

From Individual Reviews to a Qualification Corpus: Evidence Architecture Across Engineering Reviews ER-01 to ER-99

State Variables, Scope Boundaries, Cross-Paper Couplings and Research Priorities

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ER-100 · Engineering Review · Version 0.8 · 16 September 2026

Document type	Corpus boundary	Identifiers	Active records	Record state
Engineering Review	ER-01 to ER-99	99	99	Published

Statement of Significance

A large technical-review series becomes useful only when its individual papers can be interpreted as a controlled evidence system rather than as an accumulation of titles. ER-100 audits Engineering Review identifiers ER-01 to ER-99 as a corpus. It identifies the recurring state variables that govern vat-photopolymerisation claims, maps the principal cross-paper couplings, separates evidence provenance from record status, and converts the resulting structure into a minimum reporting and maintenance architecture. The sequence contains 99 identifiers and 99 active review records. ER-35 and ER-36 are separate publications with distinct scopes. This correction keeps numerical completeness aligned with the current public record.

Abstract

Engineering Reviews ER-01 to ER-99 cover photopolymer chemistry, vat-photopolymerisation process physics, qualification methods, functional materials, biomedical and occupational constraints, indirect manufacturing and lifecycle questions. This paper treats that sequence as a bounded corpus and asks what engineering logic emerges across it. The corpus reconstruction used the controlled ER-01–ER-49 map, the ER-50–ER-87 publication ledger, final record manifests for later papers and the public Zenodo community state checked on 16 September 2026. Ninety-nine identifiers were recovered without a numbering gap, and all ninety-nine correspond to active review records. ER-35 and ER-36 are separate publications with distinct scopes. Each identifier was assigned one primary descriptive cluster: process physics, metrology and control (33); photochemistry and network architecture (22); functional materials and interfaces (22); biomedical, exposure and hazard (13); and indirect manufacturing and lifecycle (9). The dominant corpus-level result is that performance claims are conditional on a material-process-workflow state. Formulation identity alone is insufficient because optical dose, conversion, network mobility, dispersion state, geometry, washing, post-cure, conditioning, environment and test method can change the measured outcome. Five recurrent coupling chains are identified, together with a five-level evidence ladder from mechanistic plausibility to intended-use qualification. The review concludes with provenance rules, a corpus-maintenance disposition, research priorities and a minimum reporting set. It is a qualitative corpus synthesis, not a systematic meta-analysis, pooled property database or product-comparison study.

Keywords: vat photopolymerisation; additive manufacturing; engineering qualification; evidence architecture; corpus audit; material-process-workflow; scope boundary; metrology; photopolymer; provenance.

1. Purpose and corpus boundary

ER-100 is the closure paper for the first numbered block of the 3Dresyns Engineering Review series. Its object is not to resummarise every earlier conclusion. Instead, it examines whether the separate reviews collectively define a coherent qualification architecture and where that architecture remains incomplete. The unit of analysis is the controlled ER identifier and its declared scope. The public repository record is used to confirm current title and release identity, while manuscript-level audit ledgers remain the source of provenance distinctions that are not visible in repository metadata [1].

The boundary is ER-01 through ER-99. The sequence contains 99 identifiers and 99 independent active papers. ER-35, Interpreting Critical Exposure and Penetration Depth in Vat Photopolymerization, is an active separate publication at version 0.2. Its permanent concept DOI is 10.5281/zenodo.22736142 and its version DOI is 10.5281/zenodo.22736143 [16]. ER-36 remains a distinct review with its own scope. RP-02, the Evidence-to-Decision Qualification Framework for Vat Photopolymerisation, is a separate methodology paper used by the series and cited here, but it is not re-numbered as an ER identifier [9].

The corpus is provider-neutral at the level of scientific inference. Manufacturer documentation may identify a product, public implementation context or declared use, but it is not substituted for independent evidence of mechanism, performance, safety or regulatory qualification. ER-100 does not compare commercial products and does not disclose proprietary formulation data.

2. Methods and audit rules

2.1 Corpus reconstruction

Four controlled sources were cross-checked: the ER-01–ER-49 publication map; the ER-50–ER-87 master ledger; the final title-and-filename audit for later papers; and the live 3Dresyns Engineering & Technical Publications community on Zenodo. Exact identifier coverage, title uniqueness and publication state were checked. On 16 September 2026, ER-35 and ER-36 were confirmed as separate public records, and the version and concept DOI identities of ER-35 were recorded. Self-citations use labelled Zenodo DOIs.

2.2 Descriptive thematic coding

Each identifier received one primary thematic label based on its controlled title and declared scope. This forced single-label coding shows only the centre of gravity of the series; many papers span more than one domain. Counts describe editorial architecture, not the frequency or weight of scientific evidence. All 99 identifiers correspond to active records.

2.3 Evidence and closure vocabulary

ER-100 preserves three distinctions that are often collapsed in technical corpora. First, publication status is not the same as evidential strength. Second, author-side verification is not promoted to independent reviewer verification. Third, a closed finding retains its closure mechanism: removal, independent verification, bounded author verification with a reproducible locator, correction of metadata or layout, or explicit acceptance as a non-blocking limitation. This vocabulary is consistent with traceability principles: information should remain findable, accessible, interoperable and reusable without erasing provenance [2].

2.4 Analytical limits

This is not a PRISMA-style systematic review, a bibliometric analysis or a meta-analysis. No effect sizes are pooled across machines, formulations, geometries or conditioning states. The paper analyses the controlled corpus architecture and recurring qualification logic. Scientific claims retained from individual ER papers remain governed by those papers and their sources.

3. Corpus topology

The sequence developed in five editorial layers. Early papers established comparability and process-coupling problems. ER-10–ER-29 broadened the domain into measurement, functional materials and application-specific qualification. ER-30–ER-49 used concise Route A notes around a common evidence-to-decision method. ER-50–ER-79 expanded the network, photochemistry and functional-property space. ER-80–ER-99 concentrated on pathway taxonomy, stability, extractables, hazard interpretation, interfaces and advanced photoinitiation.

Identifier range	Editorial role	Identifiers	Active records	Control note
ER-01–ER-09	Foundational comparability, process and application reviews	9	9	Public numbered foundation
ER-10–ER-29	Domain and application qualification reviews	20	20	Controlled existing-record block
ER-30–ER-49	Route A qualification notes	20	20	All identifiers active as separate records
ER-50–ER-79	Expanded network, process and functional-property corpus	30	30	Published with preserved numerical gaps later filled
ER-80–ER-99	Mechanism, stability, safety, interfaces and advanced photochemistry	20	20	Later focused-gate block

Table 1. Controlled identifier and active-record topology. Active records total 99.

Primary cluster	Identifiers	Active	Representative scope
Process physics, metrology and control	33	33	working curves, conversion, recoating, ageing, leak testing
Photochemistry and network architecture	22	22	dual cure, phase separation, cationic/base routes, stability
Functional materials and interfaces	22	22	electrical, thermal, optical, magnetic and mechanical functions
Biomedical, exposure and hazard	13	13	organ-on-chip, implantable ceramics, extractables, dermatitis
Indirect manufacturing and lifecycle	9	9	sacrificial tooling, casting, ceramics/metals, LCA, bio-based resins

Table 2. Forced single-label descriptive coding. Cross-domain overlap is expected and is analysed through coupling chains rather than double counting.

4. The corpus-level object is a material-process-workflow state

Across the corpus, the most stable conclusion is negative in form: a photopolymer material name, nominal formulation or single exposure setting does not define an engineering property. The measured state is created by a chain that includes raw-material composition, storage history, mixing and dispersion, optical source and spectral match, exposure history, geometry, washing, drying, post-cure, conditioning, environment and test method. ER-01 and ER-05 framed the comparability problem; ER-10 separated resolution, trueness and precision; ER-27 connected exposure to conversion and spatial cure heterogeneity [6-8,10].

This state-based view explains why apparently contradictory findings can both be valid. Thermal expansion may be orientation-dependent in one cured network and negligible across the tested orientations of another. A surface treatment may change capillary filling when freshly applied but lose its effect after ageing. A dispersant can reduce viscosity while increasing optical attenuation. A high conversion value can coexist with local under-cure, extractables or interface weakness if the measurement averages over the relevant gradient. The correct response is not to choose one universal value but to identify the state variables that differ.

5. Five recurrent coupling chains

Coupling chain	Principal ER anchors	Qualification implication
Optical dose → conversion → network state → performance	ER-02, 05, 27, 30, 31, 44, 61, 73, 75-77	Exposure is meaningful only with spectrum, geometry, conversion and spatial state.
Dispersion → rheology → optical transport → cure profile	ER-35, ER-36, 44, 53, 76, 87, 99	Interfacial chemistry can improve flow yet change scattering, absorption or cure.
Washing/post-cure → residuals → extraction → biological response	ER-06, 12, 14, 33, 42, 86, 92-95	Finished-part claims require the final conditioned article, not uncured resin identity.
Thermal/environmental history → mobility → ageing → mechanics	ER-20, 39-41, 46-48, 61, 68-73, 90, 96	Time, temperature, humidity and frequency change the measured network response.
Interface/topography → adhesion/sealing/wetting → functional transfer	ER-03, 34, 43, 53-55, 73, 79, 88, 89, 97	Bulk properties cannot substitute for interface- and geometry-specific validation.

Table 3. Recurring cross-paper coupling chains. These are directional engineering maps, not universal causal coefficients.

5.1 Optical dose, conversion and network state

The working curve remains useful but cannot carry the full qualification burden. Cure depth and critical exposure compress absorption, scattering, inhibition and reaction kinetics into fitted quantities. They do not by themselves establish uniform conversion, local interlayer continuity, residual stress, extractable content or long-term property retention. The series therefore moves from an exposure-only description toward state-resolved measurements and, where possible, in-situ or closed-loop observation [7,8,13].

5.2 Dispersion as a coupled upstream variable

Filled systems show the strongest coupling between nominally separate disciplines. Surface chemistry and dispersant architecture affect agglomeration and hydrodynamic volume, which change rheology and recoating. The same particle and additive population changes absorption, scattering and refractive-index contrast, which changes cure profile and feature fidelity. For ceramic and metal systems, the organic package continues into debinding and sintering. ER-35 addresses the operational interpretation of working-curve parameters; ER-36 addresses rheology, recoating and dispersion control; ER-44 and ER-99 address optical response and dispersant chemistry. These scopes are complementary rather than interchangeable [11,12,15,16].

5.3 Final-part state and exposure

Biomedical, microfluidic and occupational papers repeatedly reject a constituent-only shortcut. The uncured resin, freshly washed part, post-cured part, aged part and extracted part are different analytical objects. Biological response and chemical release depend on workflow, surface area, extraction design and intended contact. Hazard classification of a raw constituent can motivate control or substitution, but it does not by itself qualify a finished device or establish that a substitute is safer [14].

6. Evidence-to-decision architecture

The corpus supports a five-level evidence ladder. Movement upward requires new evidence; it cannot be achieved by repeating the same result in more confident language. A plausible mechanism can justify an experiment. A material-state result can support a bounded formulation claim. A process result can support a defined operating window. A component test can support geometry- and interface-specific performance. Intended-use qualification requires the applicable risk, regulatory and production controls.

Evidence level	Required object	Permitted decision	Boundary
1. Mechanistic plausibility	Chemical or physical rationale; adjacent literature	Defines hypotheses and failure modes	No performance or safety claim
2. Material-state evidence	Defined formulation, cure and conditioning state	Supports bounded property claim	No cross-platform equivalence
3. Process evidence	Machine, spectrum, dose, geometry and workflow	Supports an operating window	No component qualification by default
4. Component evidence	Representative geometry, interfaces and environment	Supports defined functional performance	No universal intended-use approval
5. Intended-use qualification	Risk-managed, standard-linked, production-controlled evidence	Supports the declared use within its boundary	No transfer outside the qualified envelope

Table 4. Evidence ladder used to prevent mechanism, material, process, component and intended-use claims from being conflated.

7. What the corpus reveals about standards

Standards are essential but their role must be stated precisely. ISO/ASTM 52900:2021 supplies common additive manufacturing fundamentals and vocabulary and remained current after review in 2025 [3]. ISO/ASTM 52920:2023 addresses qualification principles for industrial additive-manufacturing processes and production sites [4]. ISO/IEC 17025:2017 addresses laboratory competence, impartiality and consistent operation and remained current after review in 2023 [5]. None of these documents turns an unconditioned photopolymer trade name into a universal property value or replaces an application-specific method.

The series repeatedly encounters a standards gap at the transfer boundary. A standard test method may define specimen geometry or measurement procedure while leaving unresolved the VPP-specific cure state, orientation, support strategy, washing, post-cure, ageing, surface condition or interface. The correct use of a standard is therefore two-part: identify what it controls, and declare the state variables it does not control. Work items and adjacent standards should be labelled as such rather than presented as published VPP qualification methods.

8. Provenance, scope boundaries and corpus maintenance

8.1 Boundary convention

A new paper may declare a clear one-way boundary toward an older paper without forcing retroactive editing of the older paper, provided ownership is unambiguous and the two texts do not contradict each other. This convention prevents a growing corpus from requiring endless historical rewrites. A reciprocal update is required only when the older statement becomes materially false, when scope ownership is contradictory, or when the absence of the boundary creates a practical risk of misinterpretation.

8.2 Disposition of known coherence items

ER-80 predates ER-99 and does not carry a reverse boundary to it. ER-99 explicitly assigns in-can stability to ER-80 and limits itself to dispersant architecture. Under the one-way convention, this is closed without a retroactive ER-80 edit. ER-83 predates ER-98 and described charge-transfer-complex VPP as excluded because a controlled source pack was not then available. ER-98 now supplies that focused evidence. The older statement is treated as a documented version-state mismatch: it does not invalidate ER-98, but ER-83 should receive a narrow future version update so the historical exclusion is no longer read as a current absence claim.

8.3 Closure mechanisms and category-4 provenance

For this paper, the final controlled publication set means ER-93, ER-94, ER-96 and ER-99. It retains 14 explicitly disclosed category-4 items that were not silently promoted to independent reviewer verification: four in ER-93, five in ER-94, two in ER-96 and three in ER-99. They are non-blocking because their propositions were narrowed, author-verified with locators, access-limited or otherwise bounded in the controlling ledgers. Fourteen is a final-wave count, not a retrospective corpus-wide count; earlier ledgers did not encode this category uniformly. ER-100 therefore preserves the item-level provenance and prohibits conversion of this partial denominator into a whole-corpus percentage.

The maintenance register distinguishes `CLOSED_BY_REMOVAL`, `CLOSED_BY_REVIEWER_VERIFICATION`, `CLOSED_BY_AUTHOR_VERIFICATION_TRANSFERRED`, `CLOSED_BY_CORRECTION` and `OPEN_VERSION_COHERENCE`. The active corpus-level items are tabulated below. The ER-20, ER-50 and ER-51 entry concerns inherited core properties in candidate DOCX artefacts, not a demonstrated defect in the public PDFs.

Item	State	Mechanism or evidence	Closure or next action
ER-35	ACTIVE_SEPARATE_PUBLICATION	v0.2 public; concept DOI 10.5281/zenodo.22736142 [16].	Retain scope distinct from ER-36.
ER-80 → ER-99	CLOSED_BY_BOUNDARY_CONVENTION	ER-80 owns in-can stability; ER-99 owns dispersant architecture.	None.
ER-94 → ER-27	CLOSED_BY_BOUNDARY_CONVENTION	Clear, non-contradictory new-to-old boundary.	None.
ER-83 → ER-98	OPEN_VERSION_COHERENCE	ER-98 supplies the charge-transfer-complex evidence absent at ER-83's version date.	Publish a narrow ER-83 version update.
ER-20 / ER-50 / ER-51 DOCX metadata	OPEN_FILE_METADATA_AUDIT	Candidate DOCX core titles may inherit ER-13 metadata; body titles are correct.	Verify any reusable or deposited DOCX and correct its core title if present.
ER-99 v0.6 2.5D scope	CLOSED_BY_CORRECTION	The 2.5D extension is explicitly identified as engineering inference without direct source coverage.	None.
ER-100 cited Zenodo identities	CLOSED_BY_AUTHOR_VERIFICATION_TRANSFERRED	Author-side live check of the community count and ten DOI-to-title routes; the independent reviewer could not reach Zenodo.	Retain the verification CSV with the deposit.

Table 5. Visible corpus-maintenance register at the ER-100 v0.8 record gate.

9. Research priorities emerging across the corpus

- State-resolved interlaboratory comparisons. Round-robin studies should report resin batch, machine spectrum, dose distribution, geometry, washing, post-cure, conditioning and measurement uncertainty.
- Conversion and mobility maps rather than single averages. Spatially resolved spectroscopy, thermal analysis and mechanics are needed across surfaces, interlayers and thick sections.
- Coupled rheology-optics-kinetics datasets for filled systems. Independent measurement of dispersion state, scattering, absorption, recoating and cure is required in the same formulation state.

- Long-duration retention and ageing. Many studies qualify initial performance but not hydrothermal, photochemical, cyclic, vacuum or chemical retention under a declared use environment.
- Interface-specific qualification. Adhesion, leak tightness, metallisation, wettability and multimaterial continuity require local failure-location reporting and geometry-representative tests.
- Finished-part chemical characterisation. Raw-material hazard and cured-part extractables should be linked through conversion, cleaning, post-cure, ageing and realistic extraction design.
- Standards with explicit VPP state descriptors. Method selection should include cure state, orientation, surface, support and post-processing fields rather than relying on process-agnostic specimen labels.
- Machine-readable provenance. Public records should preserve exact title, version, hash, DOI, closure mechanism and evidence-source class so later corrections do not erase history.

10. Minimum reporting set for transferable VPP claims

Reporting field	Minimum content
Material identity	Resin/formulation code, batch, composition disclosure level, relevant raw-material state
Storage and preparation	Age, package/open-vat history, temperature, mixing, filtration and dispersion procedure
Optical source	Wavelength/spectrum, irradiance or power, calibration location and exposure strategy
Geometry and build	Machine, layer or volumetric mode, orientation, supports, feature scale and build location
Conversion/cure state	Measurement method, sampling location, time after print and spatial heterogeneity
Post-processing	Wash solvent, time/agitation, drying, post-cure spectrum/dose/temperature and delays
Conditioning	Temperature, humidity/medium, duration and equilibrium criterion
Test method	Standard and edition, deviations, specimen dimensions, rate/frequency and uncertainty
Environment and ageing	Thermal, chemical, optical, biological, cyclic or vacuum exposure before test
Failure and transfer boundary	Failure location/mode, excluded interpretations, intended-use limit and provenance class

Table 6. Minimum reporting fields derived from recurring comparability failures across the corpus.

11. Limitations

The corpus is a single-author engineering-review series produced within a compressed 2026 publication programme. Its documented editorial gates improve traceability but do not constitute formal journal peer review. The forced thematic coding is title- and scope-based and is intended for corpus navigation, not bibliometric inference. The public Zenodo state is time-dependent. Some papers rely on adjacent-domain evidence where VPP-specific primary data are sparse. Manufacturer sources are present in some papers for identity or implementation context and remain segregated from independent scientific evidence.

The reported count of 14 category-4 items applies only to the final controlled publication set for which the encoding was harmonised. It cannot be used to estimate a corpus-wide verification rate. Likewise, the active-record count describes documentary state, not scientific quality or evidential weight. ER-100 does not replace paper-level review, primary-source checking, regulatory assessment or application-specific qualification.

12. Conclusions

Engineering Reviews ER-01 to ER-99 form a coherent qualification corpus when read through state variables and evidence boundaries rather than as isolated topic papers. The corpus contains 99 controlled identifiers and 99 active review records. ER-35 is an active separate publication, and ER-36 remains a distinct review with its own scope. The editorial centre of gravity lies in process physics, metrology and control, but photochemistry, network architecture, functional materials, biomedical and hazard questions, and indirect-manufacturing and lifecycle topics are all substantial.

The unifying engineering rule is that performance belongs to a defined material-process-workflow state. Optical exposure, conversion, dispersion, geometry, post-processing, conditioning, environment and test method jointly determine what can be claimed. Evidence must move through distinct levels from mechanism to material, process, component and intended-use qualification. Standards support this movement only when their controlled and uncontrolled variables are declared.

For future growth, the series should preserve explicit scope boundaries, exact record identities, non-collapsed provenance states and a visible maintenance register. Cross-paper coherence can then improve without rewriting history, and new reviews can add depth without duplicating ownership. ER-100 closes the initial numbered block as a controlled synthesis while leaving one narrow, declared maintenance item: the future ER-83 update reflecting the now-established ER-98 charge-transfer-complex evidence base.

Data and corpus availability

The public records analysed in this paper are available in the 3Dresyns Engineering & Technical Publications community on Zenodo: <https://zenodo.org/communities/3dresyns-engineering-publications/records>

The controlled ER-100 corpus map was reconstructed from the project publication map, master ledger and final record manifests. It should be deposited with the final ER-100 record as a machine-readable supplementary file after independent review.

Competing interests and author-position statement

Juan Segurola is the author of the Engineering Review series and is associated with 3Dresyns by Resyner Technologies S.L. The paper is therefore an internal corpus synthesis with declared author-position dependence. It does not constitute independent peer review of the series and makes no comparative commercial recommendation.

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Appendix A. Primary thematic coding map

The following map exposes the exact forced single-label assignment used for the descriptive counts in Table 2. It is an editorial navigation device, not a claim that the papers lack secondary domains.

Primary cluster	Controlled identifiers	State note
Process physics, metrology and control	ER-01, ER-02, ER-04, ER-05, ER-10, ER-27, ER-28, ER-29, ER-30, ER-31, ER-32, ER-33, ER-34, ER-36, ER-39, ER-40, ER-41, ER-42, ER-44, ER-46, ER-53, ER-54, ER-71, ER-72, ER-73, ER-75, ER-76, ER-78, ER-88, ER-89, ER-90, ER-96, ER-97	All 33 identifiers active.
Photochemistry and network architecture	ER-13, ER-18, ER-52, ER-58, ER-59, ER-60, ER-61, ER-62, ER-63, ER-64, ER-65, ER-68, ER-74, ER-77, ER-80, ER-81, ER-82, ER-83, ER-84, ER-95, ER-98, ER-99	All 22 identifiers active.
Functional materials and interfaces	ER-03, ER-07, ER-16, ER-19, ER-20, ER-21, ER-24, ER-26, ER-35, ER-43, ER-45, ER-47, ER-50, ER-55, ER-56, ER-57, ER-66, ER-67, ER-69, ER-70, ER-79, ER-87	All 22 identifiers active; ER-35 and ER-36 are separate records.
Biomedical, exposure and hazard	ER-06, ER-12, ER-14, ER-15, ER-22, ER-23, ER-48, ER-51, ER-86, ER-91, ER-92, ER-93, ER-94	All 13 identifiers active.
Indirect manufacturing and lifecycle	ER-08, ER-09, ER-11, ER-17, ER-25, ER-37, ER-38, ER-49, ER-85	All 9 identifiers active.

Table A1. Exact primary-cluster coding for all 99 identifiers. The union is ER-01 to ER-99 and each identifier appears once.

Version note

v0.8 records the current corpus state. ER-35 is an active separate publication, its version and concept DOIs are identified, and ER-36 remains a distinct review. The corpus contains 99 active records, including 22 active records in the functional-materials cluster. The scientific architecture, corpus map and all other assignments remain unchanged.

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