelial surface beam) converge at this anatomical terminus, forming the apex of the optical 'wedge'.*
- Why must gonioscopy precede pupillary dilation in a patient with shallow AC? — *Dilation can precipitate acute angle closure in an occludable angle by causing the mid-dilated pupil to maximize iris bulk in the angle (relative pupillary block is greatest at 4-6 mm pupil size) – gonioscopy identifies this risk beforehand so prophylactic measures (or avoidance of dilation) can be planned.*

Primary references: Kanski's Clinical Ophthalmology (Glaucoma chapter – angle anatomy, gonioscopy lenses, grading systems); AAO Basic and Clinical Science Course (BCSC) – Glaucoma section; ZAP Study (Lancet 2019); EAGLE Study (Lancet 2016).

Consultant-Level Follow-Up Question for Extension

In a patient with chronic primary angle-closure glaucoma who has undergone a patent laser peripheral iridotomy, gonioscopy still shows Shaffer Grade 1 angles with extensive PAS for 270° and an IOP of 28 mmHg on maximal medical therapy. Walk through your surgical decision-making: how would the extent and distribution of PAS on gonioscopy influence your choice between trabeculectomy, combined phacotrabeculectomy, goniosynechialysis (GSL), or a tube shunt – and what intraoperative gonioscopic findings would make you abandon a GSL attempt midway through surgery?

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