WoodIntel™

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REFERENCE DOCUMENT

WoodIntel™ Scientific Methodology

Version 1.0

Reference architecture for AI-driven, evidence-based wood specification.

Models • Data Sources • Evidence Framework • Confidence Scoring • Consensus Engine • Open API

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Independent open platform for evidence-based wood specification
Initiated and funded by SiOO:X Wood Protection. Editorial methodology, evidence assessment and published conclusions are governed independently as described in this document.

Contents

COMPONENT VERSIONS IN THIS RELEASE

ID	VERSION	COMPONENT
WI-SL	v1.2.0	Service-life screening method
WI-CAL	v1.1.0	Zone calibration layer
WI-VAL	v1.1.0	Validation benchmark set
WI-EV	v1.0.0	Evidence Engine
WI-GAP	v1.0.0	Research Agenda gap model
WI-INDEX	v1.0.0	Prediction index
WI-FC	v1.0.0	Climate forecast model
WI-TWIN	v1.0.0	Digital twin simulation
WI-API	v1.0.0	Open read API

0 Executive summary

WoodIntel is an independent open platform that predicts, grades and publishes what is known about the durability of wood in outdoor use. This document is the full method behind it. The summary below is written for readers who need to judge the platform's credibility without reading the seventeen sections that follow.

- What it does: screens modelled service life for above-ground timber in EN 335 use classes 2 and 3, scores species and treatment states, indexes the published literature and states where the evidence agrees, disagrees or is missing.
- How numbers are produced: deterministic, published equations with seeded Monte Carlo uncertainty. Language models never generate a published value — they classify study stance and phrase explanations of numbers computed elsewhere.
- What every prediction carries: a P10/P50/P90 interval, the climate zone and parameters used, the calibration applied, and the version identifiers of every component involved.
- How claims are graded: each study receives an evidence score from study design, sample size, replication and independence; claims inherit a consensus position that is recomputed when the corpus changes.
- Independence: initiated and funded by SiOO:X Wood Protection, with no funder influence on results and no model input, score or ranking that references any commercial product, including the funder's.
- Reproducibility: every model, parameter table and grading rule is published, and every figure on the platform can be recomputed from this document without access to the source code.

QUESTION A REVIEWER ASKS	WHERE IT IS ANSWERED
Is the funding disclosed and structurally contained?	Section 2, Governance, funding and independence
How is the system layered, and where do models sit?	Section 3, System architecture
Where does the underlying data come from?	Section 4, Data sources
What is the exact service-life equation?	Section 5 and the technical appendices
How is uncertainty propagated and reported?	Sections 5 and 6
How well does the model match field data?	Validation and calibration sections, and /validation

QUESTION A REVIEWER ASKS	WHERE IT IS ANSWERED
How is literature graded and consensus derived?	Evidence Engine sections, and /evidence
What are the known limitations?	Section 16, Limitations
How do I cite or reuse this?	Section 18, Citation and licence

> One caveat governs the whole platform: modelled service life is a screening estimate, not a measured lifetime. Detailing, ventilation, end-grain protection and maintenance routinely matter more than species choice.

1 Scope and purpose

WoodIntel is an independent open platform for evidence-based wood specification. It publishes three distinct kinds of statement, and this document exists so that a reader can tell them apart and check each one: values taken verbatim from standards and datasets, values computed by published WoodIntel models, and assessments of what the scientific literature currently supports.

This report documents every model, dataset, scoring rule and interface in the platform at the release stated on the title page. It is written to be citable. A reviewer who disagrees with a result should be able to locate the exact equation, parameter table or grading rule that produced it, and to recompute the number without access to the source code.

- In scope: above-ground timber in use classes 2 and 3 as defined by EN 335, exterior cladding, decking and facade detailing, and the published literature that describes their performance.
- Out of scope: structural load-bearing design, ground-contact use class 4 and marine use class 5, fire engineering beyond published classification values, and any assessment of a named commercial product.
- Not provided: warranties, performance guarantees, product recommendations, and any statement that a specific supplier's material is preferable to another's.

> Modelled service life is a screening estimate, not a measured lifetime. Every predicted value in the platform is labelled as modelled and carries an uncertainty interval. Detailing, end-grain protection, ventilation and maintenance routinely change real outcomes by more than species choice does.

2 Governance, funding and independence

WoodIntel was initiated and is funded by SiOO:X Wood Protection. The funder has no influence on results, model parameters, evidence grading or editorial content, and no ability to suppress a published finding. This is stated on every page of the platform rather than in a footnote, because a reader is entitled to weigh it.

Two structural safeguards support that claim. First, the platform is brand-neutral by construction: no model input, score or ranking references a commercial product or supplier, including the funder's. Species and treatment classes are modelled as generic material states defined by EN standards. Second, every model is published in full and every prediction is reproducible, so a third party can detect a favourable parameter choice by inspection rather than by trust.

WoodIntel is not a research institute, a certification body or an accredited laboratory, and does not describe itself as one. It is an open platform that indexes, models and publishes.

3 System architecture

The platform is a single application with four layers. The data layer holds standards-derived parameters, species properties and climate references. The model layer computes service life, uncertainty, scores, carbon and forecasts deterministically. The evidence layer indexes literature and assesses claims. The interface layer renders the web platform and serves the open read API.

```
DATA LAYER            MODEL LAYER               EVIDENCE LAYER
------------------    ---------------------     ----------------------
EN / ISO parameter    WI-SL service life  ->    Literature retrieval
tables                     |                         |
Species properties    Monte Carlo P10/50/90     Study grading (WI-EV)
Climate stations           |                         |
Validation set   ->   WI-CAL zone calibration   Stance classification
                           |                         |
                      Scores, carbon,           Claim consensus +
                      forecast, digital twin    contradiction register
                           |                         |
                           +-----------+------------+
                                       v
                            INTERFACE LAYER
                  Web platform | Calculation records | Open read API
                  every output carries: value + interval +
                  component IDs + versions + sources
```

Figure 1. Layered architecture. Data flows downward only; no interface action writes back into the data or model layers, and no language model sits on the path that produces a published number.

LAYER	CONTENTS	DETERMINISM
Data	EN/ISO parameter tables, species properties, climate station index, validation benchmarks	Static, versioned
Model	Service life, Monte Carlo uncertainty, calibration, scores, carbon, forecast, digital twin	Fully deterministic and seeded
Evidence	Literature retrieval, grading, stance classification, claim assessment	Deterministic scoring over a model-classified corpus
Interface	Web platform, downloadable calculation records, open read API	Stateless

The separation matters for auditability: language models never produce a number that the platform publishes as a value. They are used only for retrieval framing, stance classification of individual papers, and natural-language explanation of results computed elsewhere.

4 Data sources

Every quantitative value surfaced by the platform carries a provenance record: the value, the unit, a confidence class, a one-sentence description of how it was derived, and the source references it resolves to. The confidence classes are measured, published, derived and model estimate, in decreasing order of directness.

SOURCE	TYPE	USED FOR
EN 350:2016	Standard	Natural durability classes 1–5 used as the resistance baseline
EN 335:2013	Standard	Use-class definitions bounding the modelled exposure envelope
EN 460 guidance	Standard	Suitability of a durability class to a use class
ISO 15686-8	Standard	Factor-method structure for service-life estimation
EN 13501-1	Standard	Reaction-to-fire classification values
EN 1995-1-2 (Eurocode 5)	Standard	Charring rates used in the fire sub-score
EN 16449:2014	Standard	Biogenic carbon content and CO_2 conversion
EN 15804+A2 / ISO 21930	Standard	Whole-life carbon module structure (A1–A3, B, C, D)
ERA5 reanalysis via Open-Meteo	Dataset	Temperature, precipitation, humidity and wind used to build climate loads
Köppen–Geiger classification	Dataset	Climate-zone assignment and zone-level uncertainty
Lacy driving-rain index (BRE)	Paper	Wind-driven rain load term
Crossref, OpenAlex, Europe PMC, Semantic Scholar, DataCite	Registries	Literature retrieval, DOI resolution and citation counts
Field observation register	Platform dataset	User-submitted, moderated in-service condition reports

Standards texts are not redistributed. The platform reproduces only the classification values needed to compute a result, together with the reference by which a reader can obtain the standard. Climate values are reference values for a Köppen zone, not a site-specific weather file; site-specific work requires a local weather file and is out of scope.

5 Service-life model (WI-SL v1.2.0)

The service-life screening method is the platform's core physical model. It was first released on 2026-08-01 and follows the ISO 15686-8 factor structure: a reference service life derived from the EN 350 durability class, modified by climate load, orientation, macro-exposure and surface treatment, then corrected by an empirical per-zone calibration.

```
L = L_ref(durability class) × f_climate × f_orientation × f_exposure × f_treatment × c_zone
```

All factors are dimensionless. L is expressed in years and reported as a distribution, never as a single number.

- L_ref — reference service life in years, indexed by EN 350 durability class 1–5 for above-ground use.
- f_climate — composite of UV dose, wetting frequency, driving-rain index, freeze–thaw cycling and biological activity, computed from the zone climate reference.
- f_orientation — north, south, east/west or horizontal, applied separately to the UV and wetting terms because they move in opposite directions.

- f_exposure — sheltered 0.72, moderate 1.00, fully exposed 1.30.
- f_treatment — applied only for a maintained coating or a modification process, expressed as a generic material state and never as a named product.
- c_zone — empirical bias correction fitted per Köppen zone against the validation set.

Species resistance is expressed as a dimensionless 0–100 profile across six mechanisms — UV, moisture, salt, freeze–thaw, biological attack and dimensional movement. This profile is an ordinal scaling of the EN 350 class, extractive chemistry, cell-wall modification state and shrinkage anisotropy. It is not a measured quantity and is labelled as a model estimate everywhere it appears.

The model computes a load and a resistance per mechanism and reports the margin between them. A negative margin is surfaced as a detailing flag rather than being absorbed silently into the service-life number, because the correct response to a moisture-load exceedance is a detailing change, not a species change.

6 Uncertainty propagation

No prediction is published as a point estimate. Every input carries a distribution, and the model propagates them by Monte Carlo simulation with a seeded generator, so the same brief always returns the same interval and any third party can reproduce it.

- Outputs are reported as P10, P50 and P90 for both service life and maintenance interval.
- The seed is derived from the method version, the brief and the calibration value, making each run reproducible and each version change visible.
- Variance is decomposed per input group, so the interface can state which unknown dominates the uncertainty for that specific brief.
- A zone uncertainty multiplier widens the interval where the calibration is supported by fewer benchmark cases.

> Specification guidance in the platform is written against the P10, not the median. The interval is empirical model error measured against the validation benchmark, not a manufacturer expectation.

7 Calibration and validation (WI-VAL v1.1.0)

The uncalibrated factor model is systematically biased in some climate zones. The calibration layer corrects that bias with a per-zone multiplier fitted against a published benchmark set of field trials and in-service inspections. The benchmark set, the fitted multipliers and the residual error are all published.

Validation reports mean absolute error, bias and interval coverage — the share of benchmark cases whose observed service life falls inside the predicted P10–P90 band. Coverage is the metric that matters for specification: a model with a small mean error but poor coverage is understating its own uncertainty.

Benchmark cases are versioned. Adding, correcting or removing a case bumps the benchmark version and triggers a refit, and both events appear in the public release history.

8 Evidence model (WI-EV v1.0.0)

The Evidence Engine turns a set of graded publications about one claim into four auditable numbers: an Evidence Score from 0 to 100, a confidence band, a scientific consensus percentage, and a set of detected contradictions. Every one of those numbers is produced by a transparent rule, never by a model judgement, and can be recomputed by hand from the published study list.

Each study contributes a weight equal to its grade weight multiplied by 1.0 if peer-reviewed and 0.6 otherwise. Grade weights are A = 1.00, B = 0.75, C = 0.45, D = 0.20.

COMPONENT	MAX	RULE
Volume of evidence	30	Weighted directional evidence, saturating at a weighted mass of 20
Study quality	25	Mean evidence grade of the pool, scaled from 0–100 to 0–25
Agreement	20	Distance of the consensus share from an even 50/50 split
Peer review	10	Share of the pool published in peer-reviewed venues
Recency	10	Median publication age: ≤5 yr = 10, ≤10 yr = 7, ≤20 yr = 4, older = 1
Reproducibility	5	Share resolvable by DOI and either open access or independently indexed in two or more registries

Evidence Score components, maximum 100 points

```
Consensus % = weighted supporting evidence ÷ (weighted supporting + weighted contradicting) × 100
```

Neutral studies are excluded from the consensus ratio but still count towards quality, peer review, recency and reproducibility.

The engine also reports its own limiting factor — the component with the lowest share of its maximum — so a reader immediately knows whether a low score reflects thin literature, weak study designs, genuine disagreement or ageing sources.

9 Confidence model

Confidence is a deliberately coarse, three-level band derived jointly from the Evidence Score and the amount of directional evidence behind it. Both conditions must hold; a high score computed over three papers is not high confidence.

BAND	CONDITION	MEANING
High confidence	Score ≥ 75 and ≥ 8 directional studies	A substantial, peer-reviewed and largely agreeing body of work
Moderate confidence	Score ≥ 50 and ≥ 4 directional studies	Enough published work to reason from, with real gaps or disagreement
Low confidence	Everything else	Too few, too old or too conflicting sources to specify from

A separate provenance confidence class applies to individual data values rather than claims: measured, published, derived or model estimate. The two systems are never mixed in the interface, because a measured density and a high-confidence claim are different kinds of statement.

10 Consensus and contradiction engine

Consensus is reported as a weighted share, not a vote count, so a single high-grade randomised field trial is not outweighed by several low-grade opinion pieces. The platform never rounds disagreement away: where the literature is split, the split is the finding.

The contradiction engine pairs the strongest supporting studies against the strongest contradicting ones and explains the difference from metadata alone — publication era, venue type and evidence grade. It offers no speculative reconciliation, because a plausible-sounding explanation generated by a model would be indistinguishable from an established one.

The research timeline shows how the balance of evidence for a claim has moved over publication years, making it visible when a consensus is recent, ageing or reversing.

11 Quality score — study grading

Every indexed publication is graded A to D before it can influence any score. Grading is metadata-driven and deterministic: it uses venue type, peer-review status, registry coverage, DOI resolvability, open-access status, citation count and publication year. It does not attempt to judge the scientific merit of the argument.

GRADE	TYPICAL PROFILE	WEIGHT
A	Peer-reviewed, DOI-resolvable, well cited, indexed by multiple independent registries	1.00
B	Peer-reviewed and resolvable, but lightly cited or narrowly indexed	0.75
C	Grey literature, conference material or institutional reports with verifiable provenance	0.45
D	Weak provenance: unresolvable identifier, single registry, or no review process	0.20

The species-level WoodIntel Score is a separate instrument and must not be confused with study grading. It is the unweighted arithmetic mean of six sub-scores — durability, carbon, maintenance, fire, circularity and sourcing — each normalised to 0–100 with its formula published. The mean is deliberately unweighted, because any weighting encodes a project priority that belongs to the specifier, not to the platform.

12 AI models and their boundaries

Language models are used in four bounded roles. In none of them does a model output a published number, and in all of them the output is attributable to a source the reader can open.

ROLE	WHAT THE MODEL DOES	WHAT IT MAY NOT DO
Retrieval and question answering	Answers questions strictly from the indexed standards corpus and species data, with citations attached	Answer beyond retrieved context, or invent a reference
Stance classification	Labels each retrieved paper as supporting, contradicting or neutral for a claim, with a stated reason	Set a score, a consensus value or a confidence band
Structured debate	Argues both sides of a contested claim from graded evidence, then summarises where they genuinely differ	Declare a winner not supported by the evidence pool

ROLE	WHAT THE MODEL DOES	WHAT IT MAY NOT DO
Explanation and drafting	Restates a computed result in plain language, and drafts specification clauses from modelled values	Alter a modelled value or soften a stated uncertainty

Every model-mediated surface is retrieval-grounded, cites its sources inline, and is labelled as model-generated. A nightly automated sweep re-runs retrieval and stance classification for tracked claims; each resulting change is written to the public revision history with the reason it changed.

> Model outputs are assistive, not authoritative. Where a model-mediated statement and a published standard disagree, the standard governs.

13 Derived instruments

INSTRUMENT	IDENTIFIER	WHAT IT COMPUTES
Research Agenda	WI-GAP	Scores each tracked claim 0–100 on thin evidence, unresolved dissent, ageing studies and low evidence score, and states the open question that would close the gap
Prediction index	WI-INDEX	Precomputed P10/P50/P90 matrix across species, zones, orientations and treatment states
Climate forecast	WI-FC	Applies IPCC AR6 SSP climate deltas to the service-life model to project how decay load changes over the design horizon
Digital twin	WI-TWIN	Simulates hazard accumulation per facade of a building brief and reports risk curves over time
Carbon intelligence	WI-CARB	Whole-life biogenic and process carbon following the EN 15804+A2 module structure
Field register	WI-FIELD	Moderated register of user-submitted in-service observations, aggregated by species, zone and age

Each derived instrument declares the base method it depends on. When the base service-life method changes version, every dependent instrument is re-derived and the dependency is recorded in the release history.

14 Open API (v1.0.0)

Everything the platform displays about species, scores, climate zones, modelled predictions, evidence and research gaps is available as JSON. The API is free, unauthenticated, CORS-open, read-only, serves no personal data, and is licensed CC BY 4.0.

ENDPOINT	RETURNS
GET /api/public/v1/	Service index, licence and republication terms
GET /api/public/v1/species	Density, EN 350 class, EN 335 use classes, fire class, charring rate, biogenic carbon
GET /api/public/v1/scores	Six sub-scores and the unweighted composite, with the formula behind each
GET /api/public/v1/climate-zones	Station coordinates, Köppen class, distance to open water, index coverage
GET /api/public/v1/predictions	P10/P50/P90 service life and maintenance interval per species, zone, orientation and treatment

ENDPOINT	RETURNS
GET /api/public/v1/evidence	Tracked claims with score, consensus, confidence and version; a single claim returns studies, contradictions, timeline and revisions
GET /api/public/v1/research-agenda	Gap scores with per-factor breakdown and the open question per claim
GET /api/public/v1/carbon	Whole-life carbon values by module
GET /api/public/v1/forecast	Projected decay load and service life under SSP scenarios
GET /api/public/v1/field-observations	Approved field observations, JSON or CSV
GET /api/public/v1/graph	Knowledge-graph nodes and typed relations

Every response is wrapped in an envelope carrying the API version, licence, attribution string, generation timestamp and the caveats that must travel with the numbers. Republished service lives must be labelled as modelled estimates. Scores are comparative and are not recommendations.

15 Reproducibility and versioning

Every calculation performed in the platform can be exported as a machine-readable record containing the inputs, intermediates, equations, parameters, seed and method versions used. A third party can recompute the result from that record alone.

Each component carries an independent semantic version. A patch corrects an error without changing published values; a minor version adds capability or data without invalidating existing results; a major version changes model behaviour, at which point previously published numbers must be regarded as superseded rather than corrected.

All changes are published in the public release history, and evidence-level changes additionally appear in the evidence changelog and its RSS feed, revision by revision, with the reason each score moved.

16 Limitations

- Climate loads are zone reference values, not site weather files. Local microclimate, shelter and thermal mass are not represented.
- Detailing dominates outcomes. The model can flag a detailing risk but cannot evaluate a junction drawing.
- The validation benchmark is small relative to the parameter space, so calibration confidence is uneven between zones and this is reflected in the interval, not hidden.
- Literature coverage is limited to what the connected registries index, which under-represents non-English and pre-digital field-trial reporting.
- Stance classification is model-mediated. It is published per study with its reason so that it can be challenged, but it is not error-free.
- Field observations are self-reported and moderated, not instrumented measurements, and are aggregated rather than treated as validation data.

- The platform models generic material states. It cannot predict the performance of a specific commercial formulation, and does not attempt to.

17 Companion reference documents

This report is the anchor document of a numbered WoodIntel reference series. Each companion document has its own identifier, version and release history, and is cited independently. The series exists so that a reader can go from the whole system to one component without reading the whole report, and so that a component can be revised without reissuing the anchor.

ID	DOCUMENT	COVERS	STATUS
WI-METH-1.0	Scientific Methodology (this document)	Whole system: models, evidence, interfaces, governance	Published
WI-SL v1.2.0	Service-life method specification	Equations, parameters, Monte Carlo propagation	Published, section 5 and appendices
WI-CAL v1.1.0	Zone calibration record	Bias correction per climate zone and its evidence base	Published, appendices
WI-VAL v1.1.0	Validation benchmark set	Benchmark cases, sources and residuals	Published at /validation
WI-EV v1.0.0	Evidence Engine specification	Study grading, stance classification, consensus scoring	Published at /evidence
WI-EDIT-1.0	Editorial policy	Correction procedure, independence safeguards, review	Published at /editorial-policy
WI-API v1.0.0	Open API reference	Endpoints, response envelope, licence terms	Published at /developers

Every identifier resolves to a versioned page on woodintel.io. Superseded versions remain retrievable in the release history rather than being overwritten.

> Where a companion document and this report disagree, the companion document governs for its own component, and the discrepancy is recorded as a correction in the release history of both.

18 Citation and licence

Cite this document as: WoodIntel. (2026). WoodIntel™ Scientific Methodology: Reference architecture for AI-driven, evidence-based wood specification. woodintel.io/methodology

Corrections are welcome and are handled in public: a substantiated error becomes a versioned change in the release history, with the previous value preserved rather than overwritten.

A Equations in execution order

Every equation the engine evaluates, in the order it runs. Each is stated with its terms and the standard or dataset it rests on. Together with Appendix B and C, this is sufficient to reproduce any published prediction by hand.

E1 · UV load L_uv = clamp(UV_climate · f_orientation.uv · f_exposure, 0, 100)

UV_climate = normalised annual global horizontal irradiance for the Köppen zone; f_orientation.uv and f_exposure from the parameter tables. Basis: Orientation weighting after EN 927-1 exposure severity; climate term from ERA5 reanalysis.

E2 · Moisture load L_m = clamp(((rain + RH) / 2) · f_orientation.wet · f_exposure, 0, 100)

rain = driving-rain index; RH = mean relative humidity, both normalised 0–100. Basis: Driving-rain exposure per EN ISO 15927-3; wetting/drying logic per EN 335 use class 3.

E3 · Chloride and freeze-thaw load L_salt = clamp(salt · f_exposure, 0, 100); L_ft = clamp(FT · f_exposure, 0, 100)

salt = coastal chloride deposition index; FT = annual count of 0 °C crossings, normalised. Basis: ERA5 2 m temperature series; distance-to-coast chloride gradient.

E4 · Biological load L_bio = clamp(((RH + rain) / 2) · f_orientation.wet · k_north, 0, 100), k_north = 1.15 for north, else 1.0

North correction accounts for reduced drying and algal colonisation. Basis: Decay-hazard logic after EN 335 and Scheffer-type climate indices.

E5 · Weighted performance P = 100 − Σ_i (L_i / ΣL) · max(0, L_i − R_i) · 1.35

R_i = species resistance for stressor i, including the treatment credit; each stressor penalises in proportion to its share of the total load. Basis: WoodIntel formulation. Ordinal, not a physical damage model.

E6 · Service life L_service = clamp(L_ref(DC) · (0.55 + P/160) · t, 5, 80) years, t = 1.22 if treated else 1.0

L_ref(DC) = reference life for the EN 350 durability class. Basis: Factor-method structure after ISO 15686-8, with a single aggregated performance factor.

E7 · Maintenance interval M = max(2, round(M_base · (0.55 + P/150) · s)), s = 0.8 for south, else 1.0

M_base = 11 years treated, 7 years untreated. Basis: Recoat intervals after EN 927-1 thin-film system classes.

E8 · Silvering S = clamp(46 − 0.33 · L_uv, 8, 60) months

Time to visually uniform grey on an untreated or clear-finished surface. Basis: Photodegradation rate as a function of cumulative UV dose.

$$C = \mathrm{clamp}(96 - \min(40,\ 0.8 \cdot \max_i(L_i - R_i)) - p_{exposure} - p_{treatment} - p_{profile},\ 25,\ 96)$$

E9 · Confidence C = clamp(96 − min(40, 0.8 · max_i(L_i − R_i)) − p_exposure − p_treatment − p_profile, 25, 96)

p_exposure = 3 / 6 / 10; p_treatment = 8 when a system is assumed but not declared; p_profile = 12 when the species has no tabulated resistance profile. Basis: WoodIntel uncertainty heuristic. Not a statistical confidence interval.

E10 · Heuristic service-life range [L_service − k·L_service, L_service + k·L_service], k = 0.15 / 0.25 / 0.40 by confidence band

Band: High ≥ 80, Moderate ≥ 62, otherwise Indicative. Retained for backwards comparison only. Basis: Deterministic spread. Superseded by the Monte Carlo percentiles in E11–E13.

E11 · Input sampling X_j^(n) = X̂_j · (1 + z·σ_j^rel·m_zone) for relative terms; X_j^(n) = X̂_j + z·σ_j^abs for absolute terms, z ~ N(0,1) truncated at ±3

X̂_j = nominal parameter value; σ_j from the declared uncertainty table; m_zone = Köppen main-class reliability multiplier (climate terms only). Draws use a mulberry32 PRNG seeded from a hash of the brief, so a run is exactly reproducible. Basis: Standard Monte Carlo propagation, GUM Supplement 1 (JCGM 101) structure.

E12 · Output percentiles P10, P50, P90 = empirical quantiles of {y^(n)} over N = 1200 draws, y ∈ {P, L_service, M, S}

Every draw re-evaluates E1–E8 in full; percentiles are the sorted empirical quantiles, not a normal fit. Basis: Non-parametric quantiles; no distributional assumption on the output.

E13 · Per-parameter uncertainty share s_g = Var_g(L_service) / Σ_g Var_g(L_service), Var_g from a one-at-a-time run of 400 draws per group g

Group g varies alone with every other input held at its nominal value. Shares are first-order contributions and do not capture interaction terms. Basis: One-at-a-time variance decomposition. An approximation of a Sobol first-order index.

E14 · Empirical calibration L_final = L_model · k_zone, k_zone = exp((n/(n+m))·mean(ln(obs/pred))_zone + (m/(n+m))·ln k_global)

obs = observed service life in the WI-VAL benchmark; pred = uncalibrated model P50; n = benchmark cases in the Köppen main class; m = 2 shrinkage pseudo-observations. Basis: Fitted against WI-VAL v1.0.0. Applied to service life only, as a published layer on top of E1–E8, so the physics and the correction can be audited separately.

E15 · Residual σ inflation σ_residual,calibrated = σ_residual · 4.5

σ_residual is the declared model residual on service life (12 %). Basis: Chosen so that leave-one-out P10–P90 coverage on the benchmark reaches the 80 % target. Declared input uncertainty alone understated real scatter roughly fourfold.

B Species resistance profiles

Dimensionless 0–100 resistance per degradation mechanism. These are expert-assigned ordinal scores derived from the EN 350 durability class, extractive chemistry, cell-wall modification state and shrinkage anisotropy. They are model estimates, not laboratory measurements.

SPECIES	UV	MOISTURE	SALT	FREEZE-THAW	BIOLOGICAL	MOVEMENT
Norway spruce	34	38	32	52	34	55
Siberian larch	62	72	70	76	68	58
Western red cedar	54	74	62	66	78	92
Thermally modified ash	58	88	78	70	90	84
European oak	60	76	66	72	80	56
Accoya	66	96	88	88	96	94
Douglas fir	48	58	52	62	52	58
Scots pine	40	48	44	58	44	56
Thermally modified pine	54	84	74	64	84	82
Sweet chestnut	58	74	64	70	80	72
Robinia	64	82	76	78	92	60
Iroko	68	84	82	74	90	78

C Modifier tables and scalar constants

ORIENTATION	UV FACTOR	WETTING FACTOR	RATIONALE
North	0.45	1.25	North — low UV, slow drying, algae risk
South	1.35	0.80	South — peak UV and thermal cycling
East west	1.00	1.00	East / west — balanced load
Horizontal	1.25	1.55	Horizontal — standing water and end-grain uptake

Orientation modifiers, applied separately to the UV and wetting terms.

EXPOSURE	MULTIPLIER
Sheltered	0.72
Moderate	1.00
Fully exposed	1.30

Macro-exposure multiplier, applied to every climate load term.

DURABILITY CLASS	REFERENCE SERVICE LIFE (YEARS)
1	60
2	45
3	30
4	18
5	10

Reference service life by EN 350 natural durability class, above ground.

CONSTANT	VALUE
Treatment credit (resistance units)	14
Gap penalty gradient	1.35
Service-life intercept	0.55
Service-life divisor	160
Service-life treatment factor	1.22
Service-life bounds (years)	5–80
Maintenance base, treated (years)	11
Maintenance base, untreated (years)	7
Maintenance south factor	0.8
Silvering intercept (months)	46
Silvering UV slope	0.33

Named scalar constants used by the equations in Appendix A.

D Declared input uncertainty and sampling

Every uncertain input carries a declared 1σ. These are modelling assumptions, stated openly so they can be challenged and replaced by measured field variance as the evidence base grows.

INPUT	1Σ	TYPE
UV irradiance	8 %	Relative
Driving rain	14 %	Relative
Relative humidity	7 %	Relative
Chloride load	22 %	Relative
Freeze–thaw count	12 %	Relative
Orientation modifier	8 %	Relative
Exposure modifier	10 %	Relative
Tabulated resistance score	8 units	Absolute
Default resistance score	16 units	Absolute
Assumed treatment credit	5 units	Absolute
Reference service life	18 %	Relative
Service-life model residual	12 %	Relative
Maintenance model residual	14 %	Relative

ZONE	MULTIPLIER	BASIS
A — Tropical (A)	×1.45	Sparse station density, strong convective rainfall variance

ZONE	MULTIPLIER	BASIS
B — Arid (B)	×1.3	High interannual precipitation variance, low absolute wetting
C — Temperate (C)	×1	Densest observation network; reference case for the model
D — Continental (D)	×1.1	Well observed, but strong freeze-thaw count sensitivity
E — Polar / alpine (E)	×1.6	Very sparse observations and steep topographic gradients

Köppen main-class reliability multiplier applied to every climate 1σ.

SETTING	VALUE
Iterations	1200
Sensitivity iterations per group	400
Reported percentiles	10 / 50 / 90
Distribution	Gaussian, truncated at ±3σ
Seeding	mulberry32 PRNG seeded from an FNV-1a hash of the input brief

Monte Carlo sampling configuration.

GROUP	COVERS
Climate drivers (ERA5)	UV, driving rain, humidity, chloride, freeze-thaw
Climate-zone reliability	Köppen main-class observation density multiplier
Orientation & exposure	Facade geometry and macro-shelter modifiers
Species resistance profile	Ordinal EN 350-derived resistance scores
Surface-treatment credit	Assumed, non-declared protective system
Reference service life	EN 350 durability-class reference life
Model residual	Unexplained scatter in the factor-method form

Parameter groups reported in the variance breakdown.

E Calibration factors (WI-CAL v1.1.0)

PROPERTY	VALUE
Fitted against	WI-VAL v1.1.0 (24 cases)
Fitted on	2026-08-01
Estimator	log-space mean residual, shrunk to the global factor
Shrinkage prior	2
Applies to	Service life only. Maintenance interval, silvering and performance score are uncalibrated.
Global factor	0.547
Residual inflation	×4.5

KÖPPEN MAIN CLASS	FACTOR
A	0.3268
B	0.441
C	0.7014
D	0.6906
E	0.547

Per-zone multiplicative service-life correction.

> Chosen so that leave-one-out P10–P90 coverage on WI-VAL v1.0.0 reaches 83 % against an 80 % target. The factor is large: it shows the declared input σ alone understated real scatter by roughly 4×, and the extra spread is honest model error, not measurement noise.

F Validation benchmark set (WI-VAL v1.1.0)

The 24 benchmark observations the model is measured and calibrated against. Each is a published field trial, in-service survey, standardised test or service-life database entry.

ID	SPECIES	SITE	EXPOSURE	OBSERVED (YR)	KIND	SOURCE
val-01	Norway spruce	Uppsala / central Sweden, above-ground field station	South, sheltered	12 (9–16)	field trial	RISE / Nordic Wood Preservation Council field test summaries for untreated Picea abies, above-ground exposure
val-02	Siberian larch	Stockholm archipelago, unpainted larch façade	South, fully exposed	42 (35–55)	in service survey	Documented Swedish/Finnish façade inspection surveys of unpainted Siberian larch cladding
val-03	Western red cedar	Vancouver region, coastal Pacific North-West	North, sheltered	45 (30–60)	in service survey	FPInnovations / regional building-envelope surveys of Thuja plicata cladding
val-04	Thermally modified ash	North-west European maritime coast, thermally modified hardwood cladding	East west, fully exposed	27 (20–35)	field trial	Above-ground field trials of thermally modified hardwoods (Thermowood class D), maritime temperate exposure
val-05	European oak	Scottish east coast, untreated oak boarding	South, fully exposed	35 (25–50)	in service survey	TRADA / BRE durability guidance and inspection records for Quercus robur external boarding
val-06	Accoya	Netherlands / UK coastal, acetylated radiata pine	East west, fully exposed	50 (40–60)	standardised test	Field and laboratory durability assessments of acetylated Pinus radiata, above-ground use class 3

ID	SPECIES	SITE	EXPOSURE	OBSERVED (YR)	KIND	SOURCE
val-07	Norway spruce	UK maritime, painted spruce cladding with maintained coating	North, sheltered, coated	30 (20–40)	service life database	ISO 15686-8 factor-method reference service lives for coated softwood external cladding
val-08	Siberian larch	Equatorial South-East Asia, temperate softwood in tropical exposure	South, fully exposed	7 (4–11)	field trial	Tropical field trials showing 5–10× decay-rate acceleration versus temperate stations for the same species
val-09	European oak	Arabian interior, shaded hardwood screening	South, fully exposed	18 (12–25)	in service survey	Gulf-region building-envelope inspections of exterior hardwood screens and shading elements
val-10	Accoya	Gulf coastal, acetylated pine louvres	East west, fully exposed	30 (22–40)	in service survey	Documented inspections of acetylated softwood louvres and decking in chloride-laden coastal exposure
val-11	Western red cedar	Southern Scandinavia, imported cedar cladding	South, sheltered	33 (25–45)	in service survey	Scandinavian façade inspections of imported western red cedar, ventilated rainscreen build-ups
val-12	Thermally modified ash	Coastal Oregon, modified hardwood rainscreen	East west, fully exposed	24 (18–32)	field trial	Above-ground stake and cladding trials of thermally modified hardwoods, wet-temperate exposure
val-13	Norway spruce	Equatorial South-East Asia, untreated temperate softwood	North, sheltered	4 (2–6)	field trial	Above-ground tropical field trials of non-durable softwood, EN 252 / use class 3 equivalents
val-14	Accoya	Singapore, acetylated pine louvres and screens	East west, fully exposed	22 (15–30)	in service survey	Documented South-East Asian inspections of acetylated Pinus radiata external elements
val-15	Thermally modified ash	Tropical rainscreen, thermally modified hardwood	South, fully exposed	11 (7–16)	field trial	Comparative above-ground trials of thermally modified hardwoods, humid tropical stations
val-16	Western red cedar	Arabian interior, cedar soffits under deep shading	North, sheltered	26 (18–35)	in service survey	Gulf-region envelope inspections of shaded softwood soffits and ceilings
val-17	Thermally modified ash	Gulf coastal, modified hardwood screens	South, fully exposed	15 (10–22)	in service survey	Inspection records of thermally modified hardwood screens in chloride and dust-laden exposure

ID	SPECIES	SITE	EXPOSURE	OBSERVED (YR)	KIND	SOURCE
val-18	Siberian larch	Gulf coastal, untreated larch decking and screens	East west, fully exposed	12 (8–18)	in service survey	Gulf-region inspections of imported Larix sibirica external elements
val-19	European oak	Central Sweden, untreated oak boarding and structure	East west, fully exposed	55 (40–80)	in service survey	Swedish inspection records of untreated oak boarding and exposed oak structure
val-20	Norway spruce	Coastal Oregon / Washington, painted spruce cladding	North, sheltered, coated	25 (18–35)	service life database	ISO 15686-8 factor-method reference service lives, coated softwood cladding, high driving-rain regions
val-21	Siberian larch	Scottish west coast, unpainted larch rainscreen	North, fully exposed	30 (22–40)	in service survey	TRADA / UK envelope inspection records for Larix cladding in high driving-rain exposure
val-22	Western red cedar	UK maritime, imported cedar cladding with translucent coating	South, fully exposed, coated	28 (20–38)	in service survey	UK inspection records of translucent-coated western red cedar rainscreens
val-23	Accoya	Nordic continental, acetylated pine windows and cladding	South, fully exposed	45 (35–60)	service life database	Component service-life records for acetylated Pinus radiata joinery and cladding, continental climate
val-24	Thermally modified ash	Central Sweden, thermally modified hardwood cladding	North, sheltered	30 (22–40)	field trial	Scandinavian above-ground field trials of Thermowood class D hardwood cladding

G Climate reference stations

Reference locations used to build zone climate loads. Coordinates are the reanalysis grid anchor; the distance to open salt water drives the chloride term.

STATION	COUNTRY	LATITUDE	LONGITUDE	KÖPPEN	COAST (KM)
Coastal Scotland	United Kingdom	58.209	-6.389	Cfb — temperate oceanic	1
Stockholm	Sweden	59.329	18.069	Dfb — humid continental	3
Riyadh	Saudi Arabia	24.713	46.675	BWh — hot desert	380
Singapore	Singapore	1.352	103.820	Af — tropical rainforest	2
Pacific North-West	United States	47.606	-122.332	Csb — warm-summer mediterranean	2
Dubai	United Arab Emirates	25.204	55.270	BWh — hot desert, coastal	2
Bergen	Norway	60.393	5.325	Cfb — temperate oceanic	1

STATION	COUNTRY	LATITUDE	LONGITUDE	KÖPPEN	COAST (KM)
Copenhagen	Denmark	55.676	12.568	Cfb — temperate oceanic	2
Munich	Germany	48.135	11.582	Cfb — temperate oceanic	480
Tokyo	Japan	35.676	139.650	Cfa — humid subtropical	6
Sydney	Australia	-33.868	151.209	Cfa — humid subtropical	1
Vancouver	Canada	49.283	-123.121	Cfb — temperate oceanic	2

H WoodIntel Score — sub-scores and results

SUB-SCORE	QUESTION ANSWERED
Durability	How long does it last, averaged over the modelled climate zones?
Carbon	How much biogenic carbon does one cubic metre store?
Maintenance	How long between maintenance interventions?
Fire performance	How slowly does the section char under the standard fire curve?
Circularity	How recoverable is the material at end of life?
Sourcing & biodiversity	What is the sourcing and biodiversity risk of the supply chain?

The six sub-scores and the question each answers.

SPECIES	COMPOSITE	DURABILITY	CARBON	MAINTENANCE	FIRE PERFORMANCE	CIRCULARITY	SOURCING & BIODIVERSITY
Robinia (Black Locust)	89	77	100	78	88	90	100
Thermally Modified Ash	87	75	100	77	88	82	100
European Oak	85	57	100	75	88	90	100
Sweet Chestnut	83	56	90	75	88	90	100
Iroko (FSC certified)	80	78	100	78	88	90	45
Siberian Larch	75	38	95	75	50	90	100
Thermally Modified Pine	74	56	77	76	50	82	100

SPECIES	COMPOSITE	DURABILITY	CARBON	MAINTENANCE	FIRE PERFORMANCE	CIRCULARITY	SOURCING & BIODIVERSITY
Acetylated Radiata Pine	72	78	82	80	50	74	70
Douglas Fir	72	34	86	69	50	90	100
Western Red Cedar	68	54	60	75	50	90	80
Scots Pine (heartwood)	67	32	81	66	50	75	100
Norway Spruce	63	18	73	61	50	75	100

Composite and sub-scores per species at this release. The composite is the unweighted arithmetic mean.

I Evidence grades

GRADE	DEFINITION
A	Strong — peer-reviewed, well cited, independently indexed and current.
B	Good — peer-reviewed and corroborated, but thinner citation or older.
C	Indicative — usable as context, verify before specifying from it.
D	Weak — sparse metadata or uncorroborated. Treat as a lead, not evidence.

J Source registry

PUBLISHER	TITLE	YEAR	TYPE
CEN — European Committee for Standardization	EN 350:2016 — Durability of wood and wood-based products. Testing and classification of the durability to biological agents	2016	standard
CEN — European Committee for Standardization	EN 335:2013 — Durability of wood and wood-based products. Use classes: definitions, application to solid wood and wood-based products	2013	standard
CEN — European Committee for Standardization	EN 13501-1 — Fire classification of construction products and building elements	2018	standard
CEN — European Committee for Standardization	EN 1995-1-2 (Eurocode 5) — Design of timber structures. Structural fire design	2004	standard
ISO	ISO 21930:2017 — Core rules for environmental product declarations of construction products and services	2017	standard

PUBLISHER	TITLE	YEAR	TYPE
CEN — European Committee for Standardization	EN 15804:2012+A2:2019 — Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products	2019	standard
CEN — European Committee for Standardization	EN 16449:2014 — Wood and wood-based products. Calculation of the biogenic carbon content of wood and conversion to carbon dioxide	2014	standard
ECMWF / Copernicus Climate Change Service	ERA5 global reanalysis, served through the Open-Meteo Historical Weather API	2025	dataset
Crossref	Crossref REST API — registered scholarly metadata and DOIs	2026	dataset
OurResearch	OpenAlex — open catalogue of scholarly works	2026	dataset
Building Research Establishment (BRE)	Lacy, R. E. — Driving-rain index, HMSO / BRE	1976	paper
WoodIntel	WoodIntel exposure–resistance model (uncalibrated)	2026	model

REFERENCE	TITLE	USED FOR
EN 350:2016	Durability of wood and wood-based products — Testing and classification of durability to biological agents	Durability class → reference service life (E6)
EN 335:2013	Durability of wood and wood-based products — Use classes	Use class assignment and biological load (E4)
EN 927-1:2013	Paints and varnishes — Coating materials for exterior wood — Classification and selection	Exposure severity and maintenance interval (E1, E7)
EN ISO 15927-3	Hygrothermal performance of buildings — Driving rain index	Moisture load (E2)
ISO 15686-8	Buildings and constructed assets — Service life planning: reference service life and service-life estimation	Factor-method structure (E6)
ERA5	Copernicus Climate Change Service, ERA5 hourly reanalysis on single levels	Temperature, humidity, precipitation and irradiance inputs (E1–E4)
Köppen-Geiger	Beck et al. (2018), Present and future Köppen-Geiger climate classification maps	Climate zone assignment

Standards and datasets referenced by the service-life method, with the equations they support.

K Stated limits of the service-life method

- Service life is empirically calibrated (E14) against a 24-case benchmark. The correction removes the average bias; it does not make the model a validated damage model, and the zone factors for tropical, arid and polar climates rest on two cases or fewer.
- The calibration is fitted on the same benchmark used to report accuracy. Leave-one-out metrics are published on /validation and are the correct figures to judge the model by.
- Resistance profiles are expert-assigned ordinal scores, not laboratory measurements. Only the EN 350 durability class behind them is a standardised value.

- The confidence band (E9) is a rule-based heuristic, not a statistical interval. The P10/P50/P90 figures come from Monte Carlo propagation (E11–E13) of declared input uncertainty — they are as good as those declared σ values, which are modelling assumptions until replaced by measured field variance.
- Input uncertainties are treated as independent. Real correlation between rain, humidity and biological load will make the true spread wider than modelled at the tails.
- Detailing quality — ventilated cavity, end-grain sealing, fall, ground clearance — dominates real outcomes and is only partially represented.
- Treatment performance assumes a correctly applied system maintained to its stated interval. Product-specific data is not used.
- Climate inputs are zone-level, not site-level. Local topography, shading and coastal microclimate are not resolved.
